LIFESTYLE DISEASES IN PACIFIC COMMUNITIES

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by
Terry Coyne

edited by
Robert Hughes and Sarah Langi

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Author

1. Terry Coyne, NCD Project Officer, Secretariat of the Pacific Community, BP D5, 98848 Noumea Cedex, New Caledonia

Editors

1. Robert Hughes, Nutritionist/NCD Epidemiologist, Secretariat of the Pacific Community, BP D5, 98848 Noumea Cedex, New Caledonia

2. Sarah Langi, English Editor, Secretariat of the Pacific Community, BP D5, 98848 Noumea Cedex, New Caledonia

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TABLE OF CONTENTS

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Preface

This publication, *Lifestyle diseases in Pacific communities,* is an up-date of the 1984 SPC publication, *The effect of urbanisation and western diet on the health of Pacific island populations.* The first report was produced in response to a number of medical surveys undertaken during the 1960s and 1970s that revealed an alarming prevalence of diabetes mellitus and other metabolic disorders in Pacific Island communities. It came to fruition through recommendations made at the Seventh South Pacific Commission Conference on Health Services held in Port Vila, Vanuatu in 1976 and a joint SPC/WHO Meeting on Metabolic Disorders held in Nauru in 1978 (1). Work commenced on the document in 1981 with the following objective:

> "*To bring about improved food utilisation practices and better nutrition by helping communities to be aware of the changes taking place and their consequences and then provide them with the knowledge needed to seek solutions for themselves.*"

The report was circulated among SPC member countries and territories and served as a working document for a regional meeting on the effects of urbanisation and western diets on the health of Pacific Island populations held in Suva, Fiji, 7–16 December 1981 (2).

The purpose was to assist Pacific Island governments to formulate food and nutrition policies to improve the wellbeing of Pacific Island people.

Nearly 20 years on and at the dawn of a new millennium, this second report is the culmination of more than one year's work by the same author of the first report, Dr Terry Coyne.

The focus has shifted slightly and now is concentrated more on non-communicable disease (NCD). However, the aim remains remarkably similar:

> *To continually assess the contribution NCD makes to ill-health and early death of Pacific Island people and to enable Pacific Island countries and territories to develop and implement country strategies on NCD prevention and control.*

What this report does reveal is that health outcomes in terms of non-communicable diseases are far worse now than ever before. In many places throughout the region non-communicable disease rates are much higher than in the early 1980s. This does not mean to say that the NCD prevention efforts of health workers in the region have not been successful. The rate of increase could be far higher without their dedication and persistence. Stemming the tide of the current NCD epidemic will require total commitment from country and community leaders along with the public will to change. Health workers can then facilitate the process.

Robert Hughes, November 1999

CHAPTER 1: Introduction

The countries and territories of the Pacific Islands are greatly diverse in terms of geographic and population size, climate and ethnic composition as well as in social, economic and cultural aspects. Today, however, all Pacific Island countries and territories (PICTs) share a common concern about emerging non-communicable diseases, namely cardiovascular disease, diabetes and cancer.

Rapid economic growth is accompanied by a transition to a more western lifestyle. In parallel are rapid changes in the health profile, with the increasing burden of non-communicable diseases (NCD).

> *This burden is experienced in terms of premature mortality, morbidity and disability and poses major, but unquantifiable, social, personal and economic costs on all societies in the region. No country……can afford the existing and the projected increased burden of CVD [cardiovascular disease] and diabetes.* (3)

Summary

- Pacific Island adults living according to their traditions were generally robust, physically fit, active and relatively free of nutritional deficiencies or disorders. Their very isolation and remoteness served to protect them from the diseases of the rest of the world.
- Early western contact brought epidemics of infectious diseases that rank among the worst in the world in terms of proportions of attributable deaths.
- The prevalence of chronic degenerative diseases such as diabetes, hypertension, ischaemic heart disease and cancer was low among peoples living a traditional life style.
- Today in several Pacific Island groups, prevalence rates of diabetes are some of the highest in the world – 30% – which is nine to ten times higher than rates in affluent western countries such as the USA and Australia.
- Rates of hypertension in at least seven PICTs exceed rates in western countries.
- Heart disease or circulatory diseases are the leading causes of mortality in the majority of PICTs.
- The incidence rates of cancer are lower than in industrialised countries, but are increasing rapidly, particularly of cancers of the cervix, breast, lung and prostate.
- Obesity rates are among the highest in the world with 75% of adults in seven PICTs classified as either overweight or obese.
- The major risk factors associated with these non-communicable or lifestyle diseases are preventable and include obesity, poor diet, lack of physical exercise and tobacco use.
- All of these risk factors have been increasing in the majority of PICTs, more so in the more economically advanced countries and more so in urbanised communities.
- A changing dietary pattern has been identified as a major influence on the development of obesity, and these lifestyle diseases. The modern diet has changed from one of predominantly root vegetables, coconut, fresh fish and green leaves, to one consisting of rice, bread, tinned fish and meat, sugar and salt.
- The dietary components which may be predominant factors in the development of heart disease, diabetes, hypertension, cancer and obesity include increased consumption of energy, salt, animal fat, sugar and alcohol, and decreased intake of fibre, antioxidants and perhaps some trace minerals.
- The rapid social change (increased population growth, urbanisation and economic development) experienced by PICTs is irreversible. It has resulted in lifestyles of least effort. The challenge is to provide opportunities for Pacific populations to make environmental and behavioural changes that result in lifestyles that are in balance with island ecology.
- Many Pacific Island countries and territories are taking steps to deal with the effects of urbanisation and western foods on the health of their people. These efforts include increasing emphasis on rural development, food production and the establishment of national food and nutrition plans and policies.

This document reviews existing information related to the major lifestyle diseases affecting Pacific Islanders at this time. Over 800 reports and documents were obtained from PICTs, and agencies and organisations involved in health, agriculture, or statistical aspects; extensive searches were made at the SPC library and through the medical literature. The documents reviewed and summarised here include morbidity and mortality statistics; cross-sectional field surveys; health and medical studies; and food availability and consumption reports.

This document also reviews the non-communicable diseases – cardiovascular disease, diabetes, and cancer – and the major risk factors associated with them. The discussion of lifestyle diseases in this report is by no means exhaustive – it does not include other non-communicable disease such as gout or arthritis, nor does it address injuries, accidents, suicide or mental illness. These conditions will be covered in subsequent editions.

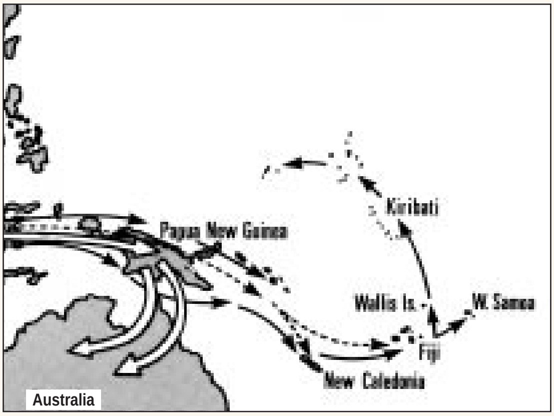
The review of these diseases is presented in the following sections which cover cardiovascular disease (including hypertension and coronary heart disease), diabetes, and cancer. Separate sections are devoted to obesity, and changes in dietary patterns, as major risk factors for these diseases. The topics have not necessarily been presented in order of priority or gravity of the effect of disease on the health of Pacific Island people.

Historical Background

Original Settlers

Much knowledge concerning the earliest settlers of the Pacific has been gained from linguistic, anthropological, serological and genetic studies. Understanding the history and migration patterns of the original settlers of the Pacific will be important in understanding differences among populations in disease patterns, especially those that may have a genetic basis (4,5).

Thousands of years before the islands of the Pacific were known to Europeans, they were settled by diverse peoples who have maintained their cultural differences until the present day. The first settlers, who arrived some 50,000 years ago, are believed to have been hunters and gatherers from Indonesia and Southeast Asia (speakers of Australoid languages) who moved across the single land mass of what is now Papua New Guinea and Australia (Figure 1.1). This was during the Pleistocene period when the lower sea level permitted a migration route through Indonesia and Papua New Guinea and perhaps as far as the Solomon Islands.



Source: (4)

Figure 1.1: Ancestral migrations in the study area of the southwest Pacific.
Open arrow: Australoid migrations ca. 50,000 years ago;
Dashed arrow: Papuan migrations ca. 10,000–15,000 years ago;
Solid arrow: Austronesian migrations ca. 3,000–5,000 years ago.

About 10,000 to 15,000 years ago, Papuan-speaking migrants came in several waves from Southeast Asia and settled Papua New Guinea, through the Solomon Islands, New Caledonia, Vanuatu and Fiji. These Papuan-speaking peoples have been referred to as Non-Austronesians (NAN).

Approximately 3,000 to 5,000 years ago, the next group of settlers to arrive were Austronesians (AN). They also came from Southeast Asia, but settled in the coastal regions of the Melanesian Islands and did not reach the highland areas. For this reason, the Papua New Guinea highlanders remain a population relatively free of Austronesian admixture in the Pacific (4). Genetic studies indicate that Melanesians of New Caledonia are approximately 20% and Fijians are approximately 50% AN descent (5).

These early explorers and settlers brought with them domestic pigs, dogs and chickens, as well as cultivated crops such as rice, taro, yam and sugar cane. Archaeologists have found evidence of elaborate ditches constructed to drain highland swamps in Papua New Guinea. These are thought to have been in use 6,000 to 9,000 years ago for the purpose of taro cultivation (6).

Micronesia may have been settled by Austronesian peoples moving from the Philippines about 4,000 years ago. Another group of people, the Lapita, thought to have come from eastern Indonesia or the Philippines, colonised Tonga and Samoa approximately 2,000 to 3,000 years ago. The Lapita people were skilled mariners, practised horticulture, caught fish, produced pottery, and were highly successful colonisers of virgin islands. By 300 to 400 AD, these early Polynesians had discovered and settled the rest of Polynesia including Marquesas Islands, Easter Island, Hawaii and New Zealand. The present-day populations of Polynesia and Micronesia are entirely of AN descent (7).

Thus for hundreds of years before Europeans ventured into the Pacific, the islands were inhabited by peoples who were physically and culturally quite different, and who had developed complex social, religious, economic and navigational systems. The different races of people and the areas they settled in the Pacific are generally divided into three groups: Melanesian, Micronesian, and Polynesian.

Captain James Cook, on three voyages between 1768 and 1780, visited Tahiti, Tonga, the Cook Islands, Vanuatu and New Caledonia. Cook vividly described the physical appearance, health, food habits and cooking methods of the inhabitants of the islands he visited (8). Several of Cook's descriptions are summarised below.

Tahiti

Description of King George's Island:

> *With respect to their persons, the men in general are tall, strong limb'd and well shaped, one of the tallest we saw measured six feet three inches and a half, the superior women are in every respect as large as Europeans but the inferior sort are in general small owing possibly to their early amours which they are more addicted to then their superiors.*
>
> *They have all fine white teeth.*
>
> *Not only fish but almost everything that comes out of the sea is eat and esteem'd by these people, ...they have hogs, fowls and dogs (next to an English lamb).*
>
> *When any of the chiefs kill a Hog it seems to be almost equally divided among all his dependants and as these are generally very numerous it is but a little that comes to each person's share, so that their chief diet is vegetables and of these they eat a large quantity.*
>
> *Cooking seems to have been little studied, here they have only two methods of applying fire, broiling and baking as we call'd it...and I am of the opinion that Victuals dress'd this way are more juicy and more equally done than by any of our methods, large fish in particular.*

To this plain diet salt water is the universal source, hardly anyone sits down to a meal without a cocoa nut shell full of it standing by them into which they dip most of what they eat, especially fish, drink at intervals large supps of it out of their hands, so that a man may use half a pint at a meal. (8)

Tonga

... They seem to be as free from disease as any Nation whatever, I neither saw a sick or lame person among them, all appeared healthy and strong, a proof of the goodness of the climate in which they live.

They have fine eyes and in general good teeth even to an advanced age. (8)

New Caledonia

Melanesians of New Caledonia:

...Its inhabitants... are strong, robust, active, well made people.

Are a much stouter race (than the people of Tonga) some were seen to measure six feet four inches. (8)

Cook Islands

It seemed to be mostly covered with trees amongst which were the breadfruit and coconut and our friend told us they had plantains and the taro root but no yams, Hogs or Dogs. Such articles as the island produced must be in great plenty as the Inhabitants seemed to be both numerous and wellfed, the men are stout, active and well made...

The inhabitants of Wautieu were thought...to be as fine a race of people as any they had seen in this sea and in general stouter and fleshier.

...tendency of the inhabitants here to corpulency...

Many of the young men were perfect models in shape...others who were more advanced in years were corpulent and all had a remarkable smoothness of the skin. (8)

While the physical condition of traditional-living Pacific Islanders was described as robust and fit, the life span may have been short. Estimates of the average age at death of adult New Zealand Maoris before 1769 seems to have been about 30 years (9).

Introduction of Disease

By the beginning of the 19th century, other adventurers had reached the Pacific. British and American whalers cruised the islands in vast numbers. In 1840, there were 500 American whaling vessels operating in the Pacific, and by 1850, whales were becoming scarce. Sandalwood traders had cut all of Fiji's accessible sandalwood by 1814, but continued logging in New Caledonia and Vanuatu for another 20 to 30 years.

The first recruitment of native labour, *blackbirding*, was made by whaling ships in Vanuatu, and then by the sandalwood cutters, for the sugar and cotton plantations of Queensland and Fiji. By 1876, Vanuatu had provided over 13,000 recruits; about 9,000 I-Kiribati were working overseas in the 1860s, and Solomon Islands had lost almost 30,000 men by 1911. Labour recruitment brought high mortality. Disease spread amongst the recruits, killing many. Those who returned to their home islands brought diseases with them.

Pacific Islanders had little resistance to the new diseases brought by European explorers and trading vessels. Epidemics of influenza, measles, tuberculosis, dysentery and whooping cough spread quickly, wiping out thousands of Islanders. A measles epidemic in the southern islands of Vanuatu in 1866 killed thousands of ni-Vanuatu. In 1875, a measles epidemic reduced the population of Fiji by one-third. A ship known to be carrying Spanish Influenza was allowed to enter Apia, Western Samoa, in 1920. This error caused the death of 8,500 people, 22 per cent of the population of Western Samoa.

A 1948 United Nations Report of the epidemic in Western Samoa concluded:

> *It ranks as one of the most disastrous epidemics recorded anywhere in the world during the present century, so far as the proportion of deaths to the population is concerned.* (10)

Thus, by the beginning of the 20th century, the populations of many Pacific Islands had been drastically reduced as a result of the practice of blackbirding and introduced diseases, to which the indigenous people had little resistance. William Ellis (1853) of the London Missionary Society in his account entitled *Polynesian researches* noted:

> *The diseases formerly prevailing among the South Sea Islanders were comparatively few; those from which they now suffer are principally pulmonary, intermittent and cutaneous. The most fatal are, according to their account, of recent origin.* (11)

Recent History

The decline in population in the Pacific Islands during the 19th century was not arrested until the early decades of the 20th century when public health programmes were introduced. Genetic selection may also have been a factor in the decline in mortality from infectious diseases. Infant and adult death rates fell and the rates of natural increase rose until the 1950s, between 3 and 3.5 per cent per year (12).

World War II had an enormous impact on the Pacific. The increased contact with western societies brought new technology, economic development, improved communications, and a general trend toward a cash economy. The large number of military installations also brought with them imported foods for their military personnel and the island people who took jobs with them. By 1953, candy and chewing gum were already having an effect on the teeth of American Samoan children whose parents held jobs with the US Naval base at Pago Pago (13).

Over the past decade, the population of the Pacific region has been growing steadily around 2.2% each year. The Melanesian countries and territories average 2.4% increase in population, an increase driven by moderately high fertility rates and declining mortality. Growth is highest in Micronesia, 2.7%, due to both a high fertility rate and influx of foreign workers, principally from the Philippines. The slower growth in Polynesian countries and territories, 1.0%, is a reflection of out-migration, causing zero growth or a decline in some islands (14). Shortage of land and the inability to obtain an acceptable level of cash income are considered the main causes of out-migration in many Pacific Islands.

The past several decades have also seen a sudden shift of population to urban centres. Twenty-three per cent of the population lived in urban centres in 1980, but that proportion has increased to about 25% in 1999. Some notable increases in the shift to urban areas have been seen in the Cook Islands (38% in 1981 to 59% in 1996), the Marshall Islands (51% to 67%) and in New Caledonia (60% to 71%). The fastest current urban growth rates are 6.7% per year for the Solomon Islands, 8.3% for the Marshall Islands and 5.6% for the Commonwealth of the Northern Mariana Islands (15). Some islands can be classed as totally urban, examples being Guam and Nauru.

The high rates of movement to, and the proportion of populations in, urban centres suggest that towns offer better opportunities than do rural areas, and that this trend is unlikely to reverse in the foreseeable future.

Migration to urban areas has been accompanied by a change in agricultural practices and food habits. Pacific Island people living in towns are most often employed, and do not have the time for fishing or hunting, or have the land to grow traditional crops. It is therefore necessary to purchase fish or meat. Rice and flour are also more convenient than root vegetables. They are often cheaper, easier to transport, take less time to prepare, and are less perishable.

The diversion of labour and land to cash crops and cattle raising has meant a reduction in the availability of traditional food crops, and thus a greater need for imported foods. If family income is sufficient, and a range of nutritional imported foods is available, the individual, family and country may benefit. This does not, however, appear to be the case in many parts of the Pacific. Incomes still tend to be low, the availability of nutritious imported foods is limited, and the cost is high.

In conclusion, initial western contact brought disastrous epidemics of communicable diseases to some islands. Resistance of Pacific Island people to common illnesses of Europe, such as influenza and measles, was low because isolation had protected them. This *first wave* of disease introduced from the west can be described as direct, infectious, rapidly transmitted and resulting in equally rapid morbidity and mortality.

The rest of this report describes the *second wave* of disease: one of an *infectious lifestyle* that has resulted, not from rapid transmission, but from rapid change in demography, society and culture. It can be described as indirect, insidious and generational, slowly transmitted and resulting in equally slow morbidity and incessant mortality.

Mortality Attributable to Non-communicable Diseases

Numerous health indicators are used to describe the degree of ill health in a community. Assessment of the health of populations is determined by availability of data, and for regions such as the Pacific Islands, the best developed data are those relating to death and the cause of death. Thus, comparisons of health status between Pacific Island countries can be achieved through measures such as life-expectancy data, death rates, infant mortality rate, and perinatal mortality rate. The disadvantage of death rates as an indicator of the health of a community is that they do not give an adequate reflection of the importance of premature death. The concept of "potential years of life lost" (PYLL) to age 65 years is an indicator used internationally to place more emphasis on death which is premature, than death at old age. For the purposes of assessing/measuring the impact of non-communicable diseases on the community, comparisons of death rates between countries, PYLL, and life expectancy have been used in this report.

Mortality data were summarised from available reports from individual countries in order to provide a picture of the impact of non-communicable diseases in the Pacific Islands. While summaries of life expectancy and death data were available from most countries at the more aggregate level, age-gender data on deaths from individual diseases (necessary for calculation of PYLL) were only available for a limited number of countries. It should also be recognised that the accuracy of mortality data in Pacific Island countries is questionable. Incomplete registration of deaths, inaccuracies in diagnosis or coding, and changes in levels of ascertainment or in registration practices were identified as limiting factors in the use of mortality data to measure the health status of a population.

Life Expectancy

Life expectancy is a statistical measure based on current mortality conditions in a country. It is an estimate of the expected number of years remaining to members of a community if prevailing mortality patterns do not change. Differences in life expectancy between countries can be related to a range of factors including: differences in age distribution of the population; death rates due to infectious diseases in infants, children and young adults; and premature death due to non-communicable diseases for people aged 45 years and over.

Table 1.1 summarises life expectancy and infant mortality for most Pacific Island countries based on SPC data (15). While it should be noted that the year of the data varies between countries and that improvements in life expectancy may have occurred in many countries, it is evident that life expectancy varies significantly between countries. Six countries have life expectancies (for all persons) above 70 years of age: New Caledonia (72.6), Guam (74.5), American Samoa (71.7), Cook Islands (70.0), French Polynesia (71.6), and Tonga (70.8). The countries with the lowest life expectancy are Papua New Guinea (51.8), Nauru (57.6) and the Solomon Islands (60.6). Life expectancy differences between countries are mostly related to infant mortality rate. In most countries, females have higher life expectancies, with the exception of Solomon Islands where males on average live 0.8 years longer.

Table 1.1: Life expectancy and infant mortality by location

	Life Expectancy at Birth				Infant Mortality Rate*	
	Males	Females	Persons	Year	Rate	Year
MELANESIA						
Fiji Islands	64.5	68.7	66.5	1996	20	1996
New Caledonia	68.8	76.5	72.6	1997	5	1997
Papua New Guinea	52.2	51.4	51.8	1990	77	1986-96
Solomon Islands	59.9	61.4	60.6	1980-84	38	1980-84
Vanuatu	61.5	64.2	62.8	1979-89	45	1985
MICRONESIA						
Federated States of Micronesia	64.6	66.8	65.7	1990-92	45	1990-92
Guam	72.5	76.6	74.5	1995	9	1995
Kiribati	58.5	64.7	61.5	1992-93	62	1992-93
Marshall Islands	59.9	62.9	61.4	1994	63	1994
Nauru	54.4	61.2	57.6	1991-93	13	1991-93
Northern Mariana Islands	66.6	72.6	69.5	1994-96	10	1992-96
Palau	65.0	69.0	67.0	1990	19	1994-96
POLYNESIA						
American Samoa	68.0	75.5	71.7	1987-93	11	1990-94
Cook Islands	68.5	71.5	70.0	1995-97	16	1991-96
French Polynesia	69.1	74.2	71.6	1996	10	1996
Niue	-	-	69.5	1990-95	18	1991-97
Pitcairn Islands	-	-			-	
Samoa	65.4	68.4	68.4	1997-98	25	1998
Tokelau	67.8	69.1	69.1	1990	38	1990
Tonga	69.8	70.8	70.8	1996	19	1996
Tuvalu	64.1	67.0	67.0	1991	56	1991-96
Wallis and Futuna	66.7	68.7	68.7	1990-95	15	1990-95

Source: SPC Fact Sheet, June 1999
* Infant Mortality Rate = number of deaths per 1,000 live births

Life expectancies at specific age categories (Life Tables) are available for a limited number of countries. Life expectancy at a particular age only takes account of the death rates at that age and higher ages, and is not influenced by death rates at younger ages. It is usually calculated using age-specific death rates for a particular calendar year. Table 1.2 provides life tables in selected countries. This table shows the influence of infant mortality on life expectancy in Kiribati compared to other countries in the table. While people in Kiribati have significantly lower life expectancies at birth than people in other countries, by the time a person reaches the age of 50 years, his/her average life expectancy is only marginally lower than people in the other countries. In fact, the average life expectancy at 50 years of age in Kiribati is higher than that in Tonga and Fiji, countries in which life expectancy at birth was approximately five years greater than that in Kiribati.

Table 1.2: Life tables in selected populations

Age	Tonga		Fiji Islands		Kiribati 1990-95		Guam 1990-94		New Caledonia 1996		American Samoa 1987-93	
	M	F	M	F	M	F	M	F	M	F	M	F
0	65.2	70.6	64.5	68.7	58.5	64.9	71.5	75.6	69.9	74.2	68.0	75.5
1	65.4	70.9	65.0	69.3	61.7	67.5	72.0	75.7	69.6	73.8	68.3	75.5
5	61.7	67.2	61.3	65.6	59.4	64.9	68.3	71.8	65.9	70.1	64.7	71.8
10	56.8	62.3	56.5	60.8	55.1	60.4	63.4	66.9	61.1	65.3	59.9	66.9
15	51.9	57.3	51.7	55.9	50.5	55.7	58.5	62.0	56.2	60.4	55.0	62.1
20	47.1	52.4	47.0	51.1	46.2	51.1	53.7	57.0	51.4	55.5	50.5	57.2
25	42.3	47.6	42.4	46.4	42.0	46.6	49.0	52.2	46.9	50.7	46.0	52.4
30	37.5	42.7	37.8	41.7	37.8	42.2	44.2	47.3	42.4	45.7	41.5	47.5
35	32.8	37.9	33.3	37.0	33.7	37.8	39.5	42.5	37.9	40.9	37.1	42.8
40	28.2	33.2	28.8	32.4	29.5	33.5	34.7	37.7	33.5	36.2	32.6	38.1
45	23.8	28.6	24.5	28.0	25.6	29.2	30.1	33.0	29.0	31.4	28.2	33.3
50	19.6	24.1	20.5	23.8	21.7	25.0	25.7	28.4	24.7	26.8	24.0	28.6
55	15.8	19.9	16.9	19.9	18.1	21.0	21.4	24.0			20.0	24.2
60	12.4	16.0	13.6	16.2	14.8	17.2	17.6	19.7	17.2	18.5	16.8	20.3
65	9.6	12.6	10.7	13.0	11.8	13.7	14.0	15.8			13.7	16.5
70	7.3	9.6	8.4	10.1	9.2	10.6	10.9	12.2	10.6	11.4	11.2	13.5
75	5.5	7.0	6.4	7.7	7.0	8.0	8.3	9.1			8.9	10.6
80	4.0	4.7	4.9	5.5	5.3	5.9	6.2	6.6	6.1	6.5	7.2	8.3
85	2.0	2.0	3.7	4.0								

Crude Death Rates

Crude death rates are the number of deaths per 1000 population per year. They are a reflection of both infant mortality and deaths that occur at older ages. According to SPC data (15), the populations with the highest crude death rate are those of Papua New Guinea (11.2 deaths per 1000 population), Kiribati (8.3/1000 population) and Tokelau (8.2/1000 population). Lowest crude death rates are found in Northern Mariana Islands (3.8/1000 population), American Samoa (4.3/1000 population), French Polynesia (4.8/1000 population), Guam (5.0/1000 population) and New Caledonia (5.1/1000 population). The limitation of crude death rates as an indicator of population health is that they do not take age into account. The older the population, the higher will be the overall death rate, even if it is relatively healthy. While not calculated for this report, age-standardisation of death rates would allow more valid comparisons between countries.

Death by Cause

Table 1.3 gives mortality data summaries for three populations. Because of the differences which occur among the various countries in how mortality data are recorded, and unavailability of death data by individual disease, data has been presented as cause of death by major disease groups as a percentage of total deaths.

Table 1.3: Mortality by disease category

TONGA 1998	No. deaths			% Deaths			Per 100,000
	Males	Females	Total	Males	Females	Total	population
Population							**98,372**
Infectious & parasitic diseases	19	11	30	7.6	6.0	6.9	30.5
Neoplasms	37	29	66	14.7	15.9	15.2	67.1
Disease of circulatory system	73	52	125	29.1	28.6	28.9	127.1
Endocrine, nutritional & metabolic	10	17	27	4.0	9.3	6.2	27.4
Nervous system	3	3	6	1.2	1.6	1.4	6.1
Respiratory system	17	8	25	6.8	4.4	5.8	25.4
Digestive system	20	11	31	8.0	6.0	7.2	31.5
Ill-defined symptoms/conditions	42	37	79	16.7	20.3	18.2	80.3
Injury and poisoning	14	3	17	5.6	1.6	3.9	17.3
Other	16	11	27	6.4	6.0	6.2	27.4
TOTAL	**251**	**182**	**433**	**100.0**	**100.0**	**100.0**	**440.2**

GUAM 1996	No. deaths			% Deaths			Per 100,000
	Males	Females	Total	Males	Females	Total	population
Population							**146,700**
Infectious & parasitic diseases	10	10	20	2.6	4.1	3.2	13.6
Neoplasms	65	42	107	16.9	17.4	17.1	72.9
Disease of circulatory system	106	79	185	27.6	32.6	29.6	126.1
Endocrine, nutritional & metabolic	25	30	55	6.5	12.4	8.8	37.5
Nervous system	13	12	25	3.4	5.0	4.0	17.0
Respiratory system	37	13	50	9.6	5.4	8.0	34.1
Digestive system	21	6	27	5.5	2.5	4.3	18.4
Ill-defined symptoms/conditions	1	6	7	0.3	2.5	1.1	4.8
Injury and poisoning	81	20	101	21.1	8.3	16.1	68.8
Other	25	24	49	6.5	9.9	7.8	33.4
TOTAL	**384**	**242**	**626**	**100.0**	**100.0**	**100.0**	**426.7**

FRENCH POLYNESIA 1996	No. deaths			% Deaths			Per 100,000
	Males	Females	Total	Males	Females	Total	population
Population							**224,488**
Infectious & parasitic diseases	16	12	28	2.7	2.8	2.7	12.5
Neoplasms	113	100	213	18.7	23.5	20.7	94.9
Disease of circulatory system	153	101	254	25.4	23.7	24.7	113.1
Endocrine, nutritional & metabolic	9	12	21	1.5	2.8	2.0	9.4
Nervous system	12	9	21	2.0	2.1	2.0	9.4
Respiratory system	55	53	108	9.1	12.4	10.5	48.1
Digestive system	28	9	37	4.6	2.1	3.6	16.5
Ill-defined symptoms/conditions	62	48	110	10.3	11.3	10.7	49.0
Injury and poisoning	97	36	133	16.1	8.5	12.9	59.2
Other	58	46	104	9.6	10.8	10.1	46.3
TOTAL	**603**	**426**	**1029**	**100.0**	**100.0**	**100.0**	**458.4**

Representing deaths from a certain disease as a percentage of total deaths does not directly measure the risk or probability of a person in a population dying from a specific disease as does a cause-specific mortality rate. It can, however, be useful for indicating within any population the relative importance of deaths by disease groups as a percentage of total deaths, and thus can aid health planners in selecting areas for further study and in determining priorities for planning purposes.

In general, cancers and circulatory diseases cause the greatest proportion of deaths in most countries. In many countries, they cause more than 30% of total deaths: the highest figure being in Tonga (48%). It is important to note that in countries where deaths from circulatory disease as a proportion of total deaths are lowest, deaths from ill-defined causes (and others) are highest. For example, in Kiribati, this category contributes to 52% of total deaths, some of which may be due to circulatory diseases. This is a reflection of inaccuracies in reporting mortality data in many Pacific Island countries. The category *injury and poisoning* (defined as accidents and injuries in some countries) varies greatly among countries. For example, this category of deaths contributes to 25% of deaths in the Northern Mariana Islands, but only 3% in Vanuatu. Combined, circulatory diseases and cancers contribute to almost 50% of total deaths in many countries, thus highlighting the effects of non-communicable diseases on the overall health status of a community.

Potential Life Years Lost (PYLL) due to Premature Mortality

A commonly used indicator of the disease burden in the population is the number of years of potential life which have been lost (PYLL) as a result of premature death. Premature death is usually defined as death occurring before the age of 65 years. The rationale for the use of this indicator is that a high proportion of deaths that occur before the age of 65 is preventable. Thus, PYLL places more emphasis on premature death than death at an older age.

The years of potential life lost were calculated by multiplying the number of deaths in each age category by the difference in the age of death and age 65 years. For example, if someone died in the age category 25–34 years of age, it was assumed that the age of death was 30 years, and the PYLL was 35 years (65 minus 30). The total PYLL is a function of the number of premature deaths, the age-distribution of the population and the total population. To enable comparison of the extent of PYLL to age 65 among countries, the number of PYLL were expressed per 100,000 population.

In all countries where data was available, approximately 65% of all PYLL to age 65 were borne by males. In both Guam and French Polynesia, males contributed to a similar proportion of total deaths prior to age 65 years. In Tonga, while males contributed to 65% of PYLL to age 65 years, they contributed to 55% of deaths. This was due to the high proportion of males (77%) in the total deaths under one year of age in Tonga compared to the other countries (58% in Guam, 68% in French Polynesia).

While deaths from circulatory disease and neoplasms contributed to just over 45% of total deaths in the three populations, they contributed to 21–25% of total PYLL. This is because deaths from these conditions occur relatively late in life compared to injuries and poisonings which tend to occur earlier in life. In Guam, injuries and poisonings contributed to 16% of deaths in 1996, but 35% of PYLL. The estimate for French Polynesia for deaths and PYLL was 13% and 33% respectively.

Deaths due to Obesity

The prevalence of obesity in Pacific Island countries and territories is rising. The proportion of deaths directly due to obesity can be estimated using the epidemiological statistic, the population attributable fraction (PAF). The PAF reflects the overall effect of morbidity and mortality from a risk factor in a population. It can be interpreted from an aetiological viewpoint (causal outcomes attributed to a particular risk factor, e.g. obesity) or from a prevention viewpoint (the maximum number of events that could be prevented). The formula for deriving a PAF is given in the footnote of Table 1.4. Information needed to calculate a PAF comprises the relative risk for a specific disease associated with the risk factor and the prevalence of the risk factor in the population.

Table 1.4: Estimate of mortality directly related to obesity (French Polynesia, 1995)

Disease	RR BMI>30		PAF Males		PAF Females		No. of deaths 1995		No. of deaths due to obesity Low		No. of deaths due to obesity High	
	Low	High	Low	High	Low	High	M	F	M	F	M	F
CHD	1.30	3.56	0.09	0.47	0.12	0.53	37	13	3	1	17	7
Colorectal cancer	1.48	2.00	0.14	0.26	0.17	0.30	3	1	0	0	1	0
CVA	1.25	1.59	0.08	0.17	0.10	0.20	36	29	3	3	6	6
Gallstones & gallbladder disease	2.40	6.00	0.33	0.63	0.38	0.68	-	-	-	-	-	-
Hypertension	3.70	5.70	0.48	0.62	0.54	0.67	21	26	10	14	13	17
Type II diabetes	5.47	47.1	0.61	0.94	0.66	0.95	12	7	7	5	11	7
Osteoarthritis							-	-	-	-	-	-
Post-menopausal	3.87	7.37	0.50	0.69	0.55	0.73	0	18	0	0	0	7
breast cancer	1.00	2.38	0.00	0.32	0.00	0.37						
Total							**109**	**94**	**23**	**23**	**48**	**44**

Notes: Low and High refer to low and high estimates of relative risk
Note: PAF = (p(RR-1)/(p(RR-1)+1) where p = prevalence of risk factor
RR = relative risk

To illustrate the use of a PAF, an estimate of the number of deaths in French Polynesia for 1995 attributable to obesity is shown in Table 1.4. Pacific Island estimates of the relative risk of obesity and disease were not available. Instead, international estimates of the relationship between obesity and disease were used. The prevalence of obesity in 1995 in French Polynesia was 34.6% among men and 43.4% among women. Total deaths in 1995 were 1,112 (665 males and 447 females). Causes of deaths related to obesity include coronary heart disease, stroke, hypertension, type II diabetes, colorectal cancer, and breast cancer in women. Total deaths from these conditions (before applying PAF) for 1995 were 203 or 18.2 % of total deaths (109 for males, 94 for females). Applying the PAF resulted in a low estimate that 4.2%, and a high estimate that 8.3% of all deaths were directly attributable to obesity. This is likely to be an underestimate of deaths attributable to excess body weight. Not all disease categories related to obesity were included in the analysis, and the effect of being overweight (BMI 25–29.9) was not included. Despite the likely underestimate, the analysis highlights the important role obesity plays in contributing to the overall mortality rate in a population.

Limitations of Mortality Data as an Indicator of Population Health

Historically, measures of the health status of a community have been based primarily on mortality data. Mortality data does not take into account the degree to which chronic, non-fatal diseases and disability affect a person's wellbeing or quality of life. With an aging population, the impact of chronic disease on the level of disabilities and health-related quality of life is becoming more evident. This has led researchers to investigate measures that are a composite of the impact of mortality and health-related quality of life. Such measures include quality-adjusted life years (QALY); and disability-adjusted life years (DALY).

Cardiovascular Disease and Risk Factors

Cardiovascular disease is the leading cause of death and disability in the majority of Pacific Island countries and territories. Diseases of the cardiovascular system include coronary heart disease (ischaemic heart disease), cerebrovascular disease (stroke) and peripheral vascular disease, which are caused by insufficient blood supply to the heart, brain and legs. The main underlying cause of cardiovascular disease is a process of atherosclerosis that clogs the blood vessels that supply these organs. The process is most serious when the blockage affects the blood supply to the heart causing angina or a heart attack, or to the brain, causing a stroke.

A number of factors are known to be associated with an increased risk of CVD. Risk factors which are not amenable to intervention, termed *non-modifiable,* include:

- Genetic predisposition
- Gender
- Advanced age

Lifestyle risk factors, which can be changed, termed *modifiable* include:

- Diet
- Hypertension
- Cigarette smoking
- Elevated plasma cholesterol
- Excessive body weight
- Diabetes mellitus
- Physical inactivity
- Excessive alcohol intake

The following chapters provide an overview of the mortality, prevalence and risk of CVD in terms of diet, hypertension, coronary heart disease, diabetes mellitus and obesity. Chapter seven provides a review of the relationships between lifestyles and cancer in the Pacific context.

CHAPTER 2: Dietary Change in the Pacific

Summary

- The last four decades have seen radical changes in eating patterns in most islands of the Pacific.
- These changes in eating patterns have resulted in major changes in the nutrient composition of the diet.
- The changes in eating patterns and nutrient intake are most obvious in urban settings but are occurring in many rural communities as well.
- The traditional diet was, in general, moderate to high in energy, moderate to low in fat, moderate to low in protein, high in complex carbohydrates and fibre, possibly high in antioxidants, potassium and trace minerals and low in simple carbohydrates (sugar) and salt.
- The current urban diet is moderate to high in energy, high in fat and protein, low in complex carbohydrates and fibre, probably low in antioxidants, potassium and trace minerals and high in simple carbohydrates and salt.
- These changes in nutritional patterns are thought by many to be a major contributor to increased rates of non-communicable diseases in Pacific communities.

Traditional Dietary Patterns

Atoll and Coastal-living Groups

Food habits throughout the Pacific differ widely, particularly between atoll or coastal groups, and inland volcanic island groups. Turbott (16) gives an excellent description of traditional dietary patterns on the atolls of Kiribati. His information was collected from consultations and observations with the old men on Tarawa and Abemama, and is shown in Table 2.1.

Table 2.1: Traditional diet in Kiribati

Average daily diet

Moimoto (drinking coconuts)	2	nuts
Ben (ripe coconut)	2	nuts
Riki (germinating coconuts)	1.5	nuts
Babai (taro root)	1.5	lbs
Mai (breadfruit)	0.5	lbs
Ika (fish, cleaned)	1.5	lbs
Karewe (fresh toddy mixed)	0.25	lbs
Kamaimai (molasses made from fresh toddy)	0.75	lbs

Source: (16)

- Coconuts in various stages of development form a major part of the traditional atoll diet. Green nuts are used for drinking, and the soft flesh is popular for both infants and adults. The germinating nut is split and the *coconut apple* removed. This is eaten raw, or is boiled. The ripe nuts are grated and eaten with fish or sugar. The grated coconut can be squeezed so that the *coconut cream* is extracted by squeezing. In 1954, Holmes (17) estimated that the average adult Cook Islander consumed three to four coconuts daily.

- Swamp taro, taro and other root crops are widely used throughout the Pacific. They can be prepared in numerous ways: baked, boiled, mashed, dried, or prepared into a pudding with palm syrup and/or coconut.

- Bananas, pandanus nut and green leaves also supplement the diet.

- Seafood provides a readily available source of animal protein, which appears to be more than adequate on traditional atoll islands. Fish is often eaten raw or wrapped in leaves with coconut cream and baked. The livers from all deep-sea fish are eaten, as well as those of pigs, domestic fowls and sea birds.

Inland Volcanic Island Groups

The traditional food pattern of inland volcanic people differed from that of the atoll or coastal groups. As an example, in Papua New Guinea, the diet consists almost entirely of vegetable staples: sweet potato, yams, taro, bananas and sago. In the traditional diet the quantity of meat and fish was extremely low, dairy products non-existent and only small amounts of grains, legumes and greens were consumed. While the energy and protein intake of the diet was low compared to Caucasian standards, the vitamin intake appeared to be adequate. The intake of minerals was adequate for adults, but calcium may have been in short supply for children. Iodine deficiency has been noted in localised inland areas in the Pacific (18).

Changes in Nutritional Composition Resulting from the Move from a Traditional Way of Life to an Urban Environment

Early studies by the Ministry of Health and Research in French Polynesia (19), Pargeter in Kiribati (20), Matenga-Smith et al. in the Cook Islands (21) and Ringrose et al. in Nauru (22) provide estimates of the nutrient composition of dietary patterns in the Pacific. Surveys in Vanuatu (23), American Samoa and Samoa (24) and in Fiji Islands (25) highlight the changes in the diet that have occurred with the move from a traditional to an urban environment. Tables 2.2 and 2.3 summarise the major changes in nutrient composition taking place over the past 50 years in Pacific communities.

With urbanisation and westernisation, dietary changes appear in both atoll and coastal islanders and volcanic island dwellers. Root vegetables such as taro, yams and sweet potatoes are replaced by lower-fibre bread and rice. Fresh fish is replaced by tinned fish and high-fat, highly salted tinned meats. Consumption of sugar, sugar-based soft drinks and salt has increased enormously.

Table 2.2: Changes in nutrient composition of diets of ATOLL and COASTAL dwellers with move from traditional to urban lifestyle

Nutrients	Traditional eating pattern	Urban eating pattern
Energy	Low to moderate	⇧
Total fat	Moderate to high	⇧
Saturated fat	High	⇧ ⇧
Cholesterol	Low	⇧ ⇧ ⇧
Complex carbohydrate	Moderate to high	⇩ ⇩
Sucrose	Low	⇧ ⇧ ⇧
Protein	Moderate to high	⇧
Fibre	Moderate to high	⇩ ⇩
Salt	Low to moderate	⇧ ⇧

Table 2.3: Changes in nutrient composition of diets of VOLCANIC ISLAND dwellers with move from traditional to urban lifestyle

Nutrients	Traditional eating pattern	Urban eating pattern
Energy	Low	⇧ ⇧
Total fat	Very low	⇧ ⇧
Saturated fat complex	Very low	⇧ ⇧ ⇧
Cholesterol	Very low	⇧ ⇧ ⇧
Carbohydrate	High	⇩
Sucrose	Low	⇧ ⇧
Protein	Low	⇧
Fibre	High	⇩ ⇩
Salt	Very low	⇧ ⇧

⇧	increase	⇩	decrease
⇧ ⇧	substantial increase	⇩ ⇩	substantial decrease
⇧ ⇧ ⇧	enormous increase		

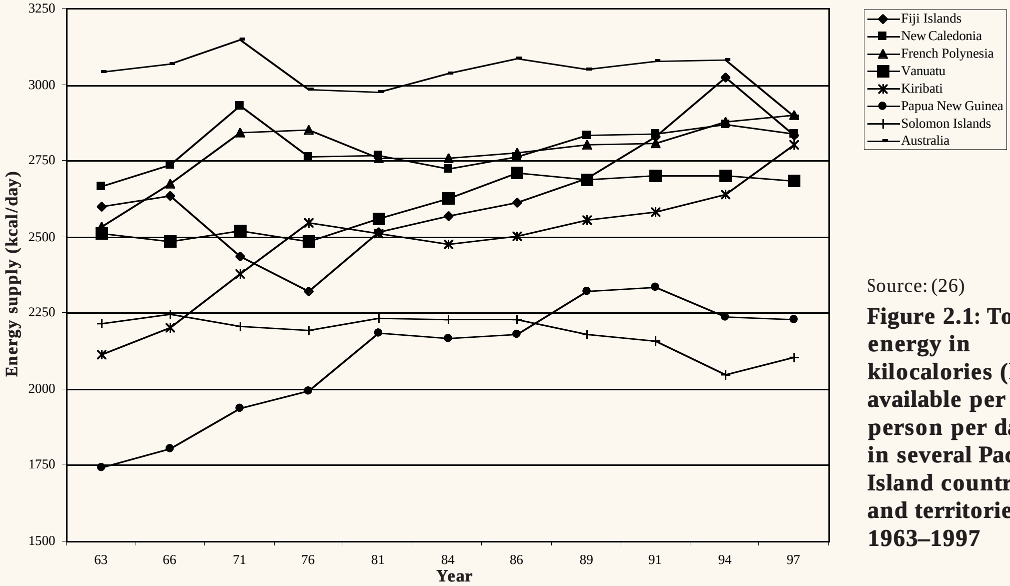
Changes in Energy Supply and Availability of Common Foods within the Last 40 years in Several PICTs

The Food and Agriculture Organization (FAO) (26) provides data regarding the availability of different types of food and beverages for many, but not all countries of the world. Seven countries and territories in the Pacific have these data available.

The accuracy of the food balance sheets depends on the reliability of the underlying basic statistics of population, supply and utilisation of foods and of their nutritive value. The FAO food balance sheets are estimates of the availability of the food in a country and only show the quantities of food reaching the consumer. These data do not provide information about the amount of food actually consumed or who consumes the food.

The amount of food actually consumed may be lower than the quantities shown on food balance sheets depending on losses occurring in storage or during food preparation and cooking. The opposite can also occur if estimates of local food production do not cover all producers (e.g. subsistence farmers). One advantage of food balance sheets, however, is that they provide the possibility of assessing trends or changes in the availability of major food types over time for a specific country.

Figures 2.1 to 2.6 show the changes in total energy and availability of major food types in several PICTs: Fiji Islands, French Polynesia, Kiribati, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu. Comparison data for Australia are also included.

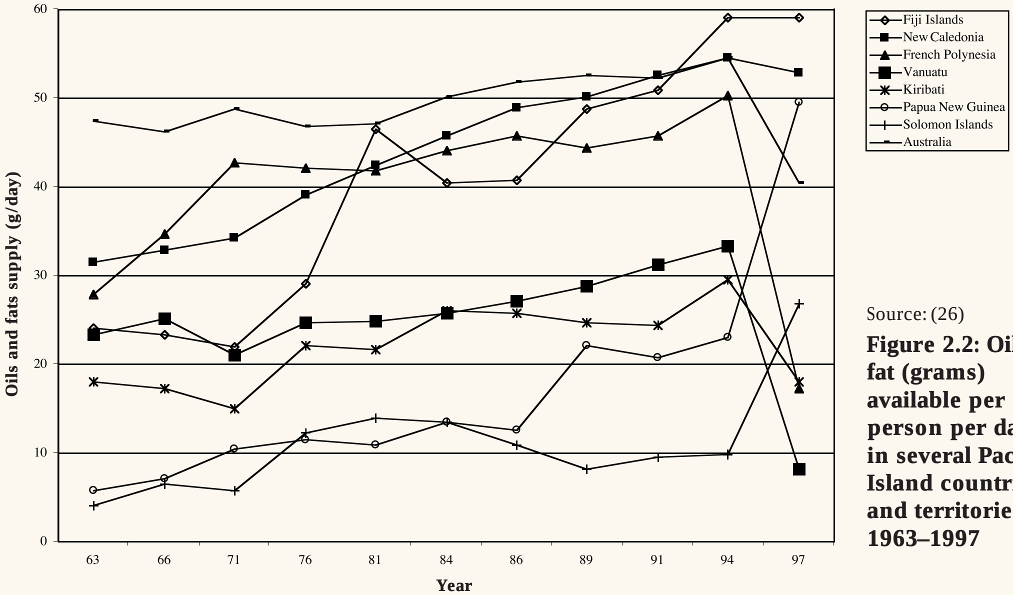


Source: (26)

Figure 2.1: Total energy in kilocalories (kcal) available per person per day in several Pacific Island countries and territories, 1963–1997

Total Energy (kcals)

Fiji Islands, New Caledonia and French Polynesia have the highest per-capita energy supply, while Papua New Guinea and Solomon Islands have the lowest. There appears to be a slight increase in energy for most countries and territories, but most dramatically for Papua New Guinea and Kiribati (Figure 2.1).

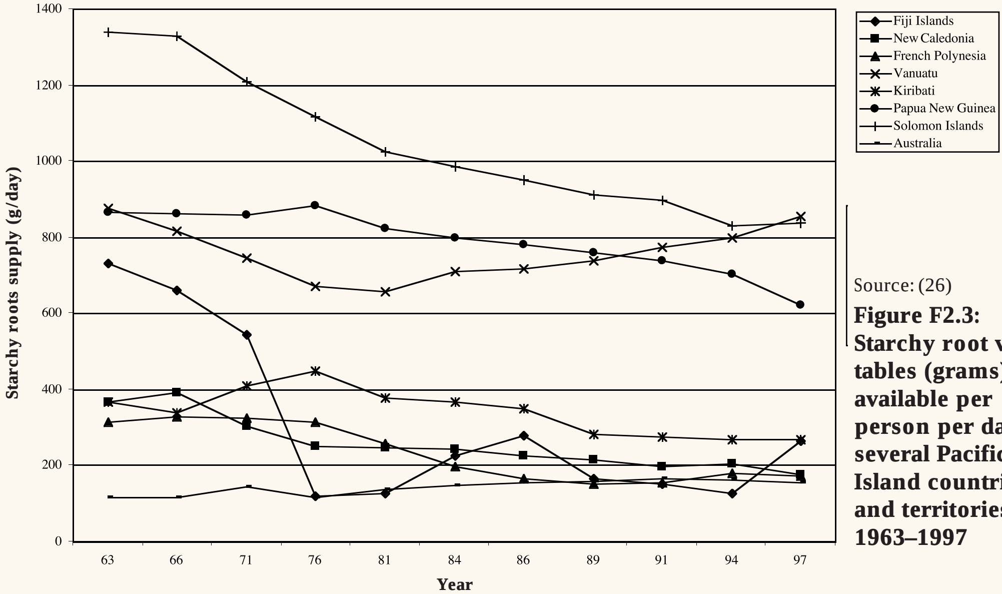


Source: (26)

Figure 2.2: Oil and fat (grams) available per person per day in several Pacific Island countries and territories, 1963–1997

Oil and Fat

Oil and fat have generally become more available over the past three decades in all countries and territories, but particularly in Fiji Islands, New Caledonia and French Polynesia (Figure 2.2).

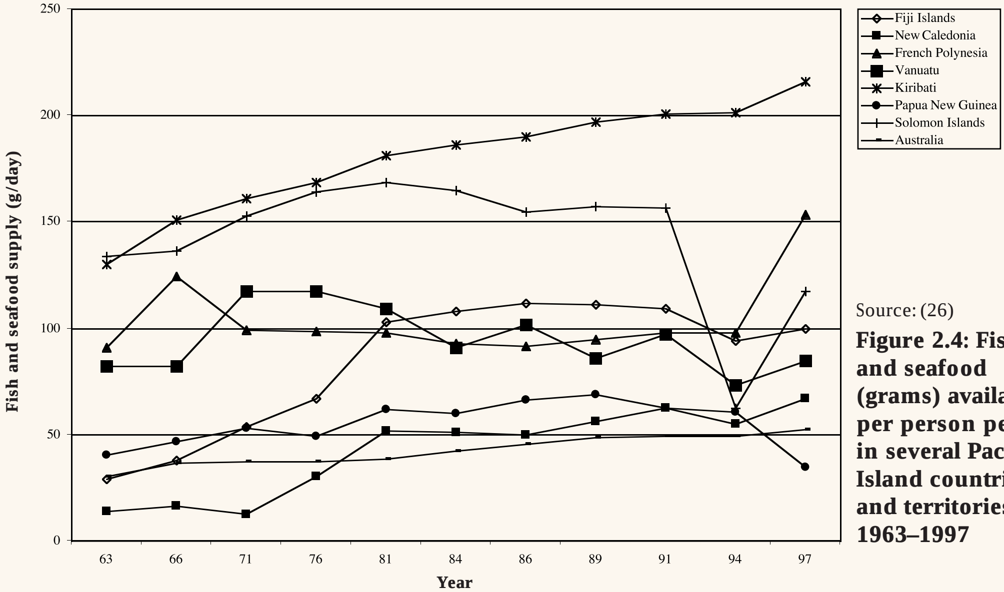


Source: (26)

Figure F2.3: Starchy root vegetables (grams) available per person per day in several Pacific Island countries and territories, 1963–1997

Starchy Root Vegetables

The PICTs with the highest availability of starchy root vegetables are Solomon Islands, Vanuatu and Papua New Guinea and those with the lowest are Fiji Islands, French Polynesia and New Caledonia (Figure 2.3). The availability of starchy root vegetables appears to have steeply declined in Fiji Islands and Solomon Islands. The decline in the availability of root crops in Fiji Islands is thought to be due to the relaxation of a law (1962) requiring all indigenous Fijian families to grow root vegetables.

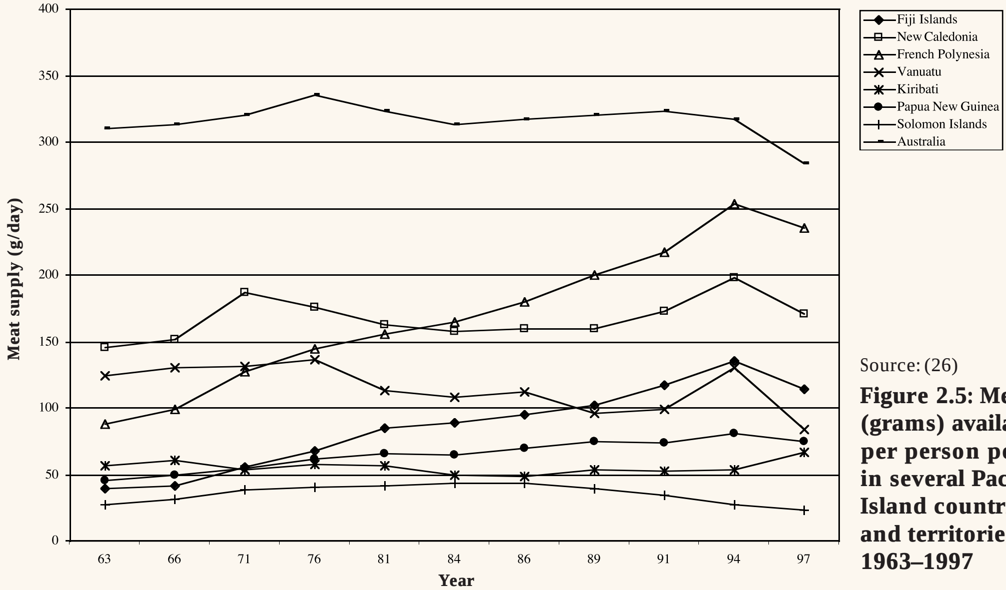


Source: (26)

Figure 2.4: Fish and seafood (grams) available per person per day in several Pacific Island countries and territories, 1963–1997

Fish and Seafood

Kiribati has the highest availability of fish and seafood, which also appears to have increased within the past 30 years (Figure 2.4). The availability of fish and seafood in New Caledonia and Fiji Islands has substantially increased. On the other hand, in the Solomon Islands the availability of fish and seafood has decreased dramatically beginning in the 1990s.

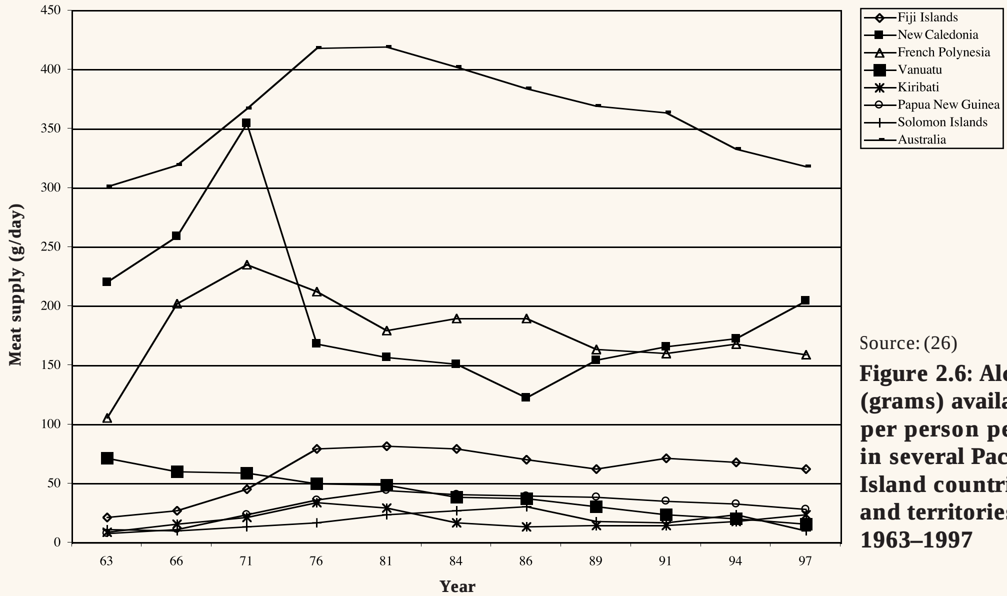


Source: (26)

Figure 2.5: Meat (grams) available per person per day in several Pacific Island countries and territories, 1963–1997

Meat

French Polynesia, New Caledonia and Fiji Islands have the highest meat supply per capita, although all are considerably below the Australian meat supply (Figure 2.5). Solomon Islands, Kiribati and Papua New Guinea have the lowest supply. The availability of meat appears to have increased remarkably in this time period in French Polynesia and Fiji Islands has but remained relatively constant in the other countries and territories.



Source: (26)

Figure 2.6: Alcohol (grams) available per person per day in several Pacific Island countries and territories, 1963–1997

Alcohol

The availability of alcohol appears to have declined from highs in the 1960s and 70s in New Caledonia, French Polynesia and Vanuatu (Figure 2.6).

In summary, while energy availability has remained essentially stable, the sources of the supply have switched from starchy root crops to fat, cereal and sugar. The major nutritional changes from a traditional diet to an urban one appear to be: an increase in total fat, especially from meat, a decrease in fibre, an enormous increase in simple carbohydrates, and a probable increase in salt. In terms of food types, there has been a decrease in vegetables, fruit and fish with an increase in bread, rice, biscuits, sugar and sugar-based soft drinks. Yet it is difficult to generalise dietary changes as a result of urbanisation. It seems that each country needs to be considered individually to determine the nature of the changes, and the effect on the health of the people of these islands. The following are summaries of a number of dietary surveys conducted in various Pacific Island countries and territories over the past 50 years.

Melanesia

Fiji Islands

A number of food-consumption and dietary surveys were carried out in Fiji Islands since the early 1950s. These surveys highlight the dramatic change in food patterns and nutrient intake that has occurred over the past five decades.

Naduri surveys

A number of quantitative and qualitative food-consumption surveys were carried out between 1952 and 1994 at Naduri, a rural village not far from Sigatoka town. The purpose of the surveys was to describe changes that might occur in the dietary patterns of the Naduri people during the development of a Naduri Co-operative Farm project, directed by the Sigatoka Agricultural Station. The first surveys were conducted in the middle of 1952, and at the beginning and end of 1953 by Langley (27). Two or three times daily, households were visited and all food was weighed. The percentage loss from peeling, from kai shells (freshwater mussel) or other items was also determined. The nutrients consumed per capita were calculated on the basis of mean edible portions consumed.

> *The villagers have traditionally farmed the fertile river flats at the same time obtaining wild food supplies from the bush. The people have customary rights to fish for the "kai" shellfish which occur in abundance all year round. The river also supplies a variety of fish, some seasonally. At the end of 1953 there was an increase in the consumption of store foods particularly of cereal products such as rice, bread, biscuits and flour. These purchased foods were replacing the locally grown root crop in the morning meal. Tapioca was still the main root but had decreased in quantity in the diet since a greater variety of root crops are being used.*(27)

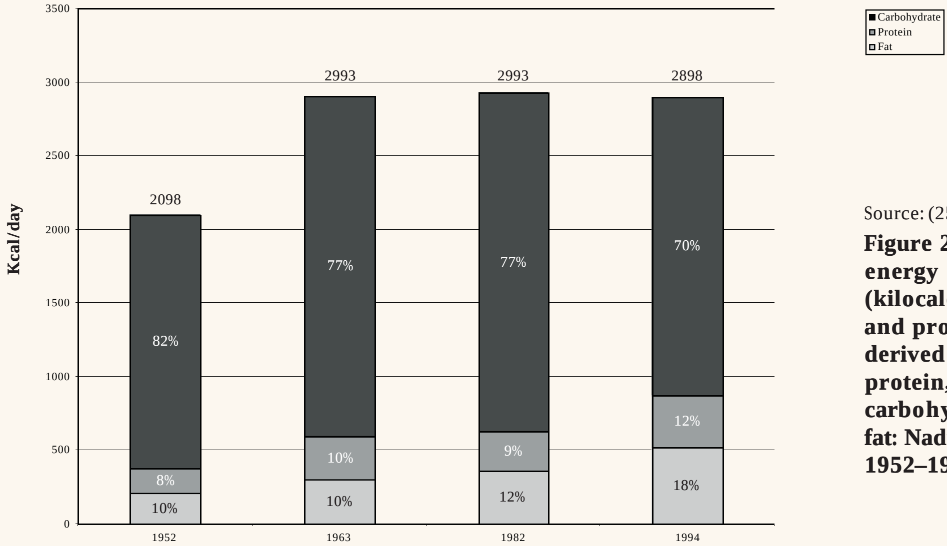
A ten-year follow-up survey was conducted by Wilkins in 1963 (28). A significant increase in total energy, protein, fat and carbohydrate was observed but the proportion of these different nutrients did not change dramatically.

Another study was conducted in Naduri in 1982 by Parkinson and colleagues (29). The findings showed that since 1952 there was an increase in the mean energy intake from 2098 to 2993 kilocalories, a 50% increase. There was an increase in fat, carbohydrate and protein. The additional carbohydrate was in the form of sugar, rice and wheat starch. There was also a decrease of vitamin C and some B vitamins, a reduction in daily iron intake and an increase in vitamin A.

In 1994, another survey was conducted in Naduri (25). Data on the quantitative and qualitative food consumption pattern from each household was collected for a period of seven days. This survey showed clearly the change from traditional patterns of food consumption to that of a more cereal-based diet, for example the consumption of bread for breakfast, or *roti* (flat bread made from coarsely ground white flour) being taken to school instead of the traditional root crops.

There was a greater variety of foods in 1994 – 107 food items were recorded compared with 42 items in 1982. On average the diet was nutritionally adequate but a high rate of goitre was reported (5% of the study group).

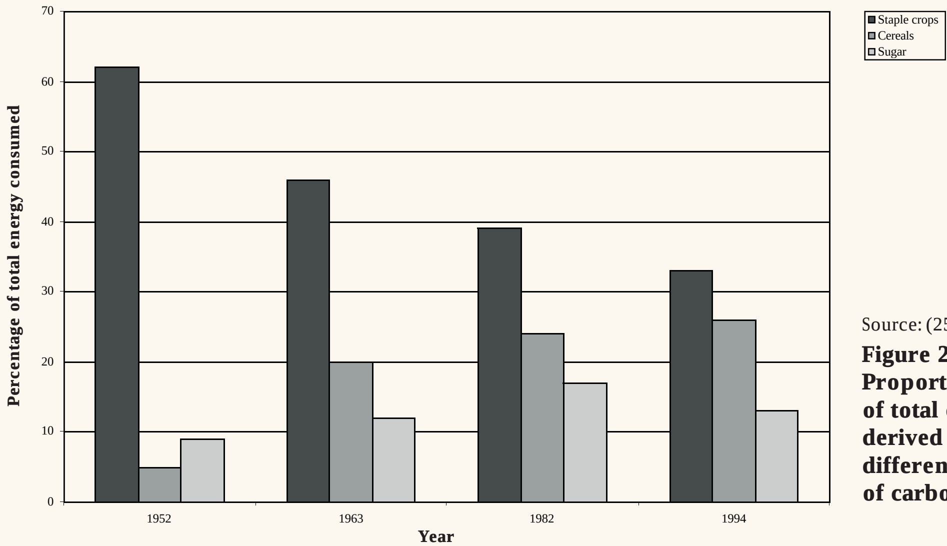
Between 1952 and 1994 there was a steady increase in total energy, protein and fat intake with a decrease in carbohydrates. Figure 2.7 shows the increase in energy and the proportion of energy derived from protein, carbohydrate and fat.



Source: (25)

Figure 2.7: Total energy (kilocalories) and proportion derived from protein, carbohydrate and fat: Naduri surveys, 1952–1994

The proportion of energy in the diet derived from starchy roots has decreased. At the same time, cereals and sugar intakes have increased (Figure 2.8). Table 2.4 provides the percentage of energy derived from major foods at the 1952 survey and the 1994 survey. These data also highlight the dramatic shift away from root crops to cereals.



Source: (25)

Figure 2.8: Proportion (%) of total energy derived from different sources of carbohydrate

However the continual heavy reliance of Naduri villagers on their traditional and natural sources of food for their daily meals is a positive habit that needs to be reinforced. It appears that adherence to their traditional diet may be the major factor influencing their acquisition of a nutritionally adequate diet. (25)

Table 2.4: Sources of energy – Naduri, 1952 and 1994

Energy source	1952	1994
Root crops	61 %	33 %
Cereals	9 %	25 %
Sugar	11 %	12 %
Animal protein	12 %	17 %
Fats & oils	4 %	8 %
Fruits & vegetables	3 %	3 %

The annual per-capita alcohol consumption has remained constant at about 24 litres of beer from the 1980s to 1993. In both sexes, more people drank more alcohol in urban than in rural areas. The overall consumption of alcohol decreased with age while the proportion of habitual drinkers (daily consumption) increased.

Dietary Intake of Indo-Fijians

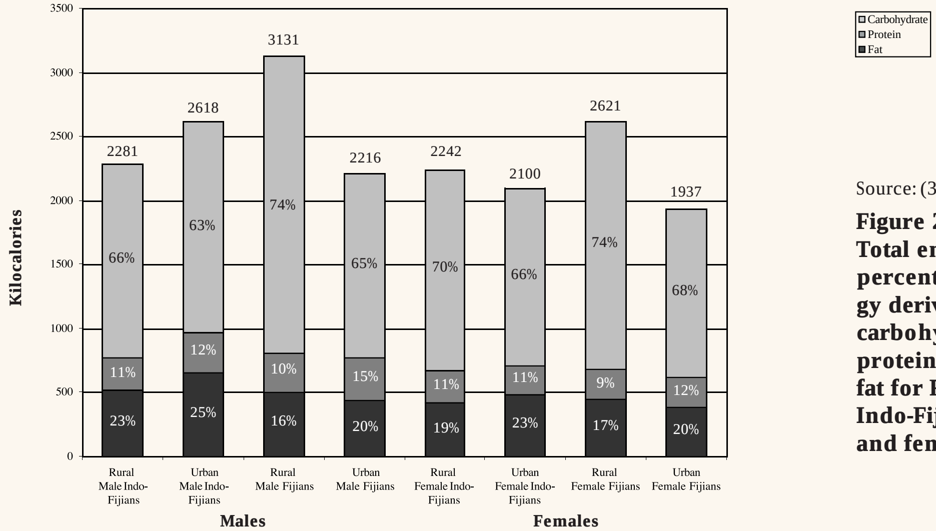
O'Loughlin and Holmes conducted a survey in 1954 among 71 Indian households on the outskirts of Suva (30). In 1963 another survey was undertaken among 18 Indo-Fijian households selected from an urban centre and rural cane-farming settlements around Rakiraki which is a rural area (31). During that decade there appeared to be an increased intake of energy (from 1966 to 2764 kilocalories), fat (38g to 60g per day), protein (63g to 71g per day), and carbohydrate (367g to 484g per day). The contribution of carbohydrates and protein to the total energy intake decreased from 74% to 70% and from 13% to 10% respectively, while the contribution of fat to the total energy intake increased from 17% to 20%.

A survey was conducted which included 160 persons living in the settlements of Vaileka, Narai and Naivunivuni over a period of one week (32).The majority of the families had an adequate intake of energy, protein, iron and calcium. Vitamins A and B1 (thiamine) were low and signs of thiamine deficiency were observed in women.

A national dietary survey, using a 24-hour recall methodology, was carried out in 1980 among 3625 Fijians, 1165 Indo-Fijians and 174 persons from other ethnic groups (33). For Fijians the most important foods were cassava, *dalo* (taro), rice, breadfruit, sugar, *lolo* (coconut cream), fresh fish, tinned fish, *rourou* (taro leaves) and *bele*, a green leafy vegetable (*Hibiscus manihot*). The most important source of carbohydrate was cassava (78.4% of the households). Fresh fish was the protein food most consumed, followed by canned fish and meat. Twenty-one per cent of the households used milk, but it was consumed in small amounts in tea or coffee. Fruit consumption was also very low considering the abundance of fruit. *Rourou* and *bele* were the two vegetables consumed in the largest amounts.

For Indo-Fijian families the most important foods were rice, *roti* (flat bread made from wheat flour), bread, sugar, *dahl* (lentil curry), milk, canned fish, mutton, eggs and curried vegetables. The main carbohydrate foods were rice and *roti* and the main protein food was *dahl* followed by milk and canned fish. As in the Fijian diet, fruit consumption was rather low. Vegetable curry provided the main source of vegetables in the diet.

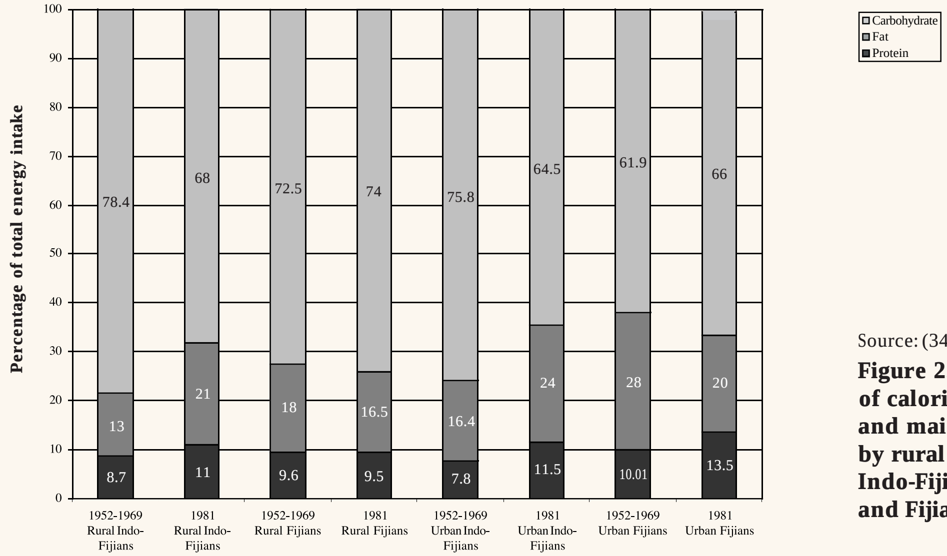
Taylor and colleagues (34) carried out a 24-hour dietary recall survey among 510 people in 1980. For each ethnic group and each gender the total energy intake was found to be higher in rural areas than in the urban setting but the percentage of energy from fat was higher in all urban groups. The percentage of energy from carbohydrate was lower in the urban groups than the rural groups. Figure 2.9 provides the relative energy derived from protein, fat and carbohydrates for females and males.



Source: (34)

Figure 2.9: Total energy and percentage of energy derived from carbohydrate, protein and fat for Fijian and Indo-Fijian males and females

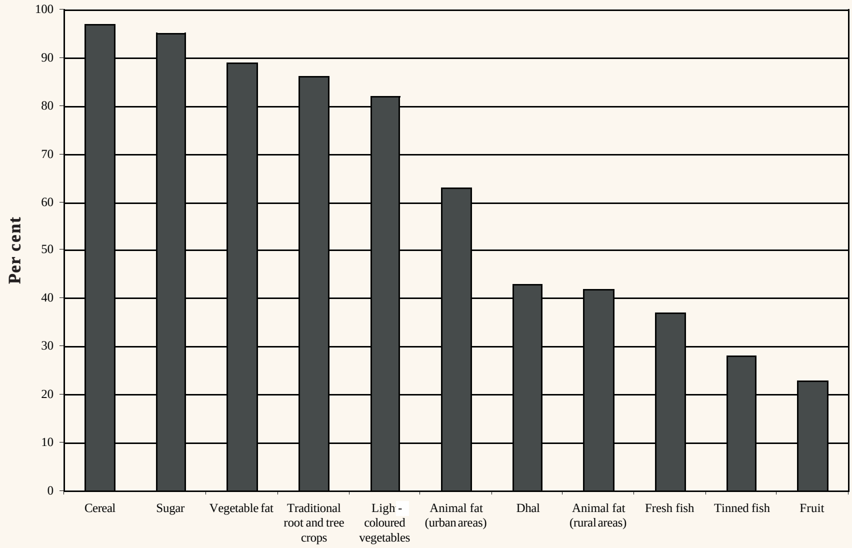
The Taylor survey can be compared with a survey that was conducted from 1952 to 1969 by Grawford and Willmott (35). They examined the changes taking place in food consumption in Fiji Islands. Among Indo-Fijians there was an increase in the percentage of energy derived from fat and protein and a decrease in carbohydrate energy. For Fijians, this trend appeared to be slightly reversed.



Source: (34,35)

Figure 2.10: Intake of calories and main nutrients by rural and urban Indo-Fijians and Fijians

A 24-hour dietary recall survey was conducted in 1993 among 4606 individuals as part of the National Nutrition Survey (36). The diet of Fijian and Indo-Fijian groups in both rural and urban areas included a high proportion of cereals, animal fat and sugar. Figure 2.11 shows the percentage of people who consumed different types of foods. For the Indo-Fijians, *dahl* was the major source of protein; they also ate more light-coloured vegetables, such as garlic, eggplant, chillies or beans than the Fijians. More green leaves were consumed by Fijians than by Indo-Fijians.



Source: (36)

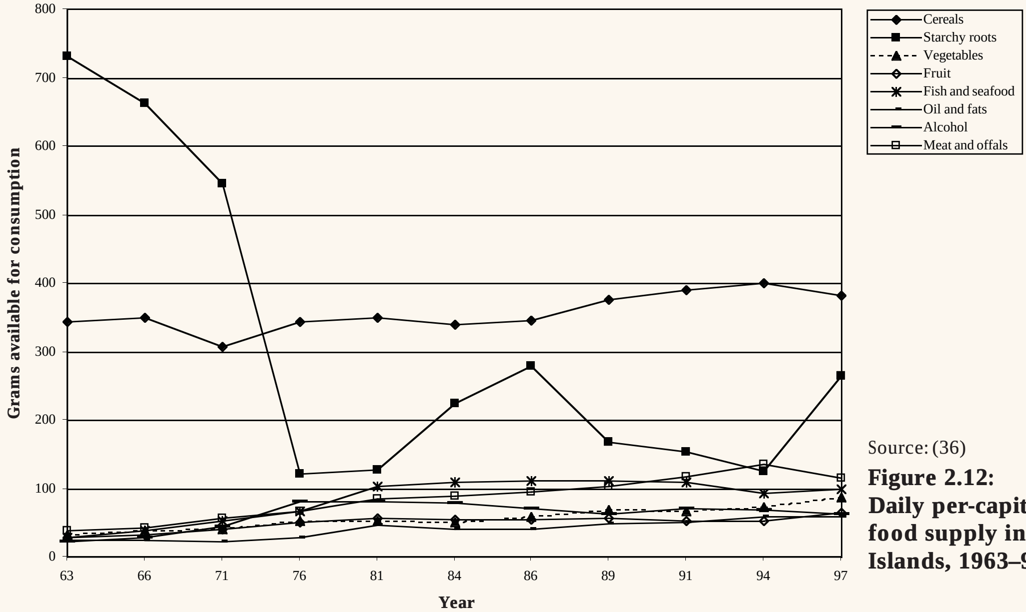
Figure 2.11: Proportion of people eating different types of foods in Fiji Islands, 1993

The results of the Fiji Island surveys confirm that for the ethnic Fijian, the consumption of animal fat has increased and there is a trend to a more cereal-based diet. This change is more marked among urban Fijians than among rural Fijians, who retain their traditional dietary pattern. The contemporary urban Fijian diet is of poor quality in comparison to the rural diet and to that of other ethnic groups when assessed by the percentage of energy derived from carbohydrates, protein and fat. Traditional foods, which are rich in minerals, vitamins and protein, are being replaced by sugar, rice, fatty meat and white bread because these foods are cheaper and have a different taste.

The FAO food balance sheets (26) indicate that since 1963, there has been a dramatic decrease in the availability of starchy root vegetables as seen in Figure 2.12. This sharp decrease in the 1960s is attributed to the uplifting of the 'Family Crops Regulation' in 1962 by the government administration. The regulation required that indigenous Fijians grow root crops sufficient for their requirements. In the 1980s more starchy roots were available as the focus shifted from subsistence farming to exporting. This change increased the demand for *dalo* exports and also increased the production and availability of cassava and *kumala* (sweet potato). Over the same time period, there was an increase in the amount of cereals, meat and offal, and fish and seafood available for consumption. There has been a slight increase in the availability of fruit and vegetables as well as oil and fats over the past 30 years (26).

The lack of increase in the availability of cereals may reflect the stability of the Indo-Fijian diet. The Indo-Fijian eating pattern is based on rice and cereals and has changed very little over the past several decades. Also the Indo-Fijian population makes up approximately half of the total Fijian population.

The energy (kilocalories) provided by imported foods also increased during this time – from 37% in 1961 to nearly 75% in 1995–97 (26).



Source: (36)

Figure 2.12: Daily per-capita food supply in Fiji Islands, 1963–97

New Caledonia

In New Caledonia the diet has changed with westernisation but differences still exist between the different ethnic groups.

In 1953, Malcolm (37) visited the rural villages of Ponerihouen and Poindimie on the east coast of mainland New Caledonia where living conditions seemed representative of the population in that area.

> *The villagers used a wide variety of local roots, greens, fish, shellfish and some wild game. Of the imported foods, sugar was used regularly but rice, bread and tinned fish and meat rarely.* (37)

Loison et al. (38) wrote in 1973, that in the bush, diets seemed to be mainly vegetarian. There was an exchange of food between coastal and mountain tribes and imported fruit plants, such as citrus and avocado, were currently popular. Cereals had been cultivated but in very low quantity and rice had become a staple food. Food contained little salt and dairy products were rarely eaten. Little by little the consumption of imported tinned foods was increasing.

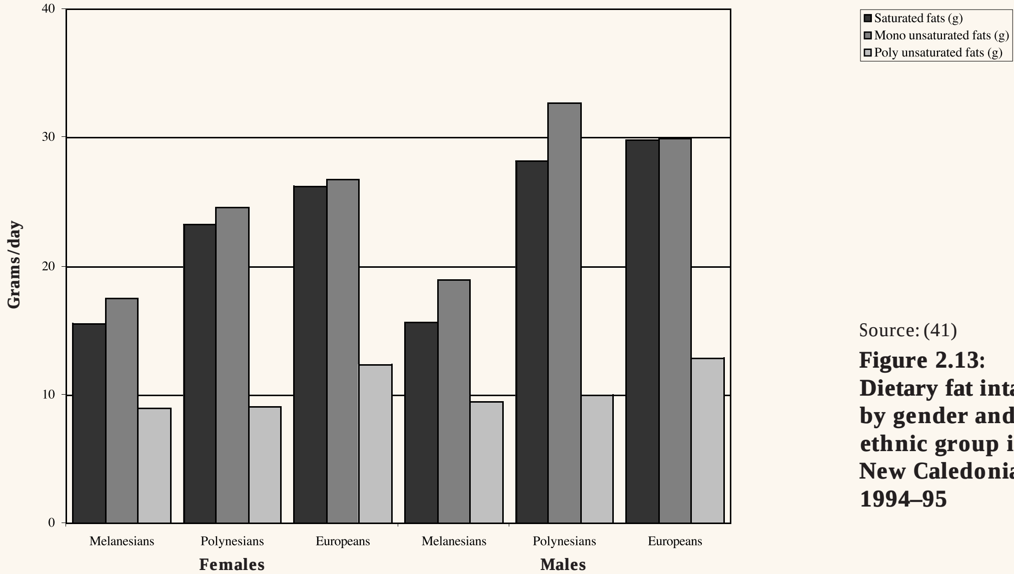
Taylor and Zimmet (39) suggested that in Noumea the diet is very different from that of the east coast rural Melanesian communities (specific data are not available).

In 1991, a dietary survey using a 24-hour recall methodology was conducted by the Institut Pasteur de Nouvelle-Calédonie (40) on a population of 192 Melanesian people. They found that fibre, minerals, and vitamins were above the recommended intake. But saturated fat and cholesterol intakes were excessive. One recommendation was to replace imported meats with fish.

Tassie (41) compared nutrient intakes in Melanesians, Polynesians and Europeans living in urban and rural areas in New Caledonia using a 24-hour dietary recall methodology. In the urban groups, total energy intake (kilocalories) was higher (except for European males) and was composed of less carbohydrate and protein and more fats (not significant) than in the rural groups.

The composition of energy varied among these three ethnic groups. Among Melanesians, more than 55% of energy was derived from carbohydrate. This proportion was less for Polynesians and Europeans. The difference in carbohydrate intake was mainly due to greater consumption of starchy roots by Melanesians. The contribution of fat to the energy intake was higher for Polynesians and Europeans than for Melanesians (data not shown). As shown in Figure 2.13, Polynesians and Europeans had significantly higher intakes of saturated and mono-unsaturated fat than Melanesians.

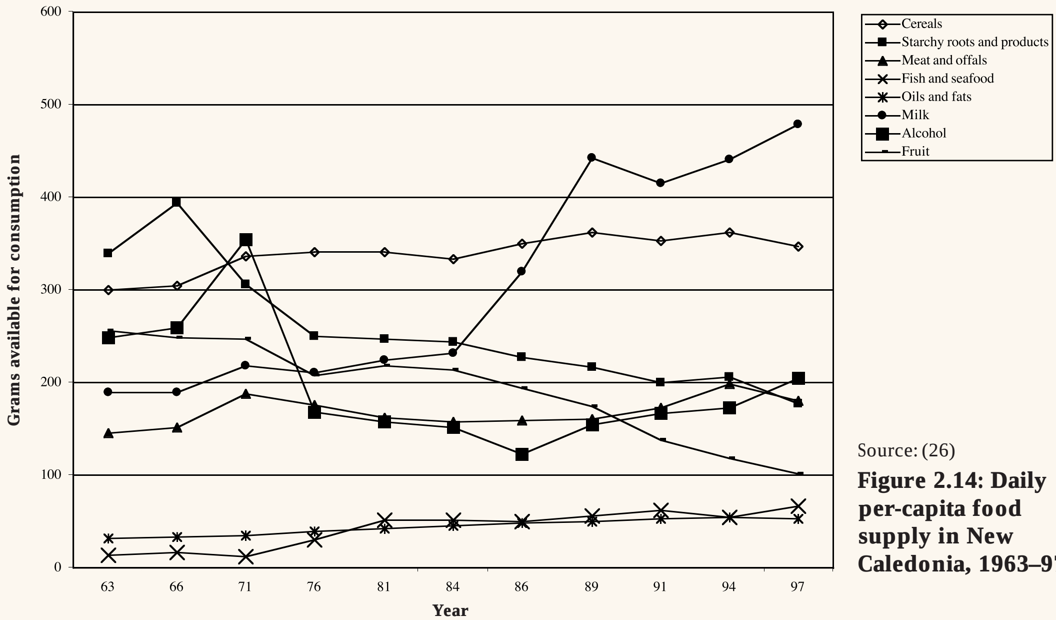
There were no differences in fibre intake between the groups, which is surprising given the higher consumption of root vegetables by the Melanesian people. Root crops are known to be rich sources of dietary fibre.



Source: (41)

Figure 2.13: Dietary fat intake by gender and ethnic group in New Caledonia, 1994–95

The FAO food balance sheets for New Caledonia show a striking increase in milk, a moderate increase in cereals, and a dramatic decline in root vegetables (Figure 2.14).



Source: (26)

Figure 2.14: Daily per-capita food supply in New Caledonia, 1963–97

Table 2.5 summarises the major trends in food availability in New Caledonia since 1963.

Table 2.5: Changes in food availability in New Caledonia, 1963–1997

Increase	Milk (dramatic); cereals
Decrease	Starchy vegetables (dramatic); fruit; alcohol
Stable or minor change	Fish; oil; meat

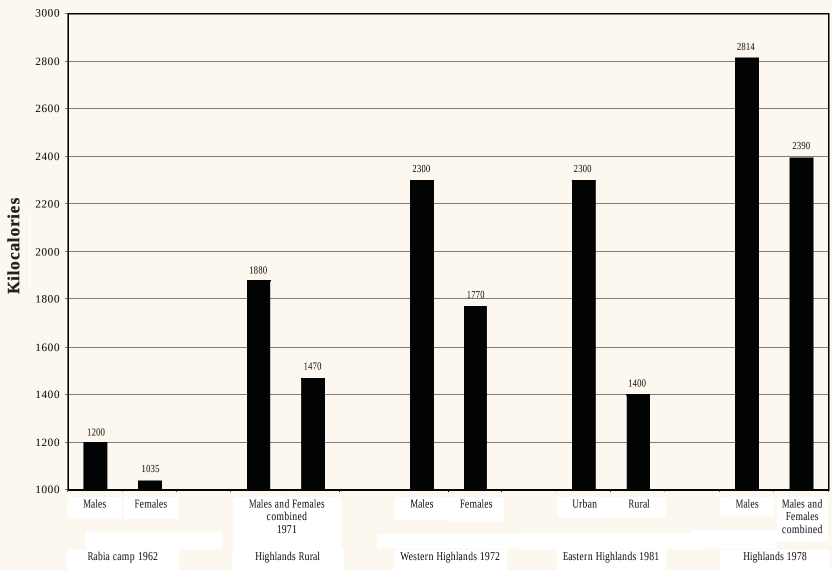
The FAO food balance sheets also showed that the percentage of energy (kilocalories) provided by imported foods increased from 60% to 78% between 1961 and 1996 and that over 50% of most foods (with the exception of root vegetables) are imported. Cereals, fat and vegetable oil are nearly all imported while starchy roots are nearly all produced in the country.

Papua New Guinea (PNG)

The traditional diet in PNG is predominantly based on a small number of staple crops. Meggitt (42) gives a very interesting account of agriculture, hunting and fishing among the Enga-speaking people of the Enga Province. The main starchy crops in the lowlands are sago and banana. Sweet potato, taro and yam are the main staples in the Highlands.

In 1956–57 a dietary survey was conducted in the village of Yobakogl in the Simbu area of the Highlands of PNG (43). The intakes of protein were found to be low but energy intakes were adequate. Imported foods were not mentioned.

A study by Hitchcock and Oram (44) revealed that energy intake in a poor migrant settlement (Rabia camp) in the capital of Port Moresby was 1200 kilocalories for men and 1035 kilocalories for non-lactating women. These rates (Figure 2.15) are the lowest ever recorded in PNG. Seventy-two per cent of the energy came from flour, rice, sugar, bread and biscuits. Sugar provided 11% of the energy while starchy root vegetables only 9%. Figure 2.15 compares the mean energy intake of various surveys in PNG between 1962 and 1981.



Source: (44,45,49)

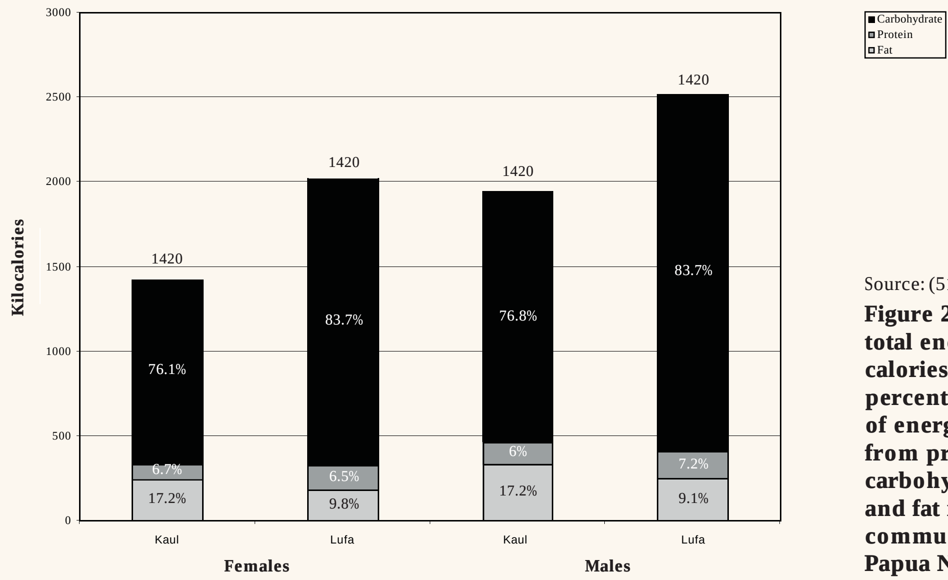
Figure 2.15: Mean energy intake (kilocalories) in Papua New Guinea, 1962–1981

Omen (45) suggested that in the Highlands in 1971 the average adult's intake was 1880 kilocalories while 1470 is the average in the lower regions (Figure 2.15). In the Highlands, low protein intakes were common and were dependent on the variety of sweet potato available. Generally, the vitamin and mineral composition of the diet was sufficient (45).

A dietary survey undertaken in the Western Highlands in 1972 showed that the diet consisted almost entirely of sweet potato. The daily energy intake was 2300 and 1770 kilocalories for males and females respectively as seen in Figure 2.15. Of the total energy, 94% was derived from carbohydrate, 3% from protein and 2.4% from fat (46). Adults consumed only 25g of protein per day. By contrast, Australians derive 40% of their calories from fat and consume approximately 100g of protein per day. However, in spite of this low protein intake the New Guineans represent a remarkably healthy group.

In a low-income urban setting in Lae, protein was found to represent 12% of the total energy intake (38% from animal sources) and refined carbohydrates represented 77% of the total energy intake (50) (data not shown).

Norgan and colleagues (51) conducted a survey in two villages: Kaul in a coastal region and Lufa in a highland region. Approximately 200 individuals were investigated during a period of 5–7 consecutive days. All the food to be eaten by each individual was weighed after cooking and immediately before consumption. The mean daily energy intake was 1940 kcal for Kaul men and 2520 kcal for Lufa men, 1420 kcal for Kaul women and 2105 for Lufa women as shown in Figure 2.16. The intakes of protein were low and there was no large difference in protein intake between the two villages. Fat provided about 10% of the energy in the highland diet and 17% in the coastal diet. Most of the energy and protein in the diets came from the staple root vegetables (taro in Kaul and sweet potato in Lufa). Carbohydrate intake was higher in the Highlands village than in the coastal community.



Source: (51)

Figure 2.16: Mean total energy (kilocalories) and percentage of energy derived from protein, carbohydrate and fat in two communities in Papua New Guinea

Jeffries (52) described the dietary differences between a rural village, Awande, in the Eastern Highlands and one in the urban centre of Lae. Dietary patterns were assessed using a 24-hour recall method of frequency of types of foods eaten. The rural diet was high in complex carbohydrate, low in protein, low in fat and high in physical bulk (fibre). Sweet potato provided 85% of the energy and 65% of the protein in the diet. The diet of people living in Lae was higher in refined carbohydrate, and rice was the main staple. On the whole the urban diet was:

more refined, sweeter, higher in fat and therefore less bulky and probably lower in some vitamins and minerals. (52)

Martin and co-workers (48) conducted a dietary survey in the rural village of Kalo and in a relatively affluent suburb of Port Moresby (Koki) as part of a diabetes epidemiology survey.

The village people ate a diet in which yams, cassava and bananas were most commonly consumed with very little refined food; in contrast, the urban population ate a largely western diet in which bread, polished rice and tinned foods were most common. (48)

The energy intake was estimated to be 2300 kcals for urban dwellers and 1400 kcals for rural people (48).

A survey was carried out by Date et al. (47) in 1981 in the Eastern Highlands Province. Men aged 20 to 29 years were reported to have a daily energy intake of 2814 kcals (Figure 2.15) with 91% derived from carbohydrates, 6% from protein and 3% from fat.

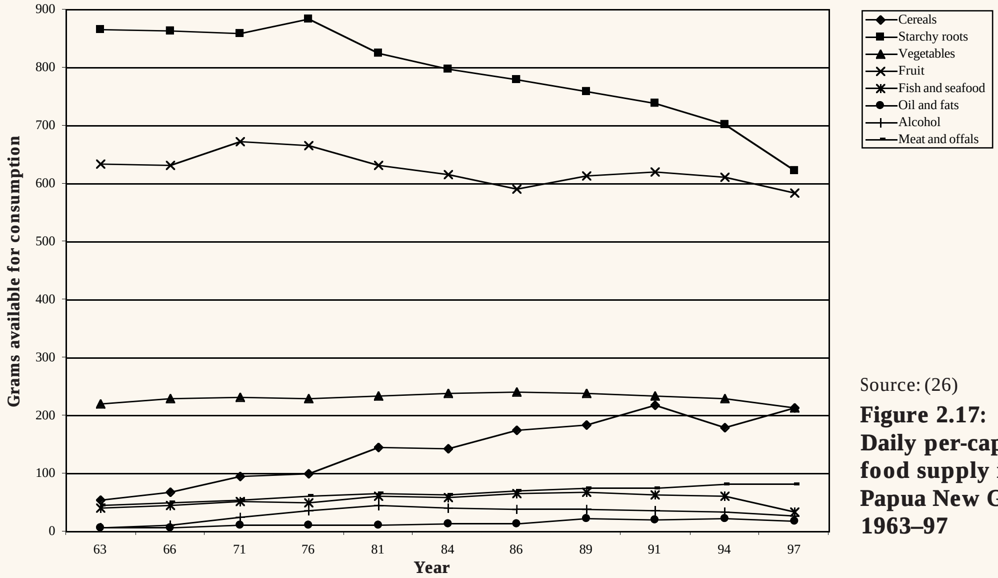
In order to assess the effect of economic development, another survey was carried out in 1981 among 67 individuals in the village of Yobakogl in the Simbu area of the Highlands (53). Intakes of individual villagers were assessed by weighing food before consumption and asking about other foods eaten. The intakes of both energy and protein were much higher than those found in the Kaul and Lufa surveys (51). These increases have occurred largely because of increased consumption of imported foods, such as cereals, tinned fish or meat. The investigators suggested that younger members of the community might have acquired a greater taste for imported foods as opposed to adults who still have a greater reliance on traditional foods. Sweet potato remained the most important item in the diet but the source of protein now came from cereals, meat and fish.

A nutrition survey was carried out in 1978 at Kalugaluvi near Lufa in the Eastern Highlands Province (49). The food intake of 18 healthy adults aged from 20 to 40 years was measured over two or three consecutive days. The 24-hour individual weighed-intake method was employed. Both raw food before cooking and cooked foods before eating were weighed. Leftovers and edible portions were also weighed and subtracted from the initial weight. The mean daily energy intake was 2390 ± 540 kcal as seen in Figure 2.15 and the daily protein intake was 35.2 ± 10.7g. Of the total energy intake, 78.1% came from carbohydrates, 16.8% from fat and 5.2% from protein. These results are probably exceptionally high in energy and fat because the survey was held during the yearly festival season of the village when the people often ate fatty pork.

The PNG Department of Agriculture studied the price of food in the five major urban markets of PNG between 1971 and 1986 (54). During this time period, the prices of imported foods had fallen and imported staples were the cheapest form of energy for urban consumers. The result of this was 'that the rational urban consumer now prefers rice and wheat flour to his/her traditional diet' (54). The study in rural areas showed that the price still favoured the traditional staples. This appears to be a fundamental finding in the Pacific. Where there is a cash economy, there are cheap imported foods. Where there is no cash, there is less expensive local produce.

In 1980 the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) showed that there was a dramatic increase in dependency on imported foods. Although this was most marked in urban areas, it was also evident in many rural communities.

The FAO food balance sheets (26) as shown in Figure 2.17 indicate the availability of starchy root vegetables and fruits in PNG between 1963 and 1997. However, with the increase in the availability of cereals, there has been a decline in the availability of starchy root crops. There was no dramatic change for fruit, vegetables, meat and offal, and fish and seafood. The calories provided from imported foods have doubled from 16% in 1961 to 34% in 1996.



Source: (26)

Figure 2.17: Daily per-capita food supply in Papua New Guinea, 1963–97

Solomon Islands

Several surveys have shown that in Solomon Islands the intake of nutrients was adequate. In 1971, dietary surveys were conducted in the capital city of Honiara, the second largest town of Auki and in the Ngella district, a rural agricultural area, by Jansen and Willmott (55). In all three areas, the total energy, fat, protein and carbohydrate intakes were adequate and did not vary significantly. The intake of vitamins A and B depended on the availability of fruits and vegetables for the household. The types of foods eaten, however, were quite different for the three groups. The urban group consumed more imported food and meat and the villagers ate more root vegetables. The rural diet was described as follows:

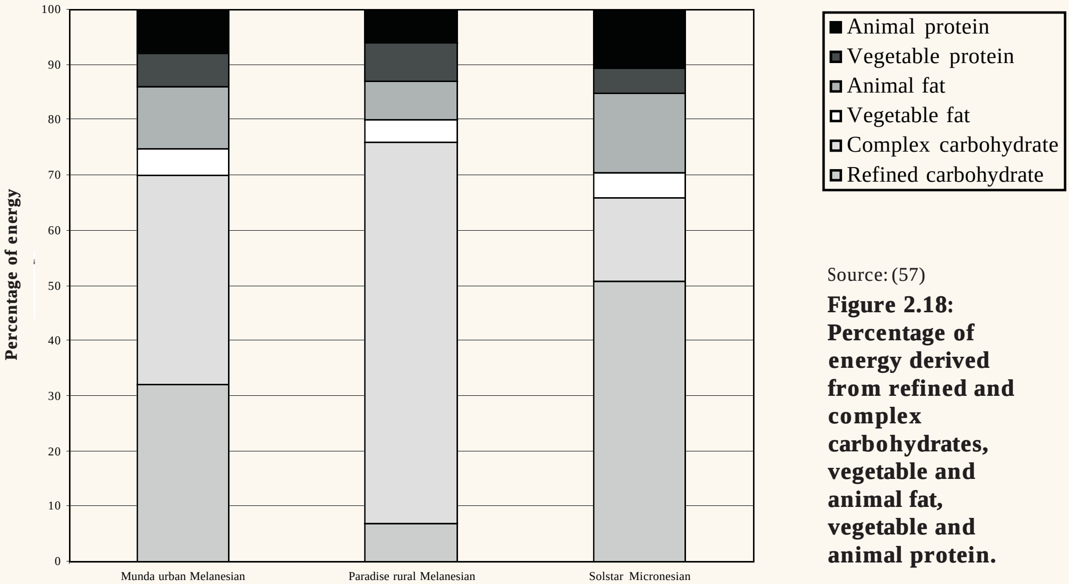
> *…root based with green leafy vegetables added in the form of a soup which often contained the cream from the squeezed flesh of the mature coconut.* (55)

A dietary survey was conducted in 1980 by the Harvard Solomon Islands Project (56), using both a 24-hour recall method and a diet habit interview. The survey of dietary habits and nutrient intake among six Solomon Island groups showed considerable diversity depending on habitat, local custom, and degree of cultural change. All groups were heavily dependent on root crops, chiefly sweet potato and taro, which were major sources of energy and very low in fat. Other important dietary staples included both local foods and imported items such as rice or flour. Diets for all groups were adequate in protein and most vitamins. Clinical observations indicate that nutritional deficiencies were uncommon among all six Solomon Island groups.

In 1985, Eason et al. conducted a dietary survey in three areas in the western province of Solomon Islands. Traditional (Paradise), more urbanised Melanesian (Munda) and semi-traditional Micronesian (Solstar) communities were compared (57). Approximately 1000 people aged 18 years and over took part in a 24-hour dietary recall interview.

For all groups, sweet potato was the main starch portion of the carbohydrate intake and refined sugar or toddy was the sucrose component. The principal protein source was fresh fish, and fats were derived mainly from reef fish, tinned fish, meat and coconuts. Traditional villagers of Paradise consumed more root vegetables, complex carbohydrates and crude fibre than did urbanised Melanesians of Munda.

The urban Melanesians also consumed more imported cereal such as rice and flour, tinned goods, refined carbohydrates, salt and alcohol. Figure 2.18 shows that Micronesians had the highest intake of refined carbohydrate and animal fat and the lowest intake of complex carbohydrates. Micronesians also have the highest intake of energy and the lowest intake of fibre (data not shown). Fifteen per cent of the daily energy intake of Micronesians was derived from drinking toddy, which is not consumed by Melanesians.

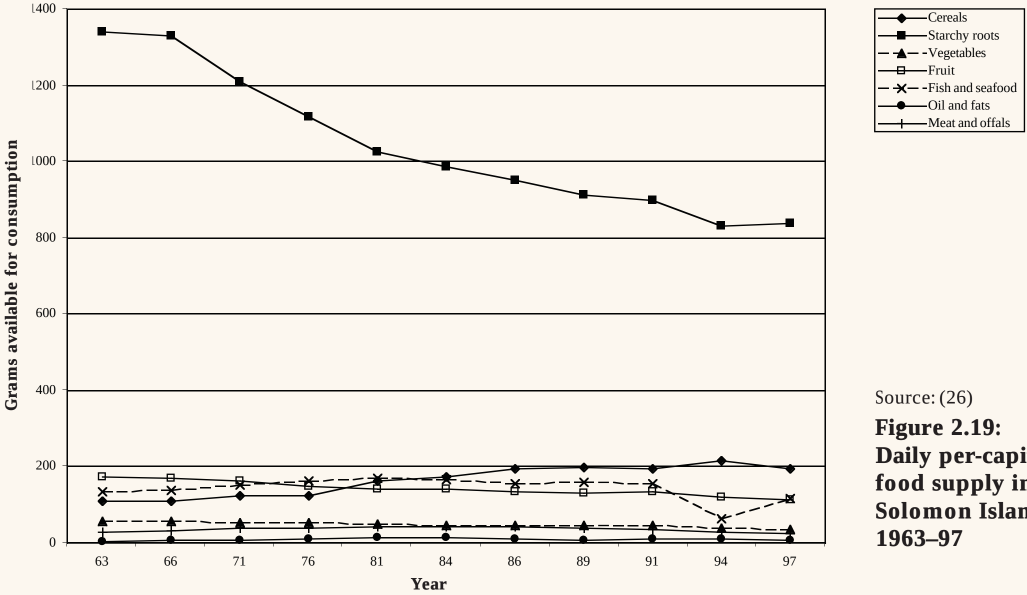


Source: (57)

Figure 2.18: Percentage of energy derived from refined and complex carbohydrates, vegetable and animal fat, vegetable and animal protein.

A 24-hour dietary recall survey was conducted among children aged 0 to 4 years and women aged 15 to 49 years as part of the 1989 National Nutrition Survey (58). In Honiara and in the periurban areas the intakes of rice, flour, biscuits, sugar, sugar snacks and other snacks were high. The main protein foods were fresh fish, seafood and nuts; other animal and imported protein sources were less common. Women in the higher economic activity levels consumed more protein foods and sugar and less green vegetables than women from bush villages.

The FAO food balance sheets for Solomon Islands (Figure 2.19) show a high availability of starchy root vegetables, although that amount appears to have decreased significantly since 1963. There are no appreciable changes concerning the amount of vegetables and fruits available. The proportion of energy (kilocalories) provided from imported foods has doubled from 1974 to 1996, from nearly 20% to nearly 40%.



Source: (26)

Figure 2.19: Daily per-capita food supply in Solomon Islands, 1963–97

Vanuatu (formerly the New Hebrides)

Dietary surveys conducted in Vanuatu over the past 40 years show that the traditional food pattern was nutritionally adequate in some areas but may have been low or marginal in energy, vitamin A and iron in other areas, particularly for children.

The earliest known nutrition survey was conducted in 1951 in Port Vila and in the neighbouring villages of Mele, Pango and Erakor. The study also reviewed the eating patterns in a rural area, on the island of Tanna (59). Malcolm described the diet as follows:

> *The diet consisted mainly of root crops, green leaves and coconut. Fruits were eaten in season. Sweetened tea was a popular drink, when it was available. Tinned meat and fish, rice, bread and biscuits were eaten in small amounts by those close to the stores… Because of their extensive use of local foods and cooking methods, the adults of Tanna consumed a diet adequate for the maintenance of good nutritional status.* (59)

Dye (60) conducted a nutrition survey in the rural village of Walarano (Malekula) by visiting 26 households over a three-day period in 1976. The amount of energy, vitamin A and riboflavin provided by the majority of the families' diets was estimated to be marginal. Families with high economic status ate meat, poultry and cereals more often. The protein intake of families with low economic status came mainly from starchy roots, tubers and vegetables. There was also a limited consumption of provitamin A sources (beta-carotene). Inadequate energy intake was possibly related to the low fat content and the non-varied nature of the diet.

Badcock and colleagues (23) carried out a 24-hour dietary recall survey in 1985. The sample consisted of 267 males (134 in the capital city of Port Vila, 67 on the island of Nguna [intermediate] and 66 on rural Tanna) and 164 pregnant or lactating women. Only the results for the males are presented here.

With increasing urbanisation, there was a decrease in total energy intake and an increase in the percentage of energy derived from imported foods, as shown in Table 2.6. There was also an increase in the percentage of energy from protein and fat, with an increase in the proportion of these foods being imported. The overall intake of carbohydrate decreased with urbanisation but there was an increase in the percentage of carbohydrate coming from imported sources.

Table 2.6: Total energy intake and percentage of distribution in the total energy intake for males in Vanuatu by level of urbanisation, 1985

	Urban: Port Vila	Intermediate: Nguna	Rural: Tanna
Total energy intake (kcal)	2510	3248	3406
% of energy from imports	53.5	35.1	10.5
% of total energy from protein	12.3	8.9	8.1
% of protein from imports	40.8	33.2	12.8
% of total energy from fat	30.6	25.6	22.9
% of fat from imports	44.8	20.7	8.4
% of total energy from carbohydrate	55	64.9	68.2
% of carbohydrate from imports	59.5	40.2	9.8
% of total energy from alcohol	2	0.7	0.8

Source: (23)

Badcock et al. (23) reported that in urban Port Vila, animal foods, margarine and oils have progressively replaced the traditional coconut as a source of fat. White rice, white bread and sugar were also an alternative to traditional root crops which resulted in a decrease in dietary fibre intake.

Urban residents had a high meat and fish consumption and in rural areas root crops and leafy green vegetables were predominant. Thus the urban diet contained more readily absorbable haem iron than the rural diet. Calcium, iron, vitamin A and vitamin C intakes for these males were above the Recommended Dietary Intake (RDI) of Australia but these intakes decreased with increasing urbanisation. Urban males consumed more alcohol than rural males. With increasing urbanisation there was a higher use of salt.

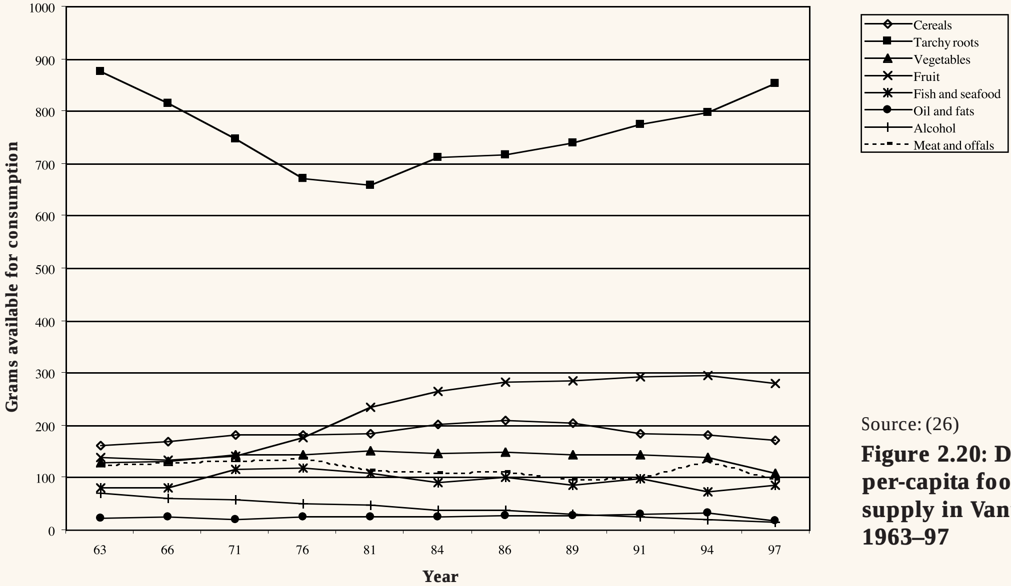
A national nutrition survey conducted in 1996 included 2122 mothers (15–49 years) and 1437 of their children under 5 years (61). A 24-hour recall method was used. The rural mothers consumed more traditional staples and less protein and imported foods than urban mothers. The amount of traditional foods in the diet of urban women has decreased since 1985.

The most recent study available was a food frequency survey done in 1998 (62). The survey sample comprised 47.5% urban people and 52.5% non-urban (intermediate and rural) people aged 20 years and over. The people were asked how often they ate 37 common food items. More than 60 per cent of the respondents ate root crops, vegetables and fruits daily, but only 17.1% prepared root crops into traditional dishes every day. Rice and bread were eaten daily by 56.4% of the respondents. Only 18.3 to 21.0% of people ate meat, fish or poultry on a daily basis. Twice as many respondents used coconut cream than oils (66.2% to 30.4%). Most of the people used salt every day (93%) while sugar was used daily by 62.2%. Soft drinks and other beverages such as milk, milo, coffee or tea were not popular everyday drinks in Vanuatu.

The 1998 study also found strong associations between the source of fat in the diet (traditional vs. imported) and obesity and diabetes. Vanuatu participants were 2.19 times more likely to be overweight or obese and 1.94 times more likely to be diabetic if they used imported fat sources compared to traditional fat sources such as coconut.

In rural areas the proportion of daily consumers of traditional food items was higher than in the urban areas where bread, rice, tinned foods, oil and soft drinks were more popular. Although the methodologies used in this study were different from the previous studies of 1985 (23) and 1996 (61) (24-hour recall), the difference between the urban diet and the rural traditional diet was similar.

The FAO food balance sheets (26) indicate that root vegetables and fruit are the major foods available for consumption in Vanuatu (Figure 2.20). There appeared to be a decrease in root vegetables between 1963 and 1981 and then a gradual increase. There has been a substantial increase in the amount of fruit available for consumption and little change in cereals, vegetables, fish and seafood and meat.



Source: (26)

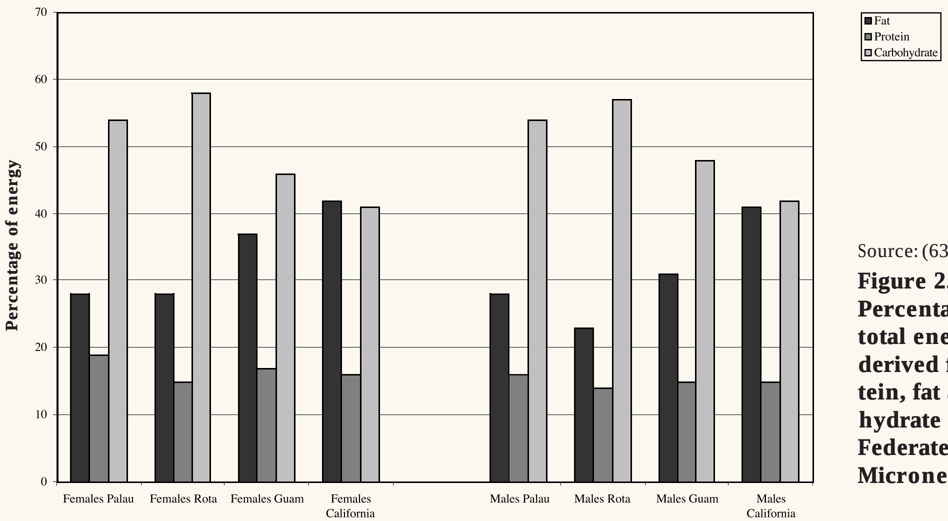
Figure 2.20: Daily per-capita food supply in Vanuatu, 1963–97

Micronesia

Federated States of Micronesia

A survey published in 1970 by Hankin and colleagues (63) compared the diets of Chamorro living a traditional way of life on the island of Rota and Palau to those living in a total cash economy in Guam and California (Figure 2.21).

The daily total energy intake was higher among the traditional groups but the major difference was the proportion of energy from fat and carbohydrate. In California and Guam the proportion of total energy coming from fat is much higher than in the rural groups. This difference was mostly due to an increase in saturated fats. The amount of energy derived from carbohydrate decreased from the rural to the urban setting (63).



Source: (63)

Figure 2.21: Percentage of total energy derived from protein, fat and carbohydrate in the Federated States of Micronesia, 1970

Taro and cassava were the predominant carbohydrate foods in Palau, rice in Rota, rice and bread in Guam, and bread in California. Protein intakes did not differ appreciably among the groups. The use of meat and poultry was greater in California and Guam than in Rota and Palau, while fish consumption showed a reverse pattern (63).

A survey including the Mariana Islands, Marshall Islands, Palau, Pohnpei, Truk and Yap was conducted in 1973 by Kincaid (64). The method of the survey was a 24-hour recall of the food cooked within the home of 295 families. Kincaid concluded that although sufficient and appropriate food was available for an adequate diet, it was not consumed – perhaps due to 'economic and social changes brought about by western education and development'.

Fritz (65) examined the impact on infant nutritional levels of the changing roles of women in Truk. Her paper is based only on a literature search. In this study Fritz describes the traditional diet of the Micronesians as follows:

> *Prior to the introduction of modernisation to the Micronesian islands, the traditional diet consisted of fish, taro, yams, breadfruit, tapioca, banana, coconuts, fruits such as mangoes, papayas, guavas, and leafy vegetables. The people lived off the land and the sea. Older children ate the same kinds of foods as the adults. The infants received mothers milk. The diet was very simple, no additive or preservatives added to the foods.* (65)

> *The dependence on imported foods is greater in the district centres, particularly in the families migrating from the outer islands. Because most of them do not own lands in the district centres, all their foods have to be bought in the stores. It is for this reason that children of these families are fed exclusively on imported foreign foods.* (65)

A national nutrition survey, carried out in 1987–88, included women aged 15 to 49 years and children aged 0 to 4 years on a randomly selected sample, which covered 28% of the population groups (66). An analysis of the dietary patterns of women showed that fat consumption is slightly lower in the rural outer island areas compared with urban areas. Greens and vegetables are almost non existent in the diet of both rural and urban women. The number of women consuming fruit or fruit juice was extremely low but nearly all fruits consumed were local fruit (except on the main islands). The consumption of sugar was moderate, but highest in the urban areas. The number of women drinking alcohol was low. Imported foods were more commonly consumed in main island areas where there was easier access to stores than in rural areas.

Guam

There is little information regarding the current dietary patterns of inhabitants of Guam. Nutritional surveys conducted by Hankin and colleagues (63) reveal the higher fat and lower carbohydrate patterns in urban Guam compared with the consumption of traditional foods in rural areas.

> *Traditional foodstuffs in Guam were taro, breadfruit, yams and rice. They were used as the basis of the regular food intake. Arrowroot,* fadang *(a cycad nut) and bananas also played an important role. Sweet potato, corn and, less importantly, cassava arrived with the Spaniards coming from Mexico. It's a good diet since it is high in fibre and low in fat, salt and refined sugars. People of Guam have continued to rely on taro, yam and some breadfruit in spite of the introduction of Spanish and American foods.* (67)

Kiribati

Early surveys in Kiribati found vitamin–A and riboflavin deficiency but by 1984 there were no more reports of vitamin–B deficiency. The survey conducted by Pargeter and colleagues (20) showed that with urbanisation the diet in Kiribati has changed.

In 1948, Turbott (16) interviewed 12 families (52 adults and 36 children) about their food intake over a period of two months. The diet was calculated to contain 3000–3500 kilocalories per person. Riboflavin, calcium and vitamin A were below recommended standards but all other nutrients were present in adequate amounts.

Holmes (68) conducted two nutrition surveys in Kiribati in 1953. One survey was in the rural atoll of Maiana and the other was in a boarding school for boys in the administrative centre of Tarawa. The latter survey reported a high carbohydrate intake of the schoolboys' diet, which came from rice, flour, and sugar. Their diet was lacking in riboflavin and ascorbic acid. The fat content of the rural diet came mainly from coconuts.

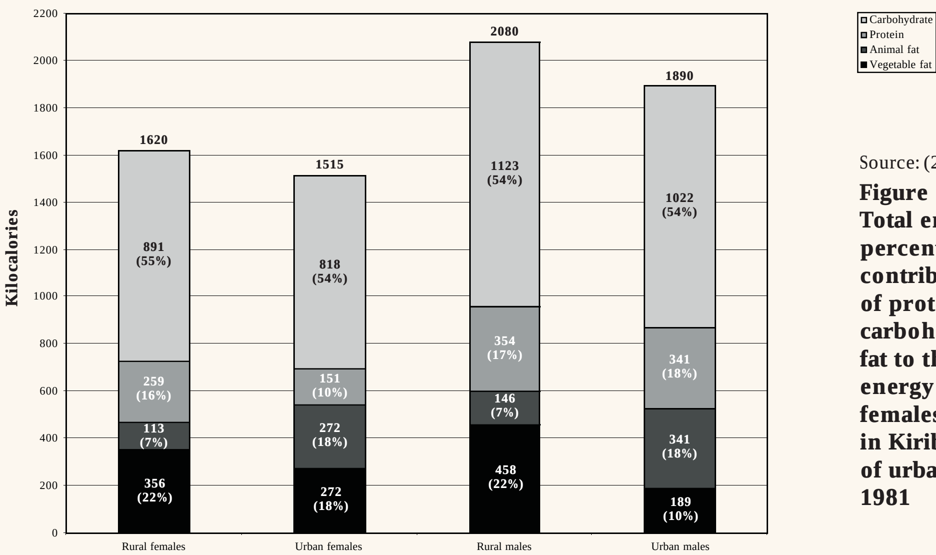
A follow-up study of the Holmes survey was made by Willmott in 1968 (69). Between 1948 and 1968 there had been at least a 40% increase in the consumption of flour, white rice and sugar, and the consumption of all three was significantly higher in the urban centre of Betio than in the rural island of Maiana. Dental caries, clinical signs of vitamin–A deficiency (Bitot's spots) and riboflavin deficiency (angular stomatitis) were reported in all age groups in both areas, but more frequently in the urban centre.

A small dietary survey of 16 families in Betio and Bikenibeu conducted by Thompson in 1977 (70) revealed that imported foods made up 40 to 50 % of the total energy of the diet.

In 1980 Zimmet and colleagues (71) calculated the proportion of total energy derived from imported foods using a 24-hour dietary recall method. Among both genders and at each age group, the proportion of energy derived from imported food was lower in the rural population. The differences were highly significant.

Taylor and colleagues (20) conducted a dietary study in 1981. A 24-hour dietary recall method was selected for the survey. A stratified random subsample was selected to represent both rural and urban sectors of Kiribati. The rural population was from the area of Tabiteuea north and the urban population consisted of residents of Betio, the administration and commercial centre of Kiribati. Individuals over the age of 20 were interviewed.

Figure 2.22 indicates that there was no significant difference between rural and urban females in mean energy intake but there was a trend for rural males to have a higher energy intake than urban males. The mean percentage contributions of protein and carbohydrate were not significantly different between urban and rural residents but there was a higher vegetable fat contribution for rural adults compared with urban adults. This difference is mainly due to consumption of coconuts which is much higher in rural areas than in urban areas. Alcohol consumption by women was negligible in both the rural and urban samples. Imported foods contributed significantly ($p<0.005$) more energy to the urban diet than to the rural diet (data not shown).



Source: (20)

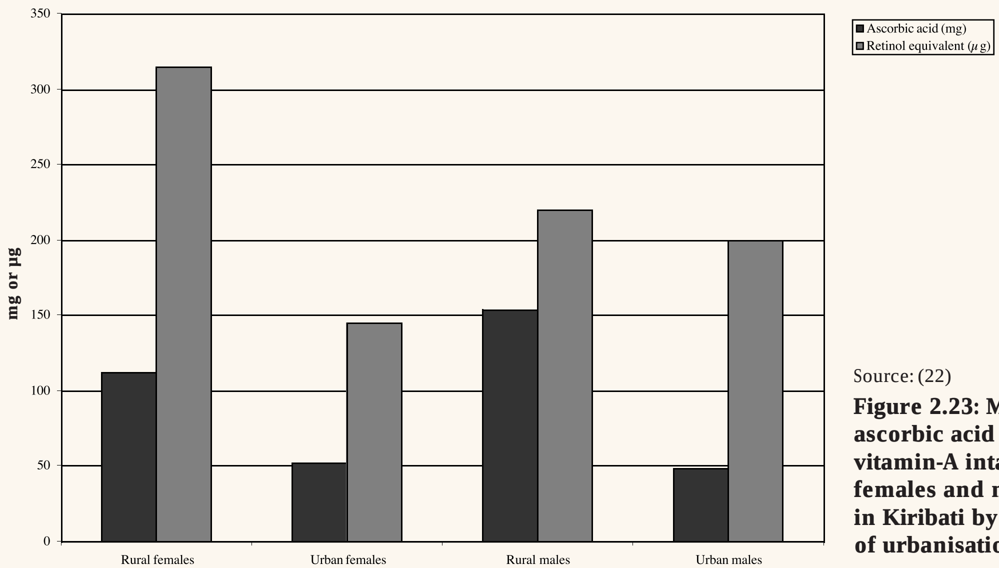
Figure 2.22: Total energy and percentage contribution of protein, carbohydrate and fat to the daily energy intake for females and males in Kiribati by level of urbanisation, 1981

The mean daily protein intake observed in both rural and urban adults was adequate. When standardised for age, rural Tabiteuean males ate significantly ($p<0.05$) more protein than their urban counterparts. In Tabiteuea there was a large variety of seafood consumed, which was not eaten in urban Betio.

Rural adults ate more carbohydrate than urban residents and less imported sugars than urban people. Imported rice and flour are major contributors to total starch intakes on both Tabiteuea and Betio. Rural females consumed significantly less starch ($p<0.05$) from both local and imported foods than urban females. No significant difference was observed in the mean intake of total sugars between the rural and urban subsample. Mean crude fibre intake in Kiribati decreases with urbanisation.

The fat content of the Kiribati diet was predominately saturated fat. Consumption of fat from vegetable sources (coconut) was significantly lower in Betio than Tabiteuea north. The consumption of fats from animal sources was significantly greater in urban Betio than in Tabiteuea north for both genders at all age groups ($p<0.005$). Consumption of coconut decreased with urbanisation.

The mean daily ascorbic acid intake exceeded the Australian RDI (Recommended Dietary Intake) of 30 mg/day for healthy adult women and 40 mg/day for healthy adult men. The major source of vitamin C in the Kiribati diet is fresh sweet coconut sap (toddy). The highly significant decrease ($p<0.005$) in mean ascorbic intakes between rural and urban Kiribati reflects the lower consumption of fresh toddy on Betio compared to Tabiteuea north (Figure 2.23).

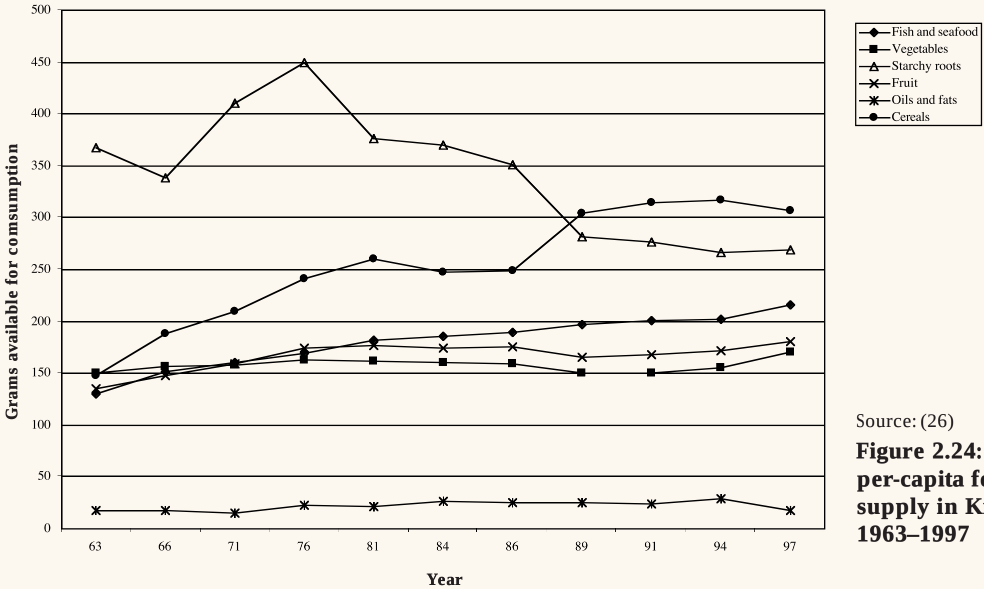


Source: (22)

Figure 2.23: Mean ascorbic acid and vitamin-A intake of females and males in Kiribati by level of urbanisation

The mean intake of retinol equivalents of Kiribati adults was significantly less than the Australian RDI of 750µg (72). Rural women had significantly higher vitamin–A intakes than the urban women. Vitamin–A deficiency may occur when the consumption of small fish is replaced by tinned meats, or when very little fresh fruit or vegetables are eaten. When the Kiribati adults eat small fish they eat the liver as well which is very rich in retinol. Intakes of thiamine and niacin appeared to be adequate and met or exceeded the Australian RDI, but riboflavin was marginally lower than the Australian RDI.

According to FAO food balance sheets (26), since 1963 there has been an increase in the availability of cereals, fish and seafood. There has also been a dramatic decrease in starchy roots. Fruit and vegetables tended to decrease slightly over this time period. There was little change in oil and fat availability. The percentage of calories provided by imported foods increased from 30% in 1963 to 55% in 1996 (Figure 2.24).



Source: (26)

Figure 2.24: Daily per-capita food supply in Kiribati, 1963–1997

The Republic of the Marshall Islands (RMI)

The principal foods grown in the Marshall Islands are coconut, breadfruit, pandanus and taro. Small quantities of sweet potato, banana, papaya, lime, watermelon, cucumber and cassava are also grown. A few pigs and poultry are raised on a limited scale and normally consumed on special occasions. Fish and seafood provide the main local sources of protein. By 1985, local food production was not sufficient to feed the whole country and three-quarters of the nation's food requirements were imported (73).

Thomas (74) estimated that 90% of all foods consumed in the RMI were imported. Agriculture and food production play a relatively insignificant part in the daily activities of many Marshall Islanders.

> *The lack of traditional foods and consumption of foods high in fat, sugar and salt, and low in fibre, [means] that the Marshallese are subject to the same diseases and causes of death as those in other Pacific Island countries that have gone through a similar change from traditional to more westernized dietary habits and lifestyle.* (74)

A survey conducted in Mili, Namu and Majuro atolls (75) shows that in the rural atolls (Mili and Namu) there is a higher consumption of local foods and a lower consumption of imported fish and meat. Across the atolls there was no great difference in rice consumption. Mili had the highest levels of fruit and vegetable consumption and in urbanised Majuro there was a much higher level of milk consumption.

The national survey carried out in 1990–91 (76) reported nutrient intakes of 1144 women aged 15 to 49 years. The per-capita energy intake was 1430 kcals composed of 188 g carbohydrates, 66 g proteins and 47 g fat. The intake of iron was 11 mg per capita per day. Clinical signs of vitamin A, B and C deficiencies were also reported.

Nauru

Since 1958 the diet in Nauru has changed from a traditional one to a practically totally westernised one. Today, almost all foods are imported. The traditional diet of Nauruans consisted almost entirely of fish and the products of the coconut and pandanus trees. Certainly by 1957, after the discovery of phosphate and the coming of Europeans, the diet had changed completely. Kirk in 1958 (77) described the changes that had occurred in less than 20 years:

> *The native Nauruan now buys his foodstuffs almost entirely from the island stores and indigenous foods contribute little to his diet. The Nauruan diet consists mainly of three foodstuffs, white rice, tinned meat and sugar.*
>
> *The native appears to have lost his taste for the coconut and rarely eats it. Its two main uses today are for making hair oils and for the collection of the sap which is drunk as toddy.*
>
> *The task of encouraging the use of more milk, margarine, fruit and vegetables (not an easy one) will prove to be primarily one of education, aimed chiefly at the younger members of the population who are less resistant to change than their elders.* (77)

A dietary survey was conducted in Nauru in 1976 by Ringrose and Zimmet (78). An adjusted 24-hour recall method was used and 77 adult Nauruans were interviewed. The results show an extremely high mean energy intake (6092 kcals) for females and males combined, which is more than twice the WHO Interim Standards for developing Western Pacific countries (79).

There are several explanations for this high rate: first, the phenomenon of 'feast and famine' which is due to fluctuations in agricultural crops and dependence on food availability in relation to the frequency of cargo ships and air services. Second, the survey coincided with the mango season – a fruit highly consumed. Therefore, it is possible that the high caloric intake in this survey may not be totally representative of normal intake as a result of supply and availability of foodstuffs. Third, the high calorie intake found in the survey may not be totally representative of normal intake but a result of supply and availability of foodstuffs.

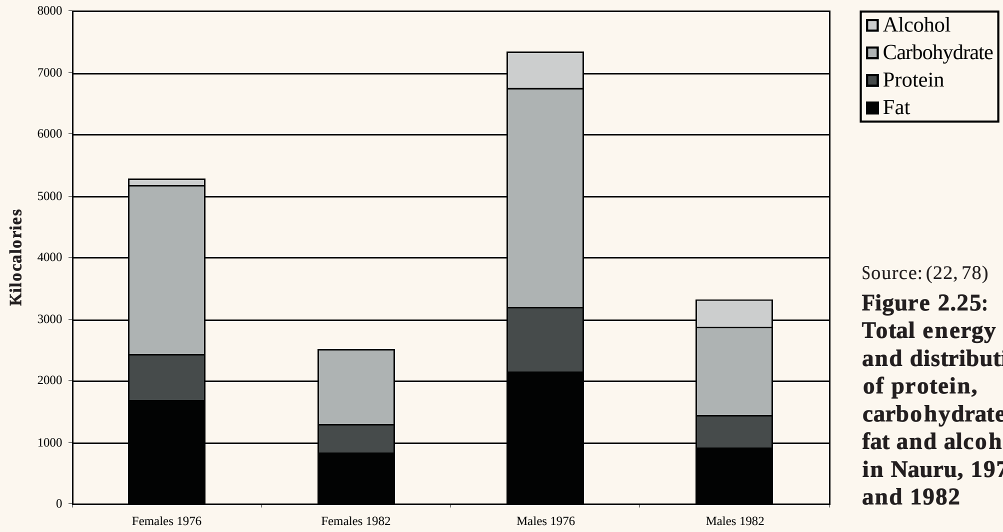
Ringrose and Zimmet (78) found that the main sources of carbohydrate were rice and sugar, and occasionally potatoes. Very few of the traditional starchy vegetables were consumed. The percentage of protein in the diet was fairly high, imported meat and fish and the cash to buy them being easily available. The moderate fat contribution may be due to the custom of cooking meat and fish in island fashion directly over an open fire.

Although Nauruans eat little fresh fruit and vegetables, there was not an ascorbic acid deficiency. However, it appeared that Nauruans were not consuming sufficient thiamine for their needs. In 1976, the mean daily alcohol consumption represented 7% of total energy intake for males and 1% for females. Figure 2.25 provides the total energy intake and the distribution of protein, fat, carbohydrate and alcohol compared with a subsequent survey in 1982 by the same investigators (22).

In 1982, Ringrose and co-workers (22) conducted a second dietary survey of 399 Nauruan adults aged 20 years and over. This study was carried out in conjunction with a diabetes and heart disease prevalence survey. Data from the 24-hour recall method were collected from a subsample of survey respondants.

For Nauruans, the relative contributions of protein, fat and carbohydrate to the total energy intake reflect that of Caucasian populations. The main foods consumed were rice, fresh fish/meat, canned fish/meat, flour-based products, sugar, tinned milk, cordials and confectionery. The dietary fibre intake of Nauruans was much lower than that of Caucasians (data not shown). Thiamine intake was low and ascorbic acid intake was above the recommended dietary allowance (72).

Alcohol consumption in Nauru was significantly much higher for males than females. Fourteen per cent of energy for males was derived from alcoholic beverages. In 1982, the energy provided by imported foods represented 82% and 81% for males and females respectively (22).



Source: (22, 78)

Figure 2.25: Total energy intake and distribution of protein, carbohydrate, fat and alcohol in Nauru, 1976 and 1982

Palau

In 1970, Hankin and Dickinson (80) conducted a 24-hour dietary recall survey in Koror, the administrative centre of the district; Peleliu, an intermediate island in the south of Koror; and Ngarchelong, an isolated island north of the largest island of the district. The survey included 261 persons over the age of 20.

The estimated mean intake of energy was higher in rural Ngarchelong (1960 kcal) than in Peleliu (1725 kcal) and Koror (1835 kcal). The total fat intake was greater in Ngarchelong due to the use of ripe coconut, and intakes of calcium, iron, vitamin A and thiamine were also higher due to the frequent eating of fish and green vegetables. The greater intake of cholesterol and niacin in the Koror sample was due to a higher consumption of meat and eggs. Except for vitamin A and ascorbic acid, the Peleliu sample had lower intakes of all nutrients. In Ngarchelong there was a higher consumption of indigenous foods than in Koror and Peleliu.

Polynesia

Cook Islands

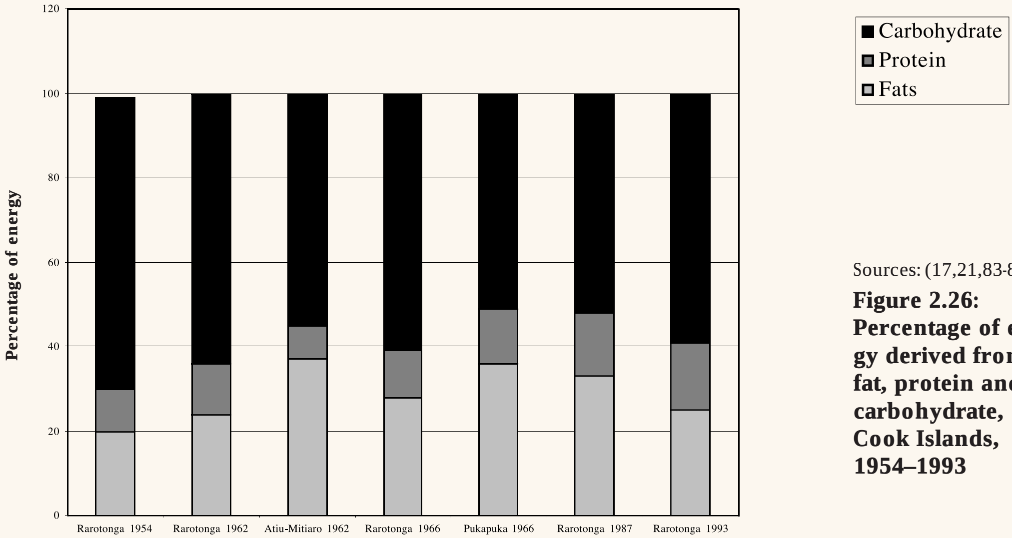
In 1947, Abraham noted a change in food habits among Rarotongans and described the value of a traditional diet (81).

> *the traditional roots, besides containing carbohydrate, also supply important mineral, vitamin and jaw exercise which are now lacking in the diet since the Rarotongan depends so largely on the European white bread and refined sugar for his carbohydrate.* (81)

Holmes (17) explained that in early times, *puraka*, a taro-like root, was a staple of the Cook Islands diet. Coconut, pandanus, *kumara* (sweet potato), banana, pawpaw, breadfruit and considerable amounts of fresh and dried fish made up most of the traditional diet. The total energy intake and the distribution of carbohydrate, protein and fat for Rarotonga in 1954 are shown in Figure 2.26 and compared with subsequent surveys.

In 1957, Fry reported that on Rarotonga, villagers engaged in subsistence agriculture regularly consumed bread and sugar (82). The average family was consuming 1535 grams of white bread and 106 grams of sugar per day.

A dietary survey was conducted in 1962 in Rarotonga, Atiu and Mitiaro in the Southern Group of the Cook Islands, of 756 people (83). In Rarotonga, which had come under considerable western influence, the energy and protein intakes greatly exceeded those of the Atiu–Mitiaro islanders (Figure 2.26). On the other hand, the percentage of energy coming from fat was higher for Atiu-Mitiaro than Rarotonga. The fat intake was higher in the rural area and different in quality as well; for Rarotongans, 86% of the fat intake came from animal sources, while 89% came from coconuts for the Atiu-Mitiaro islanders.



Sources: (17,21,83-85)

Figure 2.26: Percentage of energy derived from fat, protein and carbohydrate, Cook Islands, 1954–1993

Prior et al. (84) reported on a dietary survey carried out in 1966 which included 107 Rarotongans and 30 Pukapuka inhabitants. The food habits and meal patterns were obtained by a 24-hour recall method on people aged 40–69 years. The Rarotongans had a higher carbohydrate and energy intake than the rural Pukapukans (Figure 2.26). However, the intake of fat calories from coconut was remarkably higher in Pukapuka, 75% of fat calories being derived from coconut, compared with 23% in Rarotonga.

The 1954, 1962 and 1966 surveys showed that much of the higher carbohydrate consumption of the urban dwellers appeared to come from sucrose. The diet in Rarotonga showed an increasing reliance on imported foods. Indeed, the population was consuming more sugar, salt and animal fat, and less bulky, starchy foods and fibre. The diet had become a combination of local and imported foods. Traditional staple foods such as taro, fish and pork were still very much valued and were an important part of ceremony and custom (86).

In 1987, a dietary survey using the 24-hour dietary recall method was conducted with the participation of 384 Rarotongans (21). The proportion of energy derived from fat, protein and carbohydrate is also shown in Figure 2.26. This study showed that the energy intake was above the recommended levels (79). The dietary intake was also high in saturated fats, and all vitamins and minerals analysed were above the recommended levels except for thiamine, riboflavin, vitamin A and calcium. The imported foods represented 60% of the total daily food intake.

A 24-hour dietary recall survey was undertaken in 1993 on 127 adults in the village of Tutakimoa on Rarotonga (85). The total energy intake was 2815 kcals for men and 2524 kcals for women. This intake, as well as the intake of fat and carbohydrate, was appropriate, especially if we compare it to current recommendations (87). A considerable number of the foods eaten were local foods.

Niue

Langley (88) studied the daily food consumption of a sample of the population of two villages in Niue, Avatele and Liku, in 1953. Thirty-two households were interviewed. The study revealed a low riboflavin and calcium intake. The mean dietary intake was 2030 kcals with a contribution of approximately 70% carbohydrates, 20% fat and 10% protein. Langley described the Niuean meal pattern as follows:

> *The basis of the Niuean meal is a starchy root or fruit, more usually a mixture of several roots. They are cooked either alone or mixed with coconut cream in the stone oven or by boiling. A relish is served with the roots, and can be fish or shellfish, meat or chicken or green leaves. If the relish is made as soup no other liquid will be served. Fresh water, green coconut water, or sweetened tea are drunk otherwise.* (88)

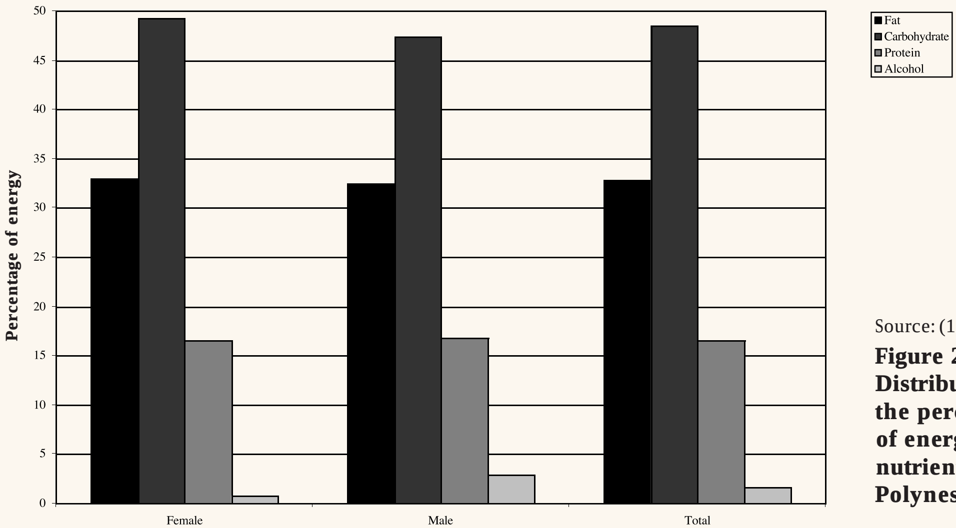
A 24-hour dietary recall survey was conducted in 1987 involving 1646 Niueans (89). The results showed a large percentage of people eating more than one balanced meal per day. Niueans had a heavy reliance on imported protein, staples, fat and sugar. The frequency of consumption of fresh fruit, green leafy vegetables and other vegetables was rather low especially when balanced against the heavy reliance on imported staples (most commonly white rice and white flour). Even though the consumption of fruit was higher than that of vegetables, it was still inadequate. People were consuming too much energy, but less fibre and less of some of the vitamins and minerals which could be found in the local staples.

French Polynesia

> *The traditional staple diet of Tuamotu [an atoll of French Polynesia] inhabitants consisted of coconut in various forms, screwpine, fruit, arrowroot and taro but these foods are virtually forgotten. Furthermore, breadfruit, bananas, domestic fishing and rearing of livestock are becoming rare. But the imported food such as flour, sugar, rice, biscuits, vegetable fats or tinned foods lead to a change in diet from traditional to modern patterns.* (2)

A nutrition survey was conducted jointly by the Health Department of the Territory of French Polynesia and the Territorial Institute of Medical Research Louis Malardé in 1995 (19). A cross-sectional survey was carried out on a random sample (N=1273) of the population aged 16 years or older, born in French Polynesia and who had lived there for at least 10 years. The survey used a food frequency questionnaire, which is often used in large sample surveys.

In the 1995 survey, the average energy intake was 3752.7 kcal/day with a significant difference between males (4404 kcal/day) and females (3350.6 kcal/day) ($p<0.001$). The intake decreases with age. Figure 2.27 presents the distribution of nutrients in the total energy intake. Fat and protein intakes were above the WHO recommended levels while carbohydrate intake was below (see Table 2.7).



Source: (19)

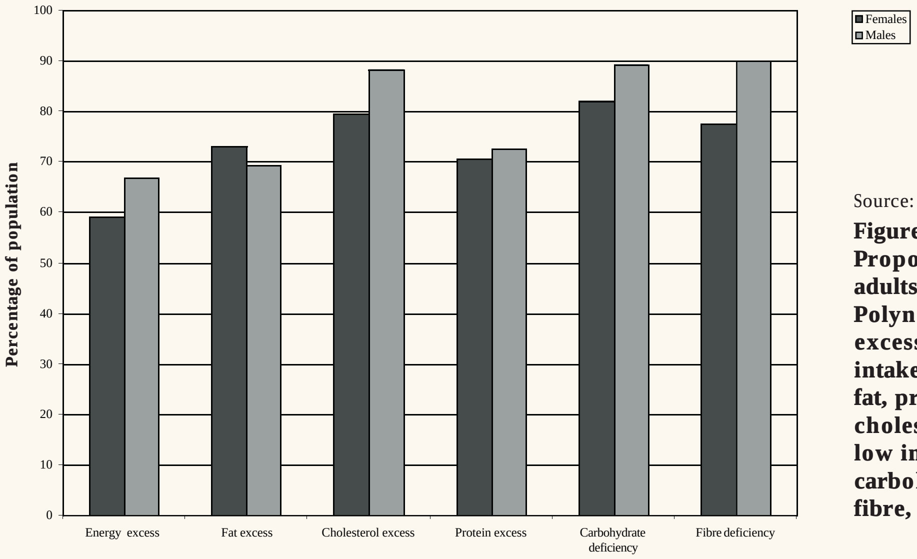
Figure 2.27: Distribution of the percentage of energy from nutrients, French Polynesia, 1995

The intake of major nutrients in French Polynesia was assessed according to WHO recommendations (90). If energy intake is lower than 80% of the WHO recommendations there is a risk of deficiency; if it is higher than 120% of the recommendations, it is considered excess energy. Table 2.7 presents the WHO recommendations of 1986 (90) for the distribution of nutrients in the total energy intake.

Table 2.7: WHO recommendations for percentage of total energy derived from macronutrients, 1986

Nutrients	Lower level	*Excess level*
Fat	15%	30%
Carbohydrate	55%	75%
Complex carbohydrate	50%	70%
Simple carbohydrate	0%	10%
Protein	10%	15%

Figure 2.28 indicates the proportion of females and males in the French Polynesian population that exceeded recommended intakes of energy, fat, cholesterol and protein and consumed low intakes of carbohydrate. A large majority of the total population exceeded the WHO recommendations for energy (62.2% of the population), fat (71.6%), protein (72.6%) and cholesterol (83%). Eighty-four per cent of the total population had low intake of carbohydrate. For all the major nutrients, intakes decreased with age.

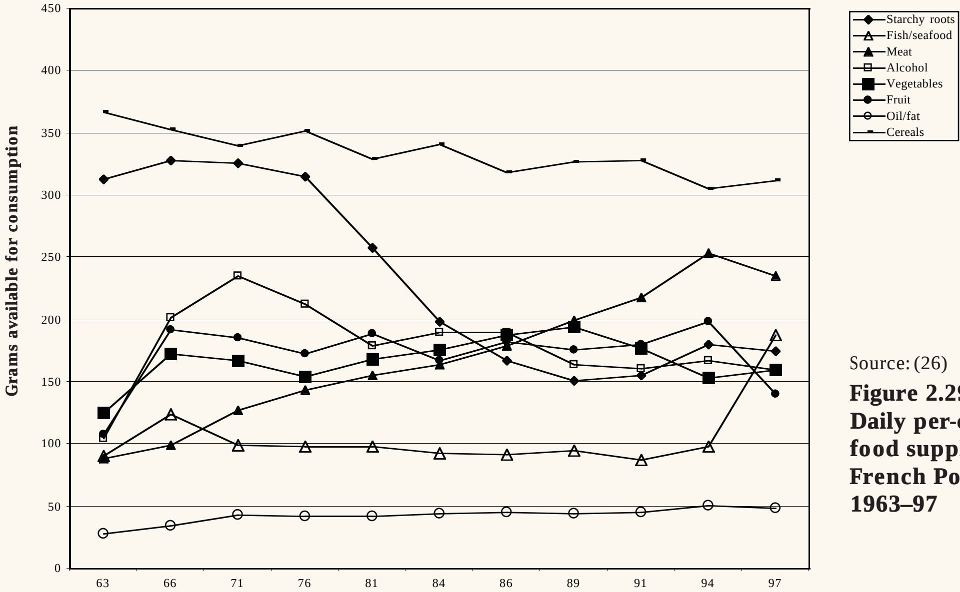


Source: (19)

Figure 2.28: Proportion of adults in French Polynesia with excessive dietary intake of energy, fat, protein and cholesterol and low intake of carbohydrate and fibre, 1995

For females and males, intakes of vitamins A, E, C, thiamine, riboflavin, niacin and B12 and of minerals (sodium, potassium, calcium, magnesium, iron, zinc) were sufficient. The per-capita intake of alcohol (13 litres for those 16 years and over) was judged to be the highest consumption in the world, along with France.

The FAO food balance sheets (26) as shown in Figure 2.29 indicate that cereals and meat are the major foods available for consumption in French Polynesia in 1997. The food balance sheets also indicate that since 1963 there has been a dramatic decrease in starchy root vegetables with a steady increase in the availability of meat. There has been no dramatic change in cereals, fruits, vegetables or fats and oils available for consumption.



Source: (26)

Figure 2.29: Daily per-capita food supply in French Polynesia, 1963–97

The FAO also reported that in 1961, 75% of the total energy in French Polynesia was provided by imported foods and by 1997, the percentage increased to 81%. Essentially, all animal fats, vegetable oils, cereals, meat and milk are imported. Approximately half of the fruit, alcoholic beverages, fish and seafood are imported as well as 30% of the starchy roots.

American Samoa

In American Samoa and (Western) Samoa the diet has changed with urbanisation, yet many surveys show that Samoans still prefer their traditional foods.

Malcolm (91) described the traditional eating pattern of Samoans as follows:

> *Taro, yams, coconut, bananas and breadfruit were the major staples. Domestic pigs and chickens were available, but these were probably reserved for special occasions and did not provide a significant contribution to the everyday diet, especially the diet of women and children who were largely excluded from eating these foods.* (91)

Bindon (92) administered 24-hour recall questionnaires to 330 Samoan adults in American Samoa and Hawaii in order to study the effect of modernisation on the Samoan diet. The traditional diet has been substantially altered after 150 years of exposure to missionaries, traders and military personnel. The data revealed a trend of increasing reliance on purchased foods and decreasing reliance on traditional Samoan items especially the energy staples of breadfruit, banana, taro and coconut. Canned corned beef, canned fish and fresh beef have become important sources of calories and protein, and bread and rice have partially replaced the traditional starchy crops.

In order to study the relationship between diet and migration, Brown and colleagues (93) conducted a survey of three different population groups: from the island of Ta'u, the most traditional area of American Samoa, from the outlying Manu'a group, and those who had migrated to Oahu, Hawaii. There were no major changes in the caloric intake or in the nutrient quality of the diet as a result of migration to Hawaii. However, there were changes in the types of foods consumed. For example, green bananas were the most frequently consumed foods in Manu'a, while rice was the most popular food item in Hawaii.

Pollock (94) carried out a study that highlighted the food preferences of Samoans living in the Wellington region of New Zealand. For the Samoan people their island foods remained important in their daily lives even though many other types of foods were readily available and often cheaper. Their island foods allowed them to affirm their Samoan values and identity. The eating pattern of the Samoans in New Zealand was described as follows:

> *taro, fish, and green bananas together with coconut cream, feature predominantly, because those are the foods that people can buy at the local greengrocer. Breadfruit, which they would eat in season back in Samoa does not travel well so is unavailable in Wellington.* (94)

Samoa (formerly Western Samoa)

As early as 1951, Holmes (95) suggested that in the villages near Apia, the main urban centre of Upolu, Samoa, there was a tendency to replace root vegetables with bread. Moreover, the traditional coconut cream and fish dishes were replaced with sweet tea and jam. However when taro and breadfruit could be obtained, they were still preferred.

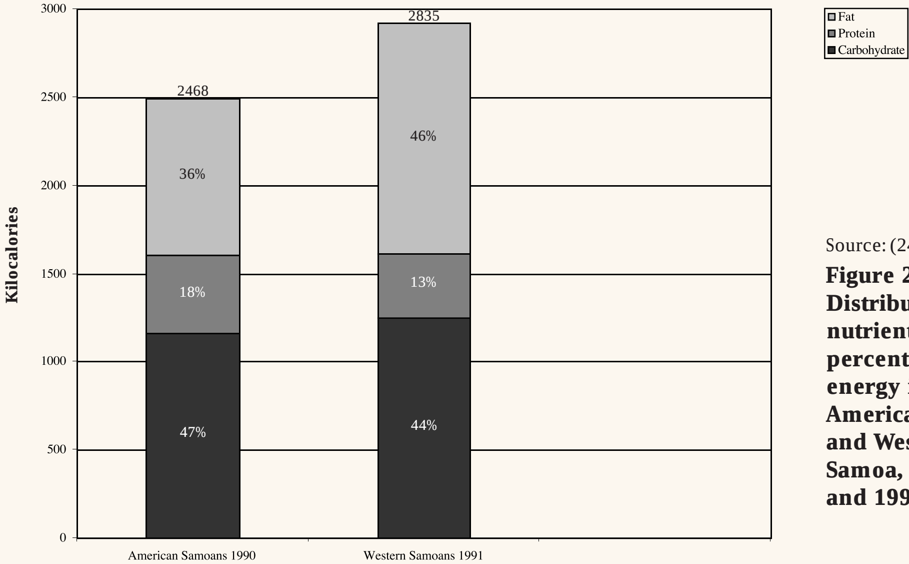
Pelletier (96) conducted a dietary survey in 1984 among Samoan men including rural villagers, urban workers and sedentary urban workers aged 18–40 years. The assessment employed a 24-hour recall interview as the primary source of information of the men's dietary patterns. The study revealed that caloric intake was higher among active workers (4300 kcals) and villagers (4192 kcals) than among sedentary workers (3794 kcals). There were no significant differences in macronutrient composition of the diet between the different groups of men.

In 1992, Quested and colleagues (97) described the Samoan diet as follows:

> *The main diet consists of taro, green bananas, fish, chicken and pork with dietary fat coming in the form of coconuts. However, over the years, there has been a significant increase in the consumption of imported foodstuffs viz. mutton flaps, turkey tails, white rice, flour and sugar. The increase in the consumption of imported foods has been because these items are much cheaper than better quality local foods.* (97)

A survey of 130 adult Samoans was conducted in Siumu Sisifo, 66 kms from Apia, in 1992 by Sparling (98), using a food-frequency methodology. The total energy intake was found to be 3193 ± 1256 kilocalories. The contribution of carbohydrates, protein and fat to total energy was 48%, 16% and 36% respectively. Modern foods contributed higher amounts of calories from protein and fat than did the traditional foods. On the other hand, the carbohydrate intake from traditional foods, as a percentage of energy, was slightly higher than the intake of carbohydrate from modern foods.

A dietary survey was conducted in 1990 in American Samoa and in 1991 in Western Samoa, including 455 American Samoans and 491 Western Samoans aged between 25 and 55 years (24). Dietary intake was measured by the 24-hour recall method. Differences between the kilocalories and nutrient intakes of men and women were noted but substantial differences were found between residents of American Samoa and those of the more traditional country of Western Samoa. As shown in Figure 2.30, the energy intake of American Samoans was 2468 kcals and that of Western Samoans 2835 kcals. The American Samoans consumed significantly more carbohydrate and protein and less fat and saturated fat. The consumption of coconut cream may explain the higher contribution of fat and saturated fat in the diet of Western Samoans. The energy-adjusted intakes of cholesterol and sodium were higher among American Samoans than Western Samoans.



Source: (24)

Figure 2.30: Distribution of nutrients as percentage of total energy intake for American Samoa and Western Samoa, 1990 and 1991

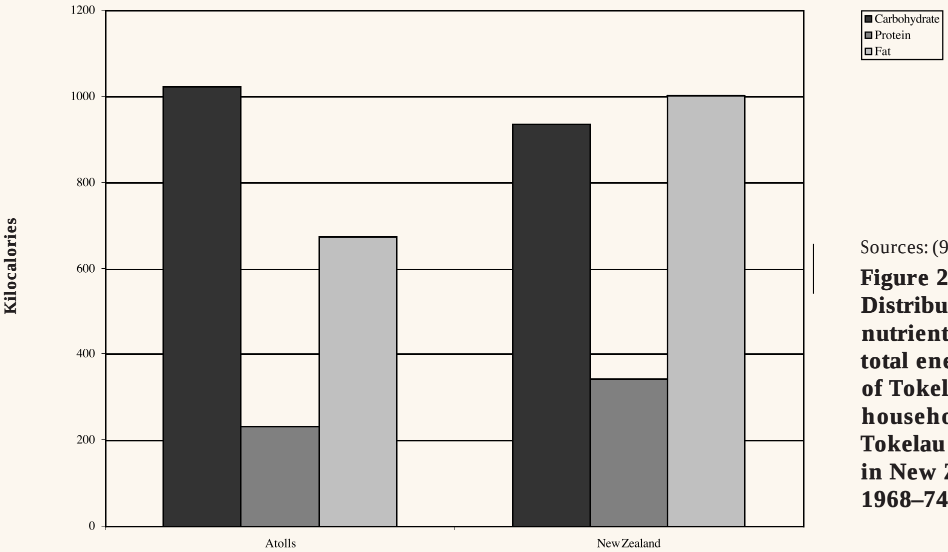
Tokelau

In 1968, 222 Tokelauans living on the isolated atoll of Fakaofo were interviewed about their food intake. It was found that their protein mainly came from fresh fish since pigs and chickens were reserved for feasts (99).

Another survey was conducted in 1974 over a seven-day period on 55 Tokelauans who had migrated to New Zealand (100). As shown in Figure 2.31, the energy intake of this group was higher than that of the atoll people (99). This was perhaps because there were more young adults in the New Zealand group. With the migration to New Zealand, protein and carbohydrate intakes increased and fat intake decreased. The increase of protein intake could be explained by the increasing consumption of meat and fish among the New Zealand Tokelauans. Fat decreased since coconuts were no longer a mainstay of the diet. In Fakaofo in 1968, coconut supplied 69% of energy. The increase of carbohydrate among the New Zealand Tokelauans is notably due to bread, rice and particularly sugar consumption. Moreover, the use of salt was markedly higher in New Zealand than on the atoll.

> *On the atoll no salt was added to food, almost no processed foods were used and rarely was salt or even sea water used in cooking.* (99)

The increased intake of meat and use of butter and eggs led to an intake of cholesterol four times higher for the migrant group than for those on the atoll.



Sources: (99,100)

Figure 2.31: Distribution of nutrients in the total energy intake of Tokelauan households on a Tokelau atoll and in New Zealand, 1968–74

Around the same time, Jardin (101) described food and dietary patterns in Tokelau.

The Tokelauans' diet was rich in fish, pork and poultry. Almost every family has one or two pigs and some poultry, so eggs and chicken are widely eaten. Toddy or coconut sap either fermented or fresh, is a speciality of the Tokelau Islands. The coconut sap, is also used to make a kind of molasses. (101)

Later, in 1979, McKenzie and Guthrie (102) confirmed that the traditional diet was found to be very low in both zinc and copper.

Naylor visited Tokelau in 1989 to review health services (103). One of the review's findings was that the dietary habits of Tokelauans were undergoing considerable change. Fresh fish, traditional roots and leaf vegetables were consumed less often, while highly refined processed foods with salt and sugar additives were used more frequently. The refined foods contained less fibre, vitamins and minerals than the traditional foods. In order to improve the diet, Tokelauans would need to create opportunities to catch more fish, grow more vegetables and promote a market on each atoll for the sale of local foods.

Tonga

In dietary studies in Tonga in the early 1950s, vitamin intake was frequently said to be marginal, especially for vitamins B, A and C (104).

In a 1972 survey, Jansen (105) found a great lack of green vegetables and fruit in the diet. More emphasis was placed on flour products in Nuku'alofa, the capital city of the main island of Tongatapu, as compared to Ha'apai and Vava'u, the two island groups to the north of Tongatapu.

More recent surveys found in Englberger's report (106) found excessive energy and high protein intakes among adults. Starchy root crops, fruit, coconut and fresh fish were generally reported as the most common foods, particularly in rural areas.

At this time urban/rural differences in dietary patterns were increasing. A high consumption of sugar was noted by some authors. All of the surveys suggested that the diet in all outer islands and in both rural and urban areas lacked protective foods such as fruits and vegetables, with the exception of Niuatoputapu and Niuafo'ou, which are relatively remote. Here, foods were local rather than imported.

It was also interesting that urban dwellers were consuming local foods whenever they could, so there was not a total switch in diet away from traditional foods. Younger people ate more imported foods than older people. In Tongatapu, the consumption of sugar and sugary snack foods was particularly high, as seen in previous studies. Overall, meals were not well balanced and morning meals in both urban and rural areas tended to be the least balanced.

In 1973, Finau and colleagues (107) conducted a survey in Nuku'alofa, the main urban area, and on Foa, a coral atoll. The study sample comprised adults aged 20 to 69 years and the 24-hour recall method was used. The Nuku'alofa population consumed significantly more imported foods than the population on Foa and the preparation of these foods also showed urban–rural differences. These trends showed that food availability might not be the only factor in the dietary revolution among the Tongan population. Nuku'alofa people were consuming western-type foods whereas the Foa people were eating traditional crops. More fresh fish and shellfish were consumed at Foa than in Nuku'alofa where the urban population ate more tinned fish. In Nuku'alofa, people also ate more imported chicken, beef or mutton.

A national survey, carried out in 1986, comprised randomly selected women aged 15 to 49 years, men aged 20 to 49 years and children up to 4 years old (108). The 24-hour recall method was employed. This study found a low incidence of anaemia among women except in one area where the incidence of mild anaemia was high. The survey also indicated that the differences in dietary patterns between urban and rural areas were attributable to availability of foods. Rural adults tended to consume more local produce. Consumption of imported foods was highest among urban adults.

The rural–urban differences were probably due to a combination of factors such as a greater availability of foods, an inconsistent supply of local foods or the lower cost and convenience of preparation and cooking of staples. For the Ha'apai islands (the group of islands between Vava'u and Tongatapu) the diet consisted predominantly of local starchy roots or fruit crops, coconut cream at most meals, and fish which was usually eaten only once a day.

A later report (109) showed that by 1995 there was an increased consumption of fatty meat, especially mutton flaps. Englberger asserted that

> *It is thought that mutton flaps may be a major contributing factor to the increasing prevalence of overweight in Tonga and to the related non-communicable disease of diabetes, hypertension and heart.* (109)

The first importation of mutton flaps was in 1954 to 1958. With a low price it replaced the more expensive corned beef. At that time fish was cheaper. Between 1976 and 1994, the quantity of imported mutton flaps doubled. In Tonga, money spent on mutton flaps has increased by a factor of 8. Mutton flaps account for a large proportion of the food imports. It has increased from 14% in 1976 to 22% in 1992.

In 1995, a successful weight-loss competition was undertaken followed by annual competitions between 1996 and 1999. For the three competitions the total weight loss per competition was between 1168 kg and 1335 kg and the number of people who participated was between 983 and 1133. Prizes were given to those who lost most weight and also to those who reached their healthy weight. These competitions have led to a better understanding of the importance of nutrition in Tonga (110–113).

Tuvalu

Wicking and colleagues (114) reviewed how changes in the traditional diet of Tuvalu have occurred:

> *Before Western influence, the customary diet on this atoll island consisted of fish, coconut, breadfruit, taro, banana and* puluka *(a variety of taro). During the 1940s the establishment of an Allied naval and air base brought considerable change to the island way of life. By 1976, four years after hurricane Bebe, the island of Funafuti was dependent on imported foods for 80% of its total food needs.*(114)

Wicking conducted a 24-hour recall survey among 113 indigenous Funafutians in 1976. Funafuti was representative of an urban area and had seen progressive socio-economic changes in the previous 30 years. The energy intake was 3133 kcals for males and 2624 for females. The mean energy intake of approximately 3000 kcals is made up of nearly 80% imported foods (sugar, flour, rice). These were all concentrated carbohydrate foods with low traditional value. The distribution of energy from protein (14%), fat (37%) and carbohydrate (47%) was similar to the urban surveys and quite different from the distribution found in more traditional diets (68,115). The major source of protein in the diet was fresh fish supplemented by small amounts of tinned fish and meat. The main source of fat was coconut oil, lard or meat dripping.

Johnson noted in a study about the food and nutrition situation in Tuvalu that the country had a heritage of good nutrition (116). He described the traditional diet as follows:

> *The traditional diet consisted of a great variety of fish, other seafood (such as crabs, mussels, sea snails, turtles and turtle eggs), wild birds and pigs, the latter being used primarily for festive occasions.*

Women have changed their diet from one based on traditional carbohydrate foods, which are high in fibre and bulky, to imported carbohydrate foods (rice, flour, sugar), that are low in fibre. The diet is also more energy dense since more fat is consumed; butter or margarine are spread on bread or oil used in frying and roasting. There is a cultural tendency for the women to eat last in the family; thus they are more likely to eat large quantities of the carbohydrate staple often prepared in coconut cream. Men, on the other hand, eat first and they are able to consume more protein and protective foods. Fruit and vegetable intakes have always been low but the consumption of these foods has increased in the attempt to avoid vitamin and mineral deficiencies.

Wallis and Futuna

The inhabitants of Wallis and Futuna have diets similar to those of French Polynesia except that they eat less meat and more starches. However, they consume similar amounts of fat and sugar. There is no possibility of their being self sufficient as regards food, as their limited resources cannot meet their requirements (117).

Loison and colleagues (118) suggested that the food staples on Wallis and Futuna Islands were generally rice, potato and bread which were a cheaper source of energy than local vegetables. Fish was still the traditional food. Tinned fish and meat were easy to prepare and thus helped avoid complex meal preparations. Sometimes fresh meat was used instead of tinned meat, but pigs were prepared only for feasts. At breakfast, coffee or tea with bread and sometimes butter and milk were eaten. The main meal was at midday when fruit and vegetable consumption was rare. The evening meal consisted of already prepared vegetable soup in a sachet. Bread accompanied each meal.

A record of daily diet and activities was made by means of daily visits to 10 households over a four-day period in 1979 and 1980 by Taylor and Zimmet (39). One or more adults in each household were asked to list everything they had eaten and drunk that day. The data show the average total intake of about 2700 kcals for weekdays and about 3300 kcals for Sundays. The proportion of local to purchased foods is 43% of calories consumed, but 66% by weight.

In 1988, Pollock (119) conducted a survey in Futuna. Twenty households in Ono, the main village of the kingdom of Alo, were visited. This study showed that the available foods were yam, taro, cassava, banana and breadfruit. In the shops, rice, a little bread, fish and tinned meat could be found. Fresh fish was rare even though women fished for seafood on the reef. There were many pigs. Coconuts were rare, and since the 1986 cyclone their consumption was forbidden by the king. The diet was generally high in fibre, low in salt and low in refined sugar; it contained a little fat when coconut was eaten or when the canned fish was fried. The main meal was at midday with a mixture of cassava and boiled bananas with a little tinned fish, either fried or baked in coconut milk. Water is the main drink at this time. In the morning and in the evening, baked rice and coffee with sugar (and sometimes milk) are eaten.

Discussion

Westernisation and the increase of urbanisation have dramatically changed the eating patterns in the Pacific Islands. During the last five decades, there has been an increase in protein and fat intakes, notably of cholesterol. There has also been an increase in consumption of refined carbohydrates and a decrease in complex carbohydrates and dietary fibre. In the Pacific Islands, refined cereals have progressively replaced starchy root vegetables. Imported foods are making up a larger and larger portion of the dietary patterns of island people. The consumption of sugar and salt has increased enormously. Numerous studies have indicated that this change in eating patterns is partly, or wholly, the cause of the increases in non-communicable diseases.

Energy Intake

Obesity, one of the most important risk factors in the development of the non-communicable diseases in the Pacific, results when energy intake (kilocalories) exceeds energy expenditure (basal metabolic rate, dietary thermogenesis and physical activity). This positive energy imbalance over a long period of time leads to an increase in energy stores and an increase in body weight. Several physiologic factors have been identified in body weight regulation. They include metabolic, hormonal and neural signals in the brain which, when functioning correctly, lead to behavioural changes in eating, physical activity and in body metabolism so that a balance of body energy stores is maintained (120).

The dramatic increase in the prevalence of obesity in most PICTs suggests that an imbalance between energy intake and energy expenditure is occurring. But it is not clear if the obesity is a result of increased kilocalories or decreased physical activity or both. Some studies indicate increased caloric intakes when islanders move from rural to urban settings. Other studies, however, have shown that energy intakes in the rural areas may actually be higher than in the urban centres but that levels of physical activity have declined in the urban setting. It is the synergy between dietary factors and physical activity patterns that have the strongest influence on energy balance and they are the key modifiable factors promoting weight gain (120).

Dietary Fat

The macronutrient composition of the diet can influence this energy balance. Dietary fat has a higher energy density (9 kcal per gram) than the other macronutrients (4 kcal per gram for either protein or carbohydrate, and 7 kcal per gram for alcohol). The high energy density of fat is thought to be largely responsible for the overeating effect or passive 'overconsumption'. Fat-induced appetite control mechanisms are thought to be too weak or too delayed to prevent the rapid intake of kilocalories from a high-fat meal (120).

The percentage of energy derived from saturated fat is the single most influential dietary determinant of plasma total cholesterol and LDL level for most individuals, and most persons experience some degree of cholesterol lowering by decreasing saturated–fat intake (121). Elevated cholesterol and LDL cholesterol, along with decreased HDL cholesterol, are major factors effecting coronary heart disease.

Dietary fat intake has been associated with increased risk of several types of cancers. Not only the amount of fat consumed but also the type of fat in the diet may be important factors in cancer development. Total fat and saturated fat intake have been strongly associated with cancers of the breast, colon and prostate (122). The role of animal fat in the development of cancer has been found in studies of lung cancer (123) and prostate cancer (124).

Some investigators have suggested that the ratio of n-3 fatty acids (polyunsaturated fatty acids from fish and flaxseed oils) to n-6 fatty acids (from corn, sunflower oils) may be protective against breast cancer.

Most dietary studies in the Pacific reveal an increase in total fat and saturated fat when islanders change from a traditional eating pattern to a more urbanised pattern. For volcanic island people this increase in fat consumption is dramatic. For atoll dwellers, who traditionally consume large amounts of coconut, the increase in fat intake from a rural to an urban setting is less significant. Also, although the fat in coconuts is saturated it was often the only major source of fat in the traditional atoll diet. A small amount of fat obtained from fish may have conferred a protective effect on cardiovascular disease.

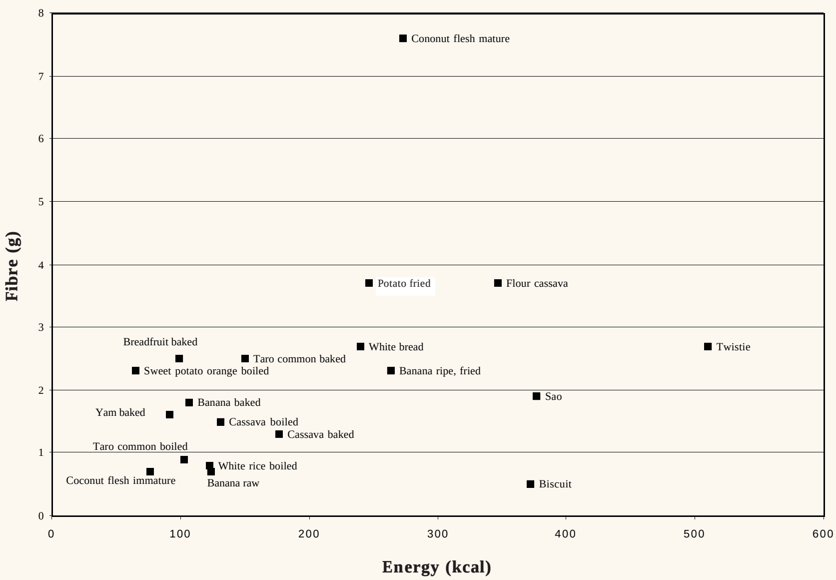
Non-starch Polysaccharides (Fibre)

There is a large body of evidence to support the protective role of dietary fibre in the prevention of non-communicable diseases. Non-starch polysaccharides (fibre) and vegetables are recognised as factors that reduce risk of colorectal cancer owing to their effect of regulating bowel function. Non-starch polysaccharides are fermented in the large bowel, and this results in short-chain fatty acids, particularly butyrate, which may protect against cancer through the ability to arrest cell growth, promote differentiation, and select cells with damaged DNA for disintegration (125).

The water-soluble fraction of fibre lowers plasma cholesterol especially when combined with a low saturated-fat intake. Dietary fibre without fat modification can lower plasma cholesterol; however, the amount of fibre required to effect a significant reduction in plasma cholesterol is 15 to 30 grams per day (126).

In patients with diabetes, high fibre diets reduce insulin requirements and lower serum cholesterol and triglyceride values, improve glycemic control and promote weight loss (127).

Over the past four decades there has been a decrease in dietary fibre in the eating patterns of Pacific Islanders, particularly fibre from root vegetables. Figure 2.32 illustrates the higher fibre content and lower energy value of common traditional foods compared with imported urban foods.

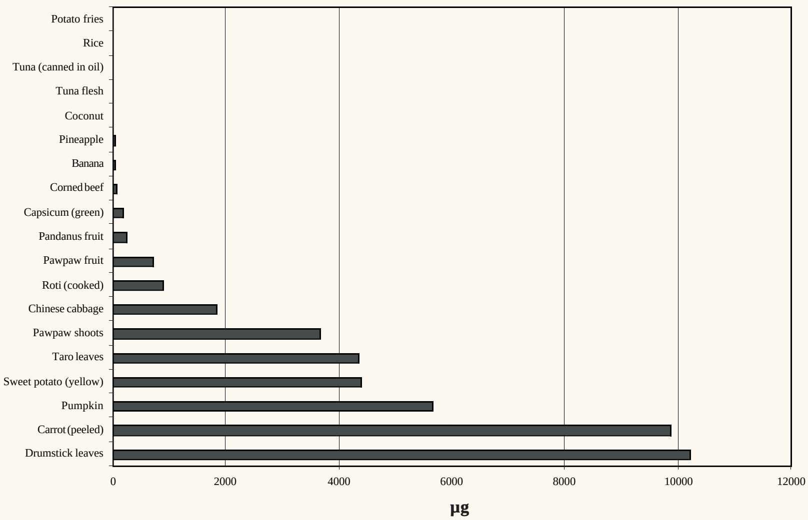


Source: (128)

Figure 2.32: Fibre and energy content of common Pacific Island foods (100 gram portions)

Epidemiological evidence suggests that a diet rich in vegetables and fruits may reduce the risk of various forms of cancer (129). It is believed that vitamins and minerals in foods contribute to a reduced risk of cancer. Naturally occurring dietary antioxidants such as beta-carotene, vitamin E, folic acid, vitamin C and selenium are considered the most important (130). Some of these components in the diet have been linked with reduced rates of cancer of the lung (129,131), breast (132), colon (132) and bladder (133). Other components found in vegetables and fruits such as phyto-chemicals and phyto-oestrogens, flavonoids and other carotenoids such as lycopene in tomatoes and lutein in green vegetables may also be major factors in the prevention of certain cancers, particularly cancer of the prostate (131).

There is concern that the consumption of vegetables and fruits may be declining in several PICTs. With the transition from a rural eating pattern to an urban diet, the decrease in the consumption of vegetables and fruits is undoubtedly accompanied by a decrease in vitamins, minerals, antioxidants, and phyto-chemicals. Figure 2.33 illustrates the beta-carotene content of common Pacific Island foods, highlighting the higher content of more traditional vegetables and fruits, compared with imported or urban-type food choices.



Source: (128)

Figure 2.33: Beta-carotene content of some common Pacific Island traditional foods compared with imported food products (100 gram portions)

Fish

Fish, which was in abundance in the traditional Pacific Island diet, is an excellent source of protein, minerals, especially potassium and iodine, and vitamins, particularly B vitamins. Fish is low in total fat and many Pacific fish varieties are also rich sources of omega-3 fatty acids. The consumption of omega-3 fatty acids of marine origin can lower blood pressure levels and reduce cardiovascular risk. Bao and colleagues (134) studied the effect of a diet rich in fish and therefore rich in omega-3 and a weight-loss regimen in overweight hypertensive subjects. The results showed a decrease in hypertension and other cardiovascular risk factors among subjects.

There is accumulating evidence that diets rich in omega-3 fatty acids may be beneficial for the Metabolic Syndrome associated with Type 2 diabetes. Omega-3 fatty acids may counteract the high levels of triglycerides and weight gain associated with this syndrome (135).

Sodium Intake

Epidemiological studies suggest that dietary salt intake is a contributor to blood pressure elevation and to the prevalence of hypertension (136). The effect appears to be enhanced by a low dietary intake of foods containing potassium.

A number of studies in the Pacific have implicated salt intake as a primary factor in rising rates of hypertension. Salt intake was the most important variable reported.

Alcohol Intake

Alcohol consumption has been related to a variety of cancer sites: mouth and pharynx, larynx, oesophagus, liver, breast, colon and rectum (137). Individuals who consume 40 to 100 grams of alcohol per day have a 3 to 8 times greater risk of developing cancer of the oesophagus. This effect is multiplied with cigarette smoking (138).

Conclusions

> *An individual's dietary habits can have a profound effect on the quality of their health. Diets which are high in saturated fats, sugars, cholesterol and sodium can lead to a number of chronic diseases including coronary heart disease, diabetes and cancer. Diets low in fibre, however, can also lead to various forms of cancer including cancer of the colon, periodontal disease and varicose veins.* (139)

CHAPTER 3: Hypertension

Hypertension, one of the most important risk factors for the development of cardiovascular heart disease, is a major disorder of most industrialised countries of the world. Left untreated, elevated blood pressure leads to stroke, coronary heart disease, heart failure, and renal damage. Studies on blood pressure levels carried out throughout the world and in Pacific Island countries and territories (PICTs) have demonstrated basic findings:

Summary

- In traditional-living populations, blood pressure levels are low and they tend to remain low throughout life. These traditional societies have little or no evidence of hypertension or hypertensive diseases.
- In the urbanised populations of all PICTs, blood pressures rise with age and are considerably higher than those of people living in rural, more traditional societies.
- Rates of hypertension in at least seven PICTs have exceeded rates in highly westernised countries – the United States and Australia.
- In PICTs now undergoing rapid economic transition, cardiovascular disease is reaching epidemic proportions.
- It is becoming evident that death and disability from coronary heart disease, stroke and hypertensive disease in many parts of the Pacific are increasing so rapidly that these diseases will rank in the top four leading causes of death in most PICTs by the year 2020 (3).
- Stroke and/or hypertensive disease are among the top five leading causes of death in nine out of fourteen PICTs for which the SPC has data.

Definition

Hypertension is a condition in which an individual has a higher blood pressure than is considered to be normal. The elevated blood pressure is caused by an increase in peripheral resistance resulting from constriction or narrowing of peripheral blood vessels. In the majority of patients, the aetiology of the condition is unknown and is considered essential hypertension; that is, it develops without apparent cause. Hypertension can also be benign, that which progresses slowly, or malignant, a form which develops rapidly and is accompanied by severe vascular damage.

The 1999 Guidelines for the Management of Hypertension were prepared by a committee of the World Health Organization and the International Society of Hypertension (140). These guidelines defined levels for the classification of hypertension and are presented in Table 3.1.

Table 3.1: WHO–ISH Definitions and Classification of Blood Pressure Levels

CATEGORY	SYSTOLIC (mmHg)	DIASTOLIC (mmHg)
Optimal	<120	<80
Normal	<130	<85
High – Normal	130–139	85–89
Grade 1 Hypertension "mild" Subgroup: Borderline	140–159 140–149	90–99 90–94
Grade 2 Hypertension "moderate"	160–179	100–109
Grade 3 Hypertension "severe"	≥ 180	≥ 110
Isolated Systolic Hypertension Subgroup: Borderline	≥ 140 140–149	<90 <90

Source: (140)

The above 1999 WHO-ISH guidelines, however, differ from criteria used in many of the blood pressure surveys of the past two decades. Table 3.2 lists the criteria for diagnosis of hypertension used in many of the surveys and studies reviewed in this section (141). Where the criteria for the definition of hypertension differs from these, it will be noted.

Table 3.2: Blood pressure values used to define borderline and definite hypertension in the majority of Pacific Island surveys

	SYSTOLIC Pressure	DIASTOLIC Pressure
Normal Blood Pressure	< 140	< 90
Borderline Hypertension	140–159	90–94
Definite Hypertension	≥ 160	≥ 95

Studies in the Pacific have revealed a trend of increasing blood pressure levels and high prevalence rates of hypertension in many communities. Tables 1 and 2 in Appendix 1 provide mean systolic and diastolic blood pressure levels and prevalence rates of hypertension in Pacific Island populations over the past 30 to 40 years.

Figures 3.1 and 3.2 provide the most up-to-date prevalence rates of hypertension in most PICTs. For comparison purposes, rates for adults from the United States over 18 years of age (142) and Australia (143) are also included. Caution should be used when comparing these studies because of a number of differences: in the time period when the surveys were conducted; in the definition of level of urbanisation; in the age ranges included in the studies; and in the criteria used to determine hypertension. Where possible in the following discussion, these differences will be noted.

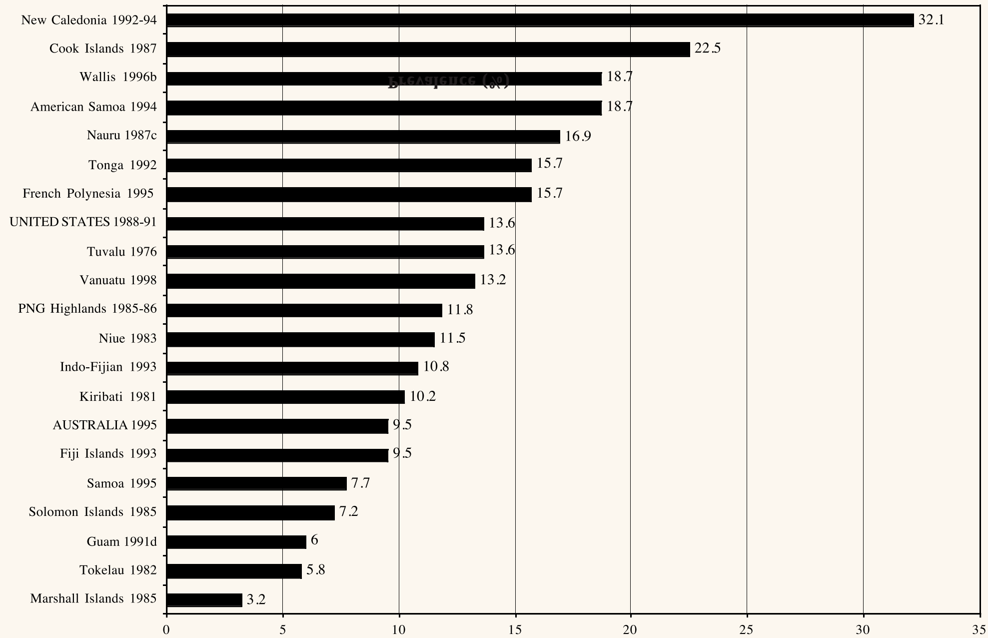


Figure 3.1: Prevalence of hypertension[a] in the Pacific: FEMALES

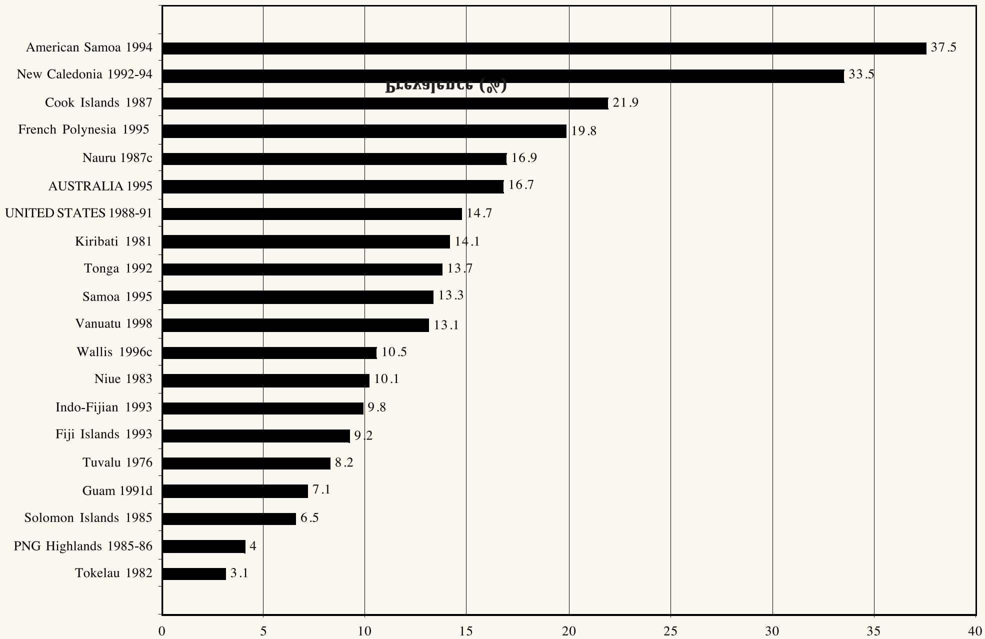


Figure 3.2: Prevalence of hypertension[a] in the Pacific: MALES

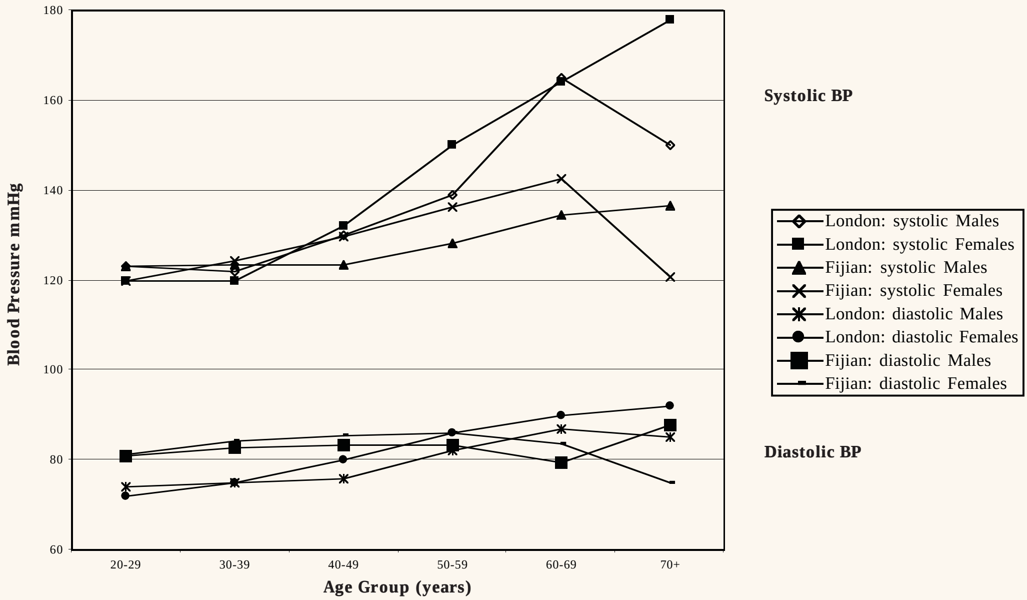
a Diastolic ≥ 95 and / or systolic ≥ 160
b Diastolic ≥ 100 and / or systolic ≥ 160, then confirmed 'a few days later'
c Females and males combined
d Self report

Melanesia

Fiji Islands

Until the 1950s, experience from Europe and the United States indicated that blood pressure increases with age. Maddocks (144) was one of the first investigators in the Pacific to show that blood pressure in traditional-living populations did not necessarily rise with advancing age. In 1958, Maddocks reported a virtual absence of hypertension among more than 700 Fijians living a traditional way of life on the island of Gau, located in the centre of the Fiji Islands. Figure 3.3 shows mean diastolic pressures not increasing with age and mean systolic pressures generally remaining below 140 mmHg. These pressures rose considerably less with age than the blood pressure levels of a London (UK) population. He concluded:

Apparently, essential hypertension does not exist among these people, or is rare (144).

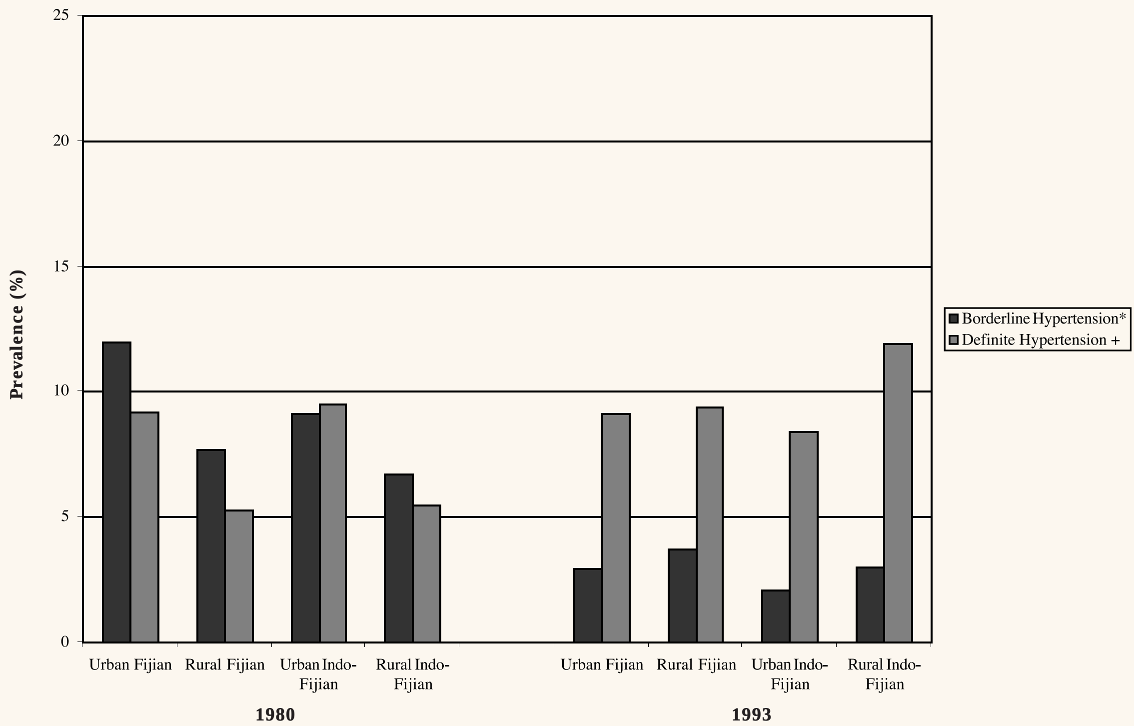


Source: (144)

Figure 3.3. Mean blood pressure of Fijians and Londoners, 1960

As part of the Cardiovascular Disease and Diabetes Survey in 1980, Taylor and colleagues (145) assessed blood pressure levels among Fijian and Indo-Fijian adults aged 20 years and over. The survey found that for most groups blood pressure increased with age to about age 55 and declined thereafter in some groups. The trend of increasing blood pressure with age was most pronounced among females, particularly urban women (data not shown).

Figure 3.4 provides rates of hypertension for females and males combined by ethnic group and level of urbanisation in the 1980 survey and also a later 1993 National Nutrition Survey (36). The rates for definite hypertension in the 1980 survey were higher in urban areas than in rural communities. However, in 1993, the rates for definite hypertension are seen to be a little higher than the rates in rural areas, but the differences are not statistically significant.



+ Definite Hypertension: systolic ≥160, diastolic ≥95 mmHg
* Borderline Hypertension: systolic 140–159, diastolic 90–94 mmHg

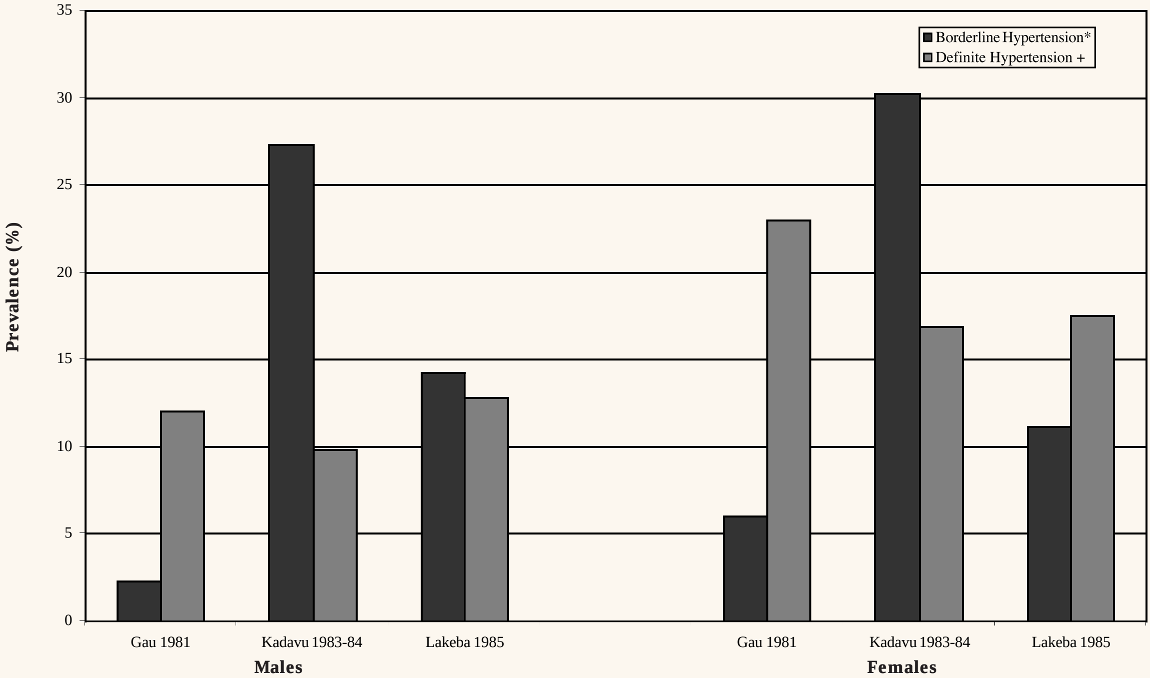
Sources: (36,145)

Figure 3.4: Prevalence of hypertension in Fijian and Indo-Fijian adults (males and females), 1980 and 1993

Ram and colleagues (146–148) conducted a series of hypertension surveys in three rural island areas of the country between 1981 and 1985.The residents of all three areas were mainly subsistence farmers and fishermen but had some cash income from the sale of copra, root crops or kava. The first survey was conducted in 1981 in Gau, a rural island 80 km from Suva. Adults (n= 703) over the age of 30 years were examined in all villages and settlements. A second survey was carried out in 1983–84 on the Kadavu group of islands lying immediately south of Suva, which had relatively good access to Suva. Adults (n=1231) 20 years of age and older were examined. The third survey was conducted in 1985 in Lakeba, considered the most developed of the Lau group of islands. Residents aged 15 years and older were examined but only those aged 20 and older (n= 685) are reported here. The investigator did not provide the ethnic make-up of the three populations; whether Fijian or Indo-Fijian.

The prevalence of borderline and definite hypertension for these communities is shown in Figure 3.5. Definite hypertension was highest among the females. The area of Gau might be expected to have higher rates than the other areas because the population was slightly older – adults 30 years and over – compared with that of Kadavu and Lakeba. Among the males, the three areas had similar rates of definite hypertension. Borderline hypertension was highest in Kadavu for both males and females. The researchers concluded that:

> *All the recent studies show a high prevalence of hypertension in Fiji. Unless preventive measures are instituted now the prevalence of hypertension may increase further and worsen the cardiovascular diseases epidemic.* (147)



+ Definite Hypertension: systolic ≥160, diastolic ≥95 mmHg
* Borderline Hypertension: systolic 140–159, diastolic 90–94 mmHg

Sources: (146–148)

Figure 3.5: Prevalence of hypertension in three rural areas of Fiji Islands 1981, 1983–84 and 1985

A survey of over 5000 Fijians, conducted in 1983, evaluated blood pressure levels among Fijians and Indo-Fijians (149). The study reported 18.5% of Fijians and 16.4% of Indo-Fijians with systolic blood pressures of ≥140 mmHg. Also, 21.5% of Fijians and 12.5% of Indo-Fijians had diastolic blood pressures of ≥95 mmHg. Age, obesity and hyperglycaemia were major predictors of elevated systolic and diastolic blood pressures in this study (data not shown).

A small study, also conducted in 1983, compared blood pressure levels among rural and urban Fijians (150). The rural population came from three isolated villages on the island of Qamea and the urban population from a settlement in the urban centre of Suva. For both men and women, the mean systolic blood pressures were significantly higher ($p < 0.05$) among the rural groups compared with the urban residents (120.5 ±1.6 and 118.6 ±1.6 mmHg vs. 116.2 ±1.4 and 113.1 ±1.5 mmHg for males and females respectively). There were no differences in mean diastolic pressures for either males or females (Tables 1 and 2 in Appendix 1). These investigators could not explain the higher systolic pressures among the rural islanders, noting that the rural Fijians had less adiposity than the Suva residents. They concluded:

> *In both populations, blood pressure was correlated with body weight but clearly factors other than adiposity must be involved in controlling blood pressure.* (150)

Rural-urban differences were also compared in a small survey undertaken in the late 1980s by Russell-Jones et al. (151) among Fijians over 40 years of age. The rural group was from the very remote central highland area of Viti Levu, the main Fijian Island. The urban group came from a suburb of Suva. This study found significantly lower ($p<0.001$) mean systolic pressures in rural compared with urban Fijians. Differences in diastolic pressures were not significant (Table 1 in Appendix 1).

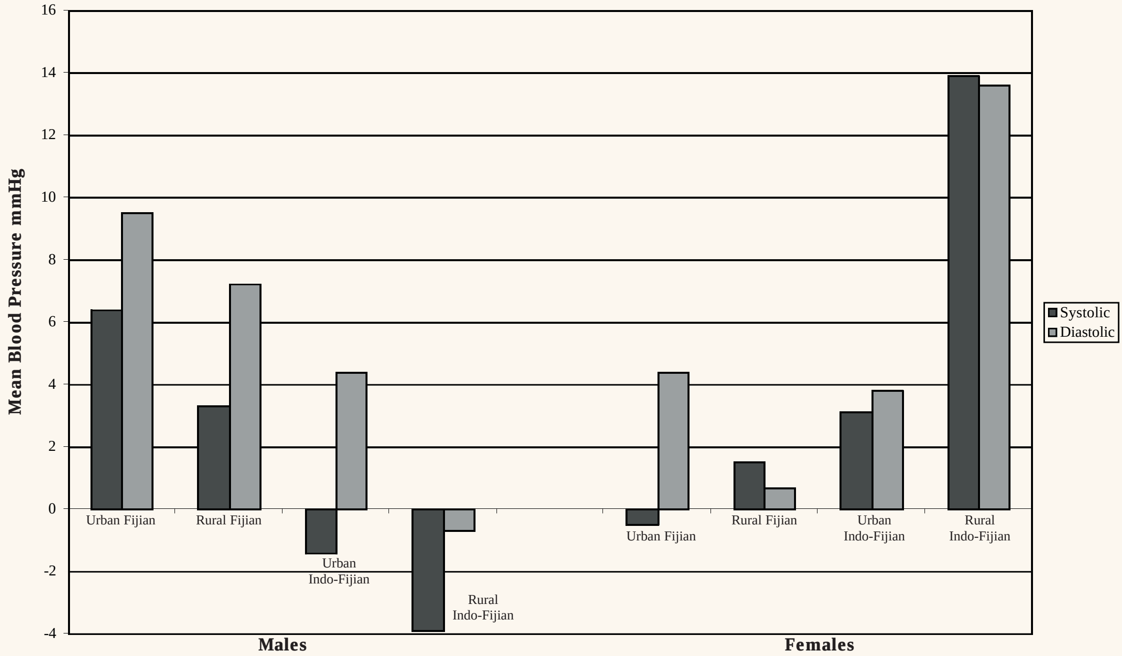
A small survey to determine the prevalence of hypertension was carried out in Rakiraki and included 239 adults, 30 to 64 years of age (152). The area included villages and settlements where residents were mainly involved in fishing and agricultural activities but had easy access to cities and towns. The study included twice as many females as males and twice as many Indo-Fijians as Fijians. Overall, the prevalence of hypertension was 20.1% (11.3% definite hypertension and 8.8% borderline hypertension). The prevalence increased with age and was higher among females than males. While 13% of the sample were known hypertensives, only 84% of these were well controlled. Obesity, smoking, educational level and alcohol were significantly related to hypertension, but physical activity and salt intake were not.

A National Nutrition Survey (36) was conducted in 1993 which included children as well as approximately 2400 adults 18 years of age and over. The results of the blood pressure examinations revealed that in general, mean blood pressures increased with age. Indo-Fijian women had the greatest increase in both mean systolic and diastolic blood pressure with age and at over 55 years had the highest rate of hypertension of any group (44.2%). More than 30% of Fijian males, Fijian females and Indo-Fijian males were hypertensive at ages over 55 years (data not shown).

Overall, close to 10% of the population had definite hypertension and a further 3% were borderline hypertensive. Figure 3.4 provides the rates of borderline and definite hypertension by ethnic group and level of urbanisation for females and males combined. The rates for both borderline and definite hypertension were higher in rural areas than in urban communities but these differences were not statistically significant.

The survey reported a strong association between Body Mass Index (BMI) and prevalence of hypertension. The highest rates of borderline and definite hypertension were found in the most obese individuals. There was also a strong association between hypertension and diabetes. Thirty-six per cent of diabetic patients were hypertensive compared with 8.7% of non-diabetic individuals. Kava drinking and having a sedentary occupation was also associated with higher rates of hypertension.

Figure 3.6 compares the changes in blood pressure among Fijian and Indo-Fijian males and females by level of urbanisation between the 1980 cardiovascular disease survey (145) and the 1993 National Nutrition Survey (36). There was an increase in mean systolic and diastolic blood pressure in all groups in urban areas except for urban Indo-Fijian males. The greatest increase was seen among the urban Indo-Fijian women. In the rural areas, the mean diastolic pressure increased in all ethnic groups, but there was an insignificant reduction in systolic pressure among Fijian women and Indo-Fijian males. The large increase in diastolic pressure among the rural Fijian males may be due to the age differences between the two surveys.



Source: (36)

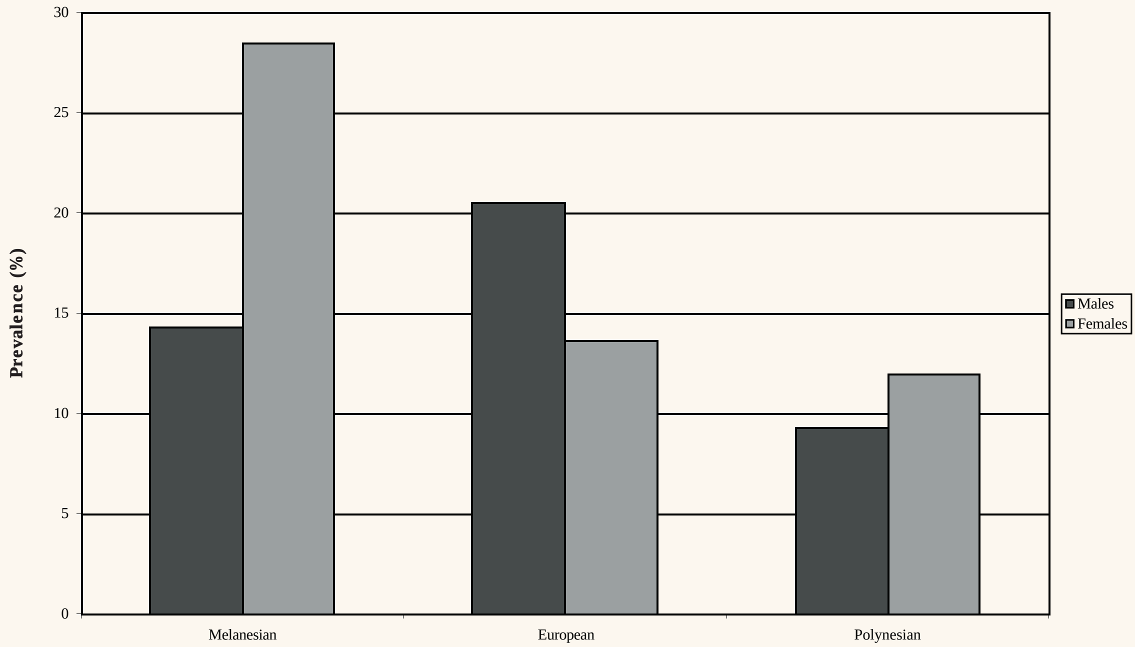
Figure 3.6: Change in mean blood pressure levels in Fijian and Indo-Fijian females and males by level of urbanisation between 1980 and 1993

New Caledonia

Health surveys were conducted in rural and urban communities in New Caledonia in 1980 by Taylor and Zimmet (39). The rural population came from Oundjo, a traditional village on the northwest coast near the town of Kone. The urban group comprised males who worked in the nickel factory in Noumea and females who were recruited from the area within the city of Noumea in which factory workers were known to live.

Although the numbers in each group were small, it appeared that prevalence rates of hypertension were highest among the rural Melanesians (18% and 28% among men and women respectively). Among the male factory workers, Melanesian males had higher rates than Wallis Island Polynesians (13% and 6.9% respectively). Prevalence rates were similar among Melanesian and Polynesian females living in Noumea (10.4% and 10.2% respectively).

Another hypertension survey conducted between 1985 and 1988 revealed similar findings to the above survey (153). This study was conducted among 1000 adults 30 years or older in the region of Thio on the east coast of the main island in New Caledonia. The region is rich in nickel ore and many inhabitants are employed in nickel mining occupations. Overall 17.8% of this population were hypertensive. Figure 3.7 indicates that Melanesian women had the highest rates of hypertension of any group. Hypertension was defined as systolic pressure ≥ 170 mmHg and/or diastolic pressure ≥100 mmHg. Rates were higher among Polynesian males than the previous survey (39) but there were small numbers of Polynesians included in this study. The rates among Europeans were comparable to rates reported in France for the same time period.



Source: (153)

Figure 3.7: Prevalence of hypertension in New Caledonia, 1985–88

This study suggests that the effect and gravity of high blood pressure in this population may reflect the overall situation in New Caledonia. Hypertension is the second most important cardiovascular disease in the country. The ethnic composition of this region mirrors that of the total population; the Thio population relies heavily on a cash economy, as does much of the country. The rates of hypertension in this study would also be even higher if the criteria used to define hypertension were the lower cut off levels (systolic pressure ≥ 165 mmHg and/or diastolic pressure ≥95 mmHg) used in other comparable hypertension studies in PICTs.

Wallon (154), however, reported a relatively low incidence of stroke in New Caledonia for the years 1995–96. A total of 232 cases of stroke were admitted to the territorial hospital in Noumea over this time period. The estimated stroke incidence was 98/100,000 inhabitants per year in New Caledonia. This incidence is lower than in other countries; for instance, among Australian males as of June 30 1996, the rate was 289.9/100,000 population.

Papua New Guinea

Maddocks (155) in 1967 reported on a blood pressure survey including over 2100 adults in three areas of Papua New Guinea. One group of villages was in the rural Eastern Highlands; a second group was from the area of Purari Delta and the third from settlements within the town of Port Moresby. Blood pressures did not rise with age in any of the rural groups but did in the Port Moresby adults, particularly among the females. The study showed that virtually none of the females in the Highland area had systolic pressures greater than 160 mmHg, while systolic pressures above 160 mmHg were seen among the Port Moresby females over 50 years of age.

> *The suggestion that high blood pressures are uncommon in New Guineans is supported by findings in clinical practice. In my experience in the Territory, high blood pressure is usually evidence of incipient renal failure.* (155)

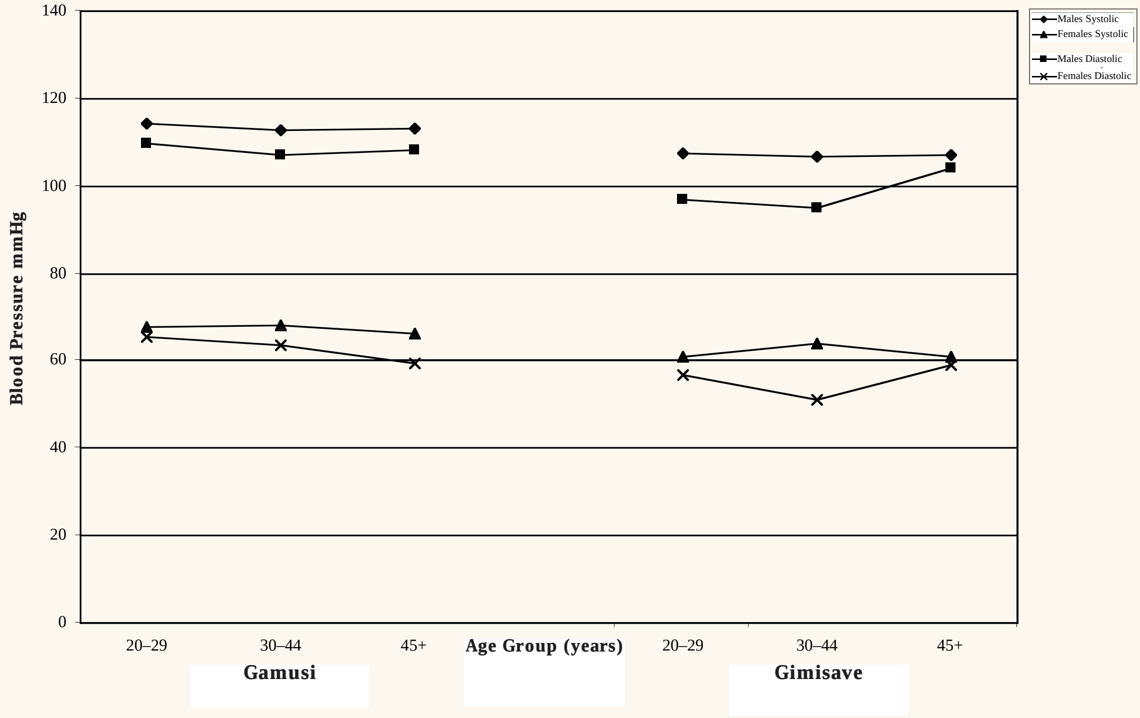
Early studies of cardiovascular disease were carried out in remote villages in the Western Highlands in 1966–67 by Sinnett and Whyte (156). The villagers were subsistence farmers and pig herders who were little influenced by western economy or dietary patterns. The survey found 6.6% of males and 5.4% of females to have elevated blood pressures (systolic > 160 mmHg and/or diastolic > 95 mmHg). Mean blood pressures were low and in general did not rise with age. In males, systolic and diastolic pressures reached their maximum level in the third decade and gradually decreased thereafter. Among the females, diastolic pressure decreased gradually after the second decade. The mean systolic pressure in females increased with age until the fifth decade and decreased thereafter.

Boyce et al. (157) also found very low mean systolic and diastolic blood pressure readings in the inhabitants of Karkar Island. This survey, conducted in the 1970s, provides the example of the "virtual absence", at least in males, of any systematic rise in blood pressure with age within a traditional subsistence economy population. It also supports, along with other studies in Papua New Guinea (156,158,159) the view that the rise of blood pressure with age, which is the norm in western countries, is related to way of life rather than an inevitable part of the ageing process.

Martin and co-workers (160) carried out health surveys in 1977 among rural villages (Kalo), in an urban community (Koki), and among young civil servants in the capital city of Port Moresby in 1979. The mean systolic and diastolic blood pressures were higher in both female and male Koki residents than either the rural village residents or the civil servants. There was a slight, but not significant increase in blood pressure with age among the Koki adults, which was not seen among the rural Kalo people. Prevalence rates of hypertension were not provided in this report.

In 1983, two villages in the Asaro Valley, not far from the town of Goroka, were chosen for a prospective study of non-communicable diseases (161). These areas were chosen because extensive genetic studies had shown that inhabitants of this area were of non-Austronesian Melanesians ancestry (see Chapter one). Both villages were involved in coffee production and a cash economy. Of the two villages, Gamusi was more remote in the highlands and the diet was more traditional than in the village of Gimisave, although both villages had some non-traditional influences in the diet.

Figure 3.8 shows that mean blood pressures of both groups remained notably low as the mean systolic pressures did not reach 120 mmHg and the mean diastolic pressures did not reach 70 mmHg even in age groups over 45 years. Only four of the 308 adults examined were judged hypertensive (systolic pressure ≥160 mmHg and/or diastolic pressure ≥95 mmHg). In general, women had lower pressures than men. Age-sex-specific mean pressures were higher in the more traditional villages, a finding that could not be explained by differences in Body Mass Index, dietary intake or physical activity. In both of these communities, obesity was rare, dietary intake was predominantly traditional and physical activity was strenuous.



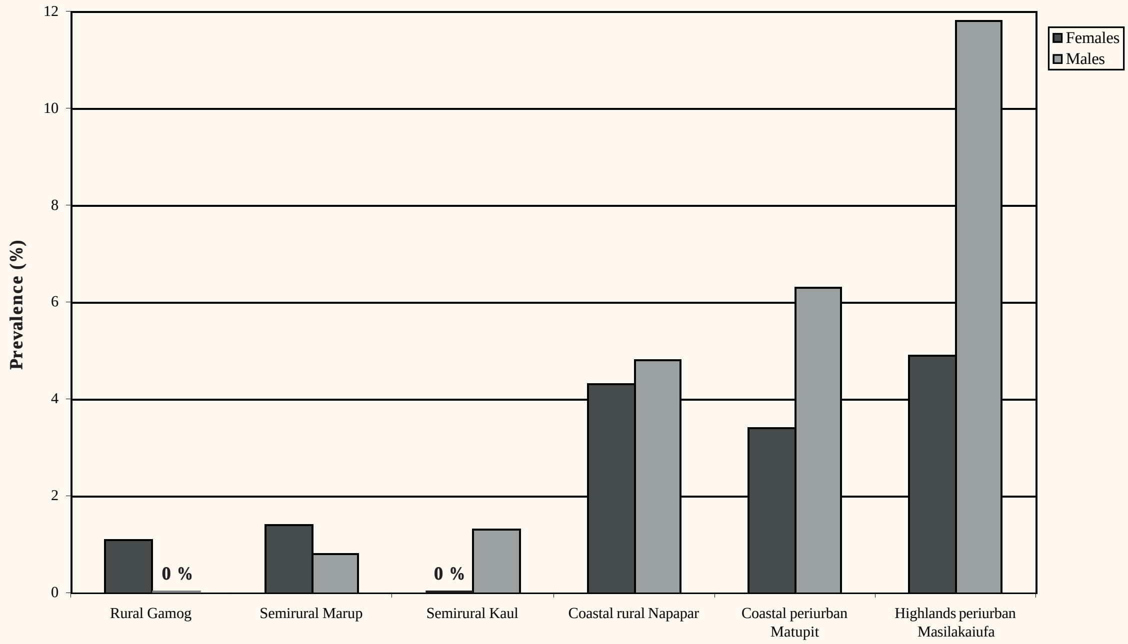
Source: (162)

Figure 3.8: Mean systolic and diastolic blood pressures in Highland villages in PNG, 1983

A small study was carried out also in the Asaro Valley of the Eastern Highlands that reported hypertension prevalence rates of 18% for males and 5% for females (163). These rates reported in 1989 are remarkably higher than the 1% prevalence reported in 1983 (161). The survey included 52 males and 69 females from three villages in the valley and from the town of Goroka. Although the data were not provided, the investigators reported that there were no significant differences in mean diastolic pressures between urban and rural men and women.

Hypertension was evaluated in a survey of non-communicable diseases conducted in six communities in Papua New Guinea during 1985–86 (164). The communities included a rural village (Gamog) and two semirural villages (Marup and Kaul) on Karkar Island. Two coastal villages (Napapar, rural and Matupit, periurban) of the Toloi population were in the East New Britain Province. Masilakaiufa was a village close to the town of Goroka, the administrative capital of the Eastern Highlands region. Communities were classified semirural if they were rural but had easy access to towns or imported consumer goods. Periurban communities were those close to a major town.

The results of the survey showed that in the rural and semirural villages blood pressure levels were low and showed little increase with age except for a modest rise in systolic pressures in the coastal and periurban groups. Figure 3.9 shows the very low rates of hypertension in the rural and semirural villages on Karkar Island (Marup and Kaul) with an absence of hypertension in males of Gamog and females of Kaul. The prevalence rates were moderate (3 to 6%) in the coastal communities of Napapar and Matupit in East New Britain and highest among men, about 12%, in the highland village of Masilakaiufa near Goroka. Analysis of variance showed that male gender; higher BMI; and speaking a non-Austronesian (NAN) language were strong and positive predictors of increased blood pressure. Non-Austronesian speaking Papua New Guineans tend to live in the highland areas whereas the Austronesian speakers are from the lowlands or coastal regions of the country.



Source: (164)

Figure 3.9: Age-standardised prevalence of hypertension in six communities in PNG, 1985–86

Of concern in this survey was the surprisingly high prevalence of hypertension in Masilakaiufa, in the Eastern Highland region. These rates are significantly higher than the rates of 1% found in two Eastern Highland villages, Gamusi and Gimisave, in 1983 (161). It has been hypothesised that non-Austronesian speaking Papua New Guinea highlanders may be genetically protected from a susceptibility to glucose intolerance. Hypertension and diabetes are known to coexist and to increase in communities undergoing rapid social and economic transition. Low prevalence rates of hypertension and glucose intolerance have been found in highland communities in past surveys. The high prevalence of hypertension in this Masilakaiufa community could be a forewarning of other non-communicable diseases – diabetes and cardiovascular disease – to follow.

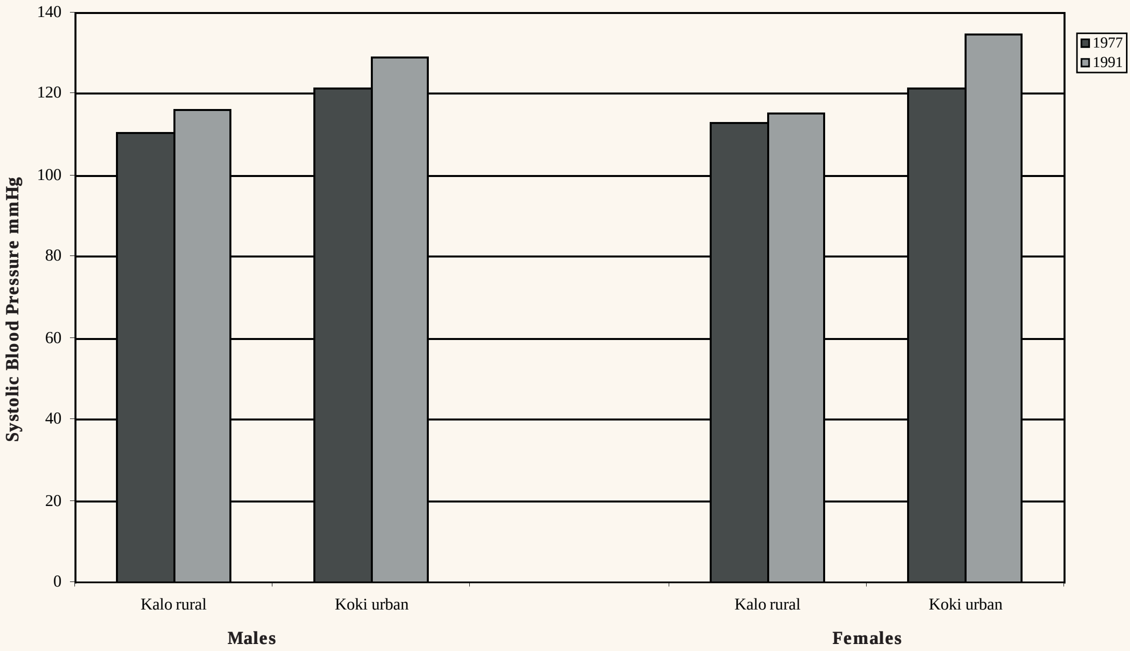
Lindeberg and colleagues (165) examined subsistence farmers aged 20 to 86 years in Kitava, part of the Trobriand Islands in 1990 for hypertension and other cardiovascular risk factors. The eating habits of these traditional horticulturists were virtually unaffected by western food imports. Earlier studies with this group of Kitavans found that sudden death, stroke and exercise-related chest pain were extremely rare or non-existent (166).

The study results showed that mean blood pressure levels were low (systolic 121 mmHg and 116 mmHg in females and males respectively and diastolic 70 mmHg in both genders). The diastolic pressures did not increase with age in either males or females, but systolic pressures did rise after the age of 50 in both genders. The researchers compared these blood pressure values to the Swedish population and showed that the Kitava males at age 70–79 had systolic pressures similar to Swedish men age 20 to 29. Kitava females 70–79 years had systolic pressures similar to Swedish women of the same age.

> *Possible nutritional explanations of the constantly low diastolic blood pressures in the present population are that the Kitavan diet is low in salt, high in potassium, high in magnesium, high in soluble fibre, rich in foods with a low glycemic index, devoid of alcohol, high in marine n–3 polyunsaturated fatty acids and satiating.* (166)

A survey conducted in 1991 by Dowes et al. (167) reported systolic blood pressures in one urban and two rural communities in PNG. All three communities are generally considered Austronesian speaking. The urban centre was Koki, a relatively affluent suburb of Port Moresby. One rural community was the village of Wanigela, about 200 km east of Port Moresby. Many of the residents of Koki originally came from the village of Wanigela. The second rural village of Kalo was on the coast about mid way between Wanigela and Port Moresby. In Kalo there are several small stores and good access to the nearby government station. The rural villagers of Kalo had significantly lower mean systolic pressure (116.1 mmHg) than those of either Wanigela (126.5 mmHg) or Koki (129.1 mmHg). Diastolic pressures were not reported nor prevalence rates of hypertension.

Figure 3.10 shows the increase in systolic blood pressures in rural and urban males and females from the 1977 surveys in Kalo and Koki to the 1991 surveys. The greatest changes were noted in the urban residents, especially among the females.



Source: (160,167)

Figure 3.10: Mean systolic blood pressure in communities in PNG 1977 and 1991

Hypertension is now a common complication accompanying diabetes in Papua New Guinea. Martin (160) reports that of 106 diabetic patients he reviewed, 32% of the males and 43% of the females had systolic blood pressure levels above 140 mmHg.

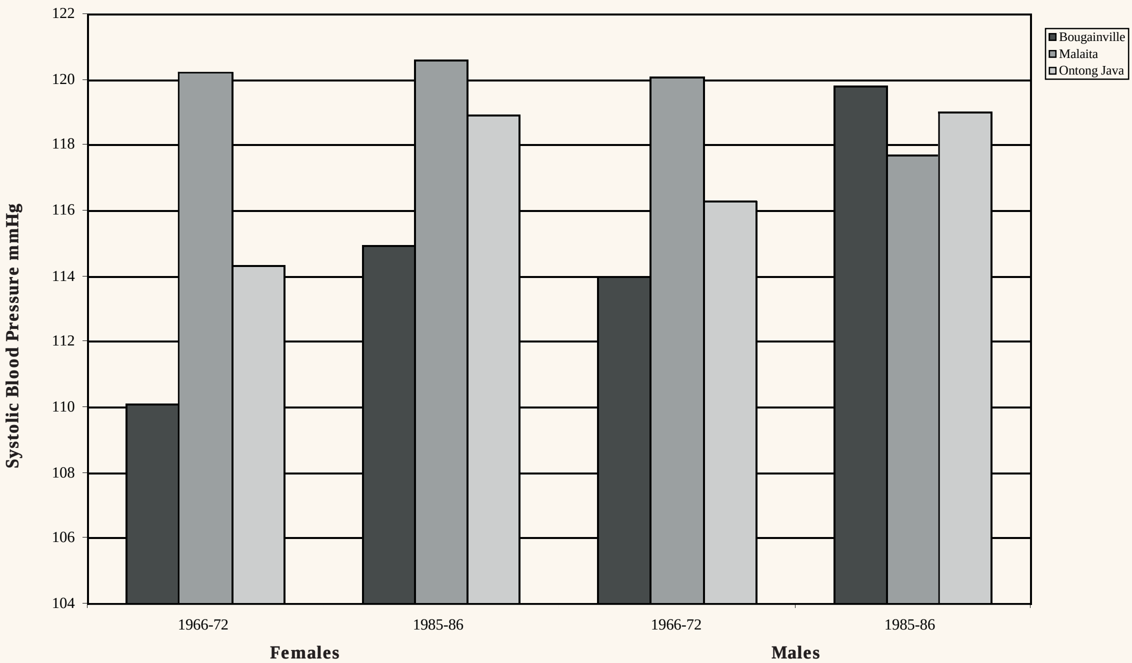
Solomon Islands

Extensive blood pressure studies were performed in the Solomon Islands between 1966 and 1970 and follow-up examinations were carried out in 1978–80 and in 1985–86 as part of the Harvard Solomon Islands Project (169). The initial surveys included 1822 individuals 15 years and over in seven communities and the third survey examined 1427 islanders. Individuals from three villages, Aita, Nasioi and Nagovisi, on the island of Bougainville represented Non-Austronesian (NAN) speaking peoples. Bougainville had seen heavy fighting during World War II and the development of large copper mining operations since 1968. Three other villages, Lau, Baegu and Kwaio, on the island of Malaita, were Austronesian speaking and had experienced relatively little European influence. The seventh community consisted of Polynesian-Micronesian people living a traditional lifestyle on the atoll Ontong Java.

At the time of the first survey (1966–1972) all groups were living in tribal villages in rural areas, where motor vehicles, electricity and other western conveniences were absent. The major elements in all the traditional eating patterns were root crops such as taro, sweet potatoes, yams, cassava, bananas, pandanus parts, and breadfruit. Protein sources were nuts, fish and the occasional feast pig. Coconut was used by all groups, but in small quantities.

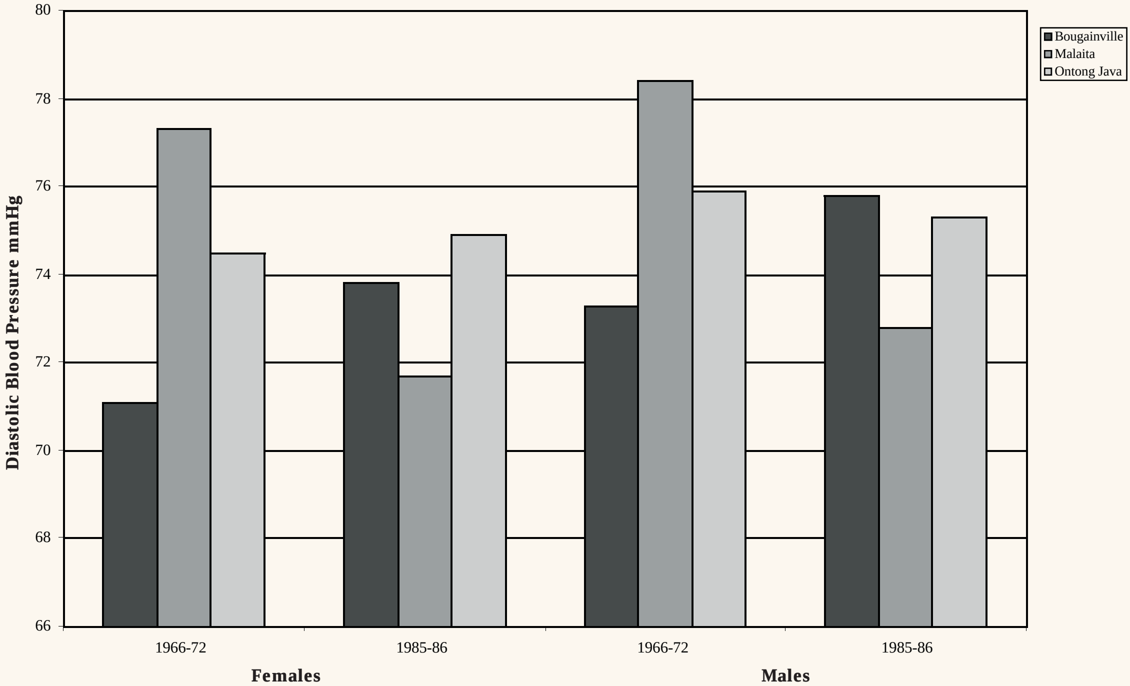
By the time of the third survey (1985–86) a substantial degree of acculturation had influenced the dietary patterns. Diet now included white rice and bread as staples, replacing taro and sweet potatoes, donuts fried in animal fat, sugar, salt, tinned mutton, tinned fish, cookies, coffee and tea. The investigators ranked the communities on the basis of indices of acculturation such as: length and significance of western contact; access to medical care; education; cash economy; imported foodstuffs; and salt intake.

Figures 3.11 and 3.12 provide the changes in mean adjusted systolic and diastolic blood pressures of males and females in the three areas at the two survey periods. For males, there were significant differences among the three groups from both mean systolic and diastolic blood pressures in the initial survey. Increased acculturation, which was evident by the third survey period, however, resulted in the disappearance of those differences. For females, there were significant differences in mean systolic and diastolic pressures at both survey periods, although less so in the third survey. The follow-up survey found increased individual variance in systolic and diastolic pressures with increased acculturation. The investigators offered several explanations for these increases: (1) they may be related to changes in demographic make up and/or changes in body muscularity, fatness and age among the groups; (2) increased intensity of environmental factors may be affecting blood pressure; (3) there is an interaction between genetic and environmental factors (169).



Source: (170)

Figure 3.11: Changes in mean systolic blood pressure in three Solomon Island communities, 1966–72 and 1985–86



Source: (170)

Figure 3.12: Changes in mean diastolic blood pressure in three Solomon Island communities, 1966–72 and 1985–86

Although no significant differences in sodium or potassium excretion between the groups was determined, the investigators commented:

> *It is clear that other dietary variables, genetic differences, or unmeasured environmental influences must explain variances in blood pressure among or within groups.* (171)

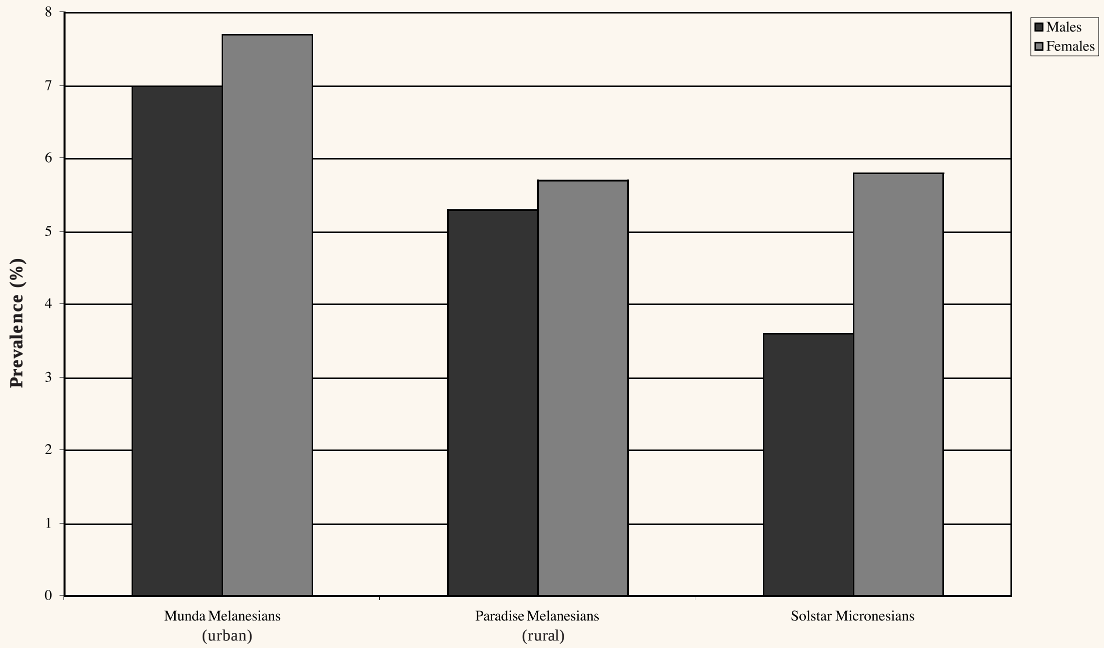
While these surveys did not provide prevalence rates of hypertension, it should be noted that mean systolic rates did not exceed 122 mmHg and mean diastolic rates were not above 79 mmHg in any of the gender/community groups. These investigators concluded that:

> *Clinical hypertension is rare in all groups.* (171)

Eason and associates (57) carried out a cross-sectional survey of non-communicable diseases in the Western Province of the Solomon Islands in 1985. The survey included 1500 individuals (≥18 years) living in three distinct communities. One group comprised Melanesians living in a traditional village accessible only by boat (Paradise). A second group included Melanesians living in the urban community of Munda. Micronesians who had migrated from the Gilbert Islands and settled in a fishing village, Solstar, 16 kilometres from the urban centre of Munda, made up the third group.

The blood pressure examinations found that mean systolic and diastolic pressure increased significantly with age in all three communities and among both genders (data not shown). There were no significant differences in mean blood pressure between the genders or among the communities. These mean pressures were also consistently and considerably higher than the mean pressures of the 1985–86 Harvard Solomon Islands project survey.

The prevalence of hypertension was not significantly different between females and males nor between the communities as shown in Figure 3.13. There were significant differences, however, in the Body Mass Index of those with hypertension compared with normotensive individuals. For both gender groups and all three community groups, those with hypertension had significantly higher BMIs than those with normal blood pressure levels (57).



Source: (57)

Figure 3.13: Prevalence of hypertension in Solomon Island communities, 1985

Vanuatu

An early blood pressure survey in 1962 found 3% of a population (sample size n= 710) from two areas on the island of Malekula and on the main island of Efate with systolic blood pressure levels above 160 mmHg (172). There was little difference in mean blood pressure between the rural villages on Malekula and the urbanised centres on Efate.

> *In fact, all three areas….Give curves with no significant difference between them, but strikingly different from the curves found in 'civilised' man, and show that, among the indigenous inhabitants of the New Hebrides, the expected rise in mean blood pressure with age apparently does not occur.* (172)

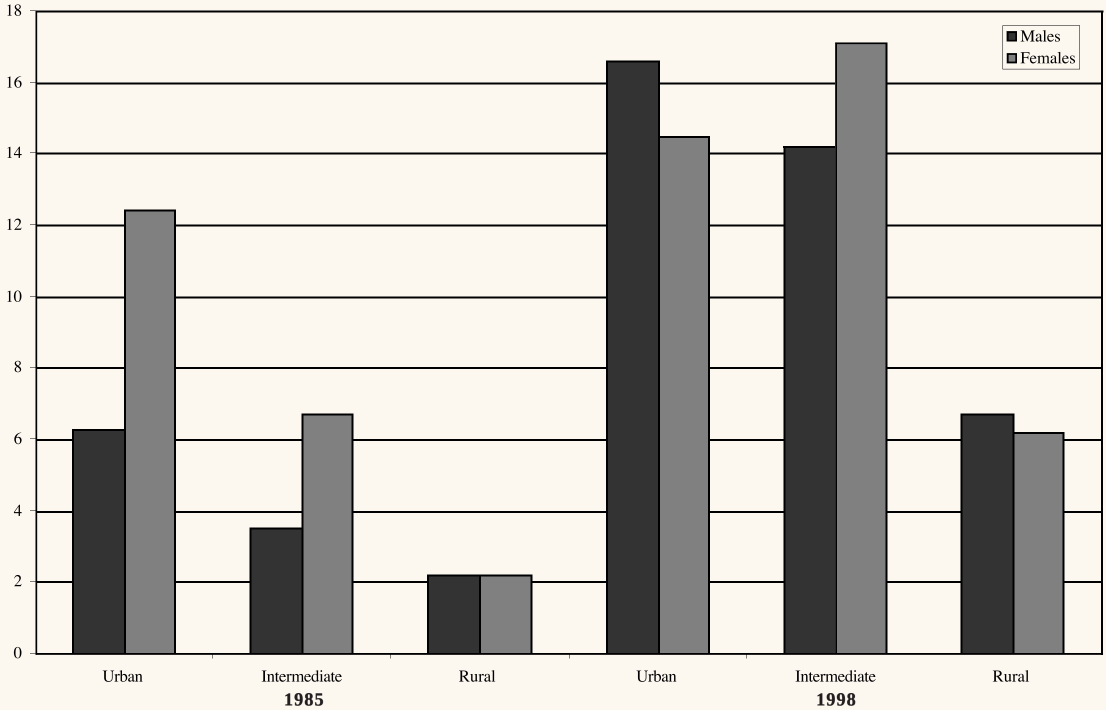
Finlayson and colleagues (173) examined two groups of ni-Vanuatu people as part of the first non-communicable disease (NCD) surveys in Vanuatu in 1980. Blood pressures were taken of 243 people in Port Vila, the capital city of Vanuatu and 77 adults in Norsup, the largest town on Malekula Island. Residents of Port Vila tended to be employed and consuming a fairly westernised diet whereas the people of Norsup were mainly involved in subsistence agriculture and fishing.

The mean systolic pressure was 120 ±1 mmHg for females and 122 ±1 mmHg for males. Mean diastolic pressure was 78.0 ±1 and 78.9 ±1 mmHg for females and males respectively. Systolic, but not diastolic, pressures were significantly higher in the urban setting. Blood pressures also rose significantly with increasing Body Mass Index. Overall, the total prevalence of hypertension was 7.8% and there were no differences in prevalence between the genders or between the urban/rural areas (173).

A NCD survey was carried out in 1985, in three populations at different levels of urbanisation (174,175). The urban group included all civil servants in Port Vila. An intermediate group consisted of residents of the island of Nguna about a half-hour boat ride from the mainland. The rural group comprised adults from remote villages in the Middle Bush area on the island of Tanna.

Mean blood pressure levels increased with age, although noticeably less so in the rural area. There were no consistent differences in mean blood pressures between the genders or between the communities.

Figure 3.14 provides the prevalence rates of hypertension in the three communities in 1985 and compares those rates with a subsequent 1998 survey. The 1985 survey found the highest rates of hypertension among both genders in the urban areas and the lowest in the rural areas. Rates of hypertension also tended to be higher among those who were judged as engaged in sedentary-light activity compared with those classified as engaged in moderate-heavy activity. There were positive, statistically significant correlations between systolic and diastolic pressure and BMI and skinfold thickness. There were no relationships between blood pressure and occupation, the use of kava, or alcohol use among men. Among women, however, alcohol use was associated with higher blood pressures among drinkers as compared with non-drinkers.



Source: (62,174)

Figure 3.14: Prevalence of hypertension in Vanuatu, 1985 and 1998

Health and nutrition examinations were undertaken in the 1998 Vanuatu Non-Communicable Disease Survey (62). The sites chosen for this survey were similar to the 1985 survey, and included urban, rural and intermediate communities. Approximately 1600 adults 20 years and over were evaluated for hypertension.

The mean systolic pressure for males (130.7 mmHg) was significantly higher than for females (125.6 mmHg). There was no difference in the mean diastolic pressure between males and females. The prevalence of borderline hypertension was significantly higher among the men (14.8%) compared with the women (11.4%), but the rates of definite hypertension were not significantly different (13.1% in males and 13.2% in females respectively).

Figure 3.14, comparing the 1998 survey with the 1985 survey, shows the dramatic increase in definite hypertension over this time period. The greatest increases were seen among the men, as rates in 1998 more than doubled in the urban centre, tripled in the rural areas and more than quadrupled in the intermediate communities compared with the 1985 survey. Hypertension rates more than doubled for women in the rural and intermediate areas, whereas the increase was not as great in the urban centres. When borderline hypertension and definite hypertension are combined, the rates for women in the urban areas also increased (data not shown).

Of the 166 adults identified with definite hypertension in the 1998 survey, 72% (119 persons) were unaware of their condition, i.e. were previously undiagnosed. In addition, of the 93 adults who had previously been told that they were hypertensive, 51% had blood pressures in the hypertensive range, i.e. had uncontrolled hypertension.

Micronesia

Commonwealth of the Northern Mariana Islands (CNMI)

> *Records from the Department of Health indicate that for 21,000 patients examined, hypertension was the second most frequent purpose for the visit for both men and women. Of the 1,109 patients that visited the hospital for hypertension, 48 per cent were Chamorros. Hypertension was the fourth most frequent cause of hospitalisation for males.* (176)

Primary school students in CNMI participated in a health assessment survey in 1996 (177). A total of 296 children between the ages of 5 and 12 years received blood pressure examinations as part of the health assessment. The survey reported that:

- 4% (11/296) of the children were classified as hypertensive (systolic or diastolic pressure > 90 percentile for age).
- 91% of the hypertensive children were either overweight or obese (these children were to be re-examined using an adult-size blood pressure cuff, to identify possible discrepancies by having to use a child-size cuff).
- Almost twice as many boys were identified as hypertensive as girls (64% boys, 36% girls).

The report concluded that hypertension among children in CNMI warrants further evaluation, but that health problems such as overweight and obesity will require collaboration among the health department, school and parents groups using specially targeted programmes.

Federated States of Micronesia (FSM)

In 1947 a small blood pressure survey was carried out in Pohnpei (178) among pure Pohnpeians. The mean systolic pressure was 111.0 mmHg among females (n=124) and 111.9 mmHg among males (n=127). Mean diastolic pressure was 76.6 mmHg among the females and 76.4 mmHg in males. In females, systolic and diastolic pressures increased at age 45 and over. Among the men, there was no significant variation with age in either systolic or diastolic pressure. The prevalence of borderline and definite hypertension combined was 12.9% for females and 8.7% for males.

Patrick and co-workers (179) studied blood pressure levels and modernity among three groups of Pohnpeians. Individuals were assigned a ranked modernity score based on segment of the economy, source of income, English language proficiency, occupation and education. Adults aged 20 to 60 years were selected from the capital town of Kolonia, an intermediate area, and a remote location.

The study, reported in 1983, found increasing systolic and diastolic pressures with increasing modernity scores in males from the capital centre of Kolonia. There was no consistent association, however, between blood pressure and modernity score for the other gender/location groups. This may have been due to small numbers in these groups with higher modernity scores. The study did not report prevalence rates of hypertension.

Auerbach et al. (180) of the US Public Health Service carried out a non-communicable disease survey in FSM that included approximately 5000 adults. Blood pressure examinations performed on a subsample of adults in 1993–94 revealed high rates of elevated blood pressure levels in three areas of the country as shown in Table 3.3. These rates were 1.2 to 1.5 times the rates for the same age groups in the United States.

Table 3.3: Prevalence of hypertension* in the Federated States of Micronesia, 1994

Age	Population with borderline and/or definite hypertension (%)		
	Kosrae N = 690	Chuuk N = 1520	Pohnpei N= 600
35–44	24	34	24
45–54	40	48	45
55–64	51	57	55
65–74	50	65	71

*Hypertension: Systolic ≥140 mmHg and/or diastolic ≥90 mmHg
Source: (180)

Guam

In 1967 and 1968, Reed and colleagues (181) conducted health surveys among 1214 Chamorros either living a traditional lifestyle on the island of Rota, a more westernised way of life in Guam, or residing in California. The blood pressure examinations indicated that the mean systolic and diastolic pressures were similar in the three areas, except for slightly lower systolic levels among the rural group. Systolic pressure rose sharply with age in both genders in all three locations.

High prevalence rates of hypertension were found in all groups as shown in Table 3.4 with the lowest rates found among the rural Chamorros in Rota.

Table 3.4: Prevalence (%) of hypertension* among Chamorros living in Guam and California, 1967–68

	Hypertension (%) *	
	Female	Male
Rota	30	31
Guam	35	34
California	32	34

* Hypertension: Systolic ≥160 mmHg and/or diastolic ≥95 mmHg
Source: (181)

These investigators also analysed mortality rates for Chamorros in Guam between 1955 and 1964 and compared them with mortality rates for the total California population for 1960. Death rates for the Guam Chamorros were higher than for Californians in terms of total mortality and from hypertensive heart disease but were lower from total cardiovascular disease and neoplasm. Guam males had higher mortality rates from cerebrovascular disease than California males.

Residents of Guam participated in a Behavioral Risk Factors Survey in 1991 (139). The survey was based on person-to-person and telephone interviews (n= 402). Respondents were identified as hypertensive if they: (1) were told on more than one occasion that their blood pressure was high, or (2) reported that they were taking medication to control their blood pressure.

Overall, 7.2% of the Guam sample surveyed reported having hypertension. Table 3.5 provides the prevalence rates for the major ethnic groups participating in the survey. The rates for Micronesians, Filipino and Chinese were significantly higher than for the other ethnic groups.

Table 3.5: Prevalence of hypertension by ethnic group in Guam: self-reported, 1991

	% Hypertension	
	N	%
Chamorro	174	7
Filipino	130	11
Micronesian	8	12
Chinese	5	11
Japanese	17	6

Source: (139)

Statistically significant differences in prevalence rates were found among other demographic variables:

- Age – the age groups 70 to 74 (58.6%), 55 to 59 (34.3%), and 50 to 54 (22%) had higher rates than the other age groups.
- Household income – rates were higher in income groups over $50,000 per year (11.8%) and below $10,000 (9.7%) than in other income groups.
- Education – rates were highest in those with technical school education (46.3%) and those with eighth grade education or less (15.4%).

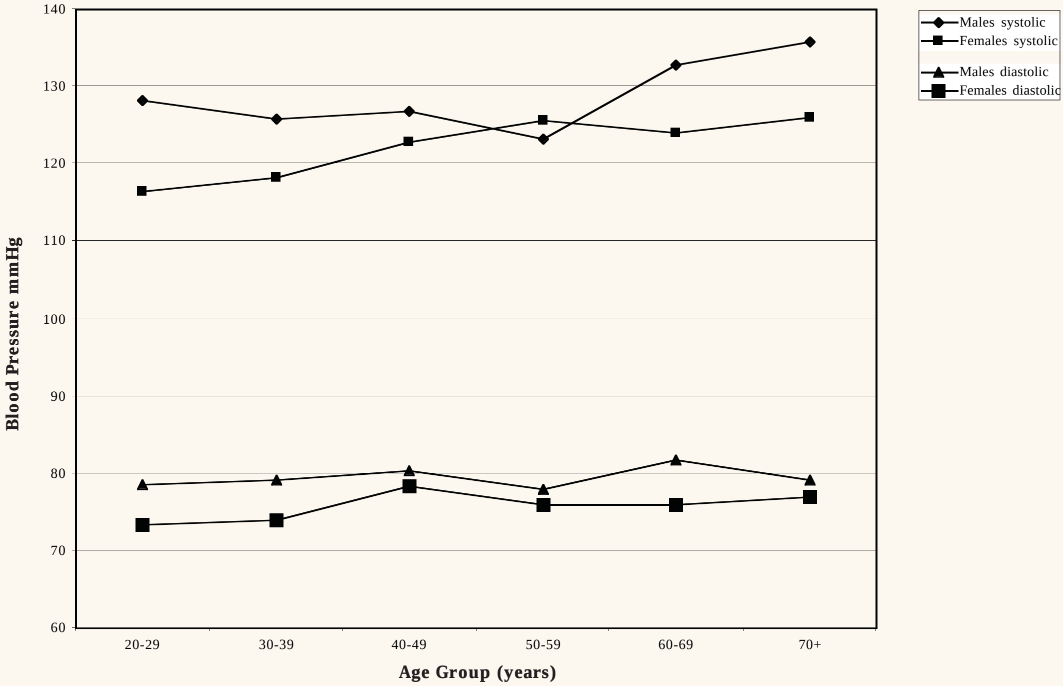
The rates reported in this self-report survey are substantially lower than those reported in the 1967–68 survey by Reed et al. (181). Of concern, is that the actual prevalence of hypertension is much higher but that the condition is unknown to the individual i.e. is undiagnosed. Other blood pressure surveys (62) have revealed that as many as 70% of those found to be hypertensive were unaware of their disease and were untreated for the disorder.

In 1997, in Guam, cerebrovascular disease and hypertensive disease together were ranked as the second leading cause of death.

Kiribati

Until the 1950s, experience from Europe and the United States indicated that blood pressure increases with age. Maddocks (144) was one of the first investigators in the Pacific to show that blood pressures in populations living a traditional lifestyle do not necessarily increase with advancing age. In 1960, Maddocks examined the blood pressures of 932 inhabitants of Abaiang, a remote coral atoll in the central Gilbert Islands (now Kiribati).

Figure 3.15 shows that among these Micronesian people, there was virtually no change in diastolic pressure with age and only a slight increase in systolic pressure in males after age 60. Females, in general, tended to have lower systolic and diastolic pressures than males.



Source: (144)

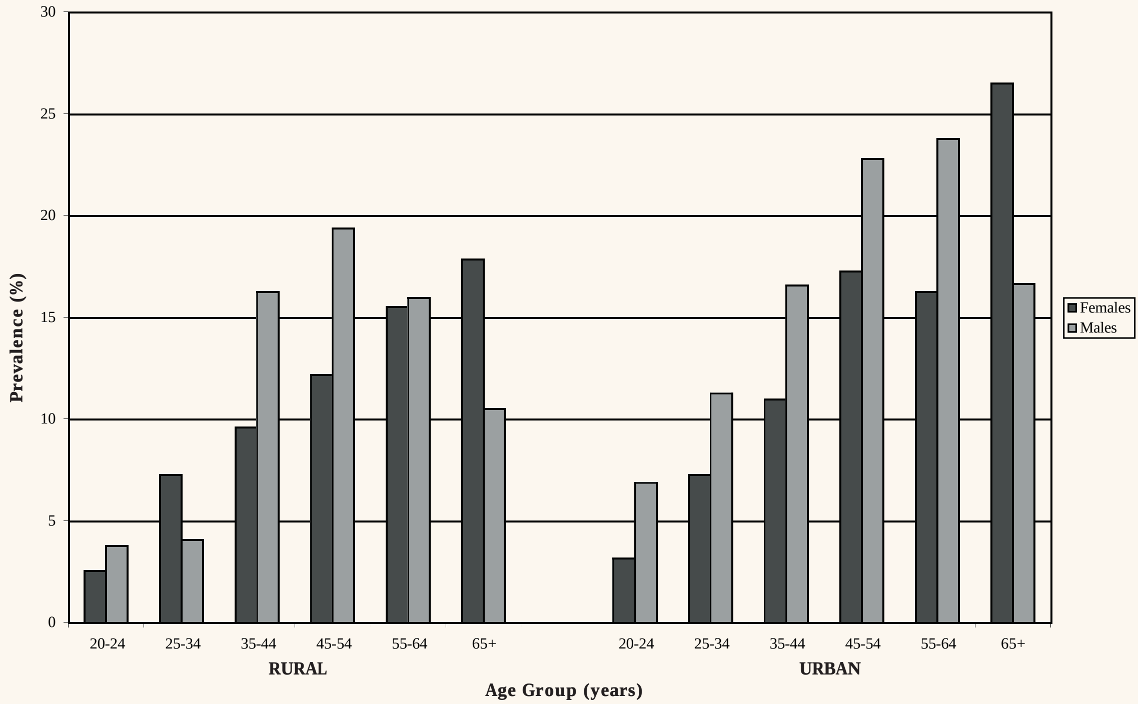
Figure 3.15: Mean blood pressure of Kiribati females and males by age, 1960

This investigator concluded:

> *Apparently essential hypertension does not exist among these people, or is rare…….Such complete, relatively isolated populations merit long-term prospective study to discover whether their blood pressures change as they become 'westernised'.* (144)

Approximately twenty years later the Kiribati Diabetes and Cardiovascular Disease Survey carried out by Zimmet (182) found increasing rates of hypertension with age in both urban and rural residents of Kiribati. Figure 3.16 reveals higher rates of hypertension in urban areas with rates above 20% in middle age group males and females over 65 years.

There are no data regarding recent rates of hypertension among Kiribati people.



Source (182)

Figure 3.16: Prevalence of hypertension in Kiribati females and males by level of urbanisation, 1981

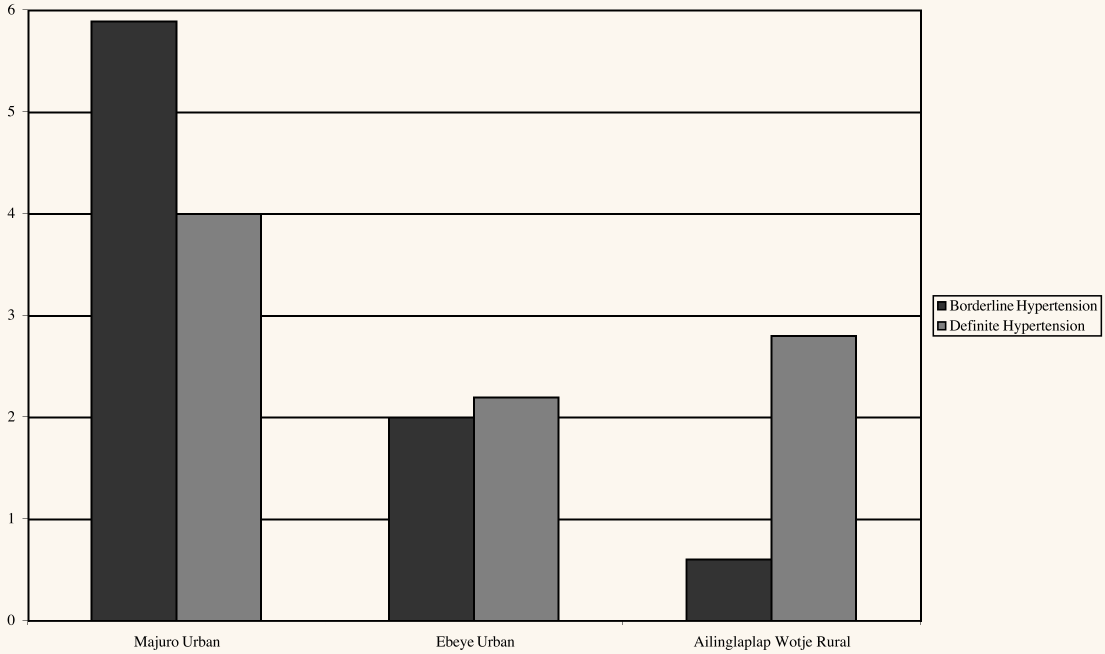
Marshall Islands

The United States Navy conducted a massive health survey in 1948 to 1950 of over 6000 children and adults in the Marshall Islands (183). This was estimated to be about 70 per cent of the entire population. The median age was 23.6 years. Mean systolic pressure of adults 45 years and over was 130 mmHg for females and 125 mmHg for males; the diastolic pressure was 79 mmHg for females and 78 mmHg for males. No mention was made of hypertensive disease in the survey results.

The Marshall Islands Women's Health Survey (184) was conducted in 1985 and included women aged 15 to 59 years. Two urban areas were selected: Majuro, the administrative centre and Ebeye, a densely populated atoll near Kwajalein. These urban areas have an almost total dependence on imported foods. The outer atolls of Ailinglaplap and Wotje were selected to represent the rural way of life.

Among all groups, mean blood pressure showed a general rise with age. When adjusted for age and BMI, systolic pressure was significantly higher in Majuro (110.7 mmHg) than in either Ebeye (101.7 mmHg) or the rural areas (102.9 mmHg). Diastolic pressure, however, was higher in the outer islands (69.9 mmHg) than Majuro (65.3 mmHg) or Ebeye (65.5 mmHg) when adjusted for age and BMI.

Overall the prevalence of definite hypertension was 3.2% and that of borderline hypertension was 3%. Figure 3.17 shows that the prevalence of both definite and borderline hypertension was highest in Majuro compared with the other two locations. Definite hypertension was found more frequently among obese women, but the same relationship was not found between borderline hypertension and obese women.



Source (184)

Figure 3.17: Prevalence of hypertension in Marshall Island females, 1985

Blood pressure was not measured in the 1991 National Nutrition Survey (185) nor in the 1996–97 study of overnutrition and undernutrition (186).

Nauru

The first full survey of diabetes, conducted in 1975 by Zimmet and Taft (187) found an overall prevalence rate of hypertension of 35.8% for males and 19.5% for females. Mean blood pressure rose with age and was significantly higher at all ages over 15 years compared with adults examined at about the same time in Tuvalu.

A second survey was carried out in 1987 in Nauru by Collins et al. (188). The study population included 1184 adults who had attended the 1975–76 and/or 1982 surveys. The overall prevalence rate for males and females combined was 16.9%. This rate is considerably lower than the 1975–76 survey. (Data were not found for blood pressure for the 1982 survey.)

Analysis of mortality data in Nauru between 1976 and 1981 by Taylor and Thoma (189) showed that cardiovascular disease was the second leading cause of premature death and that half of these deaths were due to stroke. Age-standardised mortality from stroke was four times higher in Nauru than in Australia and, in the 45 to 54 year age group, the rate was ten times higher than in Australia.

> *Inadequately controlled hypertension is probably a major contributor to this difference.* (189)

Collins found that elevated blood pressure was an important risk factor for both micro- and macro-albuminuria in Nauru's diabetic population (190).

Palau

Between 1948 and 1950 the United States Navy conducted a large health survey which included over 10,000 children and adults in Palau (183). The mean systolic pressure of adults 45 years and over was 122 mmHg and 125 mmHg for females and males respectively and the diastolic pressure 73 and 75 mmHg. No mention was made of hypertensive disease in the survey results.

Mean blood pressure levels were considerably higher in surveys carried out twenty years later (1968–1970) by Labarthe and colleagues (191) in three communities representing urban, rural and intermediate lifestyles. Table 3.6 provides the mean blood pressure values and percentage of individuals with a history of hypertension.

Mean blood pressure levels in the urban and intermediate areas were considerably higher than in the rural area and higher than the 1948–50 survey. Although Labarthe did not report the prevalence of hypertension based on blood pressure values, he did report the proportions of persons with a history of high blood pressure. For the males this was considerably higher among the urban residents than intermediate or rural residents. Among the females there was little difference between the areas in reported history of high blood pressure.

Table 3.6: Mean blood pressure and percentage of individuals with history of hypertension in Palau males and females, 1968–70

	Koror Urban	Peleliu Intermediate	Ngarchelong Rural
Males			
Systolic (mmHg)	136	135	121
Diastolic (mmHg)	88	83	81
History of Hypertension (%)	11	5	1
Females			
Systolic (mmHg)	133	137	124
Diastolic (mmHg)	84	82	77
History of Hypertension (%)	7	5	6

Source: (191)

There have been no other recent reports of blood pressure values in Palau.

A study of the physical and mental health of very aged Palauans was conducted 1986–87 by Jensen and Polloi (192). Of the 31 individuals over the age of 90 years included in the study, one case of hypertension was reported.

In 1997 stroke and hypertensive disease combined were the third leading cause of death among Palauans (193). This indicates a clear need to monitor the prevalence of hypertension in this population.

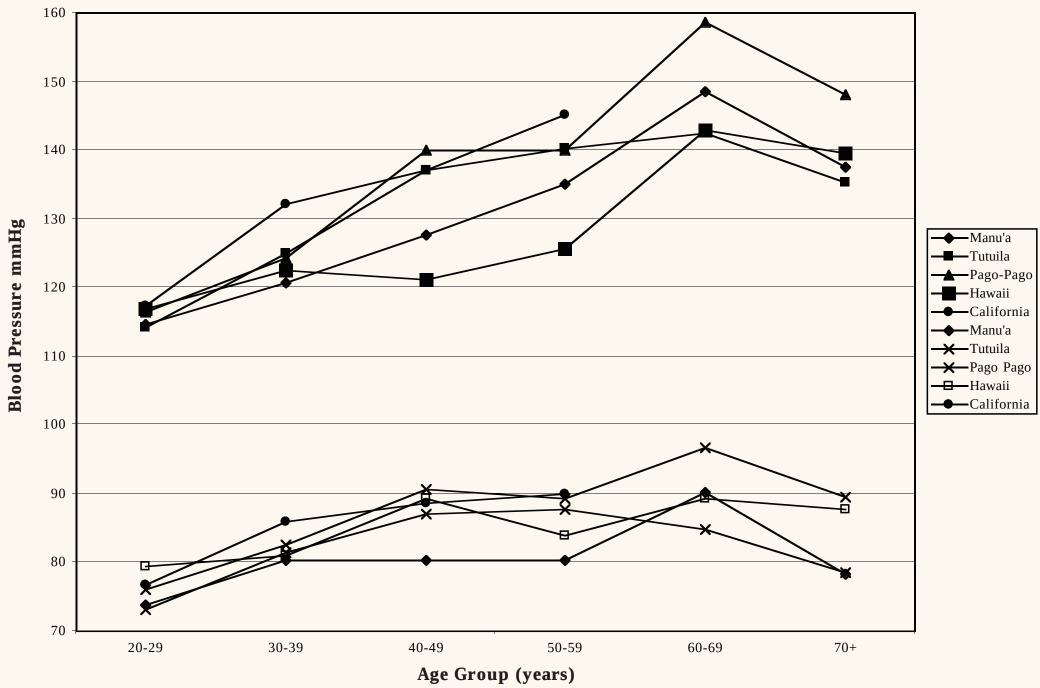
Polynesia

American Samoa and Samoa

Because a number of surveys and studies have been conducted in both American Samoa and Samoa (formerly Western Samoa), these countries will be reviewed together.

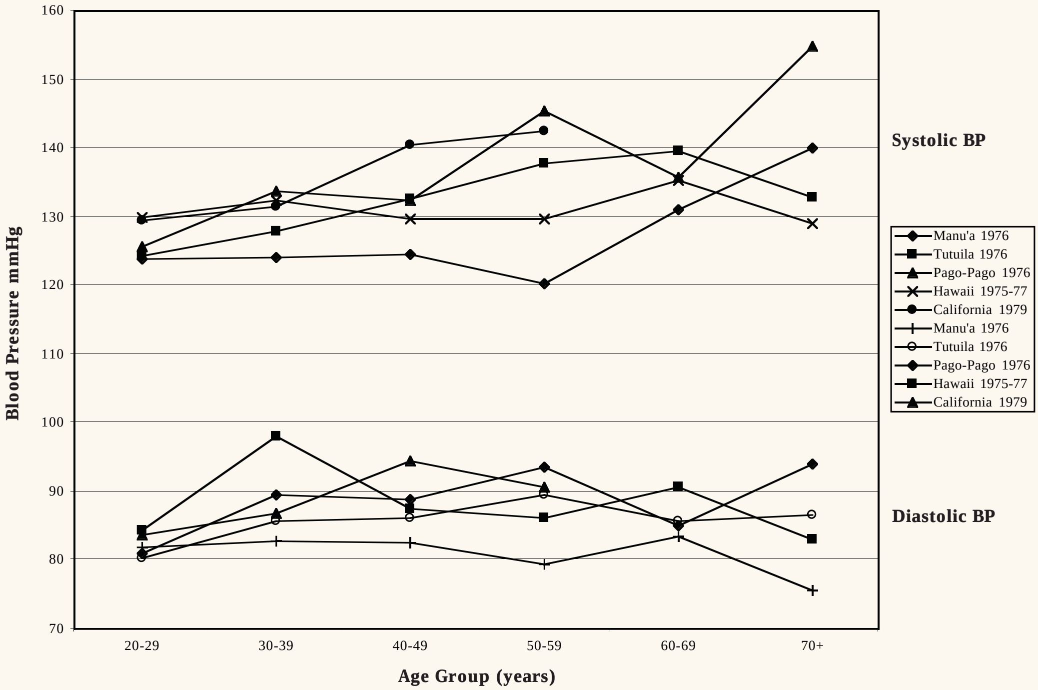
Blood pressure was extensively investigated in a series of studies carried out among Samoans beginning in 1975 as part of the Pennsylvania State University Samoan Migration Project (194–196). These investigations compared blood pressure and cardiovascular risk factors among Samoans living at differing levels of urbanisation. Samoans living on the islands of Manu'a lived a rural lifestyle but had easy access to western goods and services. Those from the area of Tutuila, the centre of commerce and government, had a more modern way of life. Samoans living in several areas on Oahu, Hawaii and in the San Francisco area of California were considered the most westernised.

The surveys showed (Figure 3.18 and 3.19) that in general mean blood pressures were similar in the younger age ranges and are lowest in the less urbanised populations. For males, pressure increased with age, and most dramatically in the more urbanised men. Among the females, there was a gradual rise in pressure from age 20 and a sharper rise after age 50 years. This rise in pressure was seen among the rural women as well as among the more urbanised females. The increase in pressure among the Hawaiian Samoans was less than expected, which could be due to variation in length of residence in Hawaii and area of origin.



Source (195)

Figure 3.18: Mean blood pressure of Samoan females by level of urbanisation, 1976–1982

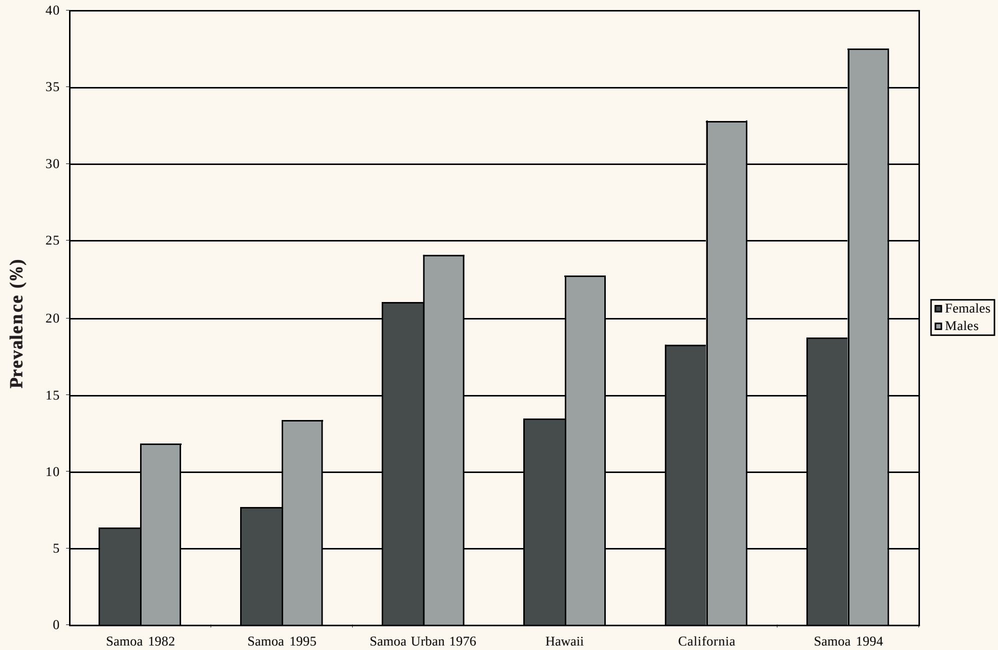


Source (195)

Figure 3.19: Mean blood pressure of Samoan males by level of urbanisation, 1976–1982

McGarvey and colleagues (pers.comm.1999) conducted a series of studies of cardiovascular disease risk factors between 1990 and 1995 in American Samoa and Samoa. The study included 723 adults 25 to 74 years of age from American Samoa and 730 individuals of the same age range from Samoa.

Figure 3.20 provides the prevalence rates of hypertension for Samoans living in Samoa and American Samoa at two time periods, and in Hawaii, and California. These data indicate that more males than females have high blood pressure regardless of lifestyle and that rates of hypertension for both genders increase with increased modernisation. Of particular concern are the very high rates among males living in California (1979) and in American Samoa (1994). These are some of the highest rates recorded in the Pacific to date. These data confirm that Samoans are highly susceptible to hypertension.



Source (195)

Figure 3.20: Prevalence of hypertension in Samoans by level of urbanisation, 1976–1995

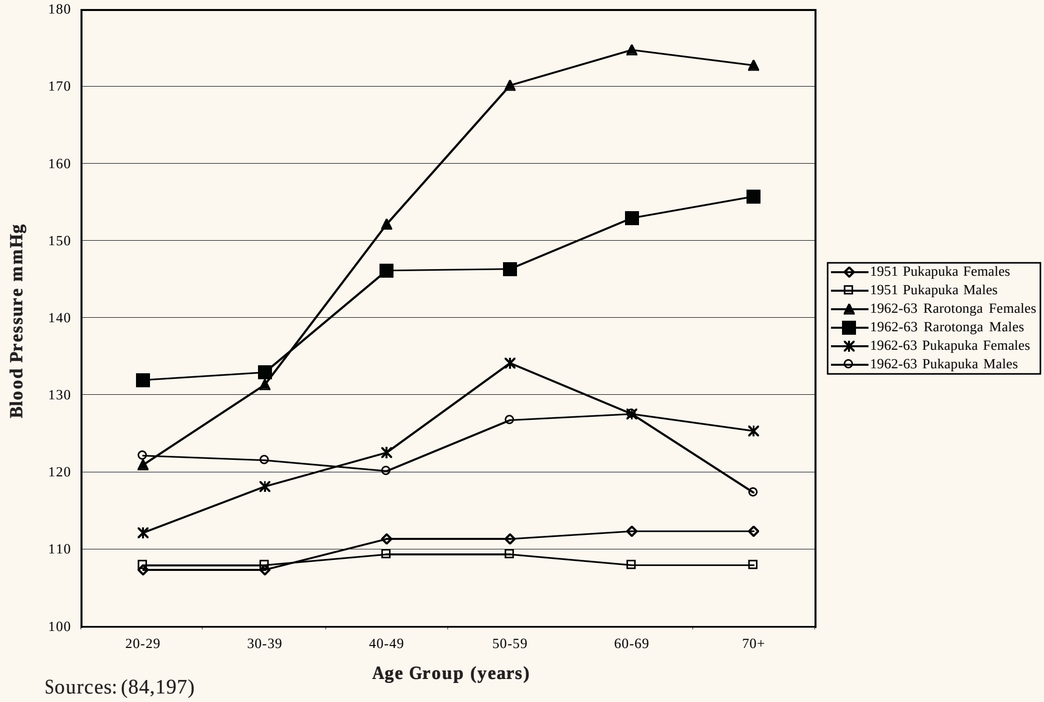
Cook Islands

Hypertension was unknown to the people of Pukapuka when Murphy (197) measured blood pressure on this atoll in 1951. The mean systolic and diastolic measurements were extremely low, and did not increase with age. Only two persons, both females in the 25–45 age group, were seen who might have been regarded as hypertensive relative to the general population. Murphy noted that practically no European foodstuffs were consumed, and that cardiac abnormalities were uncommon. Murphy further commented on the absence of stress.

About 10 years later, when Hunter (83) examined urban and rural Cook Islanders, his findings were quite different. The mean blood pressures rose with age among both the urban Rarotongans and the villagers of the islands of Atiu and Mitiaro. By the age of 40 years, the Rarotongans had much higher mean systolic and diastolic readings than the more traditional groups. Urban females (26%) had higher rates than traditional females (21%), but the difference was not statistically significant (data not shown). The prevalence of hypertension among urban males 40 years and over (25%) was much greater than for rural males (10%), and this was statistically significant.

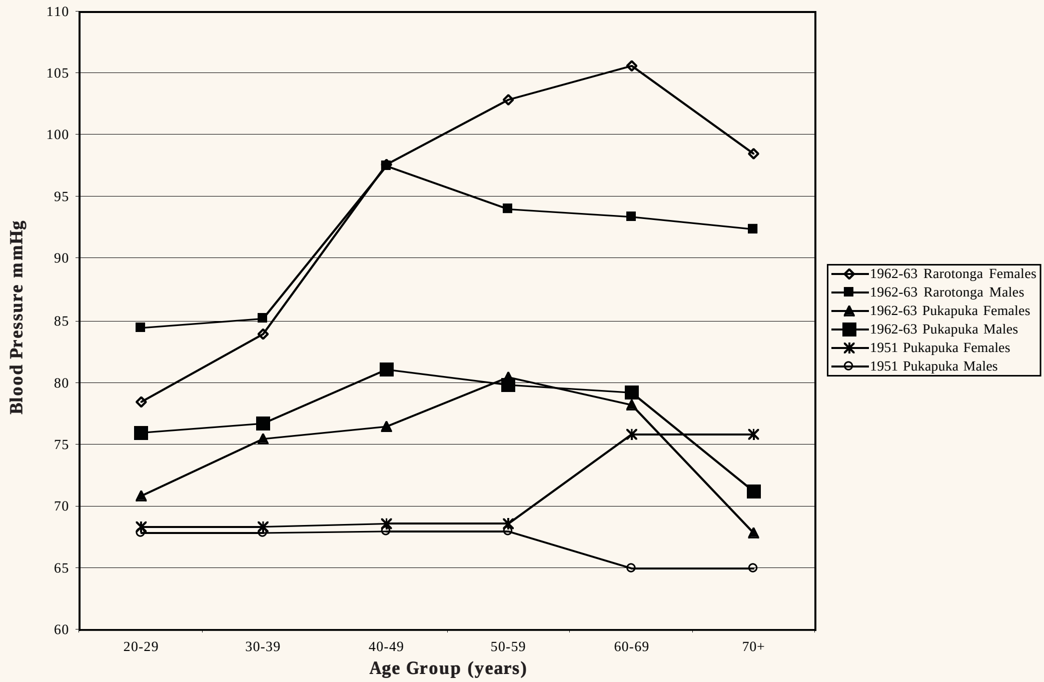
Prior and co-workers (84) found a similar situation when they examined urban and rural groups a few years later, 1962–63. The Rarotongans had much higher mean systolic and diastolic values than the traditional Pukapukans as seen in Figures 3.21 and 3.22. The Rarotongans' mean blood pressure increased dramatically with age, whereas the Pukapukans' did not. Females generally had higher blood pressure than males. Also interesting is the marked increase in mean blood pressure of the Pukapukans between 1951 and 1962–63.

The prevalence of hypertension was reported by Prior only for adults aged 40 and over. Of the Rarotongan residents, 47% of the females and 28% of the males were hypertensive compared with 7% of the females and 3% of the males in Pukapuka. Differences in urinary sodium output and casual mean urinary sodium concentration of urine suggested a higher dietary sodium intake in Rarotongans compared with the inhabitants of Pukapuka.



Sources: (84,197)

Figure 3.21: Systolic blood pressure (mmHg) in Cook Islanders, 1951 and 1962–63

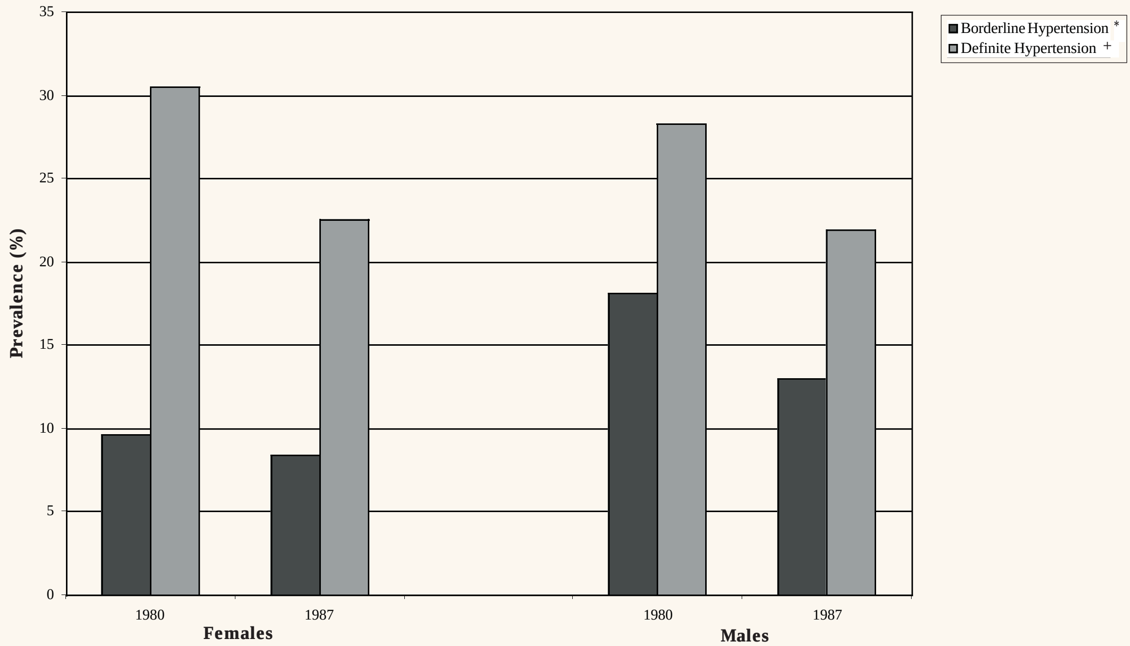


Sources: (84,197)

Figure 3.22: Diastolic blood pressure (mmHg) in Cook Islanders, 1951 and 1962–63

SPC conducted two NCD surveys in the Cook Islands during the 1980s. The first survey in 1980 by Bennett and co-investigators (198), included 1127 Cook Islanders 20 years and older on Rarotonga. Mean blood pressure levels did not differ substantially from Prior's 1962–63 survey. This survey reported a prevalence of hypertension of 30.5% of females and 28.3% of males (Figure 3.23). These rates included persons with normal blood pressure readings but who were currently taking medication for hypertension (199).

The second SPC survey was carried out in 1987 and included 1277 adults 20 years of age and older (200). This survey was conducted in Rarotonga in the same villages that were surveyed in 1980. Mean systolic and diastolic pressure levels were significantly lower in 1987 compared with 1980 for both males and females. The prevalence rates of hypertension were also lower in 1987 than in 1980 (Figure 3.23). Individuals who were currently taking medication for hypertension were included as hypertensive. It could be argued that the lower rates of hypertension in 1987 were due to improved medical treatment. This did not appear to be the case, however, since 50% of the known hypertensives had blood pressure levels in the hypertensive range (200).



* Borderline Hypertension: systolic 140–159, diastolic 90–94 mmHg
\+ Definite Hypertension: systolic ≥160, diastolic ≥95 mmHg

Source: (200)

Figure 3.23: Prevalence of hypertension in Cook Islanders, 1980 and 1987

Katoh and co-investigators (201) conducted a smaller survey in Rarotonga and the more rural agricultural island of Mangaia. The mean systolic and diastolic blood pressure levels of Rarotongan males and females were higher than the rural Cook Islanders, were also higher than in the 1987 survey, and were similar to the 1980 survey (see Table 1 in Appendix 1).

Losacker carried out a series of health surveys on rural outer islands and atolls in 1992–93 for the Cook Islands Ministry of Health (202). Blood pressure determinations were made on all adults over the age of 40 and above 25 (years) for those who had known diabetes in their family. The medical specialist reported the number of persons with hypertension but did not provide the criteria for defining hypertension and did not report mean blood pressure levels.

The proportion of adults seen with hypertension was 18.3% and 10.0% for females and males respectively on Rakahanga and Manihiki Islands combined and 20.8% and 26.8% for females and males respectively on Aitukaki. On Pukapuka 19.1% of females and 21.4% of males were considered hypertensive. These rates for Pukapuka and the other rural islands are remarkably higher than the rates found by Prior in 1962–63 on Pukapuka, (7% and 3% for females and males respectively) but the exact age range of the Pukapukans in this 1992–93 survey was not provided.

It appears that hypertension is a problem of considerable magnitude in the Cook Islands. There is also evidence that the earlier differences in prevalence rates between outer islands and the main centre of Rarotonga may be diminishing. In 1997 hypertension was listed as the leading cause of death in the Cook Islands (203).

French Polynesia

A small survey of hypertension was carried out on the island of Maupiti, one of the most westerly and most isolated of the Society Islands, in 1973 (204). The survey included 230 persons aged 10 years of age or older. The prevalence of hypertension was 11.9% for females and 9.8% for males. When adults aged 20 years and older were considered, the prevalence rates were 16.0% and 16.6% for females and males respectively.

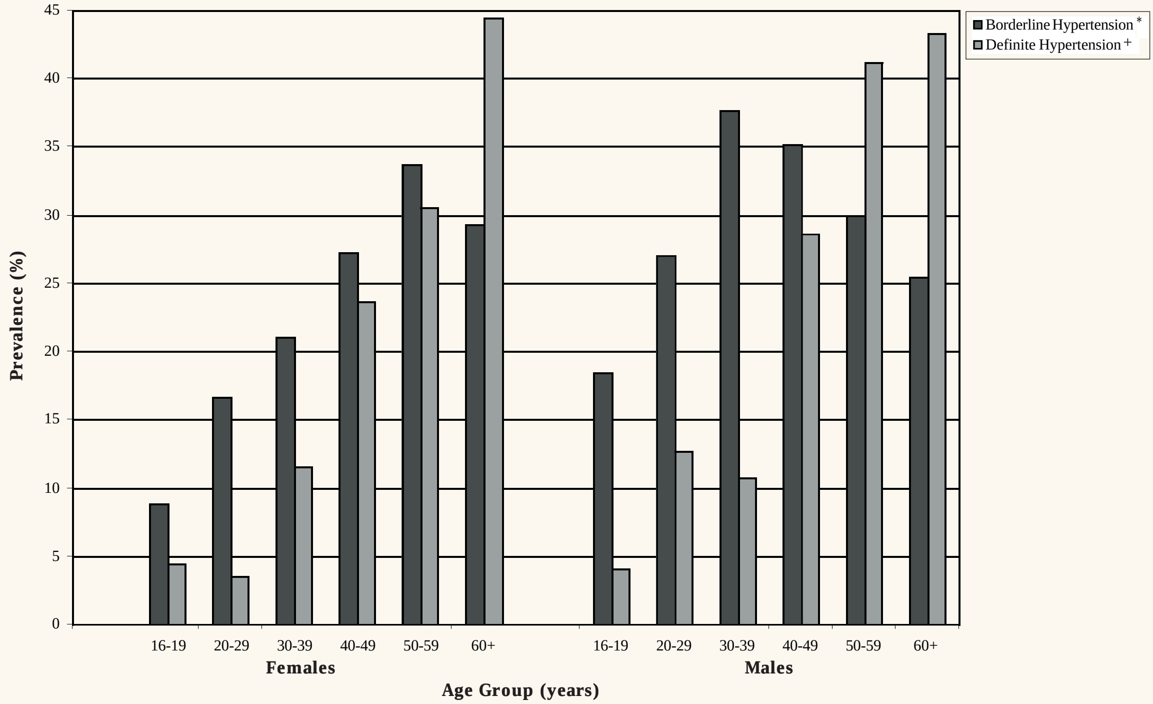
In 1986, a large health survey was conducted among 4500 adults employed in private business or in public service positions in Tahiti (205). The survey included adults aged 18 to 59 years, and more males than females (n=2903 males, n=1670 females). Mean blood pressure levels were not provided in this report but the prevalence of hypertension was 6.7% in females and 15.7% among the males. These rates were not age adjusted and the ethnic make up of the sample was not provided. It is not clear how representative this large sample was of the working people of Tahiti.

A large, comprehensive NCD survey was carried out in 1995 in six districts in the territory (19). The survey comprised 1273 individuals aged 16 years of age and over, 82% of whom were Polynesian. The prevalence of definite hypertension increased with age and was higher in males than females at almost all ages as seen in Figure 3.24. Borderline hypertension increased with age in females, but in males increased to the 30–39 year age group and then showed some decline. After adjusting for age and gender, the overall prevalence rate for definite hypertension was 17.9% (15.7% for females; 19.8% for males).

Gras et al. (206) reported the results of a survey of patients hospitalised with cerebrovascular accidents between 1 April 1990 and 31 January 1991 in the Territorial Hospital Centre of Papeete. Fifty-six patients were included; 25% were haemorrhagic and 75% were ischaemic accidents. Males made up 64% of the population and Polynesians accounted for 89% of the patients. Among the risk factors that were recorded were:

- Hypertension – 68%
- Tabagism (poisoning from excessive use of tobacco or nicotine)– 30%
- Hypercholesterolaemia – 5%

Twenty-six per cent of the patients recovered completely, half recovered incompletely and 24% died.



* Borderline Hypertension: systolic 140–159, diastolic 90–94 mmHg
+ Definite Hypertension: systolic ≥160, diastolic ≥95 mmHg

Source: (19)

Figure 3.24: Prevalence of hypertension among French Polynesians, 1995

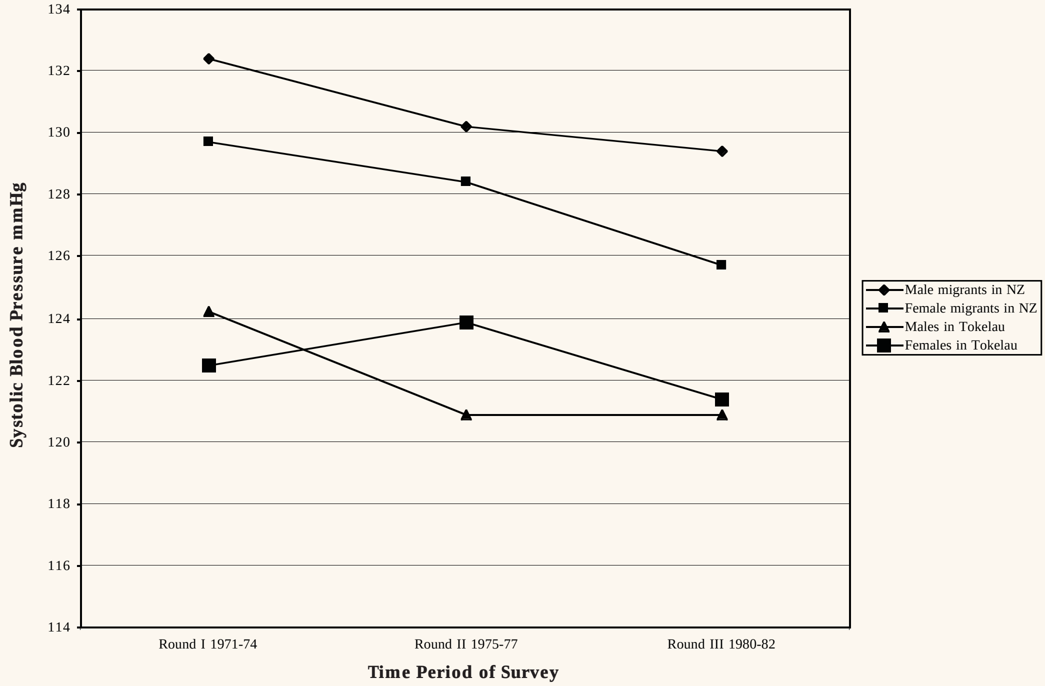
Niue

A cardiovascular disease and diabetes survey conducted in 1980 by SPC (198) included 1149 adults aged 20 years or older. The report compared the Niuean blood pressure levels to those obtained during the same year with the same methodology on Rarotonga in the Cook Islands. The results showed that Niuean males had significantly lower blood pressure levels in all age groups. Niuean females had significantly lower levels at all age groups except the 25–34 and 45–54 year age groups. Niueans also had significantly lower prevalence rates of hypertension in all age groups above 45 years and for the total age-adjusted rates than the Rarotongans.

A survey of women's health was undertaken in 1983 by the SPC (207). The prevalence rates of hypertension in the 55–65 year age group were considerably higher (41.9%) in this survey than in the 1980 survey (16.2%), although the numbers in these age groups were small. The overall prevalence rate of 11.5% was slightly higher than that of the 1980 survey (9.4%).

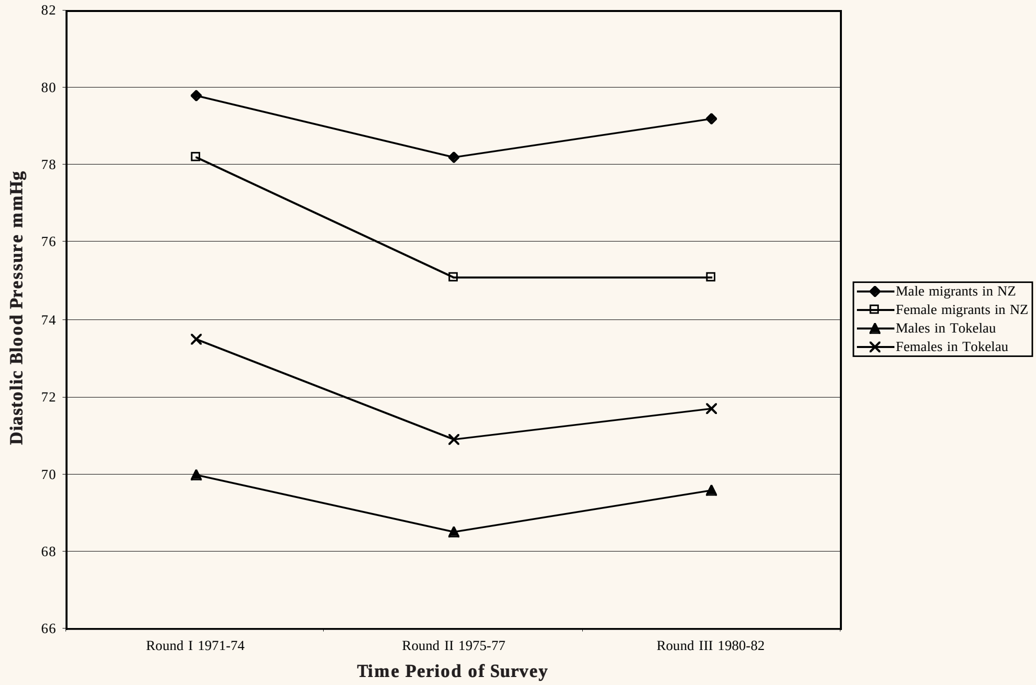
Tokelau

The Tokelau Island Migrant Study was designed to determine the degree of changes in disease patterns that would take place when Polynesians from the Tokelau Islands immigrated to New Zealand (208). The studies were carried out in three rounds of expeditions to the Tokelau Islands and three survey rounds in New Zealand. Figures 3.25 and 3.26 show the mean blood pressure levels and suggest several trends. Firstly, in all three rounds the mean blood pressures for both men and women were higher among the migrant than among the non-migrant Tokelauans. For men, mean systolic levels were between 8 and 9 mmHg higher among migrants than non-migrants, and diastolic levels were are also approximately 10 mmHg higher in the New Zealand migrants than in the non-migrants. For women, these differences were smaller.



Source: (208)

Figure 3.25: Mean systolic blood pressure for migrant and non-migrant Tokelauans, 1971–1982



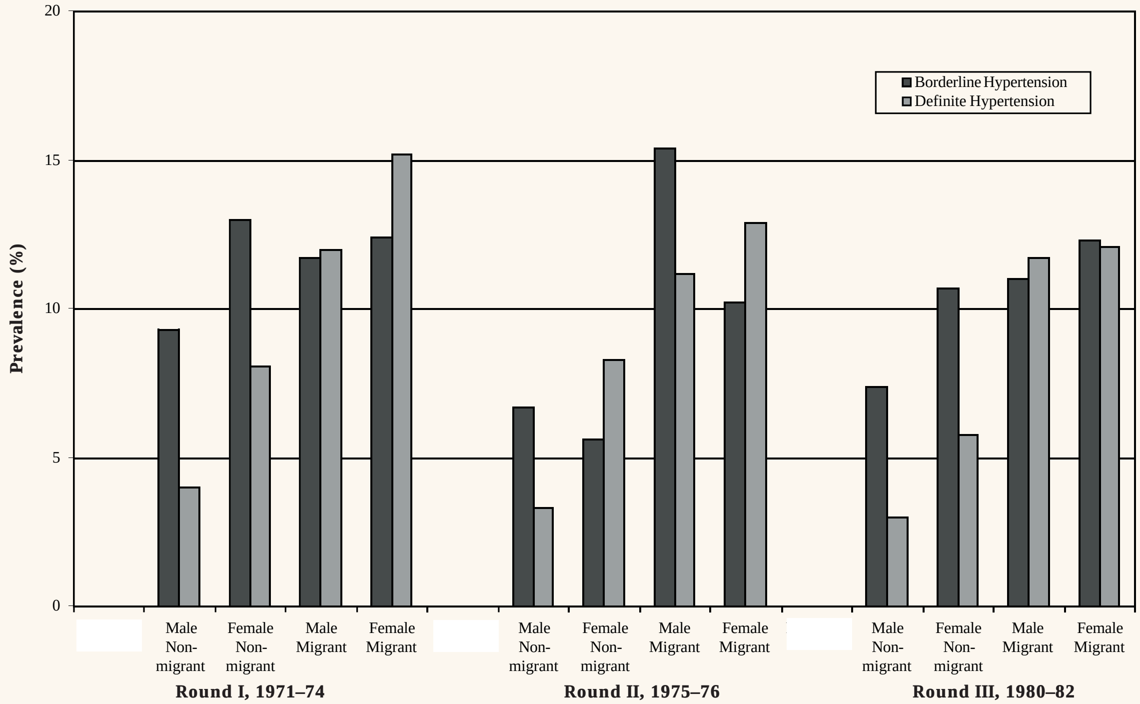
Source: (208)

Figure 3.26: Mean diastolic blood pressure of migrant and non-migrant Tokelauans, 1971–1982

Second, there was a tendency in Tokelau for women to have higher blood pressure levels than men, but this was reversed in migrants in New Zealand. This finding suggests that in future studies, attention should be paid to lifestyle factors, which may differ between men and women who migrate to urban centres.

Third, the mean blood pressure levels did not change significantly from survey period to survey period. In fact, where changes did occur, the tendency was for a decrease in both migrant and non-migrant groups.

Figure 3.27 shows the prevalence of borderline and definite hypertension among migrant and non-migrant Tokelauans. Definite hypertension was more common among migrants than non-migrants at all survey periods and the prevalence was higher among women than men, both in Tokelau and in New Zealand. Borderline and definite hypertension showed a slight decline from the first to the third survey period. This may have been due to improved treatment but the numbers of persons who received hypertension medication were small; 14% of hypertensive patients in Tokelau and 18% of hypertensive patients in New Zealand.



Source: (208)

Figure 3.27: Prevalence of borderline and definite hypertension in migrant and non-migrant Tokelauans 1971–1982

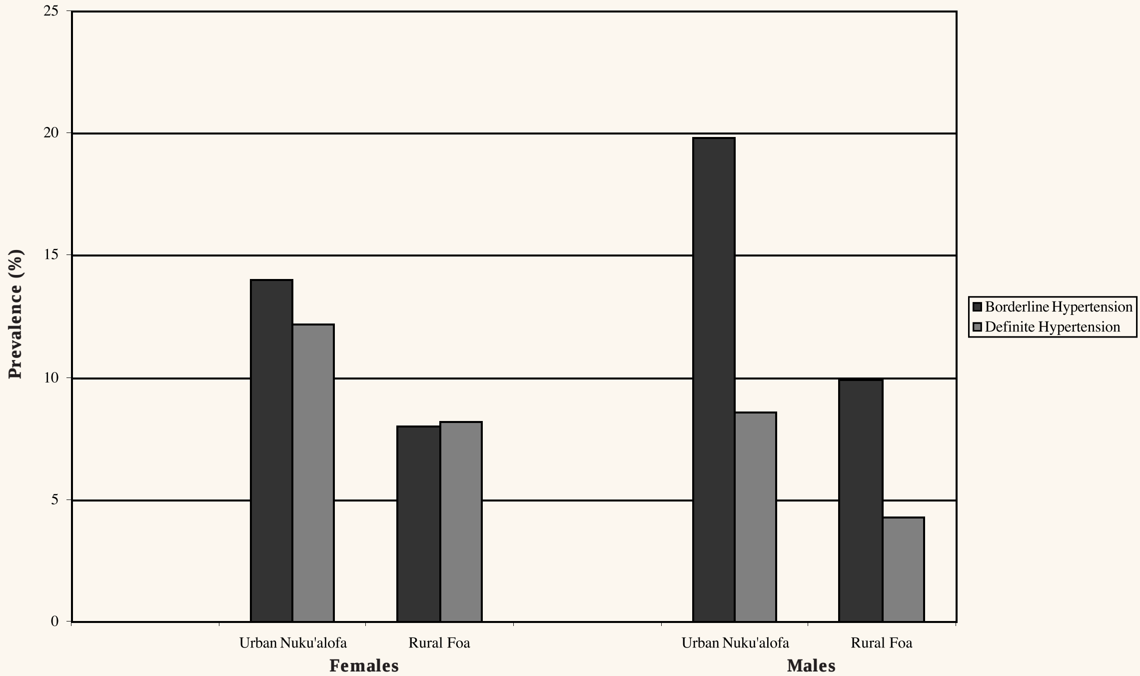
Another study (209) examined all Tokelauan children in New Zealand and in Tokelau in 1975 and 1976. Of the New Zealand Tokelau children, 64% were born in New Zealand; the rest were born in the Pacific Islands. The results showed that mean systolic pressures were greater in all age groups of boys and girls (except one) for the New Zealand children, compared to those in Tokelau. These differences were significant for children less than eight years of age. The New Zealand children were also heavier and taller than the Tokelauan children.

These investigators again compared children on Tokelau to Tokelauan children who had migrated to New Zealand between 1971 and 1977 (210). The average length of stay in New Zealand was 1.9 years – a range of 2 months to 5 years. On the whole, the Tokelau migrant children had higher systolic and diastolic pressures than the children on the atolls. These differences were statistically significant for the

5 to 9 year age group of males, and for the diastolic of 5 to 9 year age group of females. Weight and BMI were also significantly higher statistically in New Zealand in the younger age groups, for both girls and boys.

Tonga

Finau and co-investigators (211) carried out a study of cardiovascular and metabolic problems in Tonga in 1973. The survey included 399 adults aged 20 to 69 years from the main urban centre of Nuku'alofa and 392 adults from Foa, an atoll about 160 km north of Nuku'alofa, where the lifestyle was more traditional. Systolic pressure increased significantly with age in all groups except rural men and was higher in urban dwellers in all age groups. There was no significant difference in diastolic pressure between the two groups. The overall age-adjusted prevalence of hypertension was 8.4%, with higher rates in the urban centre compared with the rural area as shown in Figure 3.28.



Source: (211)

Figure 3.28: Prevalence of hypertension among Tongans by level of urbanisation, 1973

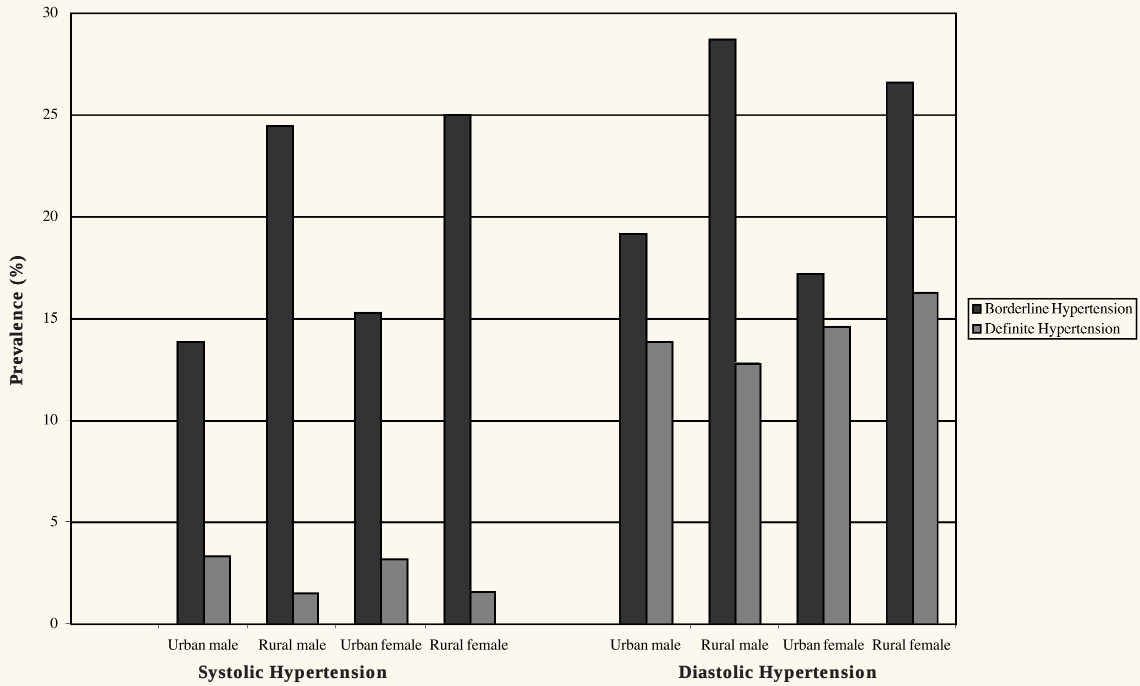
The investigators performed multivariate discriminant analysis to determine which risk factors commonly associated with hypertension were best used to distinguish between normotensive and hypertensive individuals (data from both urban and rural areas and from borderline and definite hypertensive persons were combined for this analysis). Age, BMI, and sum of triceps and sub-scapular skinfolds accounted for most of the differences between normotensive and hypertensive individuals, especially in women. Fasting plasma glucose was a significant discriminating variable for both genders and packed-cell volume was the strongest single discriminating variable in men.

The University of Tokyo carried out medical and nutritional surveys among two groups of Tongans who were 30 years of age and over (212). In 1977, 108 adults from the remote island of Uiha were examined and in 1979, 148 individuals from Kolofo'ou, Nuku'alofa, the metropolitan centre of Tonga, were seen. The results did not show differences between the rural/urban groups but blood pressure data were provided in graph form only.

Other investigators, also from the University of Tokyo (213) carried out a survey of cardiovascular disease in 1983 in Tonga. The survey included 102 adults ranging in age from 21 to 91 years. It is not clear if these individuals were also part of the above 1977 and 1979 surveys. Mean blood pressure levels for both urban/rural groups and both genders combined were 129.5 ± 16.0 mmHg systolic and 77.4 ±10.3 mmHg diastolic.

Six per cent of Tongans had diastolic pressures greater than 95 mmHg and 4% had systolic pressures greater than 160 mmHg. The degree of obesity (not defined) was positively and significantly correlated with diastolic, but not systolic pressure (212).

A survey of non-communicable diseases and nutrition was conducted in 1992 and included approximately 1000 residents of the Kingdom of Tonga (214). Blood pressure measurements were performed on individuals 15 years and over. The prevalence rates of borderline and definite hypertension for urban and rural females and males are provided in Figure 3.29. The rates are based on systolic pressure ≥ 160 **and** diastolic pressure ≥ 95. The results indicate that 12–17% of Tongans have definite hypertension and approximately 17–29% have borderline hypertension if diastolic pressure is used as the basis for hypertension. The rates might well be higher for this population if the criteria to classify hypertension were based on systolic ≥160 mmHg **and/or** diastolic pressure ≥95 mmHg.



Source: (214)

Figure 3.29: Prevalence of hypertension in Tonga, 1992

There appeared to be little difference between urban and rural residents for definite hypertension. Rural residents actually experience slightly higher rates of borderline hypertension whether criteria was based on diastolic or systolic pressure levels. As has been found in other PICTs, the urban–rural differences were not as distinct as in the 1973 survey.

It appears that the rate of definite hypertension may have almost doubled since the 1973 survey where the overall rate was 8.5%, to the present overall rate of approximately 14.5%.

Tuvalu

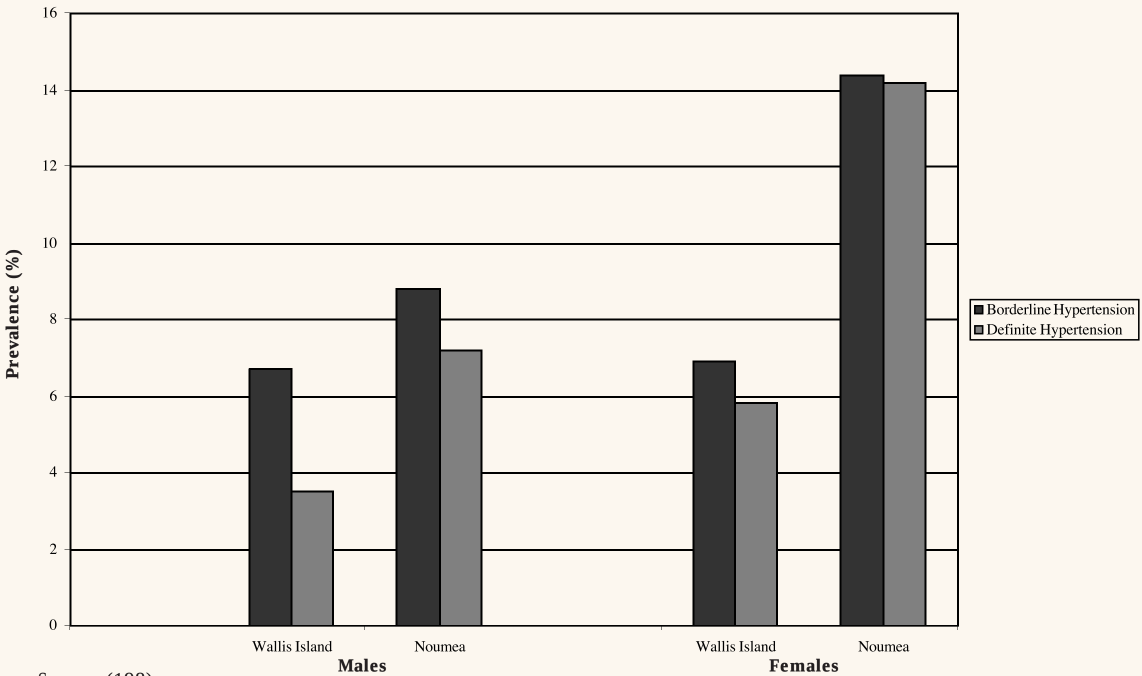
Blood pressure was measured in a health survey of 577 individuals conducted in 1976 by Zimmet and colleagues (215). The survey was carried out on the main island of Funafuti, which was partly urbanised and 85% of the food consumed was imported. The overall prevalence rate of hypertension for males was 8.2% and for females was 13.6%. The highest rates were among men 45–54 years of age (22.2%) and among females over and above 55 years of age (48.6%).

Analysis of variables associated with blood pressure was performed comparing normotensive and hypertensive individuals 35 years and over. This analysis showed that hypertensive persons had higher BMI than normotensive and this was statistically significant for females. There were no significant differences between normotensives and hypertensives for cholesterol, triglycerides, uric acid or creatinine.

Wallis and Futuna

In 1980, Taylor and colleagues (216) conducted a survey of non-communicable diseases among Polynesians residing on Wallis Island and Wallisians who had migrated to Noumea, New Caledonia. The 305 females and 274 males residing in the Wallis Islands were recruited from randomly selected rural villages. The Wallisian men in urban Noumea (n=253) worked in the nickel factory, and the women (n=311) came from communities in Noumea where nickel factory workers were known to live.

The age-standardised prevalence rates of borderline and definite hypertension of Wallisians (25 to 64 years of age) living on Wallis Island or in Noumea are displayed in Figure 3.30. Definite hypertension was 2.4 times as common in Wallisian females in Noumea compared with those on Wallis and this was statistically significant ($p < 0.01$). Although the rate for males was twice as high in Noumea compared with Wallis, the difference did not reach statistical significance. Prevalence of borderline hypertension (and borderline and definite hypertension combined) was also higher among Wallisians living in Noumea, but statistically significant only for females ($p < 0.01$).



Source: (198)

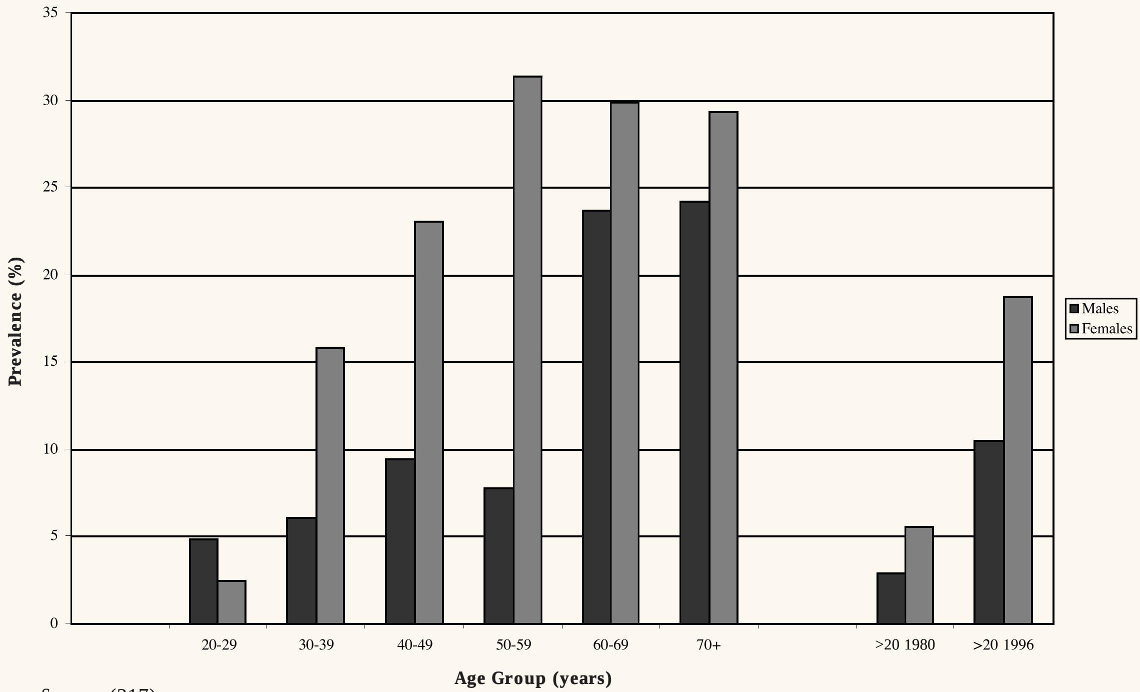
Figure 3.30: Age-standardised prevalence of hypertension in Wallisians living on Wallis Island or in Noumea, 1980

Mean systolic and diastolic pressures were significantly higher among Wallisians living in Noumea than those on Wallis. Even after adjusting for age and BMI, those differences remained statistically significant ($p < 0.001$) for females, but not for males.

These researchers suggested that obesity and sodium intake could explain the differences in blood pressure levels and the rates of hypertension. BMI and prevalence of obesity were higher among Wallisians living in Noumea than in Wallis (see Chapter 6). Mean urinary concentrations of sodium were also significantly higher among the Noumean Wallisians compared with those of Wallis Island (see below under factors associated with Hypertension).

Bezannier (217) conducted health surveys in 10 villages in the Mua district of Wallis Island in 1996. Blood pressure readings were taken of more than 1300 Wallisians aged 20 years and over. Overall, hypertension was found in 15% of this population. Figure 3.31 provides the prevalence rates by age group and gender. Females consistently have higher rates than males, with approximately 30% of females 50 years and over with hypertension.

The prevalence rates for both females and males appear to have tripled since the 1980 survey. It should be noted that the rates for females and males in 1980 and 1996 are not age standardised. Also the 1996 survey used a slightly higher diastolic cut-off level of >100 to classify hypertension, whereas a level of ≥95 mmHg was used as the cut-off point in the 1980 survey. If anything, we would therefore expect the 1996 survey to slightly underestimate the prevalence of hypertension.



Source: (217)

Figure 3.31: Prevalence of hypertension in Mua District, Wallis Island, 1996, compared to all ages 1980

Discussion

Mortality Related to Hypertension

Both systolic and diastolic blood pressure levels have been shown to be positively and consistently related to the risk of stroke, renal disease, and coronary heart disease (140). These conditions are among the leading causes of death in most affluent countries of the world, and now, in most Pacific Island countries and territories. Table 3.7 lists the number of deaths from cerebrovascular disease (ICD –9 code 430-438) and hypertensive disease (ICD-9 code 401-405) in 15 PICTs. These data are presented as per cent of total deaths and as the ranking of cause of death for most PICTs. For 11 out of the 15 PICTs, stroke or hypertensive disease are among the top five leading causes of death.

Table 3.7: Cerebrovascular and hypertensive disease in Pacific Island countries and territories as cause of death

Country	Year	Deaths			
		CVD & hypertensive disease	**Total all causes**	**Total (%)**	**Ranking**
American Samoa	1997	29	259	11.2	2nd
Cook Islands	1997	7 ‡ 17 † **Total 24***	128 128 128	5.5 13.3 18.8	Hypertension 1st
Fiji Islands	1997-98	1011 ‡ 494 †	7555	19.9	2nd
French Polynesia	1996	43 ‡ 41 † **Total 84***	1029 1029 1029	4.2 4.0 8.2	5th
Guam	1997	37 ‡ 73 † **Total 110***	865 865 865	4.3 8.4 12.7	2nd
Kiribati	1987-90	74	736	10.1	4th
Marshall Islands	1996	11	233	4.7	9th
Nauru	1994	8	121	6.6	8th
Northern Marianas (CNMI)	1991-96	80 ‡ 11 † **Total 91**	994	9.2	2nd
Palau	1997	8 ‡ 7 † **Total 15***	121 121 121	6.6 5.8 12.4	3rd
Papua New Guinea	1997	37 ‡ 19 † **Total 56***	5636 5636 5636	0.7 0.3 0.9	19th
Samoa	1991-92	37	532	7.0	2nd
Tokelau	1993-97	9 †	59	15.3	3rd
Tonga	1995	24	357	9.9	5th
Tuvalu	1993	6	94	6.4	4th
Vanuatu	1993	24 ‡ 4 † **Total 28***	525 525 525	4.6 0.8 5.3	7th

‡ - Cerebrovascular Disease ICD-9 code 430-438
† - Hypertensive Disease ICD-9 code 401-405
* - Total Cerebrovascular and Hypertensive Disease Deaths

The data on cause of death are the most recent that SPC has available from the respective countries. The countries that are not represented (Federated States of Micronesia, Fiji Islands, Niue, New Caledonia, Solomon Islands, and Wallis and Futuna) may also have data available but it was not included in their most recent country health statistic reports.

It should be recognised that there are potential problems in the interpretation of mortality data. Incomplete registration of deaths, inaccuracy of diagnosis or coding, and changes in levels of ascertainment or in registration practices are limiting factors in the use of mortality data.

It should be noted that the time period of the data collection might differ from country to country. Also, these data include the total population of the countries. This may be an important consideration in countries such as Commonwealth of the Northern Marianas, Guam or New Caledonia, where non-indigenous populations may comprise a significant proportion of the total population.

Mortality – American Samoa

An analysis of death records from 1976 through 1981 in American Samoa concluded that elevated systolic or diastolic blood pressure were statistically significant predictors of mortality from all causes, or mortality from cardiovascular disease (CVD) (218). Crews (218) compared risk factors such as age, BMI, systolic and diastolic blood pressure among survivors and decedents who had taken part in health surveys conducted in 1975–76 (219). Death registration in American Samoa is reported to be nearly 100% complete.

The analysis showed that mean systolic and diastolic pressures of survivors were significantly lower than those who died of CVD and those who died of all causes. Men and women who survived had similar blood pressures. However among the total and CVD decedents, women had significantly higher systolic and diastolic pressures than men. The relative risk of dying from all causes combined was six times higher for women with systolic hypertension and almost four times higher for women with diastolic hypertension than for normotensive women (Table 3.8).

Table 3.8: Relative risk of six-year total and cardiovascular disease mortality in Samoans by obesity and hypertension at initial examination

	Risk Factor	Total Mortality Relative Risk	Cardiovascular Disease Mortality Relative Risk
Males	Obesity	1.1	1.2
	Systolic Hypertension	3.6 **	6.3 **
	Diastolic Hypertension	1.5 *	2.4 **
Females	Obesity	0.71	1.2
	Systolic Hypertension	6.2 **	6.3 **
	Diastolic Hypertension	3.7 **	5.1 **

*P <0.05
**P <0.01
Source: (220)

The relative risk of dying from all causes for men with systolic or diastolic hypertension was lower than for women but still significantly greater than for normotensive men. Both systolic and diastolic hypertension increased the relative risk of dying from CVD more than of dying from all causes. Among diastolic hypertensives, women faced a greater relative risk of dying from CVD (RR 5.1) than men (RR 2.4).

These findings suggest that systolic hypertension may be a more important risk factor among Samoans than diastolic hypertension, in terms of mortality from CVD. Other studies have shown the diastolic pressure to be a more significant predictor of CVD mortality than the systolic pressure (221). Among women, however, diastolic hypertension may be a greater risk factor for CVD death than for men. In this population, obesity did not confer a higher risk of dying (see Chapter 6) from CVD or from all causes.

Factors Associated with Hypertension

Age and genetic determinants such as body build and height are related to blood pressure levels. Environmental influences such as obesity, excessive dietary intake of sodium and alcohol, a sedentary lifestyle and stress are commonly regarded as factors responsible for increasing blood pressure levels. Other factors, such as an insufficient dietary intake of potassium, phytochemicals and fish oils may also play a role in increasing blood pressure. Many of these factors have been shown to be associated with hypertension in Pacific Island communities.

Age

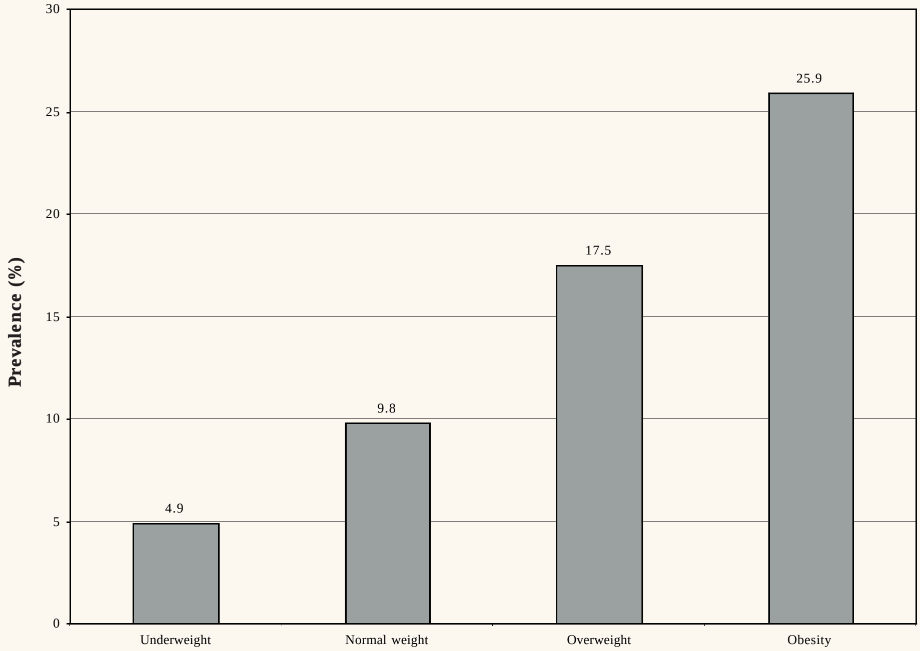
Until the early 1960s, European and North American medical practitioners believed that blood pressure levels naturally increased with age. During the late 1960s and early 1970s, however, a number of researchers sought to determine if blood pressure did increase with age among groups of people living a traditional, non-western way of life. A number of these studies were carried out in the Pacific: – in the Cook Islands by Murphy (197) and Prior et al. (84), in Fiji Islands and Papua New Guinea by Maddocks (144,155) and in the Solomon Islands by Zerba et al. (169). These studies showed that, among populations living rural, traditional lifestyles with little western influence, blood pressure levels did not increase with age.

More recent surveys and studies have found that in most PICTs today, age is significantly and positively related to both systolic and diastolic blood pressure. Blood pressure surveys in American Samoa, Samoa, Cook Islands, French Polynesia, Vanuatu and Fiji Islands have all shown an increase in blood pressure in most age groups. Figures 3.18 and 3.19 illustrate the increase in systolic and diastolic pressures among both females and males at all levels of urbanisation. The least increase was seen among the most traditional-living males (195).

Obesity

Body Mass Index has been shown to be positively associated with blood pressure in most studies in the Pacific. Surveys in Fiji Islands (36), Solomon Islands (57), Vanuatu (62,174), Cook Islands (198), French Polynesia (19), American Samoa (195), Samoa, Tonga (214), Tokelau (208), Tuvalu (215), and Wallis Island (216) have shown that, in most groups, as BMI increases, blood pressure and rates of hypertension also increase.

In Fiji Islands, when both genders and both ethnic groups were combined, Saito (36) reported a prevalence of hypertension almost three times as high in obese individuals as compared with normal-weight persons as shown in Figure 3.34.

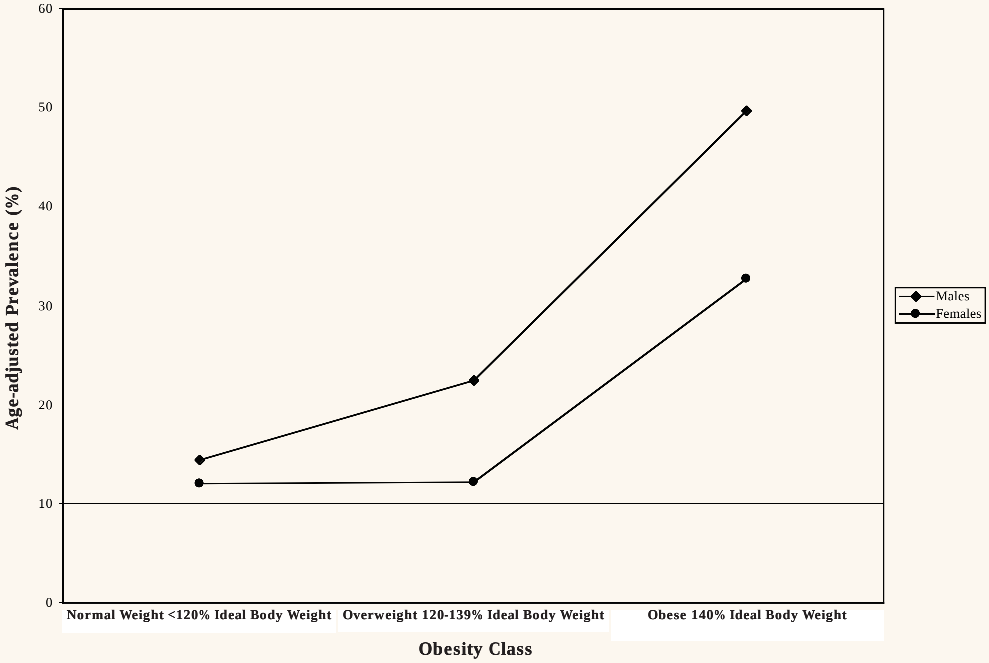


Source: (36)

Figure 3.34: Prevalence of hypertension in Fijians and Indo-Fijians by level of obesity

In the Cook Islands, Bennett et al. (198) also found rates of hypertension three times higher among obese males than normal-weight males (Figure 3.35). The rates of hypertension for obese women were more than twice as high than for normal-weight women. Among Samoans living in California, BMI was strongly and positively correlated with blood pressure in women but not men (222) (data not shown).

Measurement of the skinfold thickness of the triceps muscle also correlated significantly and positively with blood pressure in Fiji, for both rural and urban Fijians and urban Indo-Fijians (223). In American Samoa, triceps skinfold thickness was strongly associated with blood pressure in all groups except the traditional American Samoan men – this was attributed to their leanness (195).



Source: (198)

Figure 3.35: Prevalence of hypertension by obesity class in Rarotonga, 1980

Sodium Intake

Epidemiological studies suggest that dietary salt intake is a contributor to blood pressure elevation and to the prevalence of hypertension (136). The effect appears to be enhanced by a low dietary intake of potassium-containing foods.

A number of studies in the Pacific have implicated salt intake as a primary factor in rising rates of hypertension. Salt intake was the most important variable related to blood pressure among six groups examined in the Solomon Islands by Page and co-workers (224). Both Solomon Island and Bougainville groups had a rise in blood pressure as salt intake increased.

In the Cook Islands, Prior and Evans (225) estimated the dietary sodium intake and urinary sodium output of traditional-living Pukapukans, urban-living Rarotongans and European New Zealanders. The findings showed that sodium intake and output increased with level of urbanisation and with prevalence of hypertension.

Blood pressure studies in the urban centre of American Samoa assessed sodium intake by asking two questions about salt use in cooking and in eating and two questions regarding quantities used (195). The study revealed that salt use was significantly related to diastolic pressure in Pago Pago males. Among Pago Pago women, those who used large amounts of salt had significantly higher blood pressures than the moderate or low-quantity users.

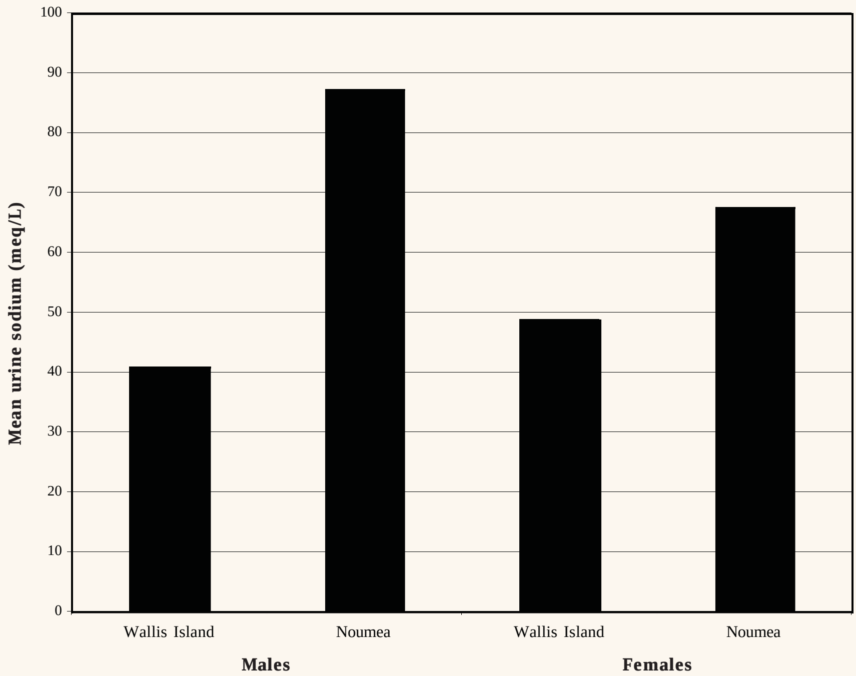
A 24-hour dietary-recall method was used to assess nutrient intake in Samoa and American Samoa by the same group of investigators (24). Table 3.9 reveals that American Samoans had a significantly higher dietary intake of sodium, a lower intake of potassium and a higher sodium-to-potassium ratio. These findings support the hypothesis that higher sodium intake is associated with higher rates of hypertension. The prevalence of hypertension in American Samoa was more than twice that of Samoa for both females and males aged 45 years and over.

Table 3.9: Mean dietary intake of sodium and potassium in Samoans and American Samoans, 1990 and 1991

	American Samoa (n=455)	Samoa (n=491)
Sodium (mg/1000 kcal)	884.00 ± 616.0 ***	622.0 ± 495.0
Potassium (mg/1000 kcal)	1437.00 ± 546.0 ***	1735.0 ± 506.0
Sodium to Potassium Ratio	0.76 ± 0.7 ***	0.4 ± 0.4

*** = P< 0.001

Taylor et al. (226) compared urinary sodium concentration, or overnight sodium urinary output from several Pacific Island populations that had taken part in NCD surveys during the 1980s. The review compared the differences between urban and rural lifestyle in Fijians and Indo-Fijians; Wallisians living in Noumea and on Wallis Island; Polynesians from the Cook Islands and Niue; and Micronesians from Kiribati. This comparison showed that urine sodium concentrations and overnight outputs were significantly higher in urban dwellers than in rural-living islanders. Figure 3.36 illustrates the differences in urinary sodium concentration among Wallisians living in the urban centre of Noumea and those living on Wallis Island. These levels were also reflected in higher rates of hypertension in those communities with higher sodium output.



Source: (216)

Figure 3.36: Mean urinary sodium concentration (meq/L) in Wallisians living on Wallis Island and Noumea, 1980

Although the methods used in the many of the above studies may not accurately estimate sodium intake, it appears highly plausible that salt intake (and perhaps an insufficient potassium intake) are important causal factors in the development of hypertension among Pacific Island populations.

Other Dietary Factors

A number of dietary factors have been associated with either a detrimental or a beneficial effect on blood pressure. These nutrients may not have yet been studied in relation to blood pressure in Pacific Island populations, but their importance has been shown among other groups.

- Alcohol – While a low-to-moderate intake of alcohol (up to 3 standard drinks per day) may lower the risk of cardiovascular disease, intakes above that amount are associated with increased blood pressure (140).

- Potassium – Numerous epidemiological studies and clinical trials have shown that a deficient intake of potassium is associated with higher prevalence of hypertension and that increasing potassium may be effective as a preventive measure and a treatment strategy (227).

- Potassium, magnesium, calcium and fibre were found to be protective of stroke risk in hypertensive men in Switzerland (228).

- A randomised clinical trial in the US has shown that a dietary pattern similar to many Pacific Islands traditional diets was able to lower systolic and diastolic blood pressure in both normotensive and mildly hypertensive individuals (229). The effective dietary pattern was rich in fruits and vegetables, reduced in saturated fat, total fat and cholesterol, while sodium intake and weight were maintained at a constant level. The investigators concluded:

The DASH combination diet may be an effective strategy for preventing and treating hypertension in a broad cross section of the population, including segments of the population at highest risk for blood pressure-related cardiovascular disease (229).

- Omega-3 fatty acids derived from fish have been associated with reduced risk of stroke among Greenland Eskimos (230) and also have been shown to be effective in reducing blood pressure in overweight hypertensives, especially when combined with a weight reduction regimen (134,231).

- The traditional dietary pattern of many Pacific Island groups is one that supports a low blood pressure. It is low in salt; rich in potassium, magnesium and other trace minerals; high in fibre; and most likely rich in omega-3 fatty acids derived from fish oils.

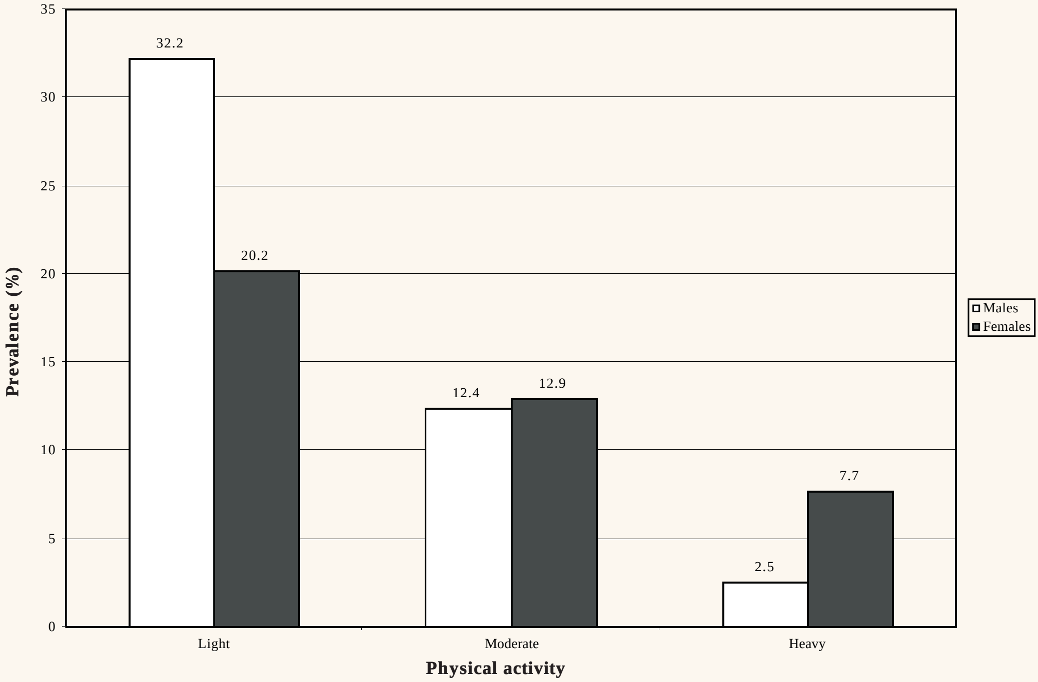
- The urbanised diet is generally the opposite: high in salt; almost devoid of potassium; and low in fibre and omega-3 fatty acids.

Physical Activity

It has been shown in other regions of the world that individuals who perform daily, light-to-moderate physical exercise have about a 30% lower risk of death from coronary heart diseases than do sedentary individuals (232) and a 34% lower risk of developing hypertension (233).

The relationship between physical exercise and hypertension however has not been clearly shown in Pacific Island studies. In the 1985 Vanuatu NCD survey, Montaville et al. (175) reported a higher prevalence of hypertension among both females and males whose activity levels were classified as sedentary-light than those who were judged to have moderate-to-heavy activity levels. These relationships, however, were not consistent, nor were the prevalence rates adjusted for age or BMI.

The 1993 National Nutrition Survey in Fiji reported that those people who did regular physical exercise had lower rates of borderline and definite hypertension (9.5%) compared with 13.6% for those who did not exercise regularly (36). These rates were also not age standardised and younger people may perform more regular physical exercise.



Source: (62)

Figure 3.37: Prevalence of hypertension by physical activity level (age-adjusted), Vanuatu, 1998

Stress

Psychological factors and stress have been associated with the adoption of less-healthy lifestyle patterns leading to increased risk of hypertension and cardiovascular disease (234). The association between stress and blood pressure has been studied in American Samoa (195). Stress incongruity was related to blood pressure in Samoan men living in the urban centre of Pago Pago. An example of stress incongruity could be for instance incongruity between occupation and education, i.e. low education in managerial job. In Pago Pago, men with less than seven years education and a managerial job had higher systolic and diastolic blood pressures compared with wage and subsistence workers. This stress of adapting to a modern way of life may certainly have an effect on increasing blood pressure, but other environmental factors may be of equal or more importance.

> *….the Samoan research project has shown consistent, strong, and biologically plausible evidence in favor of the proposition that exposure to modern life leads to elevation in blood pressure. The major factors in this modernisation-related increase are adiposity, salt intake, and socioecological and psychosocial stress.* (195)

Conclusions

Over the past three to four decades, increasing levels of blood pressure and higher prevalence rates of hypertension have been experienced in all Pacific Island countries and territories. The rates are higher in urbanised groups compared to traditional-living people, but these differences are becoming less significant. There is every sign that these high rates of hypertension are having a profound impact on the prevalence of heart disease, kidney disease and stroke among the indigenous people of the Pacific Islands.

Steps will need to be taken to address both the prevention and the control of hypertension. The WHO (140) and other health agencies (235) have issued recommendations regarding lifestyle modifications and are in general agreement. These recommendations include:

- Stop smoking;
- Reduce body weight;
- Moderate alcohol intake – avoid binge drinking;
- Reduce salt intake (and increase potassium from food);
- Improve dietary intake:
    - * increase intakes of fruit and vegetables;
    - * eat fish regularly;
    - * reduce fat intake;
- Increase physical activity.

Drug treatment, medical management and close monitoring of patients with hypertension will also be crucial to avoid the sequalae of hypertension: – coronary heart disease, stroke, and kidney disease. These treatments will be costly.

High blood pressure could be the single, most preventable important cause of early morbidity and mortality and cause of other non-communicable diseases in the Pacific. Since it is relatively easy to treat with lifestyle changes and relatively inexpensive drugs, it makes sense to tackle hypertension first. There is evidence that when this done, rates of stroke, coronary heart disease and kidney disease will decline.

CHAPTER 4: Coronary Heart Disease

Summary

- Coronary heart disease (CHD) is a major cause of premature mortality and morbidity in the majority of Pacific Island countries and territories (PICTs) today.
- CHD and/or circulatory system diseases are the first or second leading cause of death in most PICTs.
- Death rates from heart disease appear to be rising rapidly in most PICTs, while in most industrialised countries, death rates from heart disease are declining.
- The risk factors that are most predictive of coronary heart disease – high blood cholesterol, hypertension and smoking, have reached, and are exceeding, rates in western countries.
- Obesity, dietary factors and physical inactivity all have a profound influence on blood lipid levels and hypertension and, ultimately, on heart disease.
- Adequate data related to the leading causes of death in the Pacific are sorely lacking. Morbidity and mortality statistics are needed in order to know what conditions are causing death and disability, who is dying, at what ages, which risk factors are responsible, and if they can be changed.

It is difficult to obtain reliable data on the incidence of CHD in the Pacific for several reasons. One, the disease until recently had been relatively rare in many countries and territories. Secondly, surveillance systems have not been established in all PICTs. Hospital morbidity and cause-of-death statistics may not be accurate due to limitation of personnel and financial resources, small population size and insufficient length of time of follow-up.

With those limitations in mind, Table 4.1 provides the number of deaths due to heart disease, the percentage of total deaths and the ranking of heart disease as a leading cause of death. For some PICTs, deaths are given for all circulatory diseases combined, thus they include deaths from stroke and hypertensive disease. As can be seen from Table 4.1, CHD or circulatory diseases constitute the first or second leading cause of death in most PICTs except for Papua New Guinea, Kiribati, Marshall Islands and Tuvalu.

Table 4.1: Coronary heart disease (CHD) as cause of death in Pacific Island countries and territories

Country	Year	CHD deaths	Total deaths all causes	Per cent of total deaths	Ranking as leading cause of death
MELANESIA					
Fiji Islands*	1996	2071	4606	45.0	1st
New Caledonia	1991–96			22.9	1st
PNG	1997	306	5636	5.4	6th
Solomon Islands*	1997	81	504	16.1	2nd
Vanuatu	1992–94	30	525	5.7	2nd
MICRONESIA					
FSM	1989	156	886	17.6	1st
Guam	1997	111	865	12.8	2nd
Kiribati	1987–90	42	736	5.7	5th
Marshall Islands	1996	15	233	6.4	5th
Nauru	1994	25	121	20.7	1st
Palau	1997	18	122	14.8	2nd
POLYNESIA					
American Samoa	1997	56	259	21.6	1st
Cook Islands	1997	4	128	3.0	12th
French Polynesia	1996	151	1029	14.5	2nd
Samoa	1991–92	41	532	7.7	1st
Tokelau	1993–97	30	59	50.8	1st
Tonga*	1995	54	242	9.9	1st
Tuvalu	1993	8	94	8.5	3rd
Wallis and Futuna	1998–99	10	62	16.1	2nd

*All circulatory diseases combined

Definition

Coronary (ischaemic) heart disease is a term used to define several cardiac disorders resulting from inadequate circulation of blood to local areas of the heart muscle. This deficiency is nearly always a consequence of focal narrowing of the coronary arteries by atherosclerosis. Atherosclerosis is a progressive disease that often begins in childhood with a progressive narrowing of the vessels, which may cause angina pectoris, myocardial infarction (heart attack), or sudden death. The development of CHD is a silent process generally lasting decades before the onset of symptoms.

The causes of CHD are multifactorial, but it is generally accepted that the major causal factors are elevated blood cholesterol levels, hypertension and cigarette smoking. All three of these causes of CHD are found at high rates in many PICTs. Prevalence rates of hypertension and rates of cigarette smoking are several times higher than rates in neighbouring industrialised countries. Hypertension is discussed in Chapter 3 and rates of cigarette smoking are discussed in the section on risk factors for cancer (Chapter 7).

The following discussion reviews heart disease risk factors in specific PICTs with emphasis on blood lipid levels. The U.S. National Institute of Health, National Cholesterol Education Program (236) has defined categories of coronary heart disease (CHD) risk according to three levels of plasma total cholesterol and LDL (Low Density Lipoprotein) cholesterol and they are shown in Table 4.2. Studies and surveys conducted in the Pacific have used various criteria for the determination of abnormal lipid levels and these are provided as the surveys are reviewed in the following sections.

Table 4.2: Classification of coronary heart disease risk based on total and LDL cholesterol levels

Classification	Total Cholesterol		LDL Cholesterol	
	mmol/L	mg/dl	mmol/L	mg/dl
Desirable	< 5.17	< 200	< 3.36	< 130
Borderline	5.17–6.18	200–239	3.36–4.11	130–159
High	≥ 6.19	≥ 240	≥ 4.12	≥ 160

Source: (236)
To convert serum cholesterol to plasma cholesterol multiply by 0.97
SI Unit Conversion factors:
Cholesterol: 1 mmol/l = 38.6 mg/dl
Triglycerides: 1 mmol/l = 88.5 mg/dl)

Blood Lipids and Lipoproteins

Various blood lipids have been measured in surveys and studies in Pacific Island communities. These have been listed in Tables 1 and 2 in Appendix 2. Those that are generally associated with *increased* risk of coronary heart disease include elevated levels of:

Total cholesterol
Low-density lipoprotein (LDL) cholesterol
Very low-density lipoprotein (VLDL) cholesterol
Apolipoprotein B
Triglycerides

Blood lipids associated with *reduced* risk of CHD are higher levels of:

High-density lipoprotein (HDL) cholesterol
Apolipoprotein A-1

Prevalence of Coronary Heart Disease (CHD)

Electrocardiogram (ECG) abnormalities were assessed to determine the prevalence of coronary heart disease (CHD) in seven PICTs by Li and colleagues (237). The ECG examinations were part of the cardiovascular disease and diabetes surveys conducted by the International Diabetes Institute between 1978 and 1987. Adults 35 to 59 years of age were included in this analysis. The prevalence of probable CHD (Q wave changes) was higher in males than females and the prevalence of possible CHD (ST-T abnormalities) was higher in females than males (Table 4.3). Women are known to have a high proportion of non-specific ST-T wave changes that are incorrectly classified as CHD, which was suggested in this study.

The highest prevalence rates of probable CHD among females were found in New Caledonia, Fiji Islands and Nauru. Among the males, taking probable and possible rates together, the highest rates were reported for Indo-Fijians and Fijians, and in New Caledonia and Nauru.

The study showed that total cholesterol concentration of the population was consistent with prevalence of CHD in the population. Multiple logistic regression analysis showed that cholesterol and systolic blood pressure were significant independent predictors of CHD prevalence, when individuals were used as a unit of analysis. When either the fasting blood glucose or the 2-hour post load blood glucose was added to the model, total cholesterol no longer remained significant in men, but remained significant in women. The risk factors age, smoking, systolic blood pressure, serum cholesterol, BMI and 2-hour blood glucose were able to explain 66% of the variance in CHD in men and 92% of the variance in females.

Table 4.3: Prevalence of probable and possible coronary heart disease indicated by electrocardiogram abnormalities in females and males aged 35 to 59 years in select Pacific Island countries and territories.

	Females			Males		
Country/ territory	Probable Q*	Possible ST-T†	Probable & possible‡	Probable Q*	Possible ST-T†	Probable & possible‡
Fijians	1.0	17.5	18.7	2.5	6.4	8.7
Indo-Fijians	0.9	23.6	24.4	3.5	13.7	17.3
New Caledonia, Loyalty Isl.	0	15.5	14.4	5.7	5.7	9.8
New Caledonia	2.8	11.4	14.8	2.6	5.1	8.0
Kiribati	0.2	25.6	26.3	0	6.2	6.7
Nauru	0.8	5.1	5.1	1.8	5.9	7.3
Cook Islands	0.7	18.2	19.3	3.5	3.1	6.3
Niue	0.7	9.9	10.8	0.9	2.6	3.3
Samoa	0.3	12.0	11.9	1.1	2.2	2.9

* Q: Probable CHD, Minnesota codes 1.1–1.2
†ST-T Possible CHD, Minnesota code 1.3, 4.1–4.4, 5.1–5.3 and 7.1.1
‡ Q: Probable and ST-T possible together
Source: (237)

Melanesia

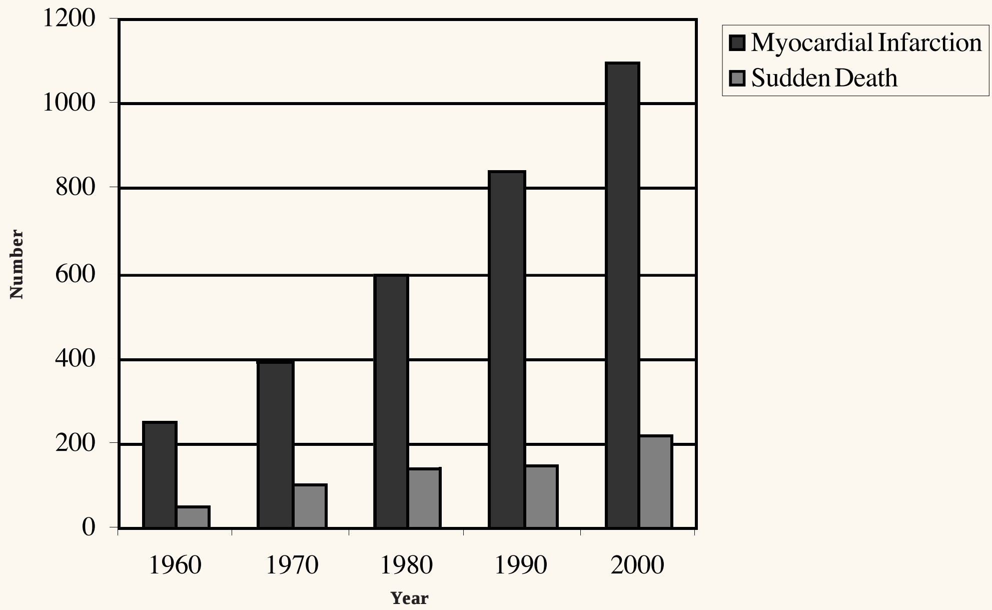
Fiji Islands

> *Morbidity and mortality statistics and several studies in the last 30 years show that most heart diseases have increased markedly and at present are reaching epidemic proportions.* (238)

In 1995, Ram and Cornelius (238) reported that heart disease had become the most common cause of death since 1971 in all ethnic groups. The proportional mortality due to heart disease increased from 18% in 1960 to 38.5% in 1987–88.

Hospital admissions for all heart diseases increased by 478% between 1960 and 1989 and for ischaemic heart disease by 1000%. A most disturbing trend was the increase in heart attacks among males in younger age groups. For the time period 1989–91, 13% of all heart attacks occurred in males below the age of 40 years.

The number of myocardial infarctions and sudden deaths has increased dramatically over the past four decades as shown in Figure 4.1. Ram and Cornelius (238) estimated that if the trend of the 1990s continued, by the year 2000 there would be 1100 heart attacks and 220 sudden deaths per year in Fiji Islands.



Source: (238)

Figure 4.1: Myocardial infarction and sudden death in Fiji Islands, 1960 to 1989

Patients at Colonial War Memorial (CWM) hospital with myocardial infarction in 1992–93 had much higher prevalence of risk factors than patients in the 1960s as seen in Table 4.4 (238). The increase in hypertension and diabetes among heart attack patients appeared to double. The increase in these risk factors was attributed to lifestyle changes, particularly the trend away from low-fat, high-fibre traditional foods, to imported foods high in fat, sugar and salt. Physical inactivity, obesity and psychosocial stresses were also mentioned as contributing to heart disease risk factors in Fiji Islands – both among heart attack patients and in the general population.

Table 4.4: Prevalence of major risk factors in clinical cases of myocardial infarction, CWM hospital, Fiji Islands, 1969–1993

Risk Factors	Prevalence (%)			
	1969–72 (n= 300)	1979–81 (n= 306)	1989–91 (n= 342)	1992–93 (n= 280)
Hypertension	21	35	48	45
Smoking	56	67	61	62
High Serum Cholesterol	49	36	na	60
Diabetes Mellitus	18	25	33	35

Source: (238)

Total plasma cholesterol and plasma triglycerides were measured as part of the 1980 Cardiovascular and Metabolic Disease Survey in Fiji Islands (239). Table 4.5 provides the mean plasma cholesterol and triglyceride levels of Fijian and Indo-Fijian females and males. In general, the mean cholesterol and triglyceride levels of non-diabetic adults were below the levels generally considered at risk for coronary heart disease (5.17 mmol/l and 2.82 mmol/l respectively).

Fijian females with normal glucose response had lower triglyceride levels than those with impaired glucose tolerance (IGT). Indo-Fijian women with IGT had lower triglycerides than Indo-Fijian females with diabetes. Indo-Fijian males with IGT or diabetes had the highest cholesterol and triglyceride levels. The men of both ethnic groups with normal glucose tolerance had significantly lower cholesterol and triglyceride values compared with those with IGT.

The prevalence of high plasma cholesterol (≥7.0 mmol/l) was highest among Indo-Fijian males, particularly urban dwellers and especially in the 35 to 44 year age group (10%) (240). Fijian males had the next highest prevalence, especially in the 55 to 64 year age group (7%). Females in general, had low rates, especially Indo-Fijian women (data not shown).

Table 4.5: Mean plasma cholesterol and triglyceride levels (mmol/l) in normal, impaired glucose-tolerant (IGT) and diabetic Fijians, by ethnic group and gender, 1980

	Normal	IGT	Diabetic
Fijian Females	(n= 570)	(n=88)	(n= 42)
Plasma cholesterol	4.4	4.4	4.6
Plasma triglycerides	1.0 †	1.2	1.3
Indo-Fijian Females	(n= 537)	(n= 78)	(n= 88)
Plasma cholesterol	4.1	4.4	4.6
Plasma triglycerides	1.0	1.1§	1.4
Fijian Males	(n= 570)	(n= 47)	(n= 22)
Plasma cholesterol	4.2*	4.7	4.3
Plasma triglycerides	1.0*	1.4	1.5
Indo-Fijian Males	(n= 456)	(n= 58)	(n= 81)
Plasma cholesterol	4.4*	5.0	5.0
Plasma triglycerides	1.4†	1.8	1.9

Comparison of normal and IGT * $p \leq 0.001$; †$p \leq 0.01$
Comparison of IGT and diabetic ‡$p \leq 0.001$; § $p \leq 0.05$
Source: (239)

The same group of researchers also examined high-density lipoprotein (HDL) and apolipoprotein A-1 in this same population (241). HDL cholesterol is a sensitive index of coronary heart disease in affluent countries; low levels may be predictive of future clinical heart disease. Apolipoprotein A-1 is the major protein in HDL cholesterol and high levels are considered protective of CHD risk. These values are provided in Appendix 2, Tables 1 and 2.

Indo-Fijian females and males had significantly higher apolipoprotein A-1 even though they have high rates of both coronary heart disease and diabetes. The factors that had a significant positive influence on apolipoprotein A-1 levels were ethnic origin, urbanisation, alcohol consumption and physical activity. Adults in the 20 to 44 year age group who lived in town had higher levels than villagers, and alcohol drinkers had higher levels than non-drinkers. Among women, physical inactivity resulted in significantly lower A-1 levels. Age, smoking and body mass index did not significantly influence A- l differences between the two ethnic groups, even though there was less smoking and overweight among the Indo-Fijians in the study.

Russell-Jones and colleagues (151) also found urban/rural differences when they measured total cholesterol, apolipoprotein A-1 and apolipoprotein B. While higher values of A-1 are associated with protective influences on coronary heart disease, high apolipoprotein B levels are associated with higher risk of heart disease.

The results showed that among Fijians (Melanesians), total cholesterol, apoliopoprotein B and the ratio of apolipoprotein B to A-1 were significantly higher among urban residents than among rural adults (Appendix 2, Tables 1 and 2). This is the opposite of the findings in the earlier 1980 study, but more what we might expect – that cholesterol levels would increase with increasing urbanisation. This study did not include Indo-Fijians.

A small study conducted in 1983 compared cholesterol levels among rural and urban dwellers (150). The rural population came from three isolated villages on the island of Qamea and the urban population from a settlement in Suva. On the whole, the study found little differences between the rural and urban populations for total cholesterol, LDL or HDL cholesterol. They did, however, report a significant positive correlation between BMI and total cholesterol and between BMI and LDL cholesterol for all groups except rural men. When skinfold measurements were used instead of BMI, the results were the same.

New Caledonia

The prevalence of probable CHD as assessed by electrocardiogram abnormalities (ECG) was 5.7% for males on one of the Loyalty Islands in New Caledonia (237). This rate was higher than rates in Fiji Islands or Cook Islands. The population of the Loyalty Islands in the study comprised two groups: Melanesians, and a community of part Polynesians who had migrated from Wallis Island circa 1800AD. The rate of probable CHD among the women was 0%. The rate of probable CHD among Melanesians and Wallis Island Polynesians on the mainland was 2.6% for both females and males.

Age-adjusted mean total cholesterol for adults aged 35 to 59 on the Loyalty Islands was 4.36 mmol/l and on the mainland 3.99 mmol/l (237). The population from the main island comprised Melanesians in urban and rural areas and Polynesians from Wallis Island who were employed in the nickel industry.

In 1966, cardiovascular diseases represented 27.9% of medical transfers off the island – approximately half of those were for ischaemic heart disease (242).

Papua New Guinea

Coronary heart disease, once thought to be rare in Papua New Guinea, is emerging as one of the "new killer diseases" (243). This suggests that risk factors associated with heart disease, such as blood lipid levels must also be changing.

Numerous studies have been conducted over the past four decades to evaluate serum lipid levels in divergent communities in Papua New Guinea. Some of these surveys and studies are summarised for females and males in Tables 4.6 and 4.7.

Sinnett and Whyte (156) found low serum cholesterol and triglyceride levels in a study of 800 adults over the age of 15 years in the western highlands (Tukisenta). They noted that the prevalence of cardiovascular diseases was low.

> *Hypertensive disease, cerebrovascular disease, peripheral vascular disease and angina pectoris and other indications of coronary artery disease, were either absent or detected in very few subjects.* (156)

The dietary assessment revealed that 90% of dietary energy was derived from carbohydrate, almost exclusively sweet potato, and only 3% of energy came from fat. Protein intake was estimated at 25 grams per day and dietary cholesterol intake was negligible.

Hornabrook et al. (244) also reported low mean cholesterol levels in a study of coastal groups and highland people. Martin et al. (160) reported low mean cholesterol and triglyceride levels in coastal rural villagers and urban (Koki) dwellers. There were no statistically significant differences between the groups despite higher rates of obesity, glucose intolerance and diabetes among the Koki residents.

Low mean serum cholesterol levels were reported in all six communities surveyed in 1985–86 by King and colleagues (164). The lowest levels were found in the most traditional villages on Karkar Island and the highest in the villages closer to urban centres.

Iser (245) found the highest mean total cholesterol values among a small group of mine workers in Bougainville, the lowest levels in rural males, and intermediate values in males residing in an urban centre.

In 1990, Lindeberg et al. (246) studied a community of subsistence horticulturalists of Kitava, Trobriand Islands – a group of well-nourished adults relatively uninfluenced by western dietary habits. When lipid levels were compared with Swedish adults, the Kitavan adults over 40 years had 10 to 30% lower levels of total cholesterol, LDL cholesterol, and apolipoprotein B. HDL cholesterol did not differ from that among Swedish adults, but, surprisingly, apolipoprotein A–1 was slightly lower among the Kitavans.

Table 4.6: Mean total cholesterol and triglyceride levels of Papua New Guinea FEMALES, 1966–68 to 1991 by community

Community	Survey year	Reference Source	Sample size	Age group	Cholesterol mmol/l ±SD	Triglycerides mmol/l ±SD
Highlands – Tukisenta	1966–68	(156)	386	≥15	4.07	1.53
Coastal – Lowlands	1968–69	(244)	69	17–48	2.3–3.9*	
Highlands – Lufa	1968–69		41	17–48	2.4–4.7*	
Urban – Koki	1977	(160)	46	>18	3.87 ± 0.16	0.61 ± 0.05
Civil servants	1979		38	18–34	4.10 ± 0.16	0.68 ± 0.08
Rural – Kalo	1977		65	>18	3.72 ± 0.28	0.58 ± 0.05
Highlands – Gamusi/Gimisave	1983	(247)	94	≥ 25	4.5 ±0.10†	1.18 (1.08–1.29)‡
Rural – Gamog	1985-86	(164)	88	≥20	4.06	
Semi-rural – Marup			143		4.27	
Semi-rural – Kaul			107		3.87	
Coastal – rural Napapar			143		4.06	
Coastal – periurban Matupit			147		4.21	
Highlands – periurban Masilakaiufa	1985–86	(247)	113	≥25	5.1 ±0.11†	1.10 (0.99–1.22)‡
Kitava	1990	(165)	43	20–86	5.7 ±1.2	1.2 ±0.5
Rural – Kalo	1991	(167)	106	≥25	5.0	1.00
Rural – Wanigela			378		4.8	0.87
Urban – Koki			349		5.1	0.91
Urban – Koki	na	(248)	58	≥19	4.5 ±0.9	1.0

* range, † standard error, ‡ 95% Confidence Interval

Table 4.7: Mean total cholesterol and triglyceride levels of Papua New Guinea MALES, 1966–68 to 1991 by community

Community	Survey year	Reference (Source)	Sample size	Age group	Cholesterol mmol/l ±SD	Triglycerides mmol/l ±SD
Highlands – Tukisenta	1966–68	(156)	391	≥15	3.83	1.53
Coastal – Lowlands	1968–69	(244)	69	17–48	2.1 – 3.2*	
Highlands – Lufa	1968–69		41	17–48	1.9 – 3.9*	
Urban – Koki	1977	(160)	130	>18	3.71 ±0.09	0.65 ± 002
Civil servants	1979		80	18–34	4.24 ±0.12	0.78 ±0.07
Rural – Kalo	1977		40	>18	3.72 ±0.28	0.61 ±0.04
Highlands – Gamusi/Gimisave	1983	(247)	90	≥ 25	4.3 ±0.09†	1.18 (1.08–1.29)‡
Rural – Gamog	1985-86	(164)	92	≥20	4.02	
Semi rural – Marup			129		3.97	
Semi-rural – Kaul			78		3.50	
Coastal – rural Napapar			126		3.69	
Coastal – periurban Matupit			126		4.08	
Highlands – periurban Masilakaiufa	1985–86	(247)	87	≥25	4.9 ±0.11†	1.24 (1.11–1.38)‡
Rural – Bougainville	1988–89	(245)	50	≥ 18	3.7 ±1.0	
Urban – Bougainville	1988–89		50	≥ 18	4.8 ±0.8	
Mine workers – Bougainville	1988–89		50	≥ 18	5.3 ±0.9	
Kitava	1990	(165)	119	20–86	4.7 ±1.0	1.14 ±0.4
Rural – Kalo	1991	(167)	106	≥25	4.9	1.07
Rural – Wanigela			378		4.9	0.98
Urban – Koki			349		5.5	1.20
Urban – Koki	na	(248)	84	≥19	4.9 ±1.0	1.3

* range, † standard error, ‡ 95% Confidence Interval

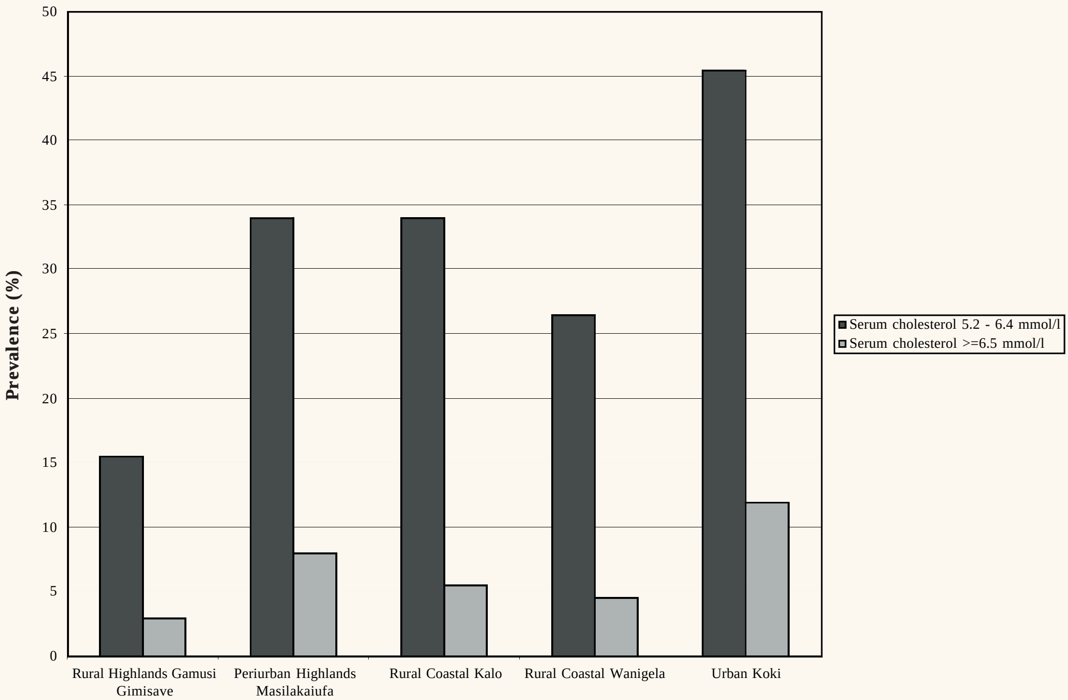
Triglycerides were higher in the Kitavans aged 20–39, most likely due to the high carbohydrate intake, mainly from sweet potatoes.

The apparent absence of stroke and ischaemic heart disease among the Kitavans was attributed to their leanness and low diastolic blood pressure; lower serum cholesterol may have provided some additional benefit. The low serum cholesterol levels were attributed to the diet; although the total fat intake was estimated to be low, about 40 grams per day, most of the fat was saturated fat derived mainly from coconut. Dietary fibre was not estimated in this study but would have been relatively high owing to the high intake of root vegetables and coconut.

Diets that are high in carbohydrate, low in total fat, but where saturated fat predominates, can result in low HDL and high triglyceride levels. These researchers concluded that serum lipoprotein and apolipoproteins may be less important risk factors in this population. The highly beneficial apolipoprotein levels (A-1) may not be a prerequisite for the very low incidence rates of ischaemic heart disease in this population.

Hodge and co-workers (249) compared serum lipid levels of Papua New Guineans from three coastal communities surveyed in 1991 and two highland areas surveyed in 1983 at different stages of urbanisation. Total serum cholesterol levels were highest among the urban (Koki) males and lowest in the more traditional highland villages. Women had slightly lower total cholesterol levels than men but levels did not differ greatly by location. Females had higher HDL and lower LDL levels than the men. In general, for both genders, the effect of urbanisation on both LDL and HDL levels was significant.

Figure 4.2 provides the age-standardised prevalence of hypercholesterolaemia for the five locations reviewed by Hodge et al. (249). The highest rates of elevated total cholesterol (≥5.2 mmol/l) were in the urban Koki community (56%) and the lowest rates in the rural highland areas (16%). The rates in Koki are higher than the rate of 51% for US males (250). Higher rates of elevated triglycerides were found in the highlands in both the periurban and in the rural highland areas.



Source: (249)

Figure 4.2: Age-standardised prevalence of elevated cholesterol in Papua New Guinea, 1991

The mean cholesterol and triglyceride levels in urban Koki and rural Kalo in 1991 (167) were considerably higher than those reported in 1977 by Martin et al. (160). Total mean cholesterol increased from 3.7 mmol/l in Koki and Kalo in 1977 to 5.5 and 4.9 mmol/l respectively in 1991. The levels of triglycerides almost doubled over this time period.

These data should serve as a warning that the recent increases in serum lipid levels among these rapidly modernising communities in Papua New Guinea may be signals of impending increases in coronary heart disease.

Solomon Islands

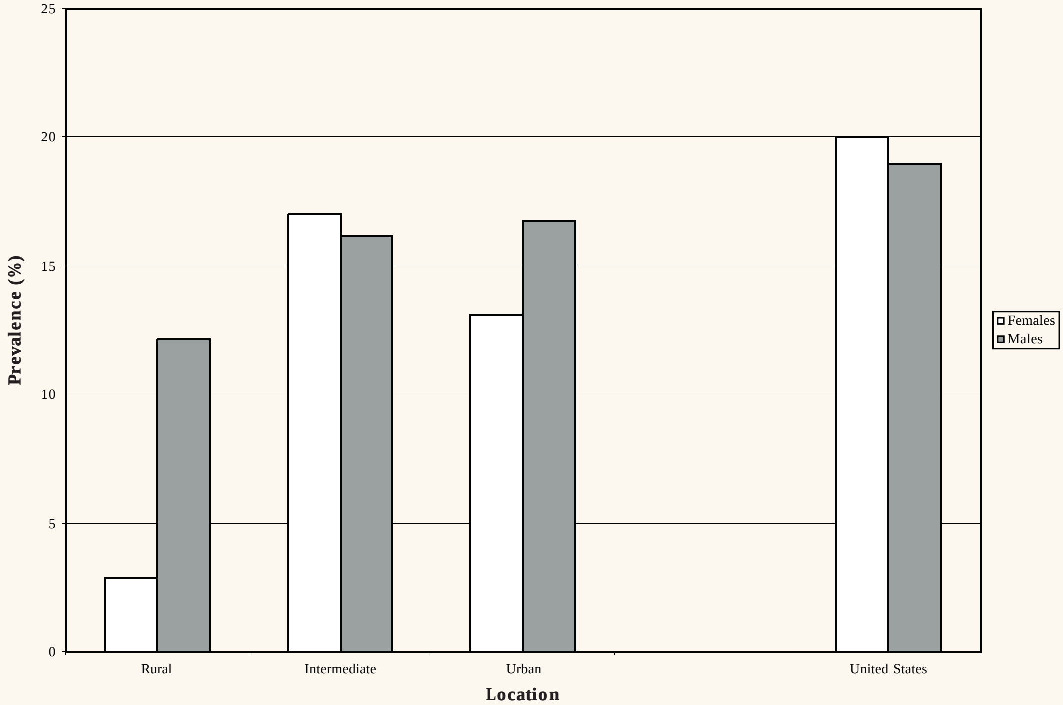
Kottke and colleagues (170) found an increase in serum cholesterol levels among Solomon Island and Bougainville groups as the degree of acculturation increased. All groups had serum cholesterol levels below 4.5mmol/l, and they did not rise with age. The highest total cholesterol and lowest triglyceride levels were found on the atoll of Ontong Java, in a Polynesian-speaking group with some Melanesian and Micronesian admixture. The researchers concluded:

> *It is of some interest that, in spite of the fact that the major source of dietary fat in the Solomon Island populations is coconuts, which contain highly saturated fatty acids, the levels of cholesterol and the prevalence of coronary heart disease are much lower than in typical U.S. populations* (170).

Vanuatu

Plasma cholesterol and triglycerides were evaluated in a non-communicable disease survey in Vanuatu in 1985 (34). Adults aged 20 years and older from three levels of urbanisation were included; rural (Tanna), intermediate (Nguna) and urban (Port Vila). Mean cholesterol levels were higher in males than females and tended to increase with age. Mean cholesterol levels were significantly lower in the rural areas (4.58 mmol/l and 4.93 mmol/l for females and males respectively) compared with the urban centre (4.95 and 5.26 mmol/l respectively). The intermediate area, however, had the highest levels (5.30 and 5.44 mmol/l respectively). Mean plasma triglyceride levels did not differ significantly between areas and all groups had levels less than 1.43 mmol/l.

Figure 4.3 shows the prevalence of elevated cholesterol levels in the three locations and compares them to rates in the U.S. (250). It is worth noting that the cut off used for the U.S. rates is lower (≥6.19 mmol/l) than the Vanuatu cut off (≥6.5 mmol/l), so we could expect slightly higher rates in Vanuatu if the U.S. cut off were used. We would then expect rates in the urban and intermediate centres to be close to those in the U.S. These rates would give cause for concern and would warrant close monitoring of mortality and morbidity from coronary heart disease in these communities.



Source: (34)
* elevated cholesterol ≥6.5 mmol/l

Figure 4.3: Prevalence of elevated cholesterol* in females and males in Vanuatu, 1985

Micronesia

Federated States of Micronesia (FSM)

> *The reported death rates from heart disease and stroke greatly exceed those of developed countries, especially in the 45 to 54 year age groups. It is estimated that the actual rates may be up twice as high because of unreported deaths.* (251)

The above quote provides evidence of the difficulties of assessing mortality rates in FSM. In an earlier study, serum lipid levels were assessed as a part of a large non-communicable disease survey conducted in 1993–94 by Auerbach and colleagues (180). Mean values for females and males combined are shown in Table 4.8. Lower levels of total cholesterol, apolipoprotein B and triglycerides were reported in Kosrae compared with Pohnpei. Those lipids are associated with increased risk of coronary heart disease. Kosrae also had higher levels of apolipoprotein A, which is associated with HDL cholesterol and considered beneficial in relation to heart disease.

Table 4.8: Mean serum lipid levels in two areas of the Federated States of Micronesia, 1993–94

	Kosrae	Sokehs Island, Pohnpei
Total serum cholesterol (mmol/l)	4.3 ± 0.9	4.5 ± 0.9
Serum apolipoprotein A	117.2 ± 24.7	104.2 ± 23.7
Serum apolipoprotein B	87.3 ± 21.7	100.3 ± 24.4
Serum triglycerides (mmol/l)	102.2 ± 143.4	105.9 ± 61.9

Source: (180)

Guam

Heart disease has been the leading cause of death for both females and males in Guam since the early 1970s. Only in 1997 was heart disease outranked by accidents (252).

Risk factors related to ischaemic heart disease were examined in studies conducted in 1968, by Reed et al. (181). The studies examined Chamorros living in a traditional village on Rota, in the urban centre of Guam, and in the cities of California. They also examined Carolinians from an isolated island of the Palau District. Tables 1 and 2 in Appendix 2 provide mean serum cholesterol and serum triglyceride levels of these groups. For males in all age groups, serum cholesterol levels were consistently highest in California, next highest in Guam and lowest in rural Rota. For females, the pattern was the same except in the youngest age groups the Rota females had slightly higher levels than women in Guam.

Approximately 50 females and males in each location were interviewed regarding their diet using a 24-hour recall methodology (63). The results showed that energy intake (kilocalories) was highest in rural Rota and lowest in California, while total fat and saturated fat were the opposite – highest in California and lowest in Rota. The dietary intakes of Chamorros on Guam more closely resembled intakes of Californians than of those living in the traditional village.

> *A strong association was observed between the percentage of dietary fat, serum lipids, and measure of illness related to disease of the coronary arteries. For all of these measures, the values were highest in California and decreased progressively from Guam to Rota* (63).

Kiribati

Mean plasma cholesterol levels were low when measured in a 1981 diabetes survey in Kiribati (34). Females had slightly higher levels than males although the difference was not significant. Rural females had significantly higher values (4.8 mmol/l ±0.9) than urban females (4.6 mmol/l ±1.2) ($p < 0.05$). Rural males, however had significantly lower values (4.3 mmol/l ±1.1) than urban males (4.5 mmol/l ±0.9) ($p < 0.05$).

Dietary intake as measured by a 24-hour recall method showed that rural men consumed significantly more energy than urban men and the percentage of energy derived from protein, carbohydrate and fat did not differ between the two groups (20,34). There were no major differences in intake between the rural and urban females. The major difference in dietary intake between the urban and rural groups was that for rural islanders: 65–75% of total fat was of vegetable origin (mostly coconuts) while for urban residents, 65–75% was of animal origin. Crude fibre was also reported lower in the urban groups due to lower consumption of mature coconuts. Both rural female and male adults had significantly higher self-reported physical activity scores than the urban dwellers.

Nauru

The mean total cholesterol of females and males combined when measured in 1987 was 5.2 mmol/l ±0.03 (253). Total cholesterol, the ratio of HDL to total cholesterol, and fasting triglyceride levels were significantly related to BMI tertiles in men. Among females, HDL, HDL/total cholesterol ratio and triglycerides were significantly associated with BMI. Waist-hip ratio was related to triglycerides in both males and females and to HDL and HDL/cholesterol ratio in women (254).

Overall, the association of BMI and waist-hip ratio with serum lipid levels in Nauruans was weaker than those found in other populations.This may indicate that either there are ethnic variations in fat distribution among the Nauruans or that the extreme obesity among Nauruans obscures these associations.

*There are neither lipid nor cardiovascular-disease data from **Marshall Islands**, nor from **CNMI**.*

Palau

Epidemiological studies were carried out between 1967 and 70 among 510 adults in three communities in Palau (255). The administrative centre of Koror was the urban setting, intermediate communities were in Peleliu, and the rural villages were in Ngarchelong. All mean cholesterol levels were low, with the lowest in rural Ngarchelong (4.43 and 3.83 mmol/l for females and males respectively), intermediate in Peleliu (4.51 and 4.22 mmol/l respectively) and highest in the urban centre (4.59 and 4.43 mmol/l respectively).

Serum cholesterol and triglycerides were significantly and positively associated with serum glucose, but there was no consistent association of dietary component with serum cholesterol levels. Coconut oil accounted for much of the fat intake in Ngarchelong (255).

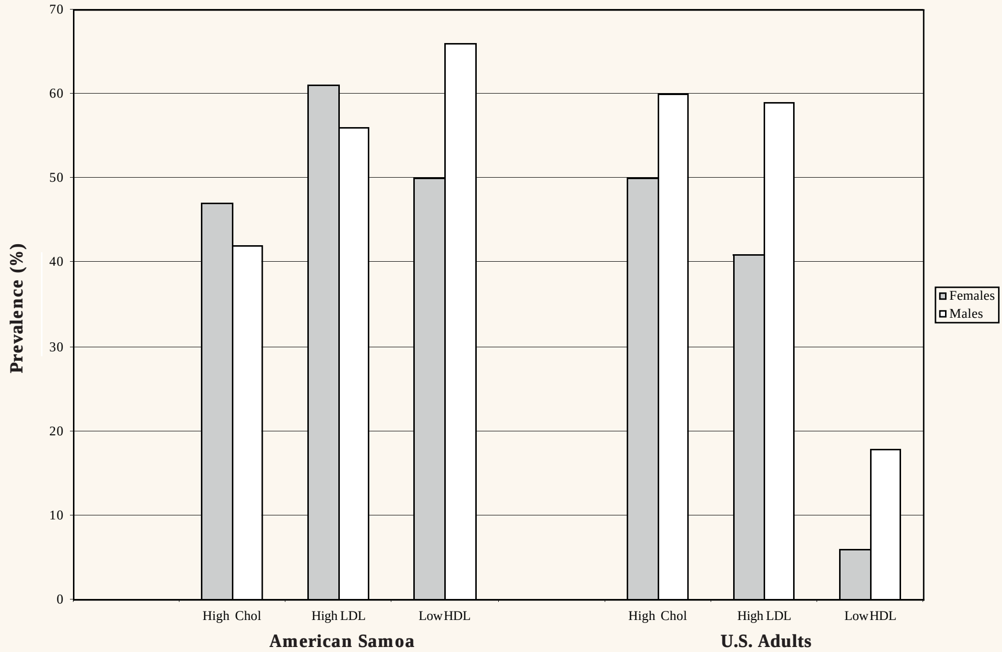
Polynesia

American Samoa

The Samoa Cardiovascular Disease Risk Factor Study 1990–95 included Samoans in American Samoa and those in Samoa (256). Baseline data were collected in 1990 and 91 and a four-year follow-up examination was completed in 1994–95. Adults 25 to 55 years of age were included.

Galanis and colleagues studied the relationship between body fat and serum lipids among 147 female and 176 male Samoans living in American Samoa and Samoa using data from the 1990–91 baseline examinations (257). The study revealed that among men, body mass index (BMI) and abdomen-hip circumference ratio were positively associated with total cholesterol, the ratio of total cholesterol to HDL, apolipoprotein B, and the log of triglyceride and insulin concentrations; and negatively associated with HDL and HDL2 cholesterol. These relationships were not found among the females, perhaps due to the extreme levels of obesity among the women.

McGarvey (pers. comm. 1999) reported cholesterol levels at the 1994 follow-up examinations for American Samoa (Figure 4.4.). The prevalence rates for high total cholesterol and LDL cholesterol levels (associated with higher risk of CHD) are similar in females and males and resembled U.S. rates (30–59 year group). But the rates for low HDL (also associated with higher risk of CHD) are much higher than in the U.S. Approximately 18% of U.S. males had low HDL levels (250), whereas 66% of American Samoan males had low levels. The proportion of American Samoan females with low HDL levels was 50%, but that of U.S. females only 6%. This combination of risk factors suggests a very high risk of CHD, especially for females.



Source: (250)
* elevated total cholesterol ≥5.17 mmol/l; elevated LDL ≥3.36 mmol/l
† low HDL cholesterol <0.90

Figure 4.4: Prevalence of elevated total cholesterol* and low HDL cholesterol† in American Samoa, 1994

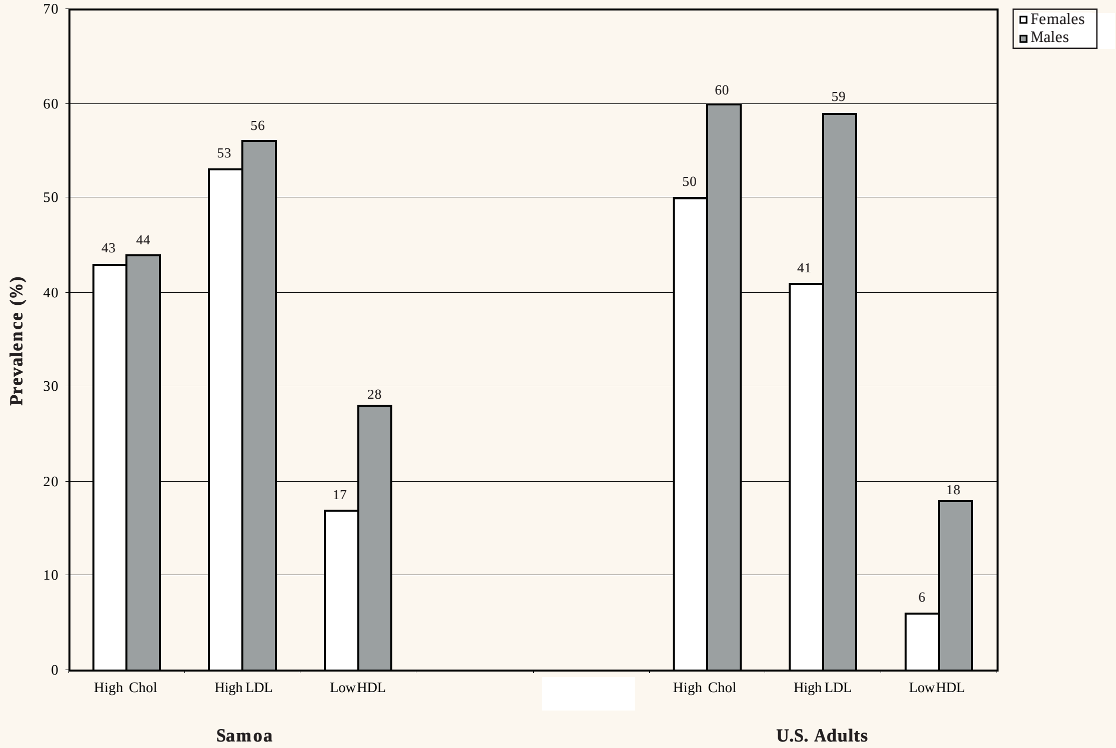
Samoa

Prevalence rates of coronary heart disease (CHD) were judged to be very low in Samoa as assessed by electrocardiogram (ECG) abnormalities (237). Probable CHD (Q wave abnormalities) was reported as 0.3% in females and 1.1 % in males (Table 4.3). These rates were considered surprising particularly in light of the high rates of obesity among these Samoans.

A longitudinal study was conducted in Samoa to describe the changes in blood lipid levels and changes in abdominal adiposity (258). Men who were originally examined in 1982 were followed up in 1990–91. In that 10-year period, mean weight increased by 10.5 kg ± 8.8, abdominal circumference increased 10.0 cm ± 7.6 and total cholesterol rose 1.29 mmol/l ± 0.7, an increase of 35%. Non-HDL cholesterol rose 1.38 ±0.7, and the total cholesterol: HDL cholesterol ratio rose 1.9 ±1.26. HDL cholesterol showed only minor changes. A new indicator (AR) that estimated changes in abdominal adiposity independent of changes in weight was highly correlated to changes in total and non-HDL cholesterol.

The prevalence of high total and LDL cholesterol, and low HDL cholesterol levels reported by McGarvey (256) for adults in Samoa in 1995 is provided in Figure 4.5. The prevalence of high cholesterol values was lower in Samoa than in American Samoa and lower than in U.S. adults (30–59 years). The rates of high LDL levels for Samoan males were similar to U.S. rates, but Samoan females had higher rates than the U.S. The prevalence of low HDL levels, although less than in American Samoa, was still almost three times as high as that in the U.S. It is believed that the low HDL levels are related to physical inactivity and a very high proportion of obesity. The lower levels of lipid risk factors in Samoa compared with American Samoa is likely due to the more traditional way of life of Samoans compared with the more urbanised lifestyle of the American Samoans. The authors concluded:

> *These are striking rates of low HDL relative to the US NHANES and require further study of both genetic and behavioural factors and their interaction in Samoans.* (256)



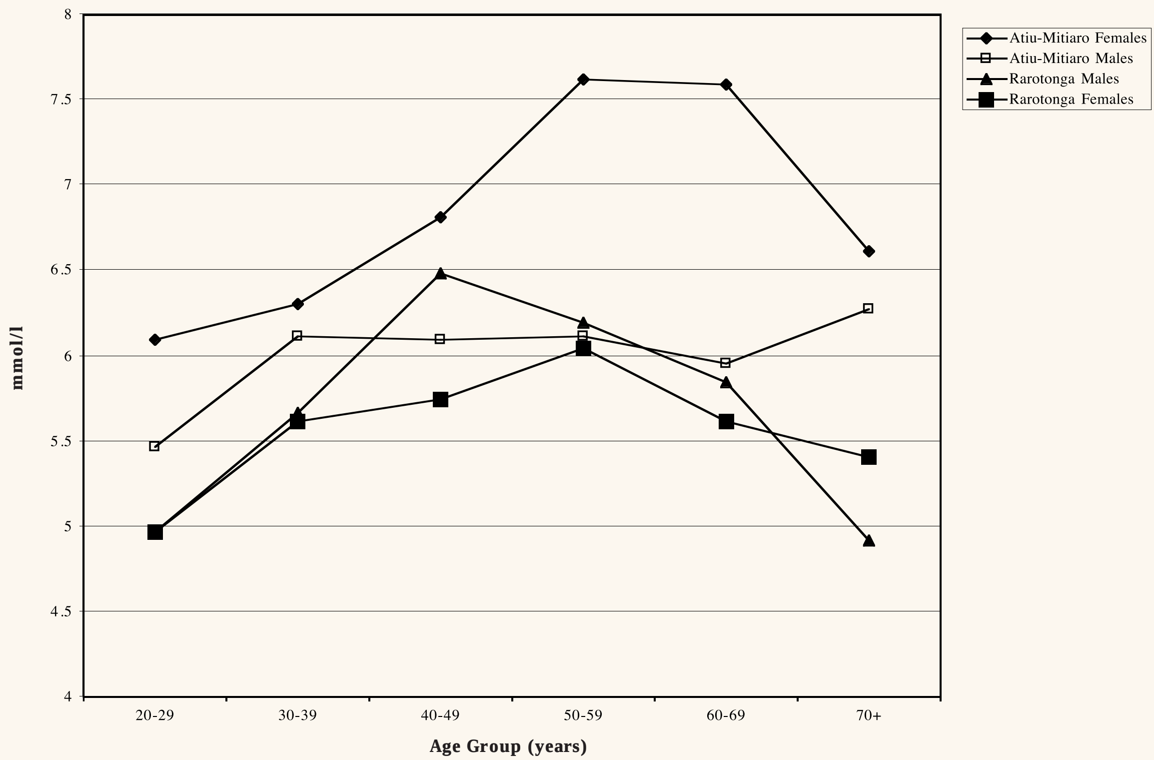
Source: (250)
* elevated total cholesterol ≥5.17 mmol/l; elevated LDL ≥3.36 mmol/l
† low HDL cholesterol <0.90

Figure 4.5: Prevalence of elevated total cholesterol* and low HDL cholesterol† in Samoa, 1995

Cook Islands

In 1960 Hunter (83) examined two groups of Cook Islanders to determine the effect of diet on serum cholesterol levels. One group, the people on the islands of Atiu and Mitiaro living traditionally ate a diet high in saturated fatty acids due to the consumption of coconut. The traditional islanders were compared to their neighbours in Rarotonga who were more modernised, consumed more imported food, took less exercise, and ate less coconut.

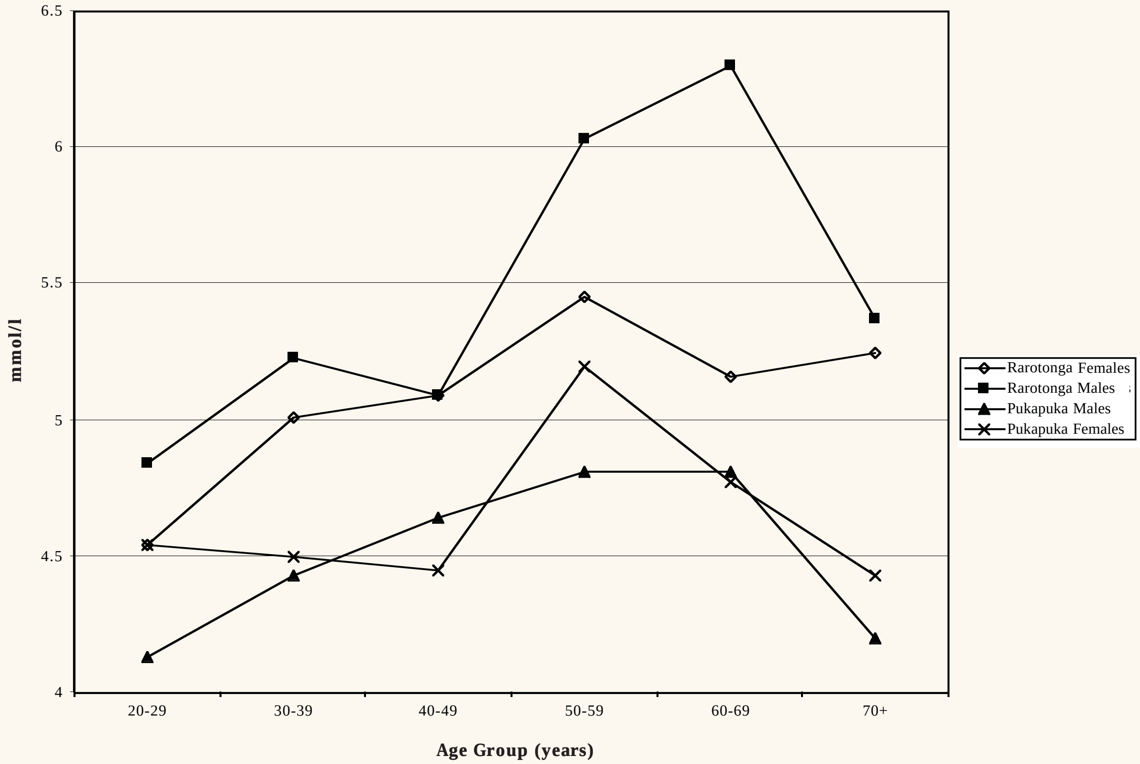
Figure 4.6 indicates that both the males and females of Atiu and Mitiaro populations, who ate large amounts of coconuts, had significantly higher serum cholesterol levels than the urbanised Rarotongans. These figures suggest that diet, especially one high in saturated fatty acids, can elevate serum cholesterol levels. We might have expected the more modern Rarotongans to have higher serum cholesterol levels since the males in particular are more overweight, have higher blood pressures and have higher rates of hypertension. Evidence of ischaemic heart disease, as indicated by electrocardiograph readings was, however, virtually absent for both groups of males (83).



Source: (83)

Figure 4.6: Mean serum cholesterol levels of rural and urban females and males in Cook Islands, 1960

However, when Prior and co-workers (84) examined the Cook Islanders in Rarotonga and in traditional Pukapuka in 1962–63, they found lower levels of cholesterol than in the 1960 survey by Hunter. They also found significantly lower mean cholesterol levels in the traditional, coconut-eating islanders than in urban residents for all age groups except 60–69 year old males as seen in Figure 4.7.



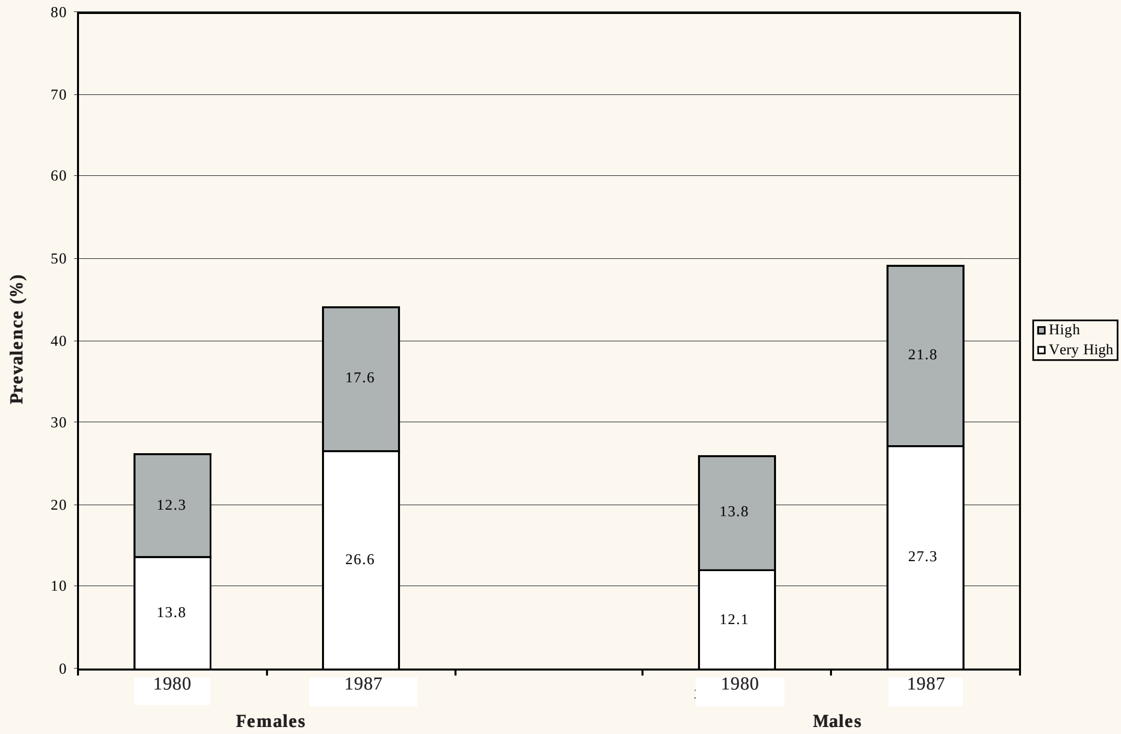
Source: (84)

Figure 4.7: Mean serum cholesterol levels of urban and rural Cook Island females and males, 1962–63

Angina, hypertension, and obesity were more common among the urban-living Polynesians than those following a traditional way of life. The Pukapukans, as the people of the Atiu-Mitiaro islands, tended to be lean and active, and consumed a relatively low-energy but high-fat diet. Seventy-five per cent of the fat in the Pukapuka diet came from coconut, 89% in the Atiu-Mitiaro diet, and only 22% in the Rarotonga diet (84,115).

SPC conducted two surveys on urbanised Rarotonga in the Cook Islands during the 1980s. The first survey in 1980 (198) included 1127 Cook Islanders and the second survey in 1987 included 1277 adults (199). Thirty-six per cent of the 1987 sample had participated in the 1980 survey.

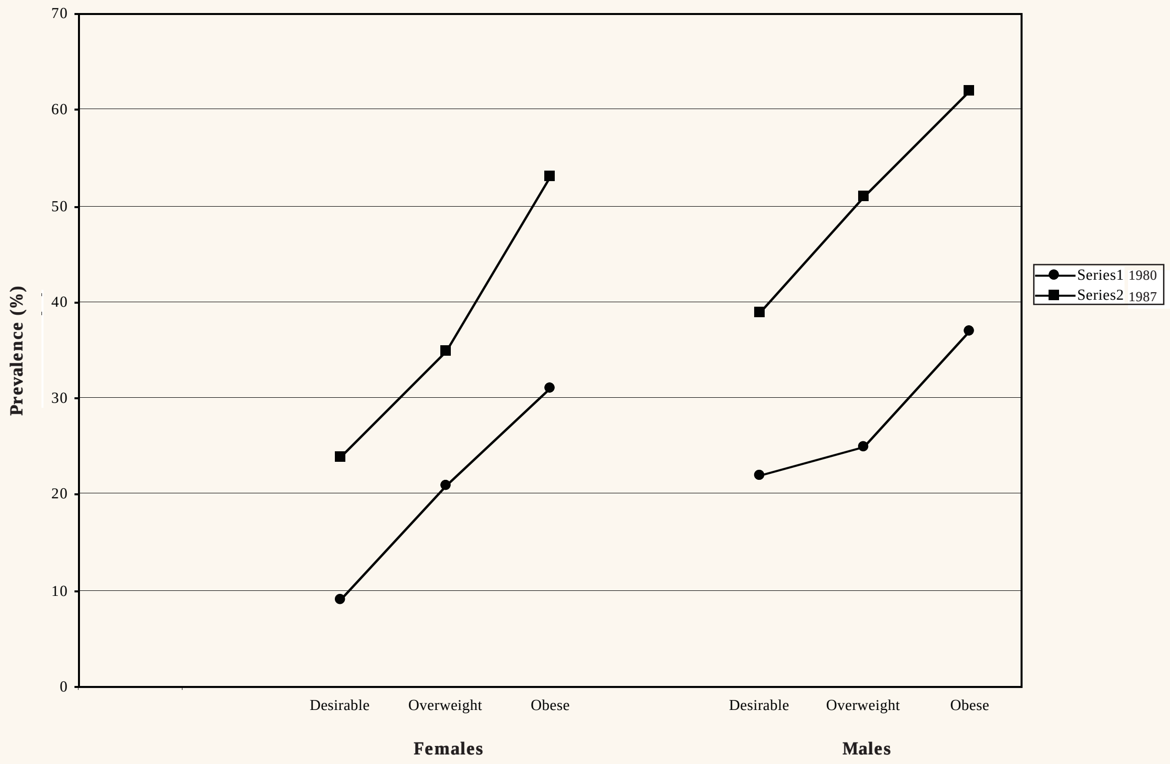
The prevalence of elevated total cholesterol levels almost doubled for both females and males in the time period 1980 to 1987 as shown in Figure 4.8. Of greatest concern are increases seen in the very high cholesterol levels ≥6.5. The 1987 rates of high and very high cholesterol levels combined (44.2% for females and 49.1% for males) may be comparable to U.S. prevalence rates. The U.S. rates of 50% and 51% for females and males respectively, aged 20 years and over, are based on cholesterol levels of ≥5.17 mmol/l whereas the Cook Island rates were based on cholesterol levels ≥5.8 mmol/l.



Source: (199)
*High cholesterol 5.8–6.4 mmol/l;
Very high cholesterol ≥6.5 mmol/l

Figure 4.8: Prevalence of elevated cholesterol* levels in Cook Island females and males, 1980 and 1987

Figure 4.9 shows the proportion of Cook Islanders with high cholesterol levels by weight category. The differences in proportions between the weight groups were significant for all groups except males in 1980. Of note is that over 50% of females and over 60% of males in the obese categories have elevated total cholesterol levels.



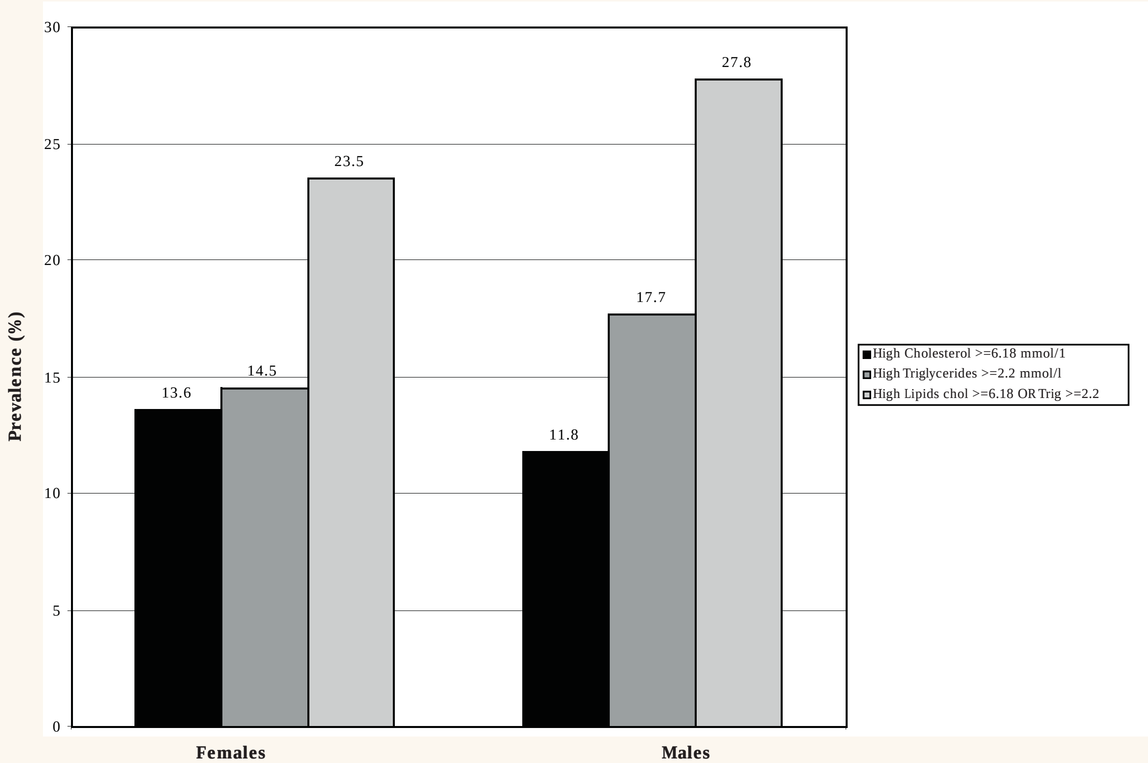
Source: (199)

Figure 4.9: Proportion of Cook Island adults with high cholesterol* levels by weight†

*High cholesterol ≥5.8–6.4 mmol/l
† Desirable weight: BMI < 25 for women, < 27 for men; Overweight 25-30 for women, 28-31 for men; Obese ≥30 for women, ≥32 for men

French Polynesia

In the 1995 survey of non-communicable diseases, 1273 individuals 16 years of age and over were evaluated for blood lipid levels (19). Figure 4.10 indicates that females had slightly higher total cholesterol levels than males, but males had higher triglyceride levels. Hyperlipidaemia was defined as blood cholesterol ≥6.18 mmol/L or triglycerides ≥2.2 mmol/L. The higher prevalence among the males compared to females was not statistically significant.



Source: (19)

Figure 4.10: Prevalence of elevated lipids in females and males in French Polynesia, 1995

Niue

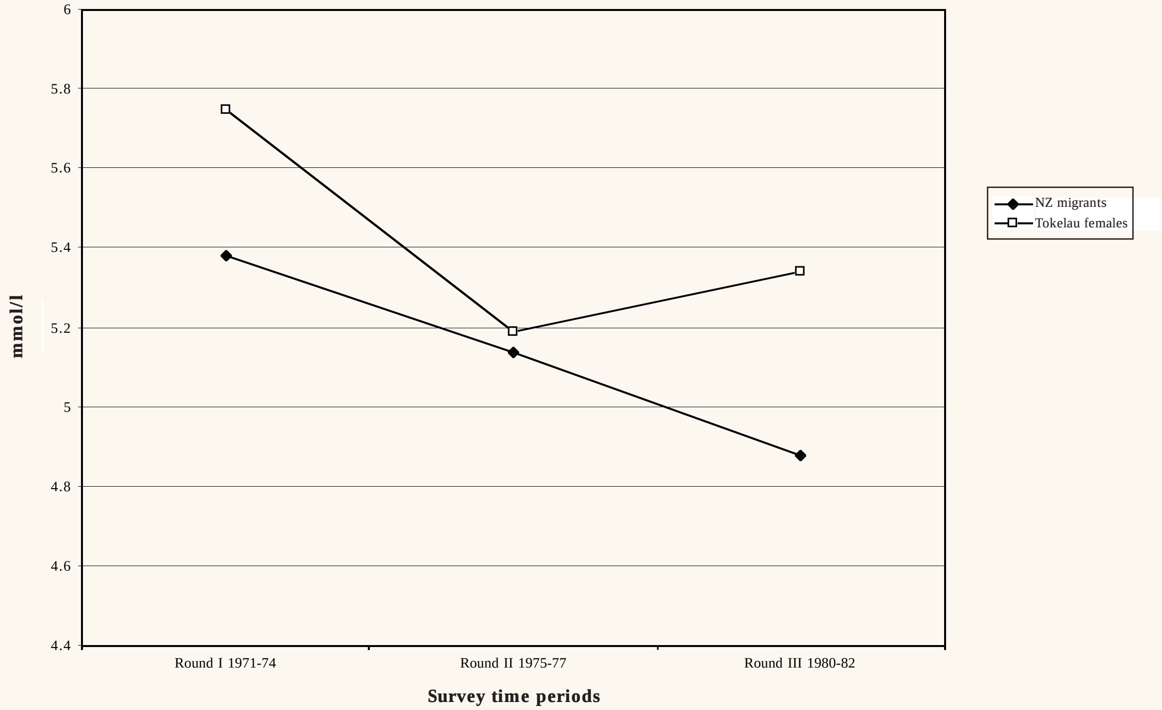
The cardiovascular disease and diabetes survey conducted by Bennett et al. (198) in 1980 compared adults living on Niue with Cook Islanders. The prevalence of probable CHD, as assessed by electrocardiogram abnormalities, was significantly lower among the more traditional Niuean males (0.9%) compared with urbanised Rarotongan males (3.5%) as noted in Table 4.3. There was no difference in prevalence of CHD (0.7%) among the females of Niue and the Cook Islands.

For both females and males, serum cholesterol levels were significantly lower in the Niue adults (3.81 and 3.71 mmol/l respectively for females and males) at each age group compared with Rarotongan adults. There were no differences in serum triglyceride levels (1.01 and 1.09 mmol/l in Niuean females and males respectively). The survey also found that adults with diabetes had significantly higher total cholesterol and triglyceride levels than normal-glucose-tolerant individuals. Those with IGT had significantly higher cholesterol levels than normal-glucose-level adults (198).

Tokelau

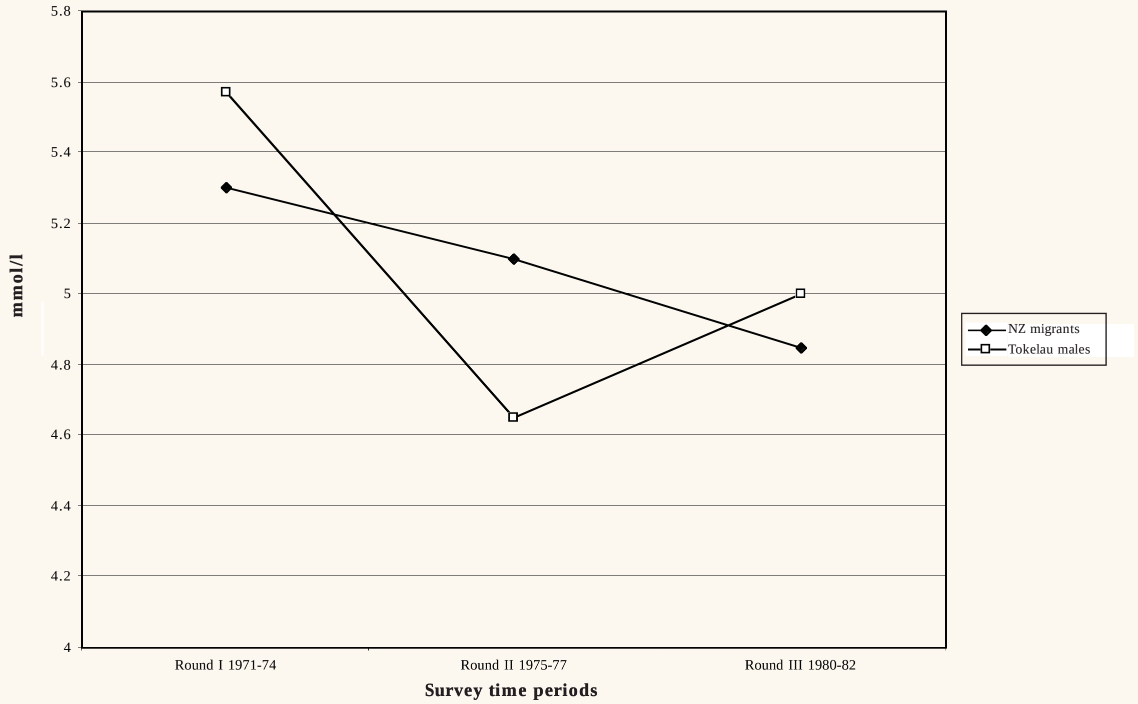
The Tokelau Island Migrant Study was a long-term research project designed to investigate the degree of changes in disease patterns that would take place when Polynesians from the Tokelau Islands immigrated to New Zealand (208). One of the questions asked by the New Zealand investigators was: would the Tokelauans who migrated to New Zealand develop obesity, diabetes and risk factors for coronary heart disease at higher rates than those atoll-dwellers who remained on their home islands?

The studies were carried out in three rounds of expeditions to the Tokelau Islands and three survey rounds in New Zealand between 1971 and 1982. There was a tendency for a decrease in serum cholesterol levels in both female and males among the migrants and non-migrants over this time period as shown in Figures 4.11 and 4.12. As a whole these mean values were relatively high. The decrease in cholesterol levels in Tokelau was attributed to a decrease in saturated fat intake from 45% of total energy consumed in 1968 to 38% in 1982. Migrants in New Zealand consumed 21% of energy from saturated fat in 1974–75, but there was no data for saturated fat intake in 1980–81. The researchers did observe that by the late 1970s, Tokelauans in New Zealand were making dietary changes such as substituting margarine for butter and chicken in place of red meat.



Source: (208)

Figure 4.11: Mean serum cholesterol of Tokelau FEMALES in Tokelau and in New Zealand



Source: (208)

Figure 4.12: Mean serum cholesterol of Tokelau MALES in Tokelau and in New Zealand

The study also looked at the prevalence of several risk factors for CHD among the Tokelauans who remained in Tokelau (1982) and those who migrated to New Zealand (1980–81) and compared them with data from an Auckland Risk Factor study (1982) (259). Table 4.9 shows that, in general, Tokelauans had lower rates of hypercholesterolaemia than Auckland adults. Rates for hypertension were similar between the Tokelau migrants and Auckland adults but low for those living in Tokelau. Smoking was remarkably more common among Tokelau migrants than Auckland males. More females on Tokelau smoked compared to migrant females.

When the researchers looked at multiple risk factors, more Tokelauan men in New Zealand had two or more risk factors present than Auckland males, while fewer Tokelau females than Auckland females had multiple risk factors. Thus by 1982, the migrant Tokelau men, because of their smoking habits and increased rates of hypertension were approaching the New Zealand level of multiple risk factors. Electrocardiogram abnormalities and angina were found more frequently among the Tokelau migrants than among the non-migrants.

Table 4.9: Age-standardised prevalence of risk factors* for coronary heart disease for Tokelauans in Tokelau and in New Zealand compared with Auckland adults†

	Females			Males		
	Tokelauan		Auckland	Tokelauan		Auckland
Risk factors	Tokelau %	NZ %	%	Tokelau %	NZ %	%
High cholesterol	18.0	10.8	23.7	6.4	9.0	22.1
Hypertension	7.2	20.1	19.7	9.8	19.4	22.2
Smoking	26.2	18.0	19.2	61.1	56.3	25.9
Factors in combination						
No risk factors	57.7	57.8	49.1	32.2	29.8	46.5
Any one factor	33.3	35.5	36.2	62.2	54.7	38.3
Any two factors	9.1	6.7	13.9	5.6	15.2	13.7
All three factors	-	-	0.8	-	0.3	1.5
Number of people	159	195	562	126	248	825

* High cholesterol: ≥6.5 mmol/l
Hypertension: systolic pressure ≥160 mmHg and/or diastolic pressure ≥95 mmHg
Smoking: five or more cigarettes per day
† adults aged 35–64 years
Source: (208)

Tonga

Sawata and co-investigators (213) studied the prevalence of cardiovascular disease in Tonga in 1983. Electrocardiogram examinations showed a relatively low prevalence of CHD, considering the level of obesity in the population. Total serum cholesterol for the group of 102 Tongan adults was 5.24 ± 1.1 mmol/l. Serum cholesterol was positively correlated with degree of obesity and skinfold measurements.

Tuvalu

Serum cholesterol and triglyceride levels were relatively low in adults examined from Funafuti (Tuvalu) as part of a study of hypertension and diabetes by Zimmet and co-workers (215). The mean cholesterol levels for females and males respectively were 4.3 ±0.08 and 4.1 ±0.08 mmol/l and serum triglyceride levels were 0.9 ±0.04 and 0.9 ±0.06 respectively.

The diet as assessed by 24-hour recall, was relatively high in protein (14 to 15% of energy), the major source of which was fish. Total fat intake was 34 to 36% of energy, derived from coconut oil, lard or animal dripping. Carbohydrate came from traditional crops such as taro and cooking bananas and made up about half of the energy in the diet.

No mention was made of CHD, but prevalence of hypertension and diabetes were each 11%.

Wallis and Futuna

The prevalence of CHD as estimated by electrocardiogram examinations was lower for Wallisians living on Wallis Island than among those who had migrated to Noumea, New Caledonia (216). Probable CHD, determined by changes in Q waves, was significantly higher among Wallisian females living in Noumea (4.3%) than among females on Wallis Island (0.6%). Among the males, the rate in Noumea (3.8%) was higher than on Wallis (1.9%), but the difference was not statistically significant.

The rates of possible CHD, determined by ST-T changes, were not significantly different between the two locations for either gender. Women had twice the rate of ST-T changes as men, but this is a common finding in population studies, and does not necessarily reflect differences in CHD.

There were no significant differences in mean plasma cholesterol for either gender between Wallisians residing on Wallis Island and those living in Noumea. Mean values of cholesterol for all groups were less than 4.2 mmol/l and mean values for triglycerides were below 1.1 mmol/l. These data suggest that hypertension and diabetes may be more important risk factors than plasma lipids in explaining possible differences in CHD between Wallisians on Wallis and those in Noumea.

Factors that Influence Blood Lipid Levels

Numerous epidemiologic and metabolic studies have demonstrated that certain dietary factors have an important influence on plasma cholesterol levels, and potentially on CHD risk. The major dietary determinants of plasma cholesterol levels are percentage of energy derived from saturated fat and polyunsaturated fatty acids and the amount of dietary cholesterol. Other dietary factors also influence plasma cholesterol levels, either directly or indirectly – such as percentage of energy from total fat, fibre, antioxidants, and alcohol. Obesity, distribution of body fat and diabetes also have a pronounced effect on plasma lipid levels.

Saturated Fat

The percentage of energy derived from saturated fat is the single most influential dietary determinant of plasma cholesterol level for most individuals, and most persons experience some degree of cholesterol lowering by decreasing saturated fat intake. Results of clinical studies indicated that only three saturated fatty acids appear to elevate cholesterol levels: lauric acid (12:0), myristic acid (14:0), and palmitic acid (16:0); together, they constitute approximately 26% of the total dietary fat consumed (121).

The fat in coconut is almost totally saturated fat – mainly lauric and myristic fatty acids. Because coconut is a major component in the diets of many Pacific Island communities, we would expect high levels of total blood cholesterol. A number of studies, however, such as those in Fiji Islands (240, 151), Papua New Guinea (164,244), the Solomon Islands (170), Vanuatu (34), FSM (180), Guam (181), Palau (255), and the Cook Islands (84) have found lower mean cholesterol levels in rural settings, despite high intake of saturated fat from coconuts, compared with their urban counterparts.

A few studies such as Hunter (83) in the Cook Islands and the study of rural females in Kiribati (34), indeed, have found higher blood cholesterol values among islanders living traditionally compared with urban residents. This apparent contradiction may be influenced by very high intakes of saturated fat as reported in the Hunter study (89% of fat coming from coconut), or by differences between the groups in total fat intake, physical activity or obesity.

Lindeberg et al. (260) studied the relationship between dietary fat components and serum cholesterol fatty acids in a group of subsistence horticulturalists on the island of Kitava, Trobriand Islands, Papua New Guinea. The typical dietary pattern of the Kitavans comprised yam, sweet potato, fruit, fish, and coconut. There was a virtual absence of dairy products, oil, margarine, lard, refined sugar and cereals. The nutrient composition of the diet was low in total fat (21% of energy) but high in saturated fat (17% of energy). Carbohydrate made up 69% of the energy; protein 10%. Alcohol was not available.

Table 4.10 provides the level of the fatty acid composition of serum cholesterol esters among the Kitavans as compared with a Swedish population. Lauric acid was detectable in only trace amounts despite a high intake from coconuts. Myristic and total saturated fatty acids were high as might be expected considering the intake from coconut. Palmitic was high although the intake from dairy products and meat was low. This may be a reflection of endogenous fat synthesis at a low-fat intake. All of the n-3 polyunsaturated fatty acids were high – a-linolenic 18:3n-3; eicosapentaenoic 20:5n-3; and docosahexaenoic 22:6n-3. The ratio of n-3/n-6 was high which is consistent with the high intake of coconut and fish and the low intake of meat, margarine, oil and dairy products.

Fatty acids derived from fish oils, 20:5n-3 and 22:6n-3 showed the same potentially beneficial relationships with blood lipids as in western populations; specifically that they were positively related to serum HDL levels and negatively related to triglyceride levels.

Table 4.10: Comparison of fatty acid composition of serum cholesterol esters of Kitavan adults with that of a Swedish population

Fatty Acid	Comparison with Swedish Population
Myristic 14:0	Very high
Palmitic 16:0	Very high
Stearic 18:0	Low
Saturated fatty acids	Very high
Palmitoleic 16:1n-7	Very high
Monounsaturated fatty acids	High
Linoleic 18:2n-6	Very low
Eicosapentaenoic 20:5n-3	High
Docosahexaenoic 22:6n-3	High
Ratio n-3/n-6	Very high
Polyunsaturated fatty acids	Low

Source: (260)

Polyunsaturated Fat and n–3 (Omega-3) Fatty Acids

Increased intake of polyunsaturated fat is associated with decreased levels of total plasma cholesterol. An increase of one per cent in energy from polyunsaturated fats (vegetable oil such as safflower, sunflower or corn) is consistent with a decrease in cholesterol of 0.04 mmol/l (121). N-3 fatty acids as derived from fish oils have been shown to reduce platelet aggregation (stickiness) and monocyte adherence, lower blood pressure and modify plasma lipids. Increased intake of n-3 fatty acids can reduce elevated triglycerides but, in general, has little effect on blood cholesterol concentrations. There is evidence to suggest that intake of fish, as part of the normal diet, may decrease risk of CHD. Those populations consuming a high proportion of fish in the diet, have lower triglyceride levels and lower rates of CHD and stroke (261). It may also be what they are not eating that makes the difference.

Monounsaturated Fat

Substitution of monounsaturated fat for saturated fat has been shown to reduce plasma cholesterol levels. Recommendations to substitute olive oil or rapeseed oil for butter or meat-based fat are advisable.

Total Fat

Although reduction of total fat has little influence on plasma cholesterol levels, reduction of total fat may decrease energy intake, resulting in weight loss, which will in turn result in lowered cholesterol levels. When total fat is high and the proportion coming from saturated fat is also high, the deleterious effect on blood lipids may be greatest. But when total fat is low, even if the proportion from saturated fat is high, the effect might not be the same. Thus a moderate fat intake (20 to 30% of energy) composed of more monounsaturated fats than saturated fats is currently recommended.

Dietary Cholesterol

Cholesterol in the diet has a relatively minor effect on plasma cholesterol in most individuals. Approximately two-thirds of people of most populations have a regulatory mechanism that is able to compensate for changes in dietary cholesterol intake. One-third of many populations, however, lacks this feedback mechanism and develops elevated cholesterol levels.

Alcohol

Much epidemiological data indicates that moderate intake of alcoholic beverages is associated with decreased risk of CHD. It is thought that an increase in HDL levels may be the mechanism by which this occurs. Studies in France showed that among middle-aged men with a 12-year follow up, mortality from cardiovascular disease was 30% lower in moderate drinkers (mostly wine) compared with abstainers. All-cause mortality was 20% lower, but mortality from cancer and violent death was increased compared with abstainers (262). Excessive alcohol intake in many countries is associated with higher rates of motor vehicle accident and higher rates of cancer, specifically cancer of the liver.

Dietary Fibre

The water-soluble fraction of fibre lowers plasma cholesterol especially when combined with a low saturated fat intake. Dietary fibre without fat modification can lower plasma cholesterol, however the amount of fibre required to effect a significant reduction in plasma cholesterol is 15 to 30 grams per day (121).

Obesity and Distribution of Body Fat

After adjusting for cigarette smoking, obesity has been clearly related to excess all-cause mortality and cardiovascular disease mortality (263). Every 1kg/m2 increase in the body mass index is associated with a corresponding increase in the total plasma cholesterol of 0.20 mmol/l and a 0.02 mmol/l decrease in the level of HDL cholesterol (264). It has been estimated that a person 10kg overweight will produce an additional 5.17 mmol/l of cholesterol per day (121). Clearly, obesity increases plasma lipid levels, alters endogenous cholesterol and lipoprotein metabolism, and contributes to CHD (121).

Evidence is accumulating that the distribution of body fat in the abdominal area contributes to an atherogenic plasma lipid profile and increased risk of CHD (265).

Several studies in the Pacific have clearly demonstrated the relationship between obesity and distribution of body fat on lipid levels. Galanis et al. (258) in Samoa showed that abdominal adiposity was highly correlated with total cholesterol and non-HDL cholesterol. Hodge et al. in Nauru (254) and Nye et al. (150) in Fiji Islands showed that waist-hip ratio, skinfold thickness and BMI were related to lipid abnormalities.

Diabetes Mellitus

Lipid abnormalities play an important role in the development of CHD in diabetic patients. These abnormalities are found in Type 2 diabetic patients and poorly controlled Type 1 patients. The main abnormalities found are increased triglyceride levels and decreased HDL values, which are related to increased HDL catabolism. The pathophysiology of lipid disorders in diabetes mellitus is multifactorial and not well understood, but hyperglycaemia and insulin resistance in type 2 diabetes very probably play an important role (266).

Physical Activity

The beneficial effects of physical activity on cardiovascular health are well known and far reaching. Physical activity strengthens the heart and improves its efficiency, increases vasculature of the heart muscle, helps decrease elevated blood pressure, decreases total cholesterol levels and increases levels of protective HDL cholesterol. Physical activity plays a major role in moderating total obesity and abdominal obesity, which are significant risk factors for CHD. Higher habitual physical activity is associated with less body fat, due to its effects on the basal metabolic rate (267).

Physical activity may also be a moderating factor when the diet is rich in saturated fat. The traditional Pacific Island diet, particularly in coastal areas and on atolls, is moderately high in total fat and relatively high in saturated fat, due to the liberal consumption of coconuts. Saturated fat in the diet is a major contributor to a high cholesterol level, which is one of the main risk factors for CHD. Yet, a number of studies have found lower cholesterol levels and lower rates of coronary heart disease among the coconut-eating islanders than among their countrymen residing in urban centres. The higher physical activity that has been reported among rural residents compared with urban dwellers may permit a higher intake of saturated fat without the deleterious effect on blood lipid levels and CHD that is seen in most industrialised countries.

Conclusions

It appears clear that the major risk factors for coronary heart disease in Pacific Islands are reaching or exceeding rates in western countries. Prevalence of hypertension in many PICTs exceeds that of Australia and the United States. Smoking rates are much higher in most PICTs, particularly in rural areas, than in westernised countries. Prevalence rates of high-risk lipid levels appear to be reaching and surpassing rates in the U.S. Rates of obesity, physical inactivity and excesses or deficiencies in other dietary factors are also likely to play major roles in the development of lipid abnormalities and hypertension.

The high rates of these important risk factors point to a continuing escalation of death and disability from coronary heart disease in Pacific Island communities. Integrated prevention and control programmes will need to be given highest priorities at both country and regional levels. Programmes will need to focus on the promotion of nutritionally appropriate dietary guidelines, encouragement of physical activity, prevention and treatment of hypertension and tobacco control. All efforts should begin in early childhood, and continue throughout the entire life cycle.

CHAPTER 5: Diabetes Mellitus

Summary

- Diabetes and the complications associated with it: cardiovascular disease, blindness, renal disease, and lower limb amputations, are the major causes of premature morbidity, mortality and disability in many Pacific Island countries and territories today (3).

- Diabetes ranks in the top five causes of death in 11 of 21 PICTs. It is estimated that by the year 2010 there will be over 200,000 persons with diabetes in PICTs (268).

- Data on the prevalence of diabetes have been collected in most countries and territories of the Pacific over the past 30 years (see Appendix 3). Rates vary from zero in the highlands of Papua New Guinea (162) and rural Vanuatu (62) to close to 30% in Nauru (269), and the urban community of Koki in Port Moresby, Papua New Guinea (167).

- These rates are remarkably among the highest in the world – nine to ten times higher than rates in Australia (3.6 %) or the United States (4.2%) (268).

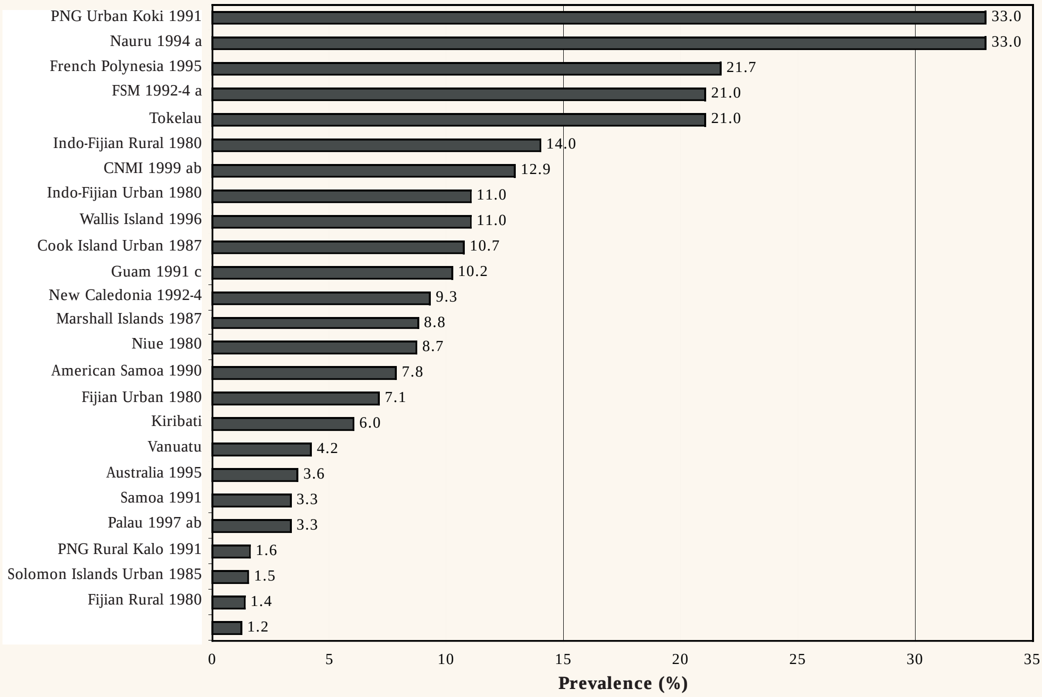
- Increases in the rates of diabetes (as much as 200%) have been reported in Fiji, French Polynesia, New Caledonia, Papua New Guinea, Cook Islands and Samoa over the past twenty to thirty years. These increases have been most pronounced in urban areas, but are also evident in rural settings.

- Marked differences in rates of diabetes are found between islanders living a rural, traditional way of life compared with those who have adopted a western or urban lifestyle. Differences seen in Fiji, New Caledonia, Kiribati, Papua New Guinea, Samoa, and Vanuatu all suggest that environmental factors such as increased intakes of energy-rich imported foods and decreased physical activity play a major role in the aetiology of diabetes.

- The economic burden of diabetes and its complications is escalating rapidly in PICTs which are also experiencing rapid socio-economic changes. The complications of diabetes inflict a heavy burden on the health care system of these countries, as well as on the quality of life of individuals, families and communities. Resources necessary for caring for diabetes will be taken from other health and social programmes – or will not be available at all.

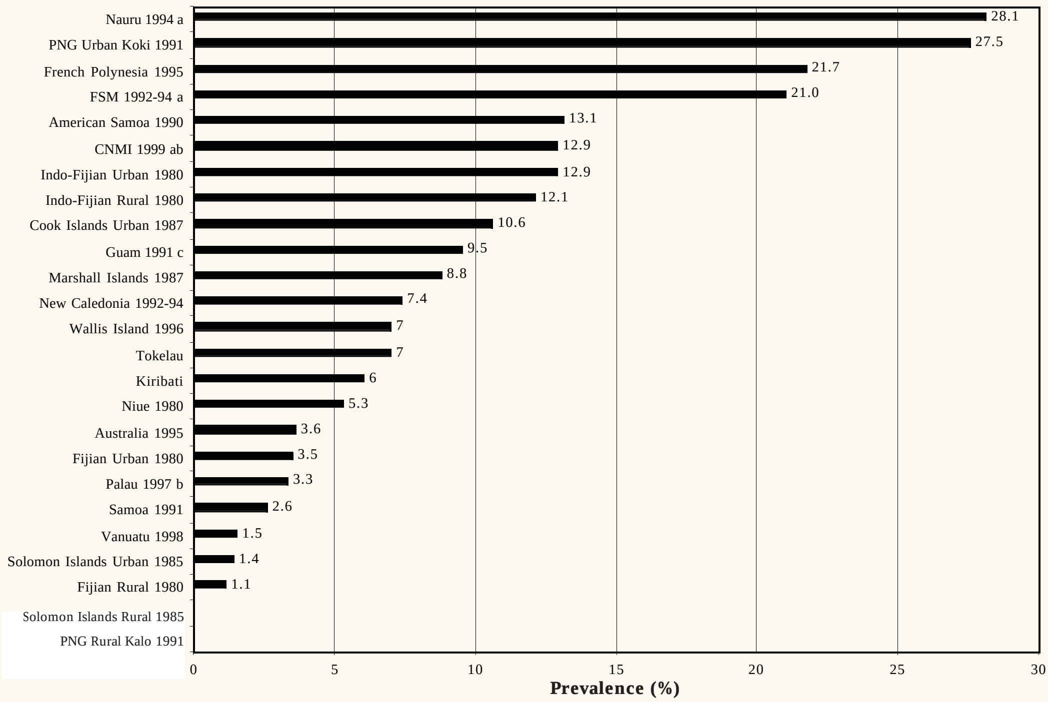
Figures 5.1 and 5.2 provide the prevalence rates of diabetes for many Pacific Island communities separately for females and males where possible, over the past 20 years. Prevalence rates for Australia are included for comparison (268). The PICTs are listed in order of descending prevalence rates. Table 1 in Appendix 3 provides a summary of most studies and surveys conducted in Pacific communities over the past 30 years. The table provides (where available) source of the reference, the sample size, the criteria used for diagnosis, prevalence rates of diabetes and impaired glucose tolerance, and per cent of newly diagnosed diabetes.

The data provided in Figures 5.1 and 5.2 can be used appropriately only to describe the issues and complexity of diabetes in the Pacific. They are not adequate to compare prevalence rates between countries. It should be noted that these prevalence rates are based on different methodologies – most are prevalence rates estimated from cross-sectional surveys of randomly selected individuals who are considered to be representative of the country or community. Other data were obtained from reviews of health system databases. One study used a self-reported prevalence of diabetes. It will also be noted that the surveys or studies were conducted at different time periods, some as long ago as 1980 and some as recently as 1998. Some surveys included different age groups; some used different methodologies for assessing blood glucose levels or different criteria for determining diabetes. Where possible, these differences are noted in Table 1, Appendix 3.



a Females and males combined. b Database review. c Self-report

Figure 5.1: Prevalence of diabetes among FEMALES in Pacific Island communities and Australia



a Females and males combined. b Database review. c Self-report

Figure 5.2: Prevalence of diabetes among MALES in Pacific Island communities and Australia

Diagnosis and Classification of Diabetes Mellitus

Historically, the diagnosis and classification of diabetes has been controversial. In an attempt to clarify these issues, an Expert Committee of the American Diabetes Association (270) and a WHO consultative committee (271) have proposed revised classification and diagnostic criteria. These definitions and criteria are summarised in a WHO report entitled, *Definition, diagnosis and classification of diabetes mellitus and its complications* (272).

Firstly, the terms, *insulin-dependent* and *non-insulin-dependent* diabetes, have been eliminated as confusing. The terms *Type 1* and *Type 2* have been retained and are defined in Table 5.1. The type of diabetes seen in PICTs is predominantly Type 2 diabetes and many studies do not differentiate between the two types. Unless otherwise specified, the following discussions refer to Type 2 diabetes.

Table 5.1: Classification of disorders of glycaemia

Classification	Description	Characteristics
Type 1 Formerly *insulin-dependent* or *juvenile-onset* diabetes	Beta cell destruction, usually leading to absolute insulin deficiency.	Auto-immune Idiopathic Insulin may be required for survival. Obesity is rarely associated.
Type 2 Formerly *non-insulin-dependent* or *adult-onset* diabetes	Most common form. May range from predominantly insulin resistance with relative insulin deficiency to a predominantly secretory defect with insulin resistance.	May not require insulin. Obesity or increased abdominal body fat commonly associated.
Other Types	Least common. Underlying disease process can usually be identified; genetic, drug or infection induced.	May require insulin.
Gestational Diabetes	Hyperglycaemia of variable severity with onset or first recognition during pregnancy.	May or may not require insulin.

Source: (270,272,273)

Secondly, the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, (270,272) changed the diagnostic criteria for diabetes, lowering the fasting plasma glucose value to ≥7.0 mmol/l (≥126 mg/dl) from the previous WHO recommendation of 7.8 mmol/ l (≥140 mg/dl) (274). The new fasting levels as shown in Table 5.2 were chosen to approximate the diagnostic significance in most persons to that of the two-hour post-glucose load concentration, which has not changed.

In general, population studies have relied on blood glucose concentrations after an overnight fast and/or 2 hours after a 75-gram oral glucose load to classify individuals with impaired glucose tolerance or diabetes mellitus. The new recommendations suggest that if the oral glucose tolerance test (OGTT) is difficult to perform in epidemiological studies due to logistics or economic limitations, that fasting plasma glucose alone can be used. Ideally, both the two-hour and the fasting values should be used.

Table 5.2: Glucose concentration for diagnosis of diabetes mellitus and other categories of hyperglycaemia

	Glucose concentration, mmol l^{-1} (mg dl^{-1})		
	Whole Blood		Plasma [a]
	Venus	Capillary	Venus
Diabetes Mellitus:			
Fasting	≥6.1 (≥110)	≥6.1 (≥110)	≥7.0 (≥126)
OR			
two-hour post-glucose load or both	≥10.0 (≥180)	≥11.1 (≥200)	≥11.1 (≥200)
Impaired Glucose Tolerance (IGT):			
Fasting concentration (if measured)	<6.1 (<110)	<6.1 (<110)	<7.0 (<126)
AND			
two-hour post-glucose load	≥6.7 (≥120) and <10.0 (<180)	≥7.8 (≥140) and <11.1 (<200)	≥7.8 (≥140) and <11.1 (<200)
Impaired Fasting Glycaemia (IFG):			
Fasting	≥5.6 (≥100) and <6.1 (<110)	≥5.6 (≥100) and <6.1 (<110)	≥6.1 (≥110) and <7.0 (<126)
two-hour (if measured)	<6.7 (<120)	<7.8 (<140)	<7.8 (<140)

a - Corresponding values for capillary plasma are: for Diabetes Mellitus: fasting ≥7.0 (≥126), two-hour ≥12.2 (≥220); for Impaired Glucose Tolerance: fasting <7.0 (<126) and two-hour ≥8.9 (≥160); and for Impaired Fasting Glycaemia ≥6.1 (≥126) and, if measured, two-hour <8.9 (<160).

For epidemiological or population screening purposes, the fasting or two-hour value after 75 g oral glucose may be used alone. For clinical purposes, the diagnosis of diabetes should always be confirmed by repeating the test on another day unless there is unequivocal hyperglycaemia with active metabolic decompensation or obvious symptoms.

Glucose concentrations should not be determined on serum unless red cells are immediately removed; otherwise, glycolysis will result in unpredictable underestimation of the true concentrations. It should be stressed that glucose preservatives do not totally prevent glycolysis. If whole blood is used, the sample should be kept at 0–4 °C or immediately centrifuged or assayed.

Source: (271,272)

Impaired Glucose Tolerance (IGT) or Impaired Fasting Glycaemia (IFG)

Persons with blood glucose levels between normal and overtly diabetic are considered as having *impaired glucose tolerance* (IGT) or *impaired fasting glycaemia* (IGF) and are at high risk of developing Type 2 diabetes. Approximately 30 to 40% of those identified as having IGT eventually develop Type 2 diabetes, with the annual rate of progression from IGT to Type 2 diabetes estimated at 1 to 5% (275). Since people with IGT are at particularly high risk of developing diabetes, they constitute a group at which interventions might best be targeted.

The Metabolic Syndrome

Persons with abnormal glucose tolerance (IGT or diabetes) will often be found to have at least one or more other cardiovascular disease (CVD) risk factor: hypertension, abdominal obesity, and/or dyslipidaemia. The clustering of these factors has been variously termed Syndrome X, the *Insulin Resistance*

Syndrome or the *Metabolic Syndrome* and can occur with or without hyperglycaemia. Persons classified with the Metabolic Syndrome are at particularly high risk of macrovascular disease. Alone, each of these risk factors conveys increased CVD risk, but together they become much more potent (272).

Individuals with Metabolic Syndrome offer a challenge to the therapeutic management of this disorder. It is important that treatment focus not only on blood glucose control, but on the reduction of the CVD risk factors as well. It has also been well documented that the features of the Metabolic Syndrome can be present for up to 10 years before detection of the blood glucose abnormalities. Thus, early identification and vigorous treatment of persons defined as having the Metabolic Syndrome may have a significant impact on the prevention of both diabetes and cardiovascular disease (272).

Definition of the Metabolic Syndrome:

Glucose intolerance, IGT or diabetes and/or insulin resistance together with two or more other components:

- Raised arterial blood pressure ≥140/90 mmHg
- Central obesity – Waist to hip ratio – females ≥0.85; males≥0.90 **OR**
  BMI >30 kg/m^2
- Raised triglycerides (≥1.7 mmol/l or 150 mg/dl) **AND/OR**
  Low HDL cholesterol: females < 1.00 mmol/l (39 mg/dl); males < 0.9 mmol/l (35 mg/dl) for males
- Microalbuminuria – urinary albumin excretion rate ≥20 μg/min or albumin:creatinine ratio ≥30 mg/g^{-1}

Other components of the Metabolic Syndrome have been described – hyperuricaemia, coagulation disorders, raised PAI-1 – but they are not necessary for the recognition of the condition (272).

Summarised below are the findings of surveys, studies and reports related to the prevalence and, if available, the incidence of Type 2 diabetes. These summaries are presented by general regional areas – Melanesia, Micronesia and Polynesia and then by country or territory in alphabetical order. In general, studies and surveys are reviewed in chronological order.

Melanesia

Fiji Islands

In 1950, diabetes mellitus was reported as the cause of four deaths among Fijians (276). For the same time period, there were 844 deaths due to infectious and parasitic diseases.There were 84 deaths due to diabetes mellitus among Indo-Fijians for this same year.

Mortality rates for diabetes were analysed for the years 1971, 1975 and 1980 by Tuomilehto and colleagues (277) and are summarised in Table 5.3. Diabetes-related deaths increased in both Fijians and Indo-Fijians in the 40–59 years and 60+ age groups between 1975 and 1980. The most dramatic increase rates, however, were seen amongst the Indo-Fijians, with rates in the 40 to 59 year age group almost doubling between 1975 and 1980.

Table 5.3: Mortality rate (per 100,000) for diabetes mellitus in Fiji Islands by age and ethnic group, 1971, 1975, and 1980

		Mortality Rate (per 100,000)					
		Fijian			Indo-Fijian		
Year	Age	20–39	40–59	60+	20–39	40–59	60+
1971		-	3	75	-	41	208
1975		3	37	36	11	87	251
1980		1	36	142	8	143	693

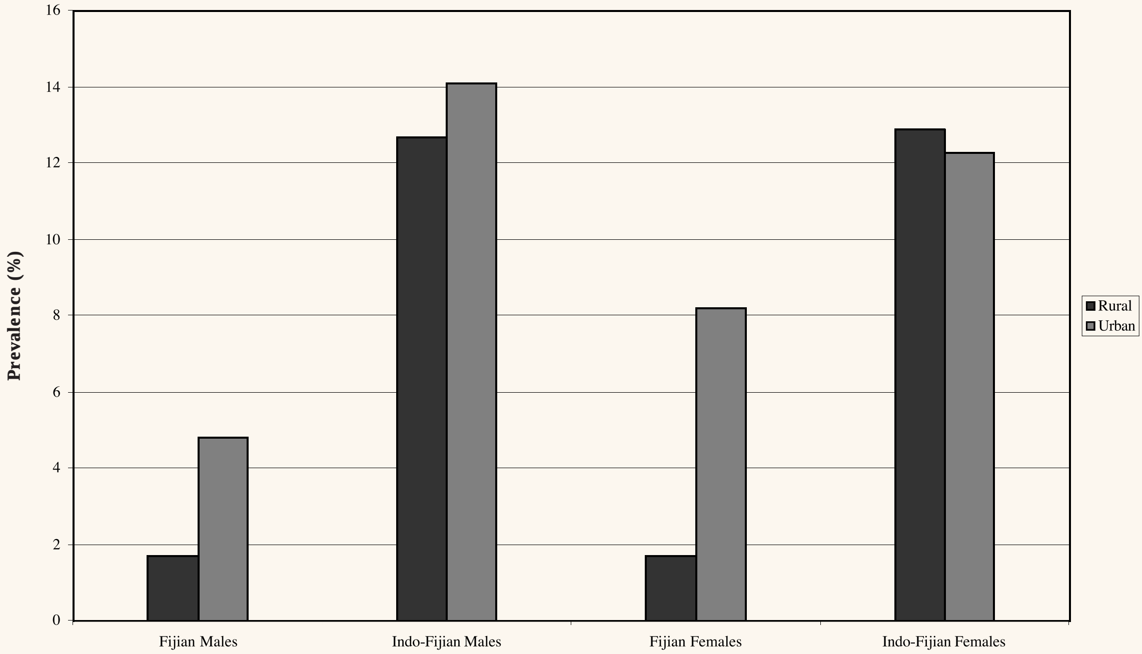
Source: (277)

In 1996, the mortality rates from diabetes were 42.9/100,000 for Fijians and 60.8/100,000 for Indo-Fijians for all ages (278).

The Tuomilehto analysis also showed an increase in hospital admissions due to diabetes between 1960 and 1979. When taken as a proportion of hospital admissions, the admissions due to diabetes for all groups during that time period increased 3.2 times, admissions due to cardiovascular disease increased by 7.5 times, while those due to rheumatic heart disease decreased by 4%. Even though the rates of hospital admissions over this time period were greatest for Indo-Fijians, the percentage increase in hospital admissions between 1960 and 1979 was greatest for Fijians (277).

Diabetes prevalence in Fijians until the late 1970s was thought to be extremely low. A study reported in 1967, reported a low rate of 0.6% among 1000 Fijians of the Rewa Delta. Among 1000 Indo-Fijians in Suva, however, the prevalence was 10 times as high – 5.7% (279).

The Fiji Cardiovascular and Metabolic Disease Survey conducted in 1980 by Zimmet and associates (280) discovered a rate of diabetes of 6.6% among Fijians living in an urban setting in Suva. This is an apparent ten-fold increase in a little over ten years, although different methodologies were used from the 1967 study. Rural Fijians from the Sigatoka Valley had lower rates than the urban Fijians. Indo-Fijians, however, continued to have high rates, whether living in a rural or urban environment (Figure 5.3).



Source: (280)

Figure 5.3: Prevalence of Type 2 diabetes in Fiji Islands by ethnic group and level of urbanisation, 1980

Attendance at health services and mortality rates were assessed among Fijians and Indo-Fijians residing in selected areas of Suva who had participated in the 1980 Fiji Cardiovascular and Metabolic Disease Survey (281). The followup covered the time period from the 1980 survey through mid-1984. Among individuals diagnosed with diabetes in 1980, the relative risk for four-year mortality was significant for Indo-Fijians (RR 4.6), but not for Fijians (RR 1.5). Inpatient admissions were increased for diabetic individuals, but this was statistically significant only for females. The relative risk of admission was 3.1 for Fijian females and 2.6 for Indo-Fijian females, both of which were significant ($p < 0.05$). These data indicate that Type 2 diabetes in Fiji is associated with excess mortality and severe health consequences.

A further assessment of mortality data was carried out among the 2638 participants in the Cardiovascular and Metabolic Disease Survey from 1980 through August 1991 (282). This analysis clearly demonstrates that both Fijians and Indo-Fijians with Type 2 diabetes have higher rates of all-cause, cardiovascular (CVD), coronary heart (CHD) and cerebrovascular mortality than those without diabetes, as shown in Table 5.4. The data indicate that diabetes confers higher risk levels for Indo-Fijians compared with Fijians, especially for CHD in females and stroke in males. Even after controlling for cardiovascular risk factors – age, systolic blood pressure, BMI, total cholesterol, smoking and urban/rural residence – these relative risks remained strikingly elevated.

Table 5.4: Relative risk (95% confidence interval) of death for Fijians and Indo-Fijians with and without diabetes, 1980–91

	Relative Risk (95% CI)			
	Fijian		Indo-Fijian	
	Females	Males	Females	Males
All-causes	2.31 (1.15–4.63)	1.34 (0.71–2.54)	3.1 (1.66–5.81)	4.35 (2.74–6.92)
Total CHD/CVD	3.2 (1.3–7.83)	1.4 (0.61–3.18)	4.05 (1.76–9.31)	4.8 (2.51–9.17)
CHD	5.36 (1.18–24.3)	1.6 (0.43–5.97)	20.7 (2.51–171)	3.15 (1.29–2.04)
CVD	2.58 (0.44–15.3)	1.68 (0.38–7.47)	2.88 (0.45–18.4)	21.8 (4.08–116)

Source: (282)

Hoskins and co-workers (283) carried out a purposive diabetes prevalence study in 1983, including over 5000 adults. This survey recruited Fijians and Indo-Fijians in rural and urban centres and compared two methods of screening for diabetes. Capillary blood was taken for the determination of both fasting blood glucose and glycosylated haemoglobin (HbA1). The HbA1 determination found lower rates of diabetes in the 1800 people tested than when fasting blood glucose was used as th3e determinant. When blood glucose was used, 24% of Fijian females and 15% of Fijian males were classified as diabetic, whereas among the Indo-Fijians, 34% of females and 25% of males were identified (data not shown).

Rural–urban differences were again compared in a survey conducted in the late 1980s by Russell-Jones et al. (151) among Fiji Melanesians over 40 years of age. The rural group was selected from a very remote central highland interior of Viti Levu, the main Fijian Island. The urban participants were residents of a suburb of Suva. This study found highly significant differences in prevalence rates of both impaired glucose tolerance and diabetes between rural and urban Fijians. Urban females had the highest rates of any group. There were also significant differences between rural and urban dwellers for mean weight, BMI, fasting glucose, two-hour glucose and glycosylated haemoglobin (HbA1).

The preceding two studies conducted by Hoskins et al. (283) and Russell-Jones et al. (151) did not use random sampling methods to select participants for their surveys, thus the results of these studies may not be representative of the communities or of the country as a whole.

The 1993 National Nutrition Survey (36) estimated diabetes prevalence rates by interviewing all respondents over nine years of age regarding the presence of diabetes. While the rates of known diabetes were less than 1% in those under 44 years of age, the prevalence rose to 10% in those above 45 years. Indo-Fijians experienced markedly higher rates, 6.9%, compared with 3.3% of Fijians. There were no statistically significant differences between males and females in either ethnic group. The mean BMI of respondents with diabetes (26.7 kg/m2) was significantly higher than those without diabetes (24.7 kg/m^2). Sixty-six per cent of patients with diabetes received medication, of which 95% were oral hypoglycaemia agents. Only 3% of patients received insulin therapy.

While these data suggest that there has not been a significant increase in prevalence of diabetes since the 1980 surveys, this self-report survey may greatly underestimate the true prevalence of diabetes in this population. Given that diabetes ranks as the third leading primary cause of hospital admissions in 1994, it is likely that diabetes is also having a major influence on other associated diseases such as cardiovascular disease, renal failure and retinopathy.

In 1996 diabetes-related amputation occurred in Fiji with a distressing frequency – 10 per week. (284)

New Caledonia

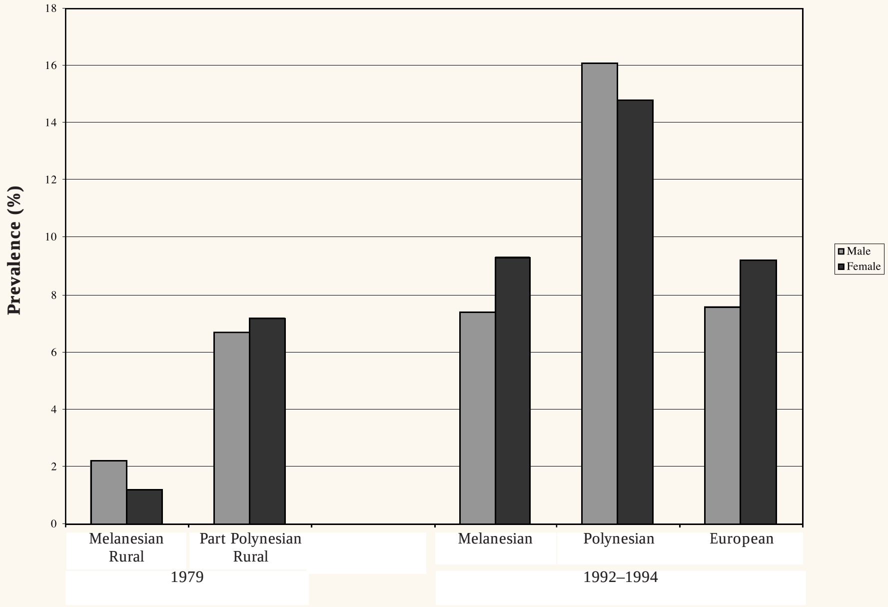
Diabetes prevalence rates have increased over the past 15 years among Melanesians and particularly among Polynesians in New Caledonia. While the rates for Melanesians appear to be low compared with other Pacific Island countries, they are still double the rates found in the affluent countries such as Australia and the US. The rates for Polynesians, Wallis Island migrants, are similar to those in other Polynesian countries.

Three communities in New Caledonia took part in a diabetes survey in 1979 (285). One group comprised Melanesians living in rural villages on the northeast coast of mainland New Caledonia. A second group of Melanesians lived on Ouvea, an island approximately 100 km from the mainland. The third group included part-Polynesians also residing on Ouvea. The prevalence of diabetes was significantly higher among the part-Polynesians residing on Ouvea (7%) compared with the rural Melanesians (1.7%) or the Melanesians on Ouvea (2.2%). The prevalence of impaired glucose tolerance was also higher among the part-Polynesian group (8%) but the difference between the rural Melanesians (5.8%) and the Ouvea Melanesians (5%) was not significant. The differences between the groups could not be explained by differences in age or degree of obesity.

A large survey (CALDIA) investigating the prevalence of diabetes in the multiracial population of New Caledonia was conducted from 1992 to 1994 in several regions of the country (286). Overall, 9390 New Caledonians aged 30–59 years participated in the survey. The majority were Melanesian; smaller numbers were Polynesians, Europeans and other ethnic groups.

Regions covered by the survey included small towns and villages of the rural Northern Province, six suburbs of Noumea, the capital city of New Caledonia, and all villages of one of the Loyalty Islands. Diabetes was defined in a two-step procedure. All study participants had capillary blood glucose measured with glucose strips. Individuals with fasting capillary blood glucose values ≥ 110 mg/dl or non-fasting values ≥ 140 mg/dl were invited to return for a two-hour oral glucose tolerance test with a 75 g glucose load. Patients known to have diabetes and individuals with fasting capillary blood glucose values ≥ 200 mg/dl (or 300 mg/dl non fasting) also received a two-hour blood glucose determination but were given a standard meal of approximately 67 g carbohydrate instead of the 75 g glucose load. Criteria for diabetes were based on WHO 1985 recommendations (274).

An overall age-adjusted prevalence rate of 8.9% was found, which suggests an estimated 5,300 diabetic patients aged 30 to 59 years in New Caledonia. There were significant differences in prevalence between the ethnic groups. The highest rate was found in adults of Polynesian origin (15.3%), compared with rates of 8.4% in both Melanesian and European groups. Figure 5.4 provides the prevalence rates by ethnic group and gender and compares them to the earlier, 1979 diabetes survey. In the 1992–94 survey, Melanesian and European females had higher rates than males. Among the Melanesians, rates were higher among urban residents than those who lived in rural villages (data not shown).



Source: (285,286)

Figure 5.4: Prevalence of Type 2 diabetes in New Caledonia by ethnic group and gender, 1979 and 1992–94

The 1992–94 CALDIA study highlighted several concerns. One was the increased rate of diabetes among the Polynesians, who were predominantly Wallis Island migrants. The rates increased from 12% in a previous 1980 survey (287) to 15% in this survey (see Wallis Island for a comparison of diabetes prevalence rates in 1980 among Wallisians living on Wallis Island and Wallisians who had migrated to New Caledonia). Another concern was the high proportion of diabetes that was undiagnosed before the survey. Seventy-nine per cent of the diabetes was previously unrecognised among the Melanesians, and 68% among the Europeans. The high prevalence of diabetes among the Europeans was also surprising. The frequency of diabetes among the Europeans, mostly of French origin, was three times that of the same age group in France. The significant rural/urban differences found among Melanesians, were not seen among the other ethnic groups, although the numbers in those groups in rural areas were small (data not shown).

Papua New Guinea

Prevalence rates of Type 2 diabetes appear to have remained relatively low in rural areas and among people of non-Austronesian (NAN) language groups. Rates have skyrocketed, however, in an urban community made up of affluent people of Austronesian (AN) language group. The prevalence rates in this group may be one of the highest in the world.

Speakers of Non-Austronesian (NAN) or Papuan languages are believed to have arrived in Melanesia much earlier than the Austronesian (AN) speakers. It is estimated that western Melanesia may have been settled by the NAN-speaking people as long ago as 50,000 years, but from where, is not known.

It is believed that speakers of the AN language-family entered Melanesia within the last 10,000 years from the Indonesian region, and made their way slowly eastwards, with Hawaii and New Zealand being settled within the last 1,000 or so years. These AN speakers migrating through the Pacific Islands would have had a greater genetic influence on coastal living islanders, while highlanders remained less affected. It is suggested that all AN-speaking peoples together probably constitute only about 13% of Papua New Guinea's population (288).

Diabetes was not mentioned in the 1947 extensive *Report of New Guinea Nutrition Survey Expedition* (18). In fact, the editors commented that *diseases common in civilised races are conspicuously rare.*

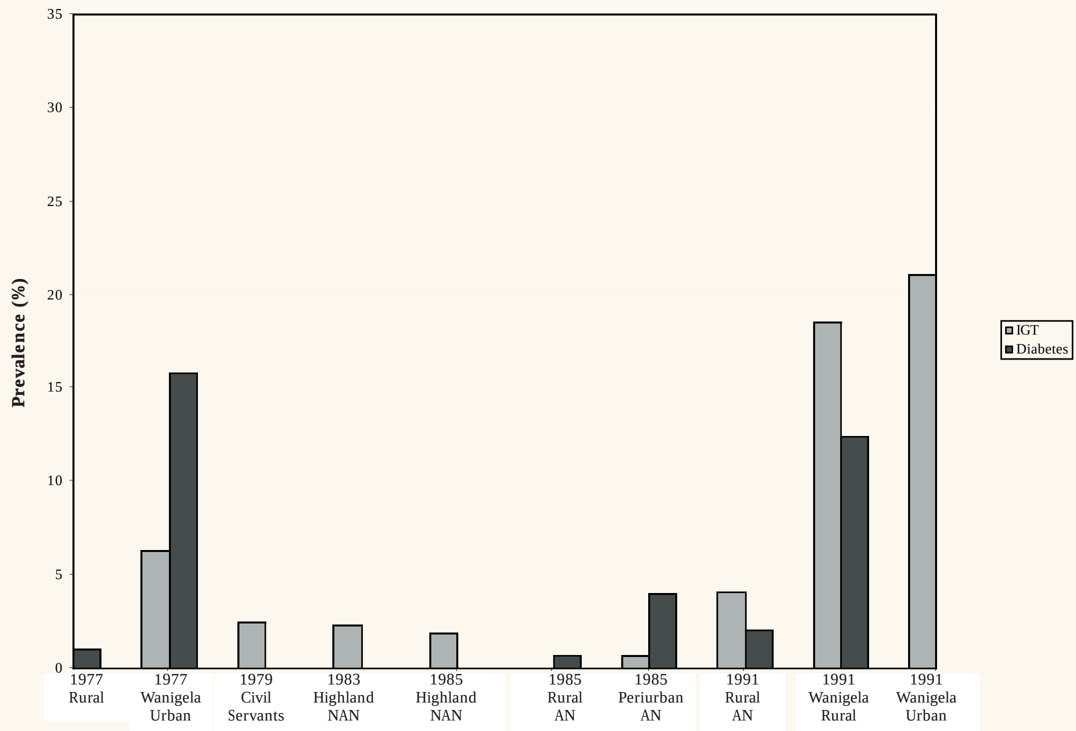
C.H. Campbell, a physician at the Port Moresby General Hospital in 1963, wrote:

> *Over a three-year period…(1958 to 1961)…only ten patients with diabetes mellitus were examined at and admitted to this hospital.* (289)

In 1962, Hingston and Price (290) performed urinary glucose examinations in two traditional rural villages and four suburban settlements around Port Moresby, the government and commercial capital of the country. No diabetes was found in the rural villages, and only two cases were found in Port Moresby. The prevalence in Port Moresby was 0.2%.

A similar study reported in 1966, noted a higher prevalence of diabetes in Port Moresby adults (1.4%) particularly in suburbs with the longest contact with the western way of life compared to suburbs with shorter western contact (0.1%) (291).

In approximately ten years, this rate was apparently to increase ten-fold. A survey conducted in 1977 by Martin and co-workers (48), found a rate of 15.8% in a relatively affluent Wanigela suburb of Port Moresby (Koki). The prevalence of diabetes was only 1.0%, however, in the rural village of Kalo where subsistence farming was the predominant occupation. Figure 5.5 illustrates changes in prevalence rates of diabetes in PNG between 1977 and 1991.



Sources: (48,161,167,292)

Figure 5.5: Prevalence of impaired glucose tolerance and diabetes in Papua New Guinea, 1977–1991

Martin and co-workers also compared these results to those of 118 civil servants employed in government offices at Waigani, Port Moresby in 1979 (160). No diabetes was found and IGT was 2.5%. The civil servants were younger than the Koki or Kalo residents, with fewer than 5% over the age of 34 years.

These investigators however did report a slightly different picture of diabetes than that found among other Pacific Island groups (293).

> *The presence of young, non-obese, non-ketotic diabetics who tolerate high blood glucose for a long time is more common in Papua New Guinea than in other countries.* (294)

A diabetes survey was conducted in 1983 in two villages in the Asaro Valley, Eastern Highland Province by Hilary King and co-workers (161). The people living in these remote areas of the highlands had not been exposed to western culture until about the 1930s. Since then, agricultural development has brought rapid economic growth and greater access to western goods. All adults in the two villages aged 20 years and over were invited to participate in the examinations; the response rate was 95%. The villages not far from the commercial and administrative centre of the region were chosen because the people were known to be of non-Austronesian Melanesian ancestry (NAN) and because preliminary dietary data had been collected. While both villages were involved in cash economy, they differed in their degree of acculturation. Gamusi was situated at an altitude of 2000 m and was accessible only by a difficult and often impassable road. Gimisave was situated near the Highland Highway, which allowed easy access to the town of Goroka. Gamusi was reported to enjoy a more traditional diet, but imported foods were observed in both villages.

Diabetes and IGT were determined by the two-hour plasma glucose concentration following a 75g oral glucose load. WHO 1980 (295) and National Diabetes Data Group (296) criteria were used to identify diabetes and IGT.

No diabetes was found among either gender in either village. IGT prevalence was 2.7% in the more traditional Gamusi and 1.7% in Gimisave, thus giving an overall prevalence of IGT of 2.3%. The difference in IGT between the two villages was not statistically significant. The mean two-hour plasma glucose concentration however was significantly lower in the more traditional Gamusi compared with Gimisave (3.8 vs. 4.7 mmol/l). Figure 5.5 shows the prevalence of both villages combined – Highland NAN, 1983.

This Asaro Valley survey thus discovered the lowest rates of diabetes (0%) and IGT yet to be reported in the Pacific. These findings lead to the hypothesis that the combination of a stable natural environment and seclusion from an Austronesian genetic admixture may result in greater degree of glucose tolerance and in a lower susceptibility to Type 2 diabetes. It suggested that certain population groups, particularly Papua New Guinea populations living in the highland areas, were not influenced by the Austronesian migration into the Pacific.

A second series of surveys was conducted in 1985 by these same researchers (292), to compare the susceptibility to Type 2 diabetes of communities comprising non-Austronesian (NAN) and Austronesian (AN) ancestry. Two villages located 3 km from Goroka in the Eastern Highlands Asaro valley were selected as the non-Austronesian population (highlands NAN). These communities, referred to as Masilakaiufa, are home to many successful businessmen, and residents there rely almost exclusively on a cash economy. Communities on Matupit Island were selected as an Austronesian population (periurban AN). On Matupit, residents rely on a cash economy, yet many families have traditional gardens. Napapar was the other Austronesian community, located in a rural area but with easy access to a town (rural AN). Diabetes was assessed by measuring plasma glucose concentration following a 75 g oral glucose load, using WHO, 1985 criteria (274).

Diabetes was absent in the highlands NAN village, and among women of the rural AN communities. Men in the rural AN villages had a prevalence of 1.6% and the overall prevalence in the periurban AN villages was 4.0%. IGT prevalence rates were 1.9% in the highland NAN villages, absent in the rural AN villages and 0.7% in the periurban AN villages. These prevalence rates are compared with other surveys and seen in Figure 5.5.

It would thus appear that people of the highland villages may have a greater degree of glucose tolerance and be less susceptible to diabetes. Yet, this study (292) also found that in the highland communities, the mean plasma insulin concentrations were significantly higher than in highland villages in the previous 1983 study (161). Hyperinsulinaemia has been shown to predict deterioration of glucose tolerance (297) and has been found in a number of groups at high risk for the development of Type 2 diabetes (298,299).

It is therefore possible that the higher insulin levels found among the highlanders in this study, could be an indication of latent tendency to glucose intolerance, and a predictor of future diabetes. Changing dietary patterns or decreasing physical activity could perhaps result in overt diabetes.

A more recent survey conducted in 1991 by Dowes at the International Diabetes Institute (167) compared prevalence rates of diabetes and obesity in three PNG communities. The urban centre of Koki is a relatively affluent suburb of Port Moresby, where people from the village of Wanigela have settled for several generations. The two rural centres were the village of Wanigela, about 200 km east of Port Moresby and the village of Kalo on the coast about mid-way between Wanigela and Port Moresby. In Kalo there are several small stores and good access to the nearby government station.

The study found an alarmingly high prevalence of diabetes among Wanigela people living in urban Koki (27.5% in men and 33% in women). The prevalence of diabetes was also high in the more rural village of Wanigela (17.9% among men and 10.0% among women). In Kalo, the prevalence was the lowest, (1.1% and 2.8% among men and women respectively). Figure 5.5 compares these rates for diabetes and IGT with other areas and surveys. It is noteworthy that the prevalence of diabetes has doubled over the 14 years since the first 1977 survey. The overall prevalence of abnormal glucose tolerance in the urbanised Wanigela people is the second highest in the world, after the Arizona Pima Indians. This prevalence is even higher than among Micronesians of Nauru, even though the Nauruans are more obese.

Solomon Islands

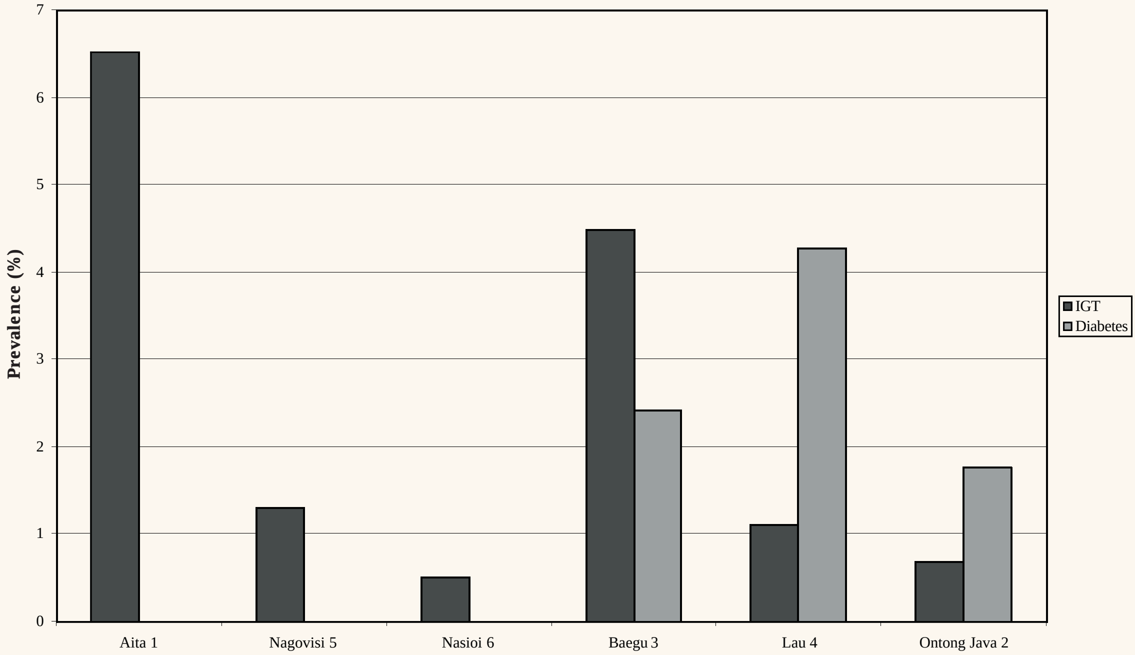
While prevalence rates of diabetes appear to be low in the Solomon Islands compared with other PICTs, the disease is emerging as a critical problem for this country.

Extensive nutritional and medical studies were conducted in six communities in the Solomon Islands as part of The *Solomon Islands Project* (300). The initial surveys were carried out from 1966 to 1972 with follow-up surveys in 1978–80 and 1985–86. Blood glucose measurements were not part of the initial surveys but were included in the 1985–86 examinations. Fasting blood glucose and a two-hour post-oral-glucose load (75 g) were used to determine the prevalence of diabetes in these communities (301). WHO criteria, 1985 were applied (274).

The six communities were ranked by the investigators on the basis of indices of acculturation such as: duration and significance of western contact, access to medical care, education and cash economy, imported foodstuffs, and salt intake. Three villages were on the island of Bougainville, now part of Papua New Guinea. The Bougainville groups are considered Non-Austronesian (NAN) and two of the villages, Nasioi and Nagovisi, were ranked as the most acculturated. This is the reversal of the pattern usually seen in other Pacific studies, where the NAN groups have seen the least amount of western influence. Aita, the third village on Bougainville and originally classified as one of the least acculturated, has seen recent rapid modernisation. Bougainville has seen heavy fighting during World War II and the development of large copper mining operations since 1968.

Two villages on the islands of Lau and Baegu are considered Austronesian (AN), as are the people of Ontong Java. On Ontong Java, a large atoll island, the people are non-Melanesian with considerable Polynesian-Micronesian affinities.

The prevalence rates for diabetes and IGT and the acculturation ranking are shown in Figure 5.6 for all six villages. No diabetes was found in any of the NAN villages, even those considered highly acculturated. When the villages and genders were combined the differences in rates of diabetes between the NAN villages and AN villages were highly significant.



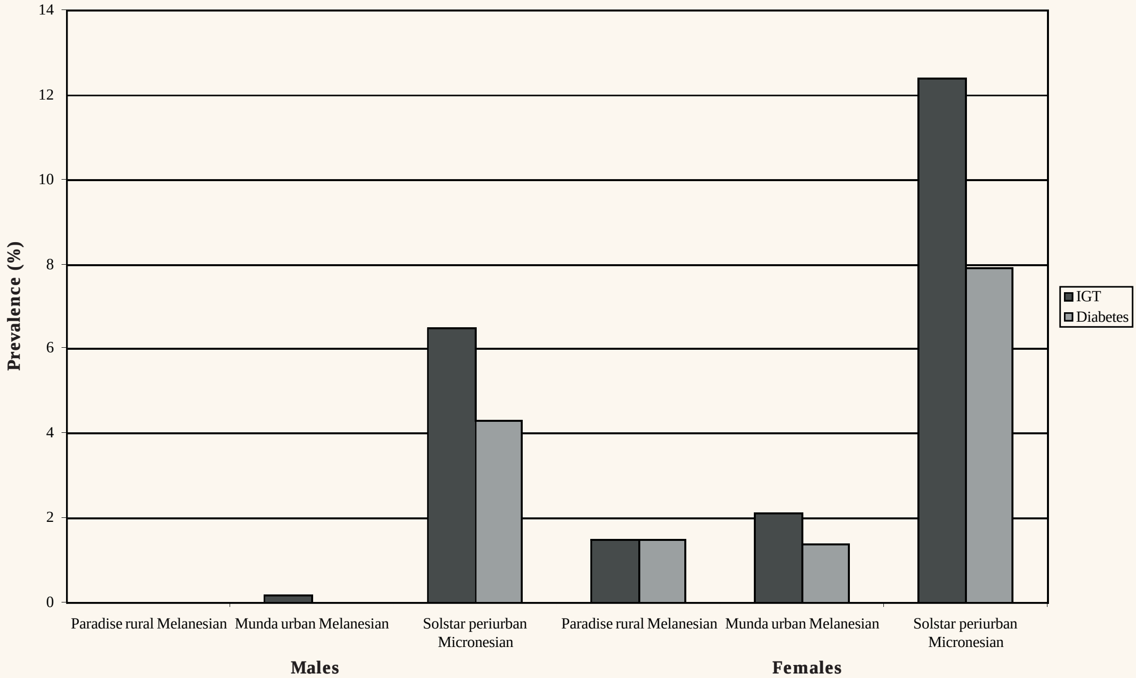
Level of Acculturation:
1= least acculturated
6= most acculturated

Source: (301)

Figure 5.6: Prevalence of impaired glucose tolerance and diabetes in six Solomon Island villages, 1985–86

A cross-sectional survey of diabetes, obesity and dietary intake was carried out in the Western Province of the Solomon Islands in 1985 by Eason and colleagues (57). The survey included 1500 individuals living in three distinct communities. One group comprised Melanesians living in a traditional village accessible only by boat (Paradise). A second group included Melanesians living in Munda, the country's third largest urban centre. The third group was made up of Micronesians who had migrated 20 years prior from the Gilbert Islands and settled in the fishing village of Solstar, 16 kilometres from the urban centre of Munda. Diabetes was determined by a fasting blood glucose measurement of ≥6.0 confirmed by a two-hour measurement of oral-glucose level following a 75 g glucose load. An oral-glucose tolerance test (OGTT) giving a glucose level ≥11.1 mmol/l determined diabetes and a level between 7.8 and 11.1 mmol/l determined IGT.

Figure 5.7 reveals that diabetes and IGT were not detected in Melanesian men living either in a traditional setting or a more urbanised environment. Melanesian women in those communities also had low rates of diabetes and IGT. The rates of diabetes and IGT among the Micronesians, however, were more than four times that of the Melanesians. BMI and dietary intake of cereals, sugar, coconut toddy and fresh fish were significantly greater in the Micronesian community than in the Melanesian communities, and intake of fruits, vegetables and root vegetables was lower.



Source: (57)

Figure 5.7: Prevalence of diabetes and impaired glucose tolerance among males and females in Solomon Islands, 1985

While the two 1985 surveys indicate that diabetes prevalence may be low among Solomon Island Melanesians, more recent data suggest that diabetes is emerging as a major health problem (302). Currently over 500 diabetic patients are registered at the central hospital in Honiara and more than 30% of those patients are estimated to have complications of the disease. In 1997, 120 new patients were registered at the diabetic clinic. In that same year, diabetic patients comprised 10% of admissions to the medical ward of the central hospital. Of these patients, 55% were admitted for management of foot ulceration, which is the most common diabetes complication requiring hospital admission. In 1997, there were 11 amputations of lower limbs performed on diabetics and in 1998, there were 12. Four patients were sent to Australia in 1997 for proliferative retinopathy, while 15 patients remained on the waiting list. The cost of sending one patient to Australia for laser eye treatment for diabetic retinopathy is SI$40,000 (302).

Vanuatu

Dr. Bastein, Chief Medical Officer, Central Hospital, Port Vila, Vanuatu, reported in 1990 that:
Diabetes is rare, with a yearly incidence rate of 0.06%. (303)

Finlayson and colleagues (173) conducted one of the first NCD surveys in Vanuatu in 1984. The investigators examined 243 people in Port Vila, the capital city of Vanuatu and 77 adults in Norsup, the largest town on Malekula Island. Residents of Port Vila tended to be employed and consuming a fairly westernised diet, whereas the people of Norsup were mainly involved in subsistence agriculture and fishing. The survey population consisted of individuals who attended the Port Vila or Norsup hospital outpatient departments with minor illnesses, or their friends or relatives.

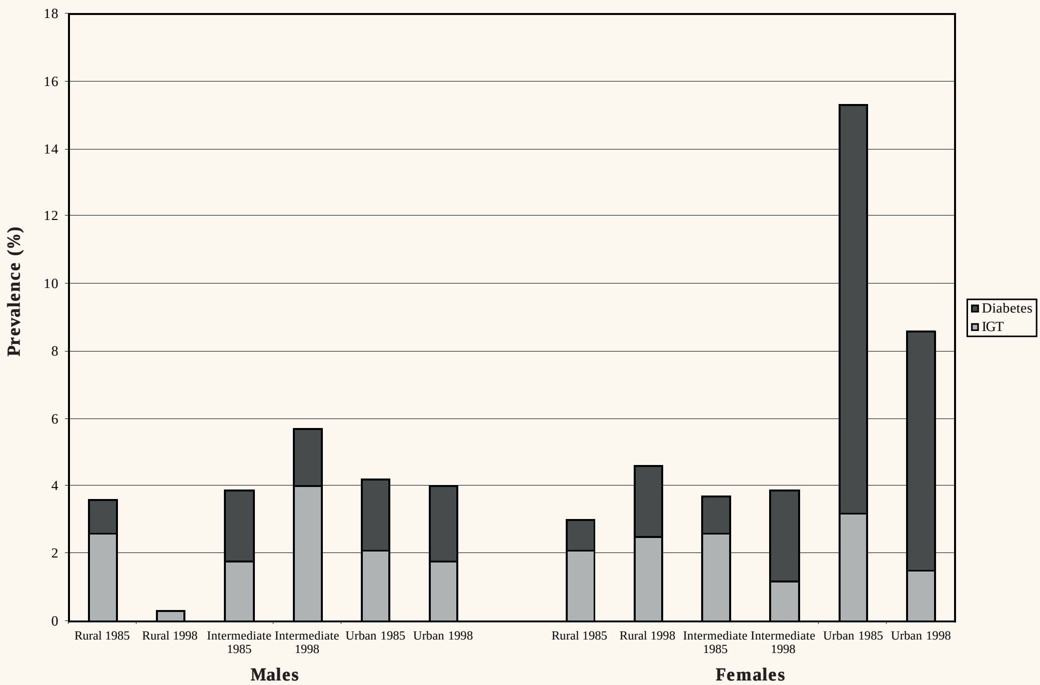
A low prevalence of diabetes and IGT was reported in both groups. The rates of diabetes were 2.1% and 2.6% in Vila and Norsup respectively and 5.8% and 3.9% for IGT in both communities respectively. These differences were not statistically significant.

Another NCD survey was carried out in 1985, in three populations at different levels of modernisation (174,175). The urban group included all civil servants in the capital city of Port Vila. An intermediate group consisted of residents on the island of Nguna, about a half-hour boat ride from the mainland. The rural group comprised adults from remote villages in the Middle Bush area on the island of Tanna.

Again in this survey, the prevalence of diabetes was low and there were no significant differences between the groups. The prevalence of diabetes in the age-adjusted population under 50 years was very low, 0.5% and 0% in Tanna and Nguna respectively. The rate was slightly higher among Port Vila civil servants (2.6%). The rates of IGT were 2.3% to 2.4% for all groups. These rates were the lowest observed in PICTs at this time. The age-adjusted rates based on the total survey population for males and females are provided in Figure 5.8 and are compared to a 1998 survey. Because there were few females over 50 years of age in the Vila sample, age adjustment was based on the under–50 age structure of the total population.

Health and nutrition examinations were undertaken in the 1998 Vanuatu Non-Communicable Disease Survey (62). The six sites chosen for this survey were similar to those chosen for the 1985 survey and included rural, urban and intermediate communities. Approximately 1600 adults over 20 years were evaluated for obesity, hypertension and blood glucose levels.

The results of the 1998 survey are provided in Figure 5.8 and are compared to the 1985 survey. It appears that prevalence rates of diabetes have remained relatively low in rural and intermediate communities of Vanuatu. Rates for men have not significantly increased from the 1985 to the 1998 surveys. The rates for females, however, have more than doubled in the rural and intermediate areas since the 1985 survey. While these rates are relatively low compared to other Pacific Island communities, these increases, especially among women, may be a signal for early intervention.



Sources: (62,175)

Figure 5.8: Prevalence of impaired glucose tolerance and diabetes in Vanuatu, 1985 and 1998

The comparison of these surveys may need to be interpreted with caution because of methodological differences used. In the 1985 examinations, blood glucose determinations were based on two-hour glucose tolerance following a 75g glucose load. Diabetes was defined as blood glucose ≥11.1 mmol/L (≥200 mg/dL) or known diabetic. The 1998 survey used capillary determinations read on a Bayer glucometer and defined diabetes as known diabetic or fasting blood glucose ≥8.0 mmol/L (≥145 mg/dL) or random blood glucose as ≥11.1 mmol/L (≥200 mg/dL). Seventy-five per cent of the sample was reported as not fasting. Finch et al. (304) have shown that random blood glucose values underestimated diabetes prevalence among Nauruans.

If these data are an accurate estimation of diabetes prevalence, the people of Vanuatu may have the opportunity to prevent the escalation of this disease that is occurring in many other PICTs. Interventions that aim to maintain the present level of diabetes prevalence may be more successful than interventions aimed at reducing the prevalence of the disease or at preventing the complications which accompany diabetes. Preventing an increase in the incidence of diabetes in Vanuatu would provide enormous savings in terms of health care costs to the country.

Micronesia

Commonwealth of the Northern Mariana Islands (CNMI)

The central computerised database of the Commonwealth Health Centre, Division of Public Health identifies patients in the population with diabetes. The age-adjusted prevalence rate of diabetes for the indigenous population was 9.3%. The Carolinian population had a slightly higher prevalence rate of 11.3 compared with 9.0 in the Chamorro patients (177).

The country paper presented at a meeting of Pacific Island nutritionists (176) lists diabetes as one of the four leading causes of premature death amongst the indigenous (Chamorros and Carolinians) population (40.9 deaths/100,000). Diabetes was listed as one of the most common diseases in the country, affecting 1880 people. Twenty-eight per cent of the indigenous population over the age of 40 has diabetes, almost entirely Type 2 diabetes. In 1996, the prevalence of diabetes among Carolinians was 5.4% and among Chamorros 5.3% as determined by a database review (176).

Federated States of Micronesia

Auerbach et al. (180) of the US Public Health Service carried out a non-communicable disease survey in three areas in the Federated States of Micronesia (FSM) during 1992–94. In Kosrae, a lush tropical island where most of the villages are along the coast and accessible by road, 690 adults were examined. The state of Chuuk, which represents a large population spread out over 39 inhabited islands, included 1520 adults ≥35 years of age. Two large semi-urban villages made up the sample of approximately 600 people from the main island of Pohnpei.

The prevalence rates appeared to be lowest in Chuuk, ranging from 9% in the 35–44 and 65–74 year age groups to 22% in the 45–54 age group. Rates in Kosrae ranged from 7% to 33% and in Pohnpei from 14% to 19% (Table 5.5). The researcher concluded that because of missing data, the prevalence rates for Pohnpei and Kosrae may not be accurate.

Table 5.5: Prevalence of Type 2 diabetes in the Federated States of Micronesia, 1994

Age (years)	Diabetes (%) Kosrae N = 600	Chuuk N = 1500	Pohnpei N = 600
35 to 44	7	9	14
45 to 54	21	22	19
55 to 64	33	18	21
65 to 74	9	9	21

Source: (180)

Endocrine, nutritional and metabolic diseases (under which diabetes is listed in disease classification codes) are listed in the top 10 causes of mortality, primary cause of hospital discharge and other causes of hospital discharge in FSM. Data related to prevalence of complications of the disease are not available at this time.

Guam

Diabetes was indicated as a problem in Guam as early as 1964 when Yen (305) demonstrated the effect of diabetes during pregnancy on the increased incidence of maternal and perinatal complications.

In 1967–68 Reed and colleagues (255) found higher mean blood glucose levels in Micronesians living on the main island of Guam compared to those living on traditional outer islands. Prevalence rates of diabetes were 3% and 8% for males and females respectively in traditional settings compared with 10% and 13% for males and females respectively on the main island of Guam.

Kuberski and Bennett (306) reviewed morbidity and mortality rates in Guam between 1971 and 1977. They showed that diabetes ranked among the top 10 causes of death, and accounted for 2.7% of all deaths. Among those over 35 years of age, diabetes ranked as the third equal leading underlying cause of death, second only to heart disease and cancer. Among deaths in persons aged 45 years and over at Guam Memorial Hospital in 1976, 50% of Chamorros and 36% of Filipinos had evidence of diabetes at the time of death.

Direct hospital costs associated with diabetes at Guam Memorial Hospital alone exceeded $600,000 for 1977 (307).

> *In the mainland United States, these costs constitute only about 20% of the total cost of diabetes to a community, and thus the current cost of diabetes on Guam can be projected to be at least 3 million dollars per year.* (307)

Abnormal carbohydrate metabolism was reported in patients in Guam with amyotrophic lateral sclerosis (ALS) and Parkinsonism-dementia (PL) (308). These two neurological conditions have been described in the indigenous Chamorro population at levels at least fifty times higher than in other populations. Abnormal carbohydrate metabolism has also been described in both of these conditions in other parts of the world. These researchers found that 62% of the 110 patients aged 34–81 years had abnormal glucose tolerance two hours after a 100 g glucose load. The largest proportion of known diabetics was found in the Parkinson group (43%) and the largest percentage of abnormal oral glucose tolerance tests in the ALS patients (44%). The investigators speculated that a possible endocrine role may be related not only to abnormal carbohydrate metabolism identified with these neurologic diseases on Guam, but also to the aetiology of the diseases themselves.

According to the 1991 Guam Behavioral Risk Factor Survey (139) diabetes ranked as the number one disease affecting the Chamorro people. The overall prevalence among Chamorros, based on self-report, was 10.7% (309). Of the total survey population, diabetic men were more likely than non-diabetic men to be Chamorro, to have not completed high school, to be unemployed, and to be impoverished at the time of the survey. Diabetic women were more likely than non-diabetic women to be impoverished.

For the years 1991–1993, diabetes was listed as the third leading cause of death among the Chamorro population (310). Although Chamorros, the indigenous people of Guam, represent only 43% of the population, they account for 73% of deaths due to diabetes. The crude death rate in the Chamorro population was 49.4 per 100,000 – which is five times the US rate of 10.1 per 100,000. The prevalence rates for diabetes in the Chamorro population increased by approximately three times from 3.7% in 1984, to 10.6% in 1991 (310).

Kiribati

A survey completed in 1981 by Zimmet and co-workers (71) found a prevalence rate of diabetes of 7.7% among I-Kiribati living in the urban area of Betio. People living a more traditional way of life in Tabiteuea North had a diabetes prevalence rate of 3.6%. The difference between the rural and urban groups was highly significant. Multiple regression analysis showed that among males, two factors were strong predictors of diabetes – having a high or medium BMI (the upper two thirds) and living in an urban area. Among females, a high BMI, living in an urban setting and physical inactivity were all predictors of diabetes. Body mass index, living in an urban setting and plasma lipids were all significant factors when comparisons were made between individuals with impaired glucose tolerance, persons with diabetes and those with normal glucose levels (311).

Many observers believe that since these rates of diabetes are already 20 years old, the rates in 1999 may be 2 to 3 times those of 1981 (312).

I-Kiribati living in an urban setting in the Solomon Islands also experienced a much higher rate of diabetes than local Melanesians in the same environment (1).

Marshall Islands

Medical surveys were carried out in 1967–69 on two atolls in the Marshall Islands that had been exposed to fall-out radiation. The accidental exposure occurred following a detonation of a thermonuclear device during experiments at Bikini atoll in March 1954. The survey reported 10 individuals with diabetes out of 197 examined (5%). No details were provided regarding how the diagnosis of diabetes was determined. The report further commented:

> *An increased incidence of diabetes of the old-age type has been noted in the Marshallese, but no more so in the exposed than in the unexposed* (313).

An ophthalmology survey was conducted on the Wotje atoll in 1987 (314).
The investigators found:

> *A relatively low prevalence of ocular pathology…..The only exception is related to the high incidence of hyperglycaemia, which indicates that greater efforts in the treatment and prevention of retinopathy are required* (314).

The examination included random capillary blood glucose determinations on 169 adults. Of those tested, 22 (13%) had glucose values exceeding 200 mg/dl (11.1 mmol/l). Five individuals had diabetic retinopathy, one with frank proliferative changes.

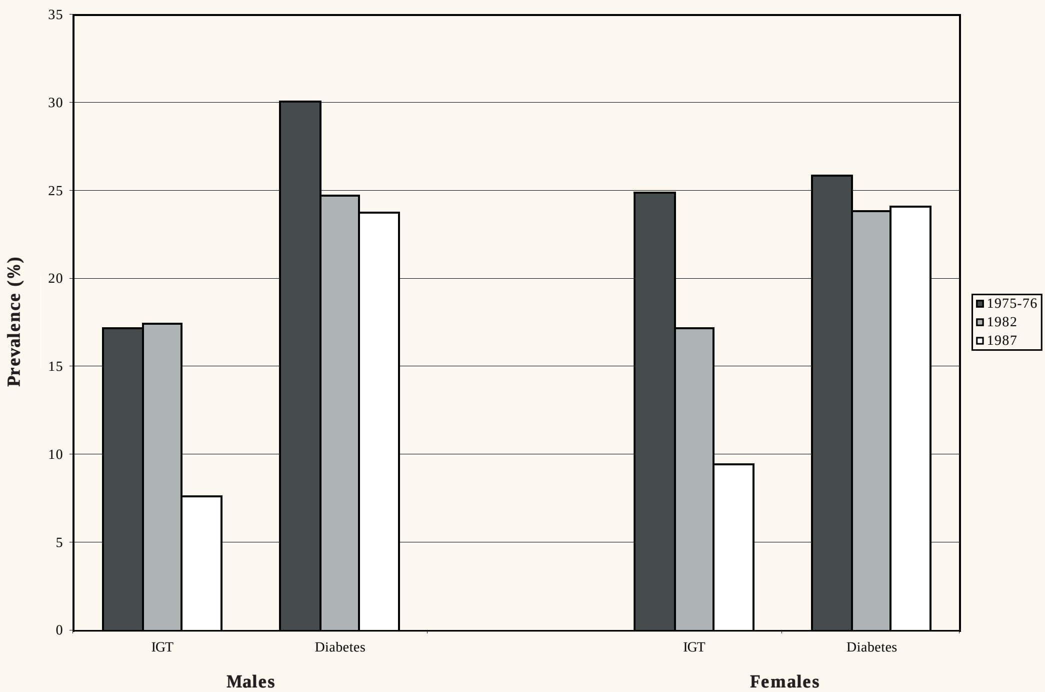
Nauru

Diabetes was not mentioned as a health problem in a survey conducted in Nauru in 1933 (315). In 1962, Tulloch (316) reported diabetes in 21 Nauruans, which was 1% of the population.

The first full survey of diabetes, conducted in 1975 by Zimmet and co-workers (317), found over a third (34.4%) of 221 Nauruans 15 years and over to be diabetic. This was one of the highest prevalence rates of Type 2 diabetes ever recorded in the world. A strong hereditary factor was evident, with 72% of those with diabetes reporting a family history of diabetes. The rate of diabetes increased progressively with age, and was highest in the 50 to 59 year age group with a prevalence of 68.6%.

The rates of diabetes in this survey were believed to be associated with obesity, which is extremely common in the Nauruan community. The mean weights of men and women were 11 and 9 kg higher, respectively, than those of a comparable Caucasian population. Yet, mean weight and Body Mass Index were not significantly different for diabetics and non-diabetics.

A follow-up survey was conducted by the same group of researchers (318) one year later. Of the 417 Nauruans 10 years of age and over who were examined, 29% were classified with diabetes and 7% with borderline diabetes, or IGT. Age-adjusted rates are combined with the 1975 survey and are shown in Figure 5.9, comparing them with rates from subsequent diabetes surveys.



Sources: (317-320)

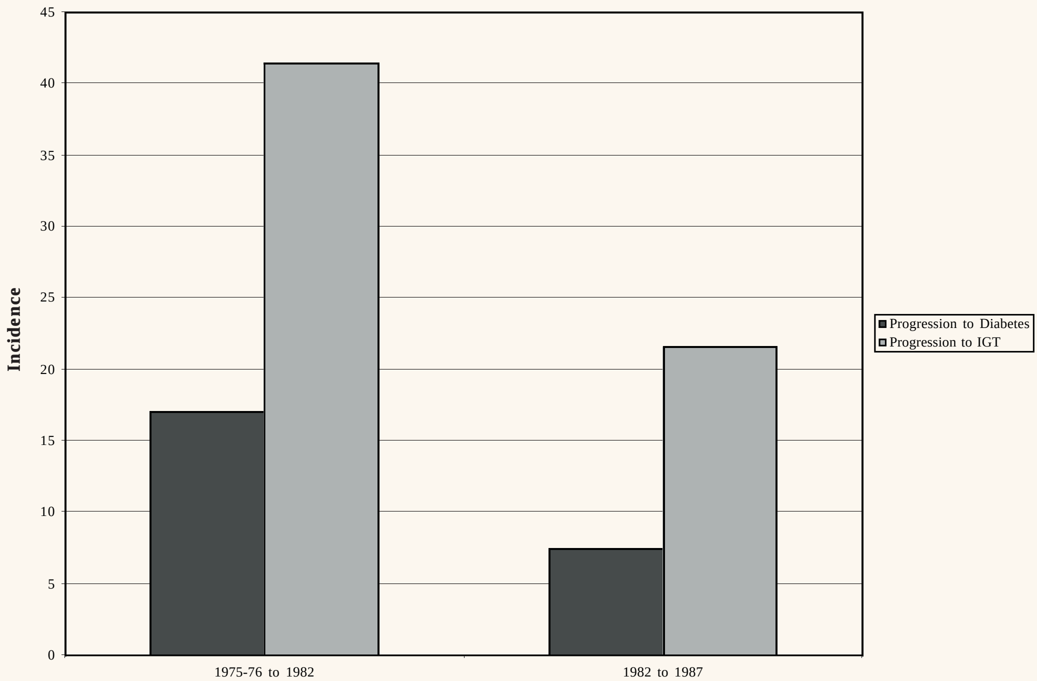
Figure 5.9: Prevalence of impaired glucose tolerance and diabetes in Nauru, 1975–76, 1982 and 1987

During the 1976 survey, nutrient intakes were estimated for 77 individuals using an adjusted 24-hour recall (78). The mean energy intake of males between 20 and 39 years was 8769 calories. This is approximately three times that recommended for developing PICTs (79).

In 1982, a third diabetes survey was carried out among 1546 adult Nauruans aged 20 years and over also by Zimmet and colleagues (319). The rates were similar for both genders with an overall prevalence of 24.2% for diabetes and 18.4% for IGT. The prevalence of diabetes and IGT rose with age in both genders, to over 50% in the 55–64 age group.

Correlational analysis revealed that age was most strongly correlated with diabetes; BMI had a weak, but still significant correlation; and systolic blood pressure was weakly correlated in women but not in men. The prevalence of retinopathy was 24% in newly diagnosed and known patients with diabetes.

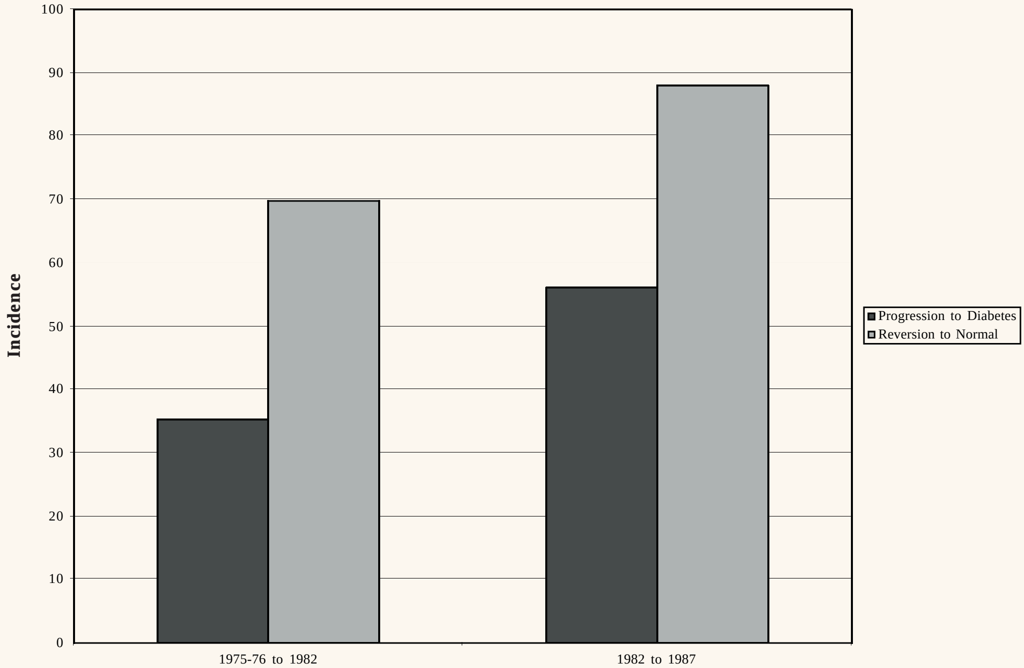
The report of the most recent survey conducted by these researchers at the International Diabetes Institute (320) compared prevalence and incidence rates of the three major survey periods: 1975–76; 1982; and 1987. These age-standardised estimates included Nauruans 20 years and over, who were residents of the island and had at least one parent of Nauruan heritage. The prevalence of diabetes declined from the 1975-76 survey to the 1982 survey and then remained relatively constant in 1987. The prevalence of IGT decreased dramatically from 1975-76 to 1987 (Figure 5.10).



Source: (320)

Figure 5.10: Changes in incidence of diabetes and impaired glucose tolerance in Nauruans with NORMAL BLOOD GLUCOSE levels at baseline

Figures 5.10 and 5.11 illustrate the changes in the natural history of glucose intolerance over these survey periods. Figure 5.10 shows the fall in the rate of progression in Nauruans with normal blood glucose in 1975–76 to diabetes or to IGT. The rate of progression to diabetes fell from 17.1 cases/1000 person-years from 1975–76 to 1982, to 7.4 cases in the time period from 1982 to 1987. The progression from normal blood glucose to IGT also declined in these time periods. Figure 5.11 depicts the reverse in Nauruans who were glucose intolerant at baseline. The progression to diabetes was 35.2 cases in the first time periods and 56.1 in the second time period. The rate of *reversion* from IGT to normal was 69.8 and 88.1 cases in the first and second time periods respectively.



Source: (320)

Figure 5.11: Changes in incidence of progression to diabetes or reversion to normal blood glucose in Nauruans with IMPAIRED GLUCOSE TOLERANCE at baseline

The investigators were unable to explain these changes based on differences in the make up of the longitudinal study population or improvements in lifestyle risk factors. Indeed, there was sufficient evidence that obesity had actually increased, physical activity levels remained constant and dietary patterns did not change.

The explanation suggested by these researchers was that perhaps the epidemic had already drained the most susceptible individuals from the pool of those with normal glucose tolerance. The environmental influences had been sufficiently strong and widespread, that a high proportion of the genetically susceptible Nauruans had already developed IGT or diabetes prior to the 1982 survey. Therefore, the susceptible genes of those whose glucose levels were normal in the 1982 survey, were less frequent compared with the group who had normal blood glucose levels in 1975–76. This hypothesis, coupled with evidence of declining fertility and higher mortality rates among Nauruan diabetics, may be foretelling a fall in the frequency of the diabetic genotype (or phenotype) in this population (320).

Palau

In 1968–70, Reed and co-workers (255) carried out health surveys among 510 adults in three communities in Palau, representing urban, rural and intermediate lifestyles. The overall prevalence of *hyperglycaemia* (defined as serum glucose ≥205 mg/100 ml {11.4 mmol/l}, one-hour following a 50 g glucose load) was 5%. The highest rate was 10% among males in the urban centre. In the rural villages, there were no females with hyperglycaemia and only one male with elevated glucose level. Correlation analysis indicated that serum glucose levels were positively associated with age, blood pressure, body weight, and serum cholesterol and triglyceride levels.

A chart review analysis of diabetes was undertaken in Palau in 1998 (321). The study included 495 individuals identified with diabetes between 1971 and 1997, who remained alive and were entered into the register. Of those registered, 96% were Palauans. The crude incidence rates increased from 0.9/1000 persons in 1985 to 3.3 /1000 person years in 1997. The researchers noted that screening and case-finding activities increased considerably beginning in 1988. The age-adjusted incidence rate for

1997 was 4.4/1000 person years – almost double the US 1987 rate of 2.9/1000 person years. The age-adjusted prevalence rate for 1997 was 3.9%.

Although the data on complications associated with diabetes were considered incomplete in this chart review, 15% of those registered with diabetes were found to have retinopathy, 13% neuropathy and 11% nephropathy or end stage renal disease (321).

Polynesia

American Samoa

Mortality rates due to diabetes were reported by Crews and MacKeen in 1982 (322). These researchers examined the cause of death from the records of 1588 American Samoan decedents. Death records were collected from the years 1962 to 1974 and included only Polynesians whose usual place of residence was American Samoa. The mortality rate for diabetes, age standardised to the comparable US population, was 32.2/100,000, which was more than double the US rate of 13.4 for the same time period. This rate was also greater than rates for 38 other countries reported in 1965.

The Samoa Cardiovascular Disease Risk Factor Study 1990–95 included Samoans in American Samoa and those in Samoa (256). Baseline data were collected in 1990 and 91 and a four-year follow-up examination was completed in 1994–95. Adults 25 to 55 years of age were included.

Figure 5.12 provides the crude prevalence rates of diabetes and impaired fasting glycaemia for females and males at the baseline examination in 1990. Diabetes was markedly higher for males in the 40 to 55 year age group than for the other groups.

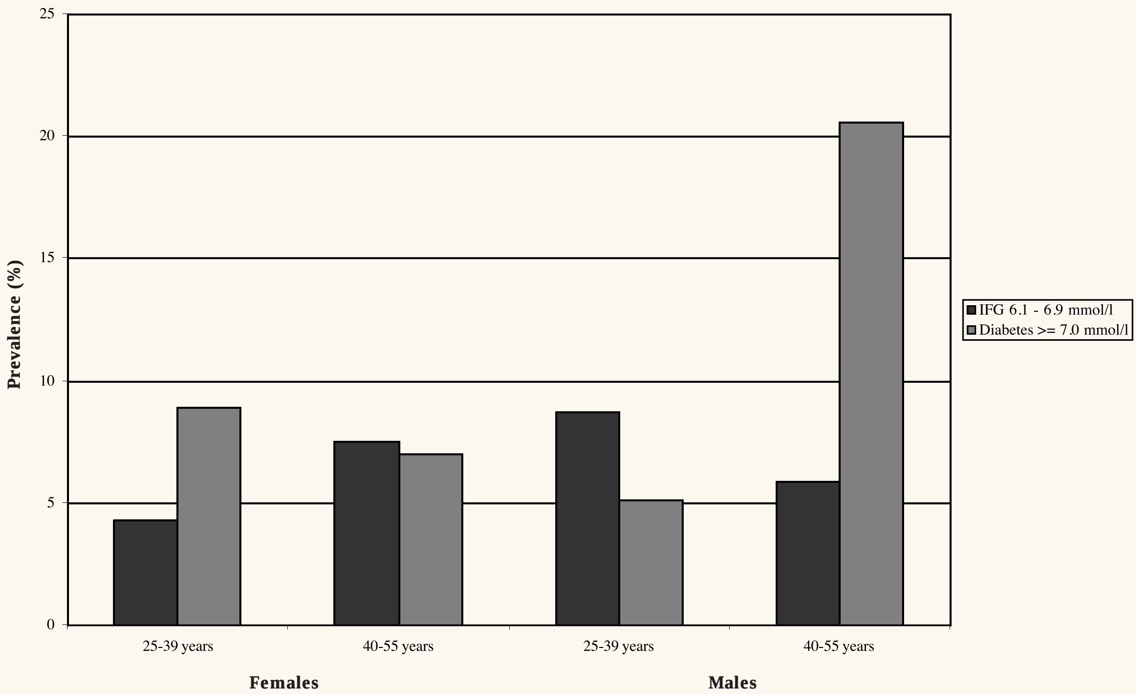
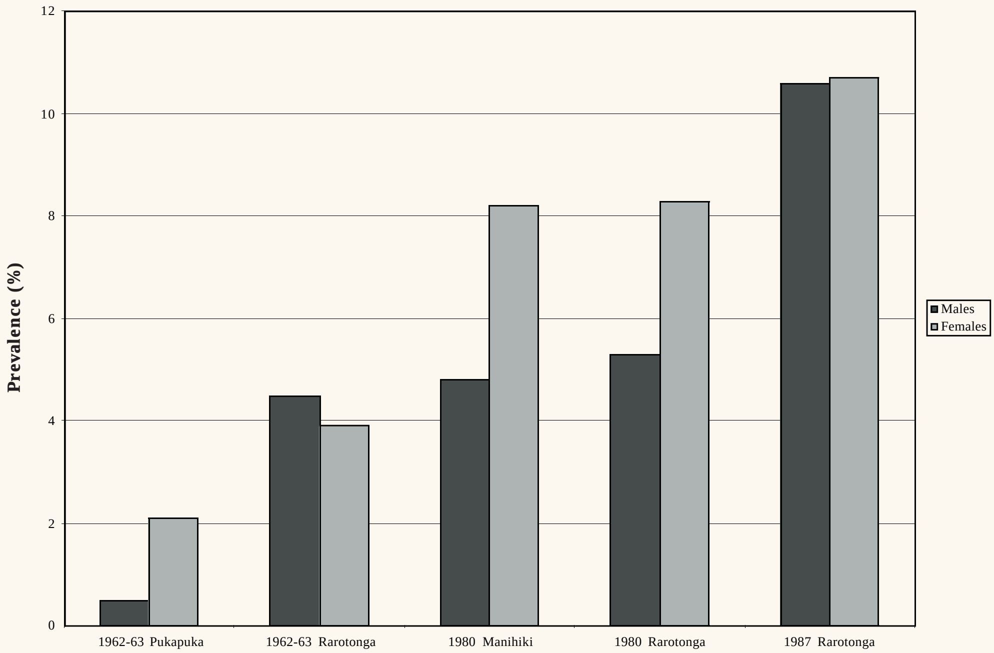


Figure 5.12: Prevalence of diabetes and IFG* in American Samoa, 1990

* IFG: Impaired Fasting Glycaemia

Cook Islands

In 1962–1963, Prior and co-workers (84,324) investigated the prevalence of diabetes in two communities in the Cook Islands. One group lived on the isolated coral atoll of Pukapuka, and had an overall prevalence of diabetes of 1.3%. A rate of 4.2% was found in the community on Rarotonga, the administrative and commercial centre of the country. In this survey, participants were tested for urinary glucose, and then a modified glucose tolerance test was performed on those with glycosuria. Abnormal glucose was considered if the two-hour OGTT was ≥ 130 mg/100 ml (7.2 mmol/l). Prevalence rates for males and females are provided in Figure 5.13 and are compared with subsequent surveys.



Sources: (198,200,324,325)

Figure 5.13: Prevalence of diabetes in Cook Island males and females, 1962–63, 1980 and 1987

Weinstein and co-workers (325) carried out a similar survey in 1980 on Manihiki Atoll. Although the island is geographically remote, islanders enjoyed a good income from the sale of copra and pearl shell. Most food was locally grown but was also supplemented with imported foodstuffs. The rates of diabetes for both males (4.8%) and for females (8.2%) were similar to rates reported for Rarotonga that same year (see Bennett survey below and Figure 5.13). The prevalence of IGT was significantly higher in females (31%) than in males (8%) and higher than in the Rarotongan population (data not shown). Obesity, lack of physical activity and consumption of imported foods were listed as possible explanations for the high rates of IGT and diabetes in this rather isolated atoll.

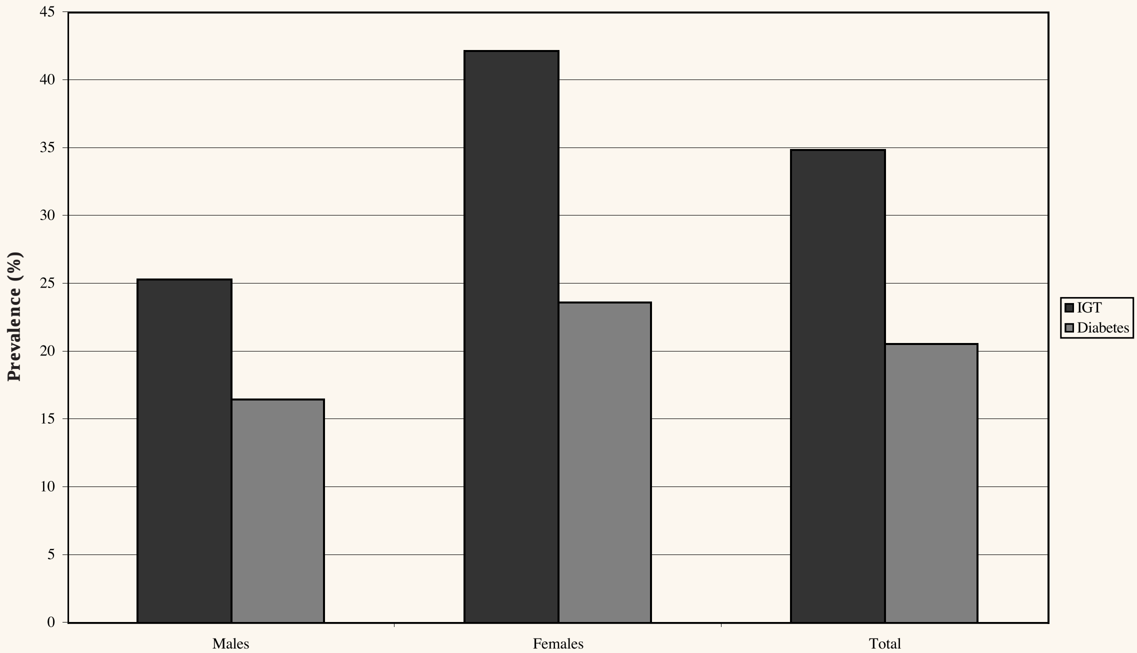
A larger survey was repeated in Rarotonga during that same year by Bennett and co-workers (198,326), when the rates of diabetes were found to be 5.3% in males and 8.3% in females (Figure 5.13). Impaired glucose tolerance was 10% in both genders.

Taylor and colleagues (200) conducted a follow-up survey in Rarotonga in 1987 and found a statistically significant increase in diabetes in males – from 5.3% in 1980 to 10.6% in 1987. The increase in rates among the females, 8.3% to 10.7%, was not statistically significant. The prevalence of IGT was also higher in 1987 compared with 1980, but statistically significant only for females. The 1980 and 1987 surveys employed similar methodologies: a two-hour plasma glucose level of ≥11.1 mmol/l (200 mg/dl) following a 75 g glucose load, or known diabetes.

French Polynesia

The prevalence of diabetes was assessed among adults 41 years of age or more in Tahiti in 1990 (327). A total of 452 persons were included, of whom 85% were Polynesian. The overall prevalence of diabetes was reported to be 4%. The investigator indicated that this rate was probably a significant underestimation of the true prevalence rate, most likely due to protocol and methodological problems with the survey.

A comprehensive survey of the prevalence of non-communicable diseases was carried out in six districts in French Polynesia in 1995 (19). There were 1273 individuals, 16 years of age or more included in the examinations, 82% of whom were Polynesian. The findings of the survey showed an overall age-adjusted prevalence of 17.7% for diabetes and 33.2% for IGT as seen in Figure 5.14. Females had markedly higher rates of both diabetes and IGT than males. There were no significant differences between rural and urban residents. These rates are approaching some of the highest in PICTs and are nearing those reported for Nauru, a population that is considered to have one of the highest diabetes prevalence rates in the world.



Source: (19)

Figure 5.14: Prevalence of impaired glucose tolerance and diabetes in French Polynesia, 1995

Niue

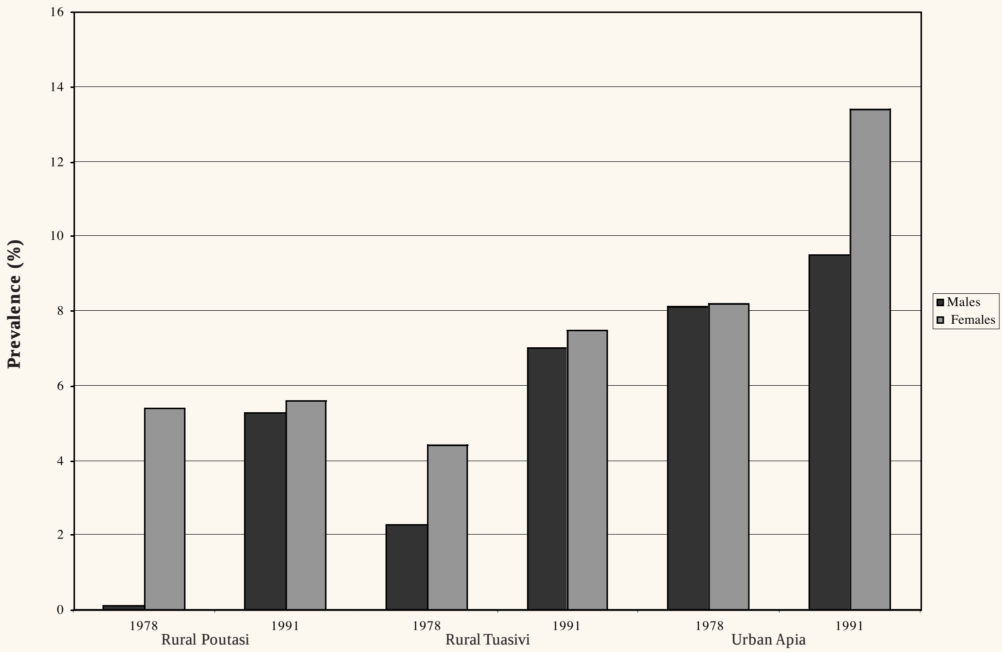
A 1980 cardiovascular disease and diabetes survey conducted by the SPC (198) included 1149 adults aged 20 years or older. The prevalence of IGT and diabetes was generally found to rise with age in both genders. The prevalence of age-adjusted diabetes was higher in women (8.7%) than in men (5.3%), but IGT was approximately the same in both genders (6.7% men; 6.6% women). In both genders the prevalence of diabetes increased with the degree of obesity, but this relationship was less marked for IGT.

The researchers conducting the Niue Women's Health Survey of 1983 (207) and the 1987 National Nutrition and Dietary Survey of Niue (89) did not include blood glucose levels in their examinations.

Samoa

Surveys of non-communicable diseases were conducted in Samoa in 1978 by the International Diabetes Institute (328) with a follow-up study in 1991 (329). The three areas included in the surveys were chosen to reflect varying degrees of urbanisation. Apia, on the island of Upolu, is the commercial and government centre of Samoa and reflects the most urbanised population. Poutasi, located about 30 minutes from Apia, is considered rural, yet there is easy access to Apia and to imported goods. Tuasivi, on the island of Savai'i, is considered the most rural, but ferry and air access to Apia has improved since 1978.

Figure 5.15 illustrates the dramatic increases in the prevalence of diabetes from the 1978 survey to the follow-up examinations in 1991. The greatest increases among the men were seen in the rural areas, whereas among the women the most dramatic increase occurred in the urban areas. Overall, the highest rates were found in the urban areas. These patterns also followed the trends of obesity with higher rates of obesity in urban compared with rural areas but the greatest increases occurring in the rural areas.



Source: (329)

Figure 5.15: Prevalence of diabetes in Samoan males and females by level of urbanisation, 1978 and 1991

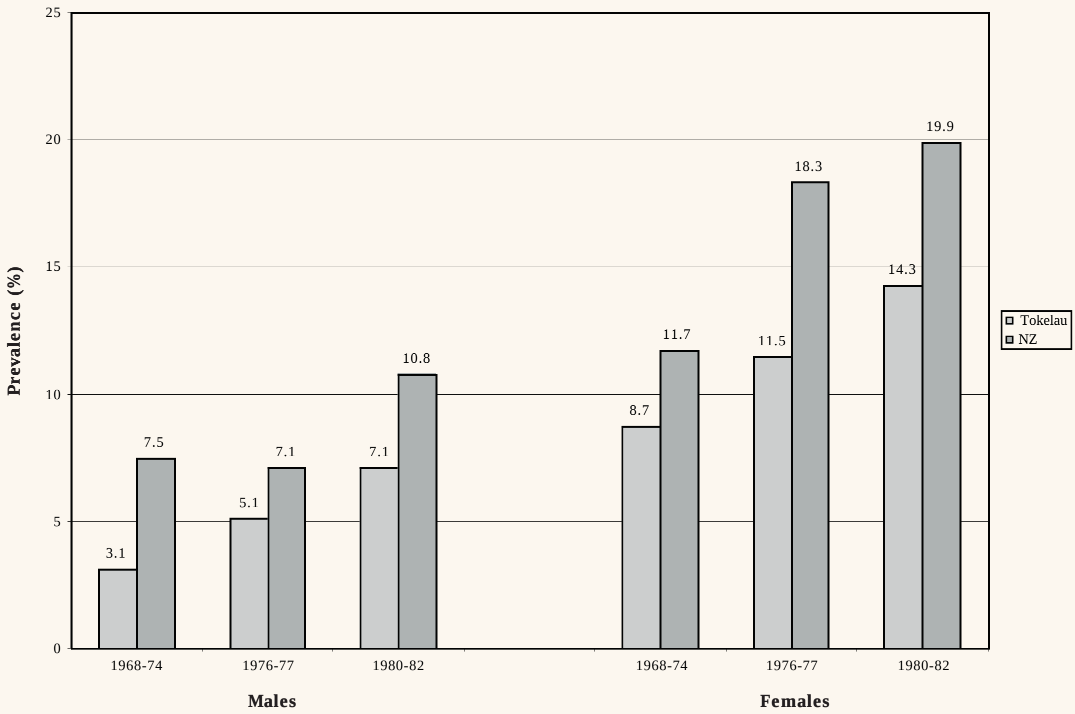
McGarvey (256) found lower rates of diabetes in examinations also in 1991 that were baseline values for a long-term study. The Samoa Cardiovascular Disease Risk Factor Study 1990–95 included Samoans in American Samoa and those in Samoa (256). Baseline data were collected in 1990 and 91 and a four-year follow-up examination was completed in 1994–95. Adults aged 25 to 55 years were included.

This survey found prevalence rates of diabetes of 3.3% for females and 2.6% for males. The much lower rates of diabetes in this survey may be due to the use of fasting blood glucose to identify diabetes. On the other hand, the International Diabetes Institute survey, also in 1991, used an oral two-hour post glucose load test to determine diabetes. There is some evidence that fasting blood glucose levels may underestimate diabetes prevalence in a population.

Tokelau

The Tokelau Island Migrant Study was a long-term research project designed to investigate the degree of change in disease patterns that would take place when Polynesians from the Tokelau Islands immigrated to New Zealand (208). The studies were carried out in three rounds of expeditions to the Tokelau Islands and three survey rounds in New Zealand. Round I was carried out in Tokelau, 1968–71 and in New Zealand, 1972–74. Round II was undertaken in 1976 in Tokelau and 1975–77 in New Zealand. Round III was conducted in 1982 in Tokelau and 1980–81 in New Zealand. A minimum of 82% of the total population was examined at each site and survey period. The assessment of diabetes was made based on a fasting plasma glucose level ≥13.9 mmol/l (250 mg/dl) following a one-hour load of 100 g of glucose. This methodology differs significantly from other studies conducted at this period of time.

The prevalence rates for diabetes for males and females at these three periods shown in Figure 5.16 illustrates several trends. Type 2 diabetes occurred more frequently in women than in men in both environments and the highest rates were found among women who have migrated to New Zealand. Diabetes prevalence rates rose consistently in both groups over time and the rates were consistently higher in New Zealand than in Tokelau.



Source: (330)

Figure 5.16: Prevalence of diabetes in male and female Tokelauans in three rounds of surveys in Tokelau and New Zealand

There were 38 new cases of diabetes in Tokelau and 46 new cases in New Zealand between 1968 and 1982 as seen in Table 5.6. The age-standardised incidence and relative risk of developing diabetes was higher among those who had migrated to New Zealand compared with those who had remained on their home island. This was significant for females but not for males.

Table 5.6: Incidence rates of diabetes in Tokelauans in Tokelau and New Zealand between 1968 and 1982

	Males		Females	
	Tokelau	New Zealand	Tokelau	New Zealand
Cases	14	20	24	26
Person Years at Risk	1608	1576	1758	1080
Incidence — New cases per 10,000 person years at risk	84.6	124.6	133.4	253.8
Relative Risk New Zealand vs Tokelau (95% CI)	1.5 (0.73; 3.04)		1.9 (1.01; 3.24)	

Source: (330)

Tonga

Prior and co-workers (331) in 1973 found little difference between prevalence rates of diabetes among urban Tongans (Nuku'alofa) and those living in traditional isolated villages (Foa). This survey revealed a prevalence of 5.5 and 9.7% in males and females respectively living in Nuku'alofa and 4.7% and 10.0% in males and females in rural Foa.

A plasma glucose level of ≥ 180 mg/dL (≥ 10.0 mmol/L) two hours following a 75-g glucose load was the diagnostic level for *definite* diabetes.

A survey of non-communicable disease and nutrition was conducted in 1992 and included approximately 1000 Tongan adults (214). Survey participants were interviewed about their personal medical history. The proportion of individuals who reported having diabetes was 0.8% in males and 2.3% among females. It is likely that these proportions are a significant underestimation of the true prevalence rates in the Kingdom, given the high rates of diabetes complications reported in Tonga.

In 1996, Palu and colleagues (332) reported diabetes complications in a sample of 146 patients attending the Diabetes Clinic in Tonga. Of note is the high number of females, and the high proportion of diabetes complications (see Table 5.7).

Tuvalu

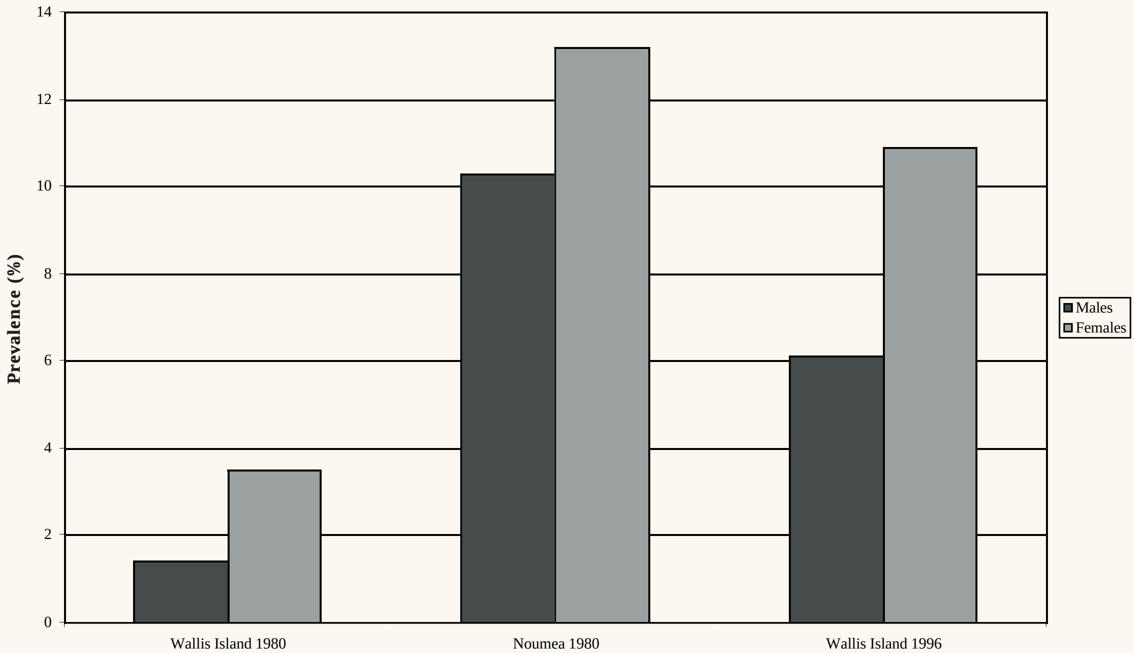
Zimmet and colleagues (333) carried out a diabetes survey among adolescents and adults in Tuvalu in 1976. The survey included 198 youths from 10 to 19 years of age and 526 adults ≥20 years. Among adults, the prevalence rates for diabetes and IGT were 3.4% and 13.6% respectively. But even among young people aged 10 to 19 years, the prevalence rates were 1.0% and 3% for diabetes and IGT respectively. The prevalence among women was five times higher than among men (334). It appeared that the greater BMI values in women accounted for some of the differences in diabetes prevalence between males and females.

It is conceivable that prevalence rates may be two to three times higher in 1999 than in 1976.

Wallis and Futuna

Taylor and co-workers (216) carried out an NCD survey of non-communicable diseases in 1980 among Polynesians residing on Wallis Island and Wallisians who had migrated to the city of Noumea, New Caledonia. The 305 females and 274 males residing in the Wallis Islands were recruited from randomly selected rural villages. The Wallisian men in Noumea (n=253) worked in the nickel factory and the women (n=311) came from communities where nickel factory workers were known to live.

Figure 5.17 compares rates of diabetes between Wallisians living in a traditional setting on Wallis Island and those living in urban Noumea. The differences in rates were highly statistically significant for both males and females (P<0.001). Wallisian females on Wallis had a higher rate of diabetes than males, but in Noumea, the rates for males and females were not significantly different.



Sources: (287,335)

Figure 5.17: Prevalence of diabetes among Wallisians living in Wallis Island or Noumea, 1980 and Wallis Island, 1996

In 1996, Bezannier and Tauvale (335) conducted health surveys in 10 villages in the Mua district of Wallis Island. The prevalence rates of diabetes increased by more than 300% from 1980 to 1996 for both males and females as seen in Figure 5.17. Females continued to experience higher rates than the males. These rates, however, were still below the 1980 rates for Wallisians living in Noumea. These data will need to be interpreted with caution because of the differing methodologies of the two surveys. The 1980 survey used venous blood glucose values ≥200 mmol/l obtained two hours following a 75-gram oral glucose load. In the 1996 survey the determination of diabetes was made using fasting capillary blood glucose levels of ≥8.2 mmol/l. We would therefore expect the 1996 figure to be an underestimate of the true rate of diabetes in this community. Given the recent WHO-recommended cutoff of ≥6.1 mmol/l for fasting capillary blood glucose level for the diagnosis of diabetes, the prevalence of diabetes on Wallis Island may be considerably higher than is estimated here.

Complications of Diabetes

In Pacific Island countries and territories there is scattered evidence regarding the very high prevalence of microvascular complications of diabetes. The prevalence of these complications is increasing in many PICTs, placing a heavy burden on health-care systems as well as on the quality of life of individuals. Diabetes is the major cause of blindness, renal failure and lower-limb amputations in the Pacific region (3).

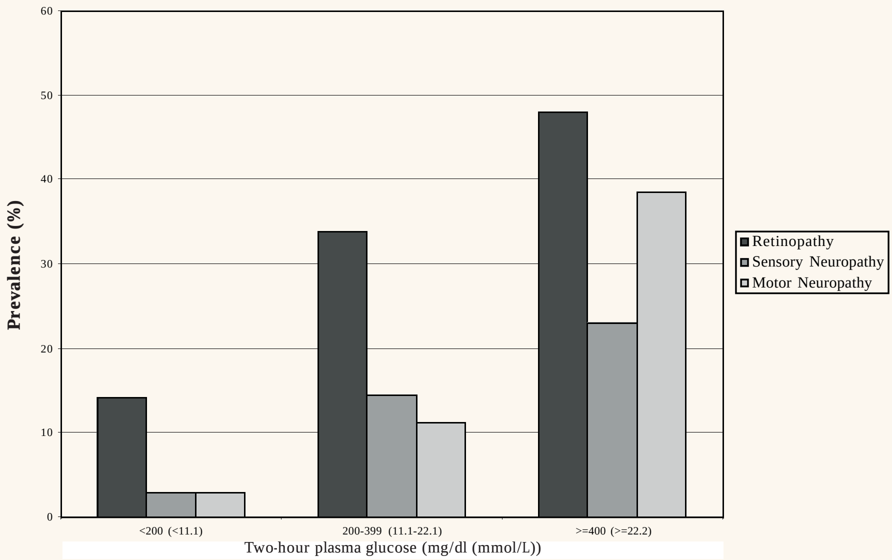
The complications associated with diabetes have been reported in various countries in the Pacific since the early 1960s. Many of these reports are based on reviews of clinic, hospital or medical records and not upon random samples of the populations. These reports could therefore be biased according to which people choose to seek clinic or hospital treatment.

Cassidy reported in 1967 (279) that 24.2% of Fijian diabetic patients had retinopathy and that 4.2% had evidence of diabetic renal disease. In Papua New Guinea, Savige (336) found that among 124 diabetic patients, 34% had significant proteinuria, 50% had signs of peripheral neuropathy, and retinopathy was present in 48%. In Tahiti in 1966, among 75 Maohi patients with diabetes, Aubry and Rignaud (337) found 29.3% with retinopathy and 32% with significant proteinuria.

In Papua New Guinea, complications of severe infections and gangrene occurred frequently among diabetic patients (338). Martin (339) examined medical records in four Papua New Guinea hospitals from 1974–1977 and found that among the diabetic patients, although atherosclerosis and retinopathy were rare, proteinuria was present in 36% of cases, severe neuropathy in 25%, and hypertension in 25%. Amputations were performed on the lower limbs of 28 out of the 127 diabetic patients reviewed.

Medical records were also examined of patients with diabetes in the Tolai villages of the Gazelle Peninsula in Papua New Guinea (336). The researchers reviewed admissions to the Base Hospital in Nonga for diabetes between 1965 and 1981 and St Mary's Hospital at Vunapope between 1974 and 1977. The recorded incidence of diabetes had risen from an average of six new diabetes cases per year in the late 1960s, to 24 in 1980. Review of the clinical findings and medical records of 124 Tolai diabetics revealed that microvascular complications were common, peripheral neuropathy, retinopathy and nephropathy were found in a third to a half of these patients.

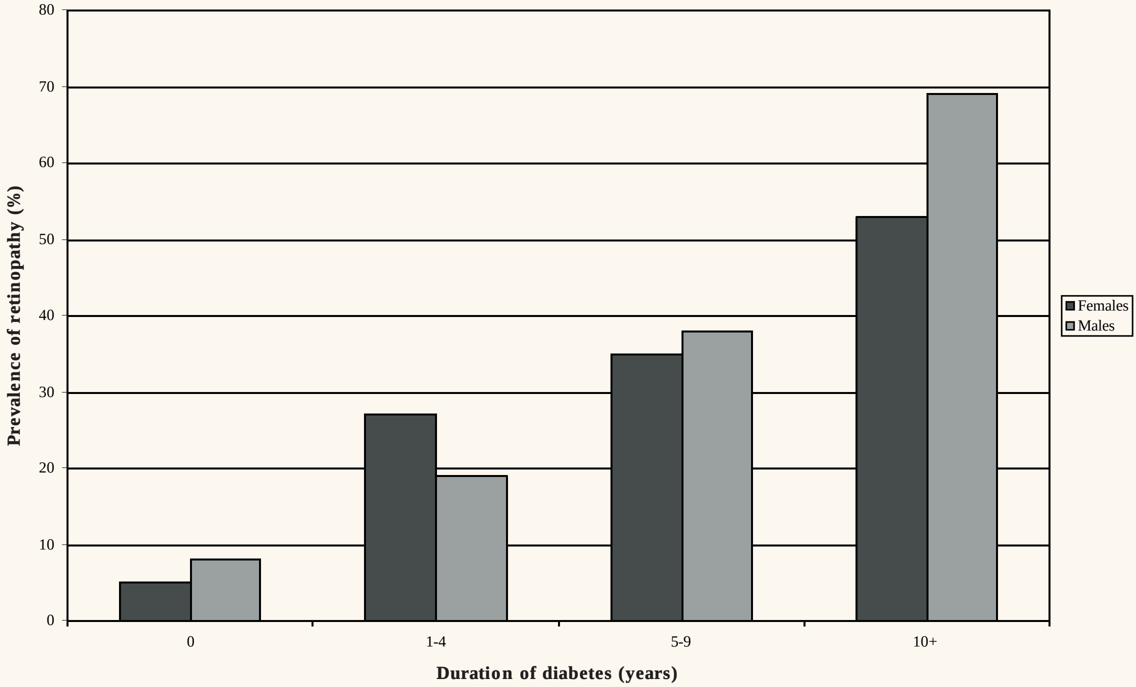
The prevalence of complications associated with diabetes is remarkably high in the Nauruan population. This country also reports one of the highest prevalence rates of diabetes in the Pacific region. In the first diabetes survey conducted in Nauru in 1975, 181 individuals with diabetes were examined for retinopathy and neuropathy (340). The prevalence of retinopathy and neuropathy rose dramatically when patients were divided into groups according to two-hour plasma glucose levels as illustrated in Figure 5.18. In diabetic patients with plasma blood glucose levels greater than 400 mg/dl (22.2 mmol/l), retinopathy was four times higher than among those with normal-range glucose levels, sensory neuropathy was eight times higher and motor neuropathy 12 times higher. The prevalence of these complications in those with blood glucose levels in the 200 to 399 mg/dl range was also many times higher than in diabetics whose blood glucose level was below 200 mg/dl. There were also dramatic increases in the rates of these complications with longer duration of the disease. In patients with diabetes for 14 years, the prevalence of retinopathy was 90% and of motor neuropathy was 73% (data not shown).



Source: (340)

Figure 5.18: Prevalence of microangiopathic complications according to plasma glucose concentrations, Nauru, 1975

Retinopathy was reported in 24% of the diabetic patients evaluated in the 1982 diabetes survey in Nauru (168). These prevalence rates were higher than in American Pima Indians, a group who also experience extremely high rates of diabetes. Retinopathy was strongly associated with duration of diabetes, with rates rising to 50% in patients with duration of diabetes of 10 years or more (341) as shown in Figure 5.19.



Source: (342)

Figure 5.19: The relationship between duration of diabetes and retinopathy, Nauru, 1982

Of the 1987 Nauru longitudinal survey population, 13% of both genders had elevated urinary albumen concentrations (≥300 µg/ml) and 66% of these individuals had diabetes (190). An additional 26% of men and 30% of women had microalbuminuria of 30 to 299 µg/ml – a level above normal but not detectable by conventional dipstick tests. These microalbuminuria levels are known to predict proteinuria and mortality in persons with diabetes (343).

The incidence of non-traumatic, lower extremity amputations was also higher among Nauruans than other populations. For the population as a whole, the incidence of amputation was 7.6 cases/1000 person years and 8.4 cases/1000 person years for the 1987-survey population (344). These rates are higher than the US rate of 6.0 per person years. Amputations were significantly associated with higher fasting blood glucose, longer duration of diabetes, higher plasma triglycerides and being male. Amputations were also associated with lower BMI, and lower blood pressure. The lower BMI among amputees is likely explained by weight loss in diagnosed diabetics and/or poor glycemic control. The association of lower blood pressure among amputees is more difficult to explain, but blood pressure has not been a consistent risk factor in other studies (345).

Since establishing High-Risk Diabetic Foot Clinics in Fiji Islands, amputation rates have decreased in Lautoka from 132 amputations in 1996 to 66 in 1998 (284).

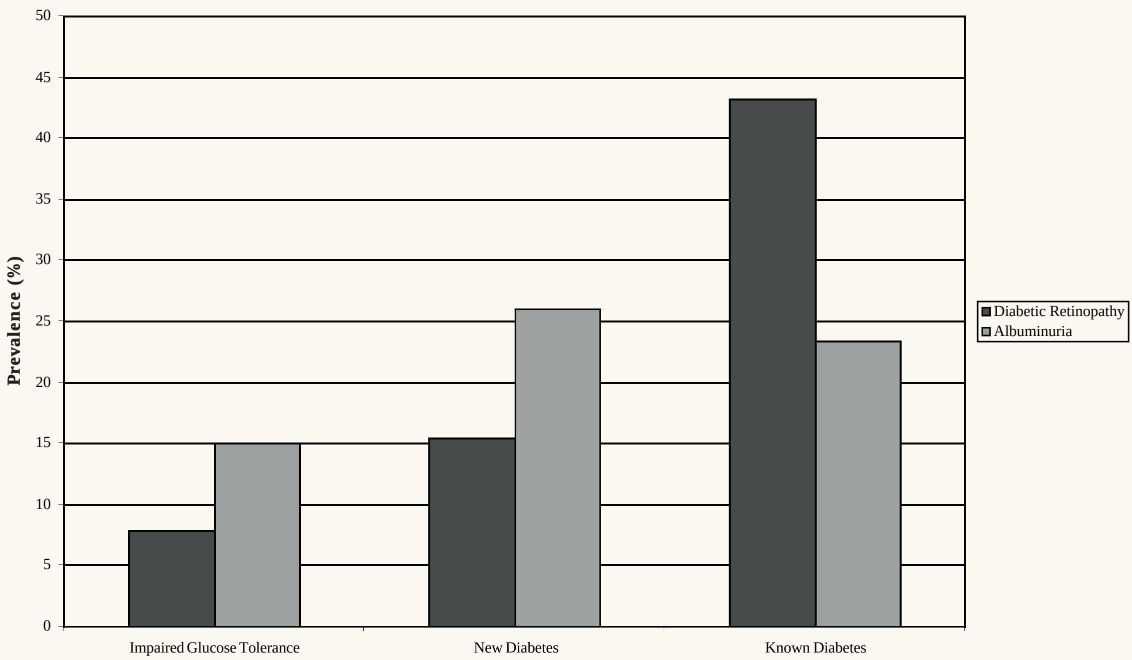
In 1996, diabetes-related amputation occurred in Fiji with a distressing frequency – 10 per week. (284)

In the Commonwealth of the Northern Marianas, a database review was conducted to determine the prevalence of complications among diabetics in the indigenous population (346). Of the 975 known indigenous patients with diabetes, 339 were screened for retinopathy. Among those patients, 70% had retinopathy (compared to 54% in U.S. diabetic patients) and 10% had proliferative (advanced) retinopathy. Over a three-year period, 26 patients had amputations of a lower extremity. This is a rate of 12.3 per 1000 diabetics (the U.S. rate is 8.3/1000). Half of all of the patients in CNMI on dialysis have kidney failure due to diabetes. The prevalence of diabetic patients on dialysis was 18.5 per 1000 diabetics. The same rate in the U.S. population in 1989 was 2.1/1000 diabetics indicating that four times more diabetic patients go on to dialysis in CNMI than in the United States.

> *More than 10% of the annual health care budget – over $3 million per year – is spent for diabetes care in the CNMI. Most of this is spent on treatment of complications (with over 1/3 spent on dialysis for diabetics with kidney failure* (346).

The 1980 diabetes survey in the Cook Islands included ophthalmic examinations (168). A total of 986 adults received eye examinations. The prevalence of diabetic retinopathy was 0.1% in persons with normal glucose tolerance, 2.1% in those with IGT and 8.2% in those with diabetes. Four cases of background retinopathy were found among 61 known diabetics, a prevalence of 15%.

Similar rates of diabetes complications were reported among Samoans in the 1991 diabetes survey (329). Retinopathy was assessed in 263 persons in the survey with Type 2 diabetes or IGT. Figure 5.20 reveals the marked increases in rates of retinopathy and albuminuria among new and known diabetics. High urinary albumin concentration (≥30 µg/ml), considered an early indicator of renal damage, was detected both in patients with IGT, and in patients with confirmed diabetes. Duration of diabetes and level of glycaemia were the strongest predictors of these complications.



Source: (329)

Figure 5.20: Prevalence of retinopathy and albuminuria according to diabetes status in Samoans, 1991

Gras and co-workers (347) reported on complications among 51 Type 2 diabetic patients monitored in the Diabetology Service of the Territorial Hospital Centre of Papeete, French Polynesia between July 1988 and December 1991. The study included 31 males and 20 females (sex ratio 1.5). The complications reported included:

- Nephropathy – 25% (7 renal insufficiency and 2 patients undergoing dialysis treatment)
- Retinopathy – 29%
- Neuropathy – 17%
- Hypertension – 55%
- Metabolic complications – 20%
- Lower limb complications – 32% (8 amputations)
- Infections – 53%

Each patient in the Papeete study with a duration of diabetes of 10 years or more suffered an average of two complications.

In 1992, Cordonnier et al. (348) reviewed data concerning the prevalence of diabetes in end-stage renal disease patients in France and in French overseas territories. The findings of this analysis revealed that while 6.9% of dialysis patients in mainland France were diabetic (80% were Type 2 diabetics), 33.7% of dialysis patients in Tahiti and 28.6% in New Caledonia were diabetic. The prevalence of Type 2 diabetes in the overseas territories was more than three times that in mainland France. It is also known that 93% of Type 2 diabetic patients in the overseas territories are non-Caucasian. The sex ratio of the overseas patients was 0.54 compared with 1.4 in the mainland Type 2 diabetic patients. It is clear from this analysis that there are many more Type 2 diabetic patients in dialysis centres in French overseas territories than in mainland centres in France. These patients are predominantly non-Caucasian and female.

End-stage renal disease was listed as the fifth leading cause of death in 1996 in the Marshall Islands (349).

Newland and associates (350) conducted a large opthalmological survey in Tonga in 1991. The prevalence rate for blindness was 0.25% which is half the 0.5% rate that is the goal of the WHO programme for the prevention of blindness (351). Cataracts were the major cause of monocular blindness (30%), bilateral blindness (68%) and low vision (83%). Diabetic retinopathy was responsible for 5% of blindness in one or both eyes and 3% of low vision. Of concern to the researchers was that diabetes was the factor most strongly associated with cataracts (adjusted odds ratio 4.28).

In 1996, Palu and colleagues (332) reported diabetes complications in a sample of 146 patients attending the Diabetes Clinic in Tonga. Table 5.7 provides the characteristics of the patients and the percentage with complications of diabetes. It is recognised that these data could be biased by those people who chose to attend the clinic, but the data provide a profile of the types of complications encountered among diabetic patients in Tonga.

Table 5.7: Characteristics and complications of diabetes clinic patients in Tonga, 1996

Number of patients	146
Mean age	58 years
Female	74%
Mean duration of diabetes	8.1 years
Mean BMI	31.9 kg/m^2
Per cent treated with diet alone	0.6
Per cent treated with oral medication	86.3
Per cent treated with insulin	10.3
Per cent taking antihypertensive medications	17.8
Complications	**Percentage with complications**
HBA_{1c} >2% above upper limit of normal	52
Cholesterol >5.5 mmol/l	40
Microalbuminuria	73
Retinopathy	32
Visual acuity 6/18 or worse	27
Blind	7
Peripheral Neuropathy	30
Foot Ulcer	8
Amputation	7

Source: (332)

These data support the conclusion that Pacific Islanders do indeed suffer from diabetes of a type that produces the major complications which have been widely reported in other high-risk groups and well-studied communities. The burden of this disease – especially the care and treatment of the complications such as retinopathy, nephropathy and cardiovascular disease – are enormous. The financial burden on health care systems and on nations' economies can be crudely measured and would be in the millions of dollars in most PICTs. The costs in terms of burden on the individual and on the community are more difficult to assess.

Discussion

Factors Contributing to the Prevalence of Diabetes Mellitus

Genetic factors

The remarkably high prevalence and incidence of obesity and Type 2 diabetes in many Pacific Island populations indicates an involvement of genetic determinants in addition to the influences of environmental and behavioural factors. There is much convincing evidence that genetic determinants play a major role in the aetiology of Type 2 diabetes in PICTs. The strong familial nature of diabetes has been demonstrated in Nauru (317) and Fiji Islands (352). Hoskins et al. (352) showed that a positive family history was a significant predictor of diabetes in both Fijians and Indo-Fijians when HBA_{1c} was the method of diagnosis. Family history was a significant predictor for diabetes in Indo-Fijians but not for Fijians when fasting blood glucose was employed.

Genetic admixture studies have shown increasing prevalence of diabetes with increasing proportions of Austronesian (AN) genetic influence. Micronesian and Polynesian groups, more recent migrants to the Pacific, may have more Austronesian (AN) admixture and may have higher rates of diabetes than the Non-Austronesian (NAN) Melanesians in Papua New Guinea, Solomon Islands and Vanuatu. These NAN groups may possess some protection from this disorder.

Different ethnic groups residing in the same country with marked differences in rates of disease add weight to the plausibility of genetic factors in the aetiology of diabetes. Indo-Fijians have remarkably higher rates of diabetes than Fijians, independent of whether they live in a rural or urban environment (280). Highlanders of Papua New Guinea (NAN) are virtually free of diabetes compared with neighbours (AN) from coastal areas (292). Polynesians in Noumea have higher rates than New Caledonian Melanesians living in the same urban area, with ostensibly similar lifestyles (286). Also in New Caledonia, rates of diabetes among Polynesians living in the Loyalty Islands were substantially higher than those among Melanesians living on the same island (285).

Even after controlling for obesity, the prevalence of diabetes among Nauruans is three times that of fellow Micronesians on Kiribati (353).

Thrifty Gene Hypothesis

An explanation relative to genetic influences, which has been proposed by Neel (354), is the thrifty genotype hypothesis. This proposal suggests that the diabetic genotype confers advantage for survival where a feast and famine situation exists. In traditional populations, those with the diabetic genotype may have been more efficient in the storage of energy at times of feast, and therefore better able to survive the famine brought on by droughts, cyclones or long canoe voyages. In present times, however, when exposed to the continual feast of an energy-dense food supply, coupled with a sedentary life style, the thrifty genotype becomes a disadvantage, resulting in obesity, hyperinsulinaemia, and insulin resistance and eventually to the development of Type 2 diabetes. It is hypothesised that this genotype would occur more frequently among Micronesians and Polynesians who have been more recent immigrants to the Pacific Islands (Austronesians) and exposed to cycles of feast and famine through long canoe voyages and periods of drought and cyclones. Highlanders of Papua New Guinea and other Non-Austronesians, much earlier migrants to the Pacific, have been successful agriculturists, living in a stable environment with a reliable climate for many thousands of years. These populations may not have experienced these feast and famine cycles and therefore had no need for the thrifty gene.

Thrifty Phenotype Hypothesis

Hales, Barker and colleagues (355–357) suggest that the emphasis on genetic factors is overstated and that environmental factors play the major role in determining susceptibility to disease. The researchers base their hypothesis on studies of birth records and infant growth of 468 men born between 1920 and 1930 in England.

They found that men born at low birth weight and who were in lower weight ranges at one year of age were more likely to have IGT and Type 2 diabetes than men of higher birth and one-year weights. Those men with diabetes or IGT had lower birth weights (227 g lighter) and weighed less at one year (450 g lighter) than men with normal glucose tolerance. Reduced infant growth was also associated with impaired pancreatic ß cell function and hypertension. The highest prevalence of Type 2 diabetes was found in adults who had low birth weight but were subsequently obese.

Studies among Pima Indians have suggested that both a low and a high birth weight confer added risk of renal disease (358). These researchers assessed elevated albuminuria in Pima Indians with Type 2 diabetes and found that those with a low birth weight had 2.3 times the risk of elevated albuminuria and those with high birth weights had 3.2 times the risk.

The investigators concluded that the higher prevalence of albuminuria in Pima Indians with low birth weight may be due to the effect of intrauterine growth retardation. For those with high birth weights it may be due to intrauterine diabetes exposure. Sixty-four per cent of those with high birth weight were borne of diabetic mothers.

Other researchers have replicated these associations between low birth weight and later disease in adults in Europe and the US (359–362). Animal studies have also confirmed that intrauterine nutrition clearly affects fetal growth and metabolic and cardiovascular function before birth and that these effects may persist after birth and even to subsequent generations (363).

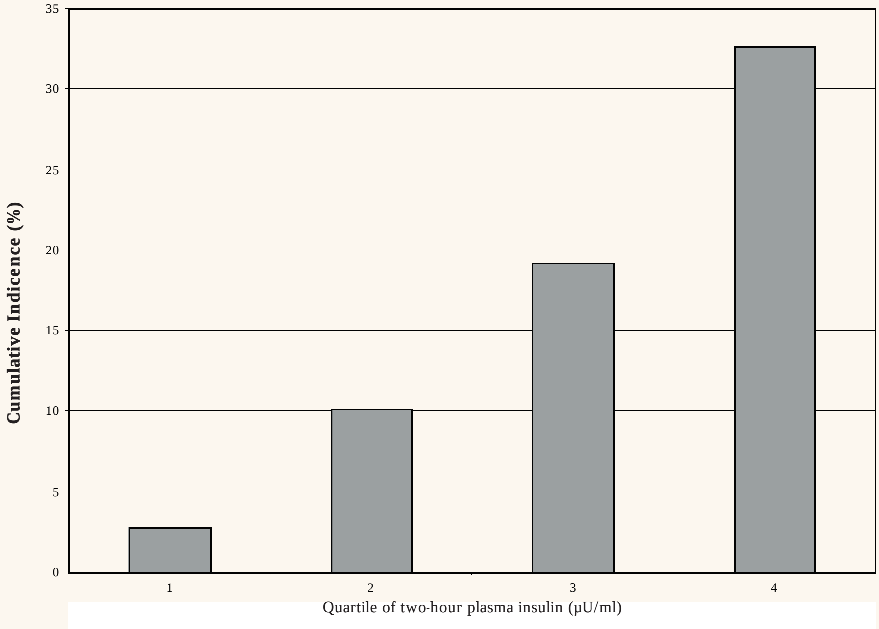
O'Dea (364) suggests that the concept of the *thrifty phenotype* may actually help to broaden the thrifty genotype hypothesis. It could explain the apparent paradox of co-existing high rates of infant and childhood malnutrition and obesity, Type 2 diabetes and cardiovascular disease in adults in PICTs.

Hattersley and Tooke (365) suggest that the predisposition to Type 2 diabetes and vascular disease is possibly the result of both genetic and fetal environmental factors. They propose that insulin resistance, which is genetically determined, could result in low insulin-mediated fetal growth in utero as well as insulin resistance in childhood and adulthood. Low birthweight, and adult measures of insulin resistance, glucose intolerance, diabetes and hypertension, would all be phenotypes of the same insulin-resistant genotype. This hypothesis is dependent on the concept that insulin-mediated fetal growth will be affected by fetal genetic factors – and that these factors regulate either fetal insulin secretion or the sensitivity of fetal tissues to the effects of insulin.

Age

The age of onset of Type 2 diabetes among Pacific Islanders is, in general, younger than in individuals of European descent (275). Onset in the 20- to 30-year age group is not uncommon in PICTs. In Nauru, 14% of 20 to 29 year olds were found to be diabetic and 17% had IGT. Of the 8 to 19 year age group, 0.6% had diabetes and 5.1% had IGT (366).

Similarly in Tuvalu, 1% and 3.5% of young people aged 10 to 19 years had diabetes and IGT respectively (366). Data from adolescents and young adults in Nauru and Tuvalu showed that plasma insulin concentrations were already similar to those of adults and possibly higher when adjusted for the effect of obesity. More importantly, increased plasma insulin levels, in the presence of normal glucose tolerance, may be predictive of later development of abnormal glucose tolerance in younger people. Figure 5.21 shows the cumulative incidence of IGT and diabetes combined in adolescents and young Nauruans, by quartile of their baseline plasma insulin level, who had normal blood glucose levels at baseline. These higher insulin levels may be indicative of insulin resistance.



Source: (366)

Figure 5.21: Cumulative incidence of IGT and diabetes in Nauruans aged 8-29 years according to quartiles of two-hour plasma insulin (μU/ml), 1976–82 (Persons with normal glucose levels at baseline)

Gender

There does not appear to be any consistent preference for gender in the frequency of diabetes in most PICTs. Much of the difference in sex ratio can be explained by the gender differences in obesity and/or physical activity.

Environmental and Lifestyle-related Risk Factors

There is much epidemiological evidence to show that environmental factors have a substantial influence on the development of Type 2 diabetes in PICTs. Some of this evidence can be cited. First, diabetes develops at different rates when groups of people move to different environments, such as from a rural, traditional to an urban setting. Secondly, there are dramatic increases in prevalence and incidence of diabetes over a relatively short period of time, more rapidly than could be explained only by genetic factors. Thirdly, the development of diabetes within countries is often strongly associated with such environmental factors as obesity, dietary intake, physical activity, and degree of acculturation. Several of these behavioural and lifestyle-related factors are discussed below.

Obesity

There is abundant evidence that obesity is an important risk factor for Type 2 diabetes in PICTs. The nature of this relationship, however, is complex and controversial. In reviewing diabetes surveys conducted in the Pacific, we need to be aware of a number of factors that complicate this issue. We know that not all obese persons become diabetic and many non-obese individuals develop diabetes. The point in time in which obesity is measured is a complicating factor. Diabetes itself can cause weight loss and, upon diagnosis, patients are encouraged to lose weight. The age at onset of obesity, the duration of obesity, and, very importantly, the distribution of body fat are other important considerations. These issues are further complicated by factors which undoubtedly interact or influence obesity, such as genetic predisposition, levels of physical activity, and intrauterine and/or early childhood growth patterns.

King and colleagues (367) compared risk factors for diabetes between individuals who participated in NCD surveys: Fijians and Indo-Fijians in 1980 and I-Kiribati in 1981. Correlation analyses as well as multiple logistic regression models were used to determine the effect of BMI, physical activity and place of residence on diabetes prevalence in males and females in these ethnic groups. Physical activity was assessed by local health staff on the basis of regular or occupational activity. Values from 1 through 4 corresponded to sedentary, light, moderate or heavy activity. The associations were inconsistent between these ethnic groups and between genders within the groups. Table 5.8 indicates the strength of the associations with these risk factors within these gender and ethnic groups.

Table 5.8: Association between risk factors for diabetes within gender and ethnic groups

(Results of forward selection logistic regression analyses)

	Body Mass Index	Physical Activity	Urbanisation
Fijian males		**	*
Fijian females		*	**
Indo-Fijian males		**	
Indo-Fijian females	***		
Micronesian males	***	*	***
Micronesian females	***	***	***

* $P < 0.05$; ** $p < 0.01$; ***$p < 0.001$
Source: (367)

This analysis highlights the differences in risk factors between the groups and between the genders within the groups. Overweight was strongly associated with diabetes risk among female Indo-Fijians and among both male and female Micronesians. Physical activity was an important risk factor among all groups except female Indo-Fijians. Level of urbanisation was important for Fijians and Micronesians, but not for Indo-Fijians. It is likely that dietary factors are involved here. A dietary survey conducted at about this time indicated that urban and rural Fijians and Micronesians had markedly different food habits. Indo-Fijians, however, maintained similar dietary patterns whether urban or rural dwellers.

The same researchers (353) compared the I-Kiribati Betio (urban) residents examined in 1981 with Nauruans surveyed in 1982. Since all the Nauruans were reported as physically inactive, only those I-Kiribati who were physically inactive were included in this analysis. Using a multiple logistic regression model, ethnicity (being Nauruan) proved to be a stronger predictor of risk of diabetes than BMI. This analysis suggests that obesity is not sufficient to explain the high prevalence of diabetes among Nauruans and provides further support for an increased genetic susceptibility in this Micronesian population.

Hoskins et al. (283), however, showed that in Fiji, when fasting blood glucose was used to classify diabetes, BMI was a significant predictor of diabetes in both Fijians and Indo-Fijians. The prevalence of diabetes increased steadily with increasing BMI in Indo-Fijians.

Dietary Change

Changes in dietary patterns have been implicated as important influences on the progression of Type 2 diabetes in the Pacific (48,368–370). Many studies have highlighted the differences in food habits between traditional-living islanders and those who have become more modernised or urbanised.

- Traditional eating patterns of inland and highland people of volcanic islands in general tend to be high in complex carbohydrate and fibre, particularly from root vegetables, low to moderate in protein and energy; very low in fat, salt and sugar but considered adequate in vitamins and minerals.

- On atoll islands and in most coastal communities, fish and coconuts feature predominantly in the eating patterns. The traditional diet was relatively high in protein and total fat, moderate in energy, carbohydrate and fibre, low in cholesterol, sugar and salt.

- The urbanised diet tends to be energy dense – high in fat, especially saturated fat; high in refined carbohydrates; low in fibre; and lacking in fruits and vegetables.

To date, however, no specific dietary components have been identified that are directly associated with the aetiology of diabetes. It is possible that the ability to measure nutrient intake lacks accuracy. It is also possible that the nutrients which may influence the development of diabetes have not yet been measured, i.e. phytochemicals such as carotenoids (371) or micronutrients such as chromium (372), selenium or zinc. The glycaemic index of foods has also been implicated in the aetiology of diabetes (373).

It is more likely, however, that it is the change in the overall composition of the eating pattern, that is a crucial factor in the development of obesity and diabetes. Because of the interaction of nutrients – which suggest an effect – it is difficult to isolate one component or nutrient as causative. Also, nutrient intake is most assuredly balanced with levels of physical activity and it is likely that at this time we are not able to separate the interaction of these two important risk factors.

There are numerous examples of differences in dietary patterns and nutrient intake between groups with high and low diabetes prevalence. In Fiji, for instance, while the way of life of Fijian and Indo-Fijian groups varies considerably, diet is probably the most important variable among the environmental factors. The rural Fijian diet continues to consist of cassava, taro and yams, with seafood providing a major source of protein. As Fijians become urbanised however, this pattern changes to a greater reliance on imported, refined, processed food. The Indo-Fijians have retained the custom of a diet of white rice, roti and chapatis made of coarsely milled flour, and highly spiced dishes. This eating pattern is maintained in both rural and urban settings (368).

One important difference is the fibre content. The Indo-Fijian dietary pattern derives 59 per cent of energy from cereals, which are basically refined white rice and milled flour. The rural Fijian eating pattern on the other hand, derives 54 per cent of energy from root crops. Sorokin (374) calculated the fibre content of the rural Fijian diet at 10.9 grams, whereas the Indo-Fijian diet contained only 4.2 grams of fibre. Both groups consumed similar quantities of sugar. Recent evidence suggests, however, that availability and consumption of root vegetables by Fijians has decreased dramatically over the past 20 years (25,375).

A dietary survey was conducted in 1977 in the rural village of Kalo, and in a relatively affluent suburb of Port Moresby, by Martin and co-workers (48), as part of a diabetes epidemiology survey.

> *The village people ate a diet in which yams, cassava and bananas were most commonly consumed with very little refined food; in contrast, the urban population ate a largely western diet in which bread, polished rice and tinned foods were most common.* (48)

Estimates of the energy intake were approximately 2300 kilocalories (9.6 MJ) for urban Port Moresby residents, and 1400 (5.9 MJ) calories for rural people. The diets were not analysed for other nutrients. The Port Moresby subjects had a significantly higher prevalence of diabetes, and higher BMIs than the rural villagers (48).

The first dietary survey conducted in Nauru in 1976 revealed an extremely high mean energy intake of the total population – 6092 kilocalories (25.5 MJ). This was more than twice the amount recommended in WHO Interim Standards for developing Western Pacific countries (79). The intake for males between 20 to 39 years was 8769 kilocalories (36.7 MJ). This is more than three times the recommended dietary intake for Australian males (72).

King and co-workers (353) compared the diets of physically inactive urban residents in Kiribati who were examined in 1981 with Nauruans who were surveyed in 1982. Dietary intake was determined from 24-hour recall interviews. The analysis indicated that the mean levels of total energy, carbohydrate, and fat were markedly higher in Nauruans than I-Kiribati, and fibre intake was lower. Multiple logistic regression analyses of these factors showed that after controlling for age, only dietary fat had significant predictive power, and this was only in females. None of the dietary variables were predictive of diabetes among males.

Hodge and co-workers (369) conducted cross-sectional and longitudinal assessment of dietary intakes of Nauruan adults. Twenty-four-hour dietary recall records were collected from 423 adults who participated in the 1982 survey and from 177 of those same adults in a follow-up survey in 1987. The cross-sectional data from the 1982 survey showed that Nauruans consumed 115% to 130% of the recommended energy intake for Australians (RIA) (369). They also consumed twice the protein and sugar, and the men consumed three times the alcohol as recommended. Dietary fibre was a third of the RIA. Even though there were no direct effects between this dietary pattern and incidence rates of diabetes, this unhealthy diet undoubtedly contributes to the higher rates of obesity among Nauruans and thus to the increased risk of diabetes and other non-communicable diseases.

In the Nauru longitudinal study (369), there were no significant differences in mean nutrient intakes between diabetics and non-diabetics over a five-year period. This may have been due to the small numbers of diabetic cases – only seven in this period. When nutrient intakes were adjusted for energy intake, age and BMI, the mean intake of total fat, total carbohydrates, alcohol, sugar and monounsaturated fat were slightly higher in the seven diabetic cases than in those who remained non-diabetic. Intakes of protein, fibre and cholesterol were lower.

There was no consistent relationship between alcohol intake and fasting or two-hour glucose levels in three Pacific Island groups at high risk for Type 2 diabetes. Hodge and co-workers (376) found no association of alcohol intake with the prevalence and incidence of diabetes and IGT among adults surveyed in Nauru (1982 and 1987), Kiribati (1982) or Mauritius (1987). Alcohol consumption was, however, related to increases in systolic blood pressure, triglycerides, uric acid and high-density lipoprotein (HDL) cholesterol and reduced two-hour insulin – parameters associated with cardiovascular disease and diabetes.

Current dietary patterns in PICTs are markedly different from the traditional pattern of fresh fish, coconut and pandanus. With increased wealth and westernisation, tinned meats and fish, white rice and sugar are rapidly replacing the traditional diet which is higher in fibre and lower in animal fats.

Physical Activity

Results of assessment of physical activity levels in PICTs provide evidence that the differing levels of exercise between rural and urban lifestyles significantly affect the degree of obesity and non-communicable disease. When energy intake reflects energy expenditure, weight-balance is assumed. The more physically active a person becomes, the more food is likely to be consumed to maintain the balance.

Physical inactivity was sited as an independent risk factor for diabetes among Fijian and Indo-Fijian men in a 1980 survey reported by Taylor and co-workers (377). The prevalence of diabetes was more than twice as high in men classified as sedentary or undertaking light activity when compared with men judged to perform moderate or heavy exercise. The difference was seen in both ethnic groups and remained after controlling for age, obesity and urban/rural lifestyles.

Ringrose et al. also reported (378) that rural Fijians had a higher energy intake than either urban Fijians or rural or urban Indo-Fijians. This suggests that higher levels of physical activity or genetic differences may be important and override other environmental influences between these groups.

Several large prospective studies have shown that physical activity acts to protect against the development of Type 2 diabetes. Studies in the United States (379), Sweden (380), and China (381) provide convincing evidence that increased physical activity or diet-and-exercise intervention programmes are able to reduce the risk of developing diabetes in high-risk individuals.

Modernisation, Urbanisation, Westernisation

Most studies in the Pacific show that Type 2 diabetes is more prevalent in urban areas than in rural communities. NCD surveys in Fiji, Papua New Guinea, New Caledonia, Solomon Islands, Vanuatu, Guam, Cook Islands, Samoa, and Wallis Island show rates of diabetes to be two to four times higher in urban settings compared with traditional environments. A few exceptions to this have been found. Hoskins and co-workers (352) in Fiji found no rural/ urban differences in a 1983 survey. It has been suggested that the rural villages selected for that survey were actually close to urban centres or had easy access to modern goods and services. In French Polynesia, little difference was noted in prevalence rates between rural and urban communities. It was suggested that the lack of difference is most likely due to similarities in dietary habits and perhaps other lifestyle behaviours.

However, marked differences have been noted in diabetes rates between most urban and rural populations in the Pacific. These may be attributed to several factors. The dietary intake in urban areas is substantially higher in energy, saturated fat, total fat, refined carbohydrate, and alcohol and considerably lower in complex carbohydrates and fibre. Fatty meats replace fish; rice and bread replace taro, yams and sweet potatoes; French fries and chips replace bananas, mangoes and pawpaw; and Coca Cola and other sugar-based drinks replace coconut water. In the cities, occupations are sedentary compared with physically active in the rural, agricultural setting.

There are synergistic effects of living in urban environments. An energy-dense diet, physical inactivity, alcohol and tobacco use, combined with stress and overcrowding, all merge to have an influence far greater than the sum of the individual components. The combined effects of lifestyle and environmental factors resulting in higher rates of obesity, are major determinants of diabetes risk among both urban and rural residents in the Pacific.

Hypertension

It has been hypothesised that hyperinsulinaemia (or insulin resistance), that is often associated with obesity and glucose intolerance, may also be involved in the pathogenesis of hypertension. Although these conditions tend to occur in the same patient, various studies have provided conflicting evidence of these associations (188,382,383).

Collins and colleagues (188) found an inconsistent and weak association between two-hour (post 75 g glucose) insulin levels and blood pressure among three Pacific Island groups: Micronesians of Nauru, Polynesians of Samoa and Melanesians of New Caledonia. These findings do not strongly support the hypothesis that insulin is a major determinant of blood pressure and that it is possibly the pathophysiologic link between obesity, diabetes and hypertension.

Gestational Diabetes

Several studies (384–386) have reported that women with IGT during pregnancy are at higher risk of developing diabetes than women with normal glucose tolerance. Approximately 30 to 50% of women with a history of gestational diabetes subsequently develop Type 2 diabetes within 5 to 10 years (275).

A study conducted among Pima Indian women compared the incidence of diabetes among women whose IGT was first detected during pregnancy and those who were not pregnant when IGT was first recognised (387). Those women who were not pregnant when IGT was first detected were at higher risk of developing diabetes than those who were pregnant when impaired glucose tolerance was determined. This suggests that women with IGT during pregnancy are at lower risk than non-pregnant women with similar plasma glucose concentration, who are likely to remain unrecognised.

There are no data regarding the association between gestational diabetes and subsequent development of diabetes among Pacific Island women.

Parity

There is little evidence in the Pacific that parity is associated with increased risk of diabetes. Collins and colleagues (388) investigated the relationship of certain risk factors with diabetes in Fiji, Nauru, Kiribati and the Mauritius. They showed that there is little independent association between parity and the development of abnormal glucose tolerance in these populations.

Sicree and co-workers (389) also found no association between parity and diabetes prevalence among five Pacific populations.

Conclusions

> *The complex interrelationship between dietary intake, obesity and energy expenditure, all of which are implicated to one degree or another in the pathogenesis of NIDDM (Type 2 diabetes), certainly suggests that there may be more than a casual role of diet in the pathogenesis of the disease. More extensive prospective studies in which all three of these related variables (diet, physical activity, and obesity) are adequately measured, and taken into account in the analysis, will be necessary to assess their relative importance to the development of NIDDM.* (275)

CHAPTER 6: Obesity

Summary

- Overweight and obesity are major epidemics in much of the modern world today (390,391).
- The prevalence of obesity is increasing dramatically in many PICTs and is reaching alarming levels in several countries.
- Rates of overweight and obesity combined are over 50% in at least ten PICTs. These PICTs also tend to be the most economically developed.
- Rates for overweight and obesity combined as high as 75% have been reported in Nauru, Samoa, American Samoa, Cook Islands, Tonga and French Polynesia.
- The still-evolving epidemic of obesity in the Pacific is characterised by increasing urbanisation and the consumption of high-fat foods that require little physical activity to acquire.
- The early trends indicate that women become obese earlier than men, but now the rates for men are slowly becoming as high as those for women.
- Obesity is more prevalent in urban areas, but recently urban/rural differences have been diminishing.
- Overweight and obesity are closely associated with increased risk of hypertension, cardiovascular disease and diabetes.
- It appears that weight gain occurs early in adulthood, between 20 and 45 years of age. The apparent lower BMIs of older population groups may reflect cohorts of less-obese survivors rather than a trend to lose weight with age.
- There is also cause for concern that obesity is starting in infancy or early childhood.

Table 1 in Appendix 4 provides the mean Body Mass Index (BMI) and prevalence of overweight and obesity for females and males by age group and, if available, by level of urbanisation, for most Pacific Island countries and territories. Figures 6.1 and 6.2 illustrate the prevalence of overweight and obesity for females and males in most PICTs. Comparison data for Australia (392) and the USA (393) are also included (120).

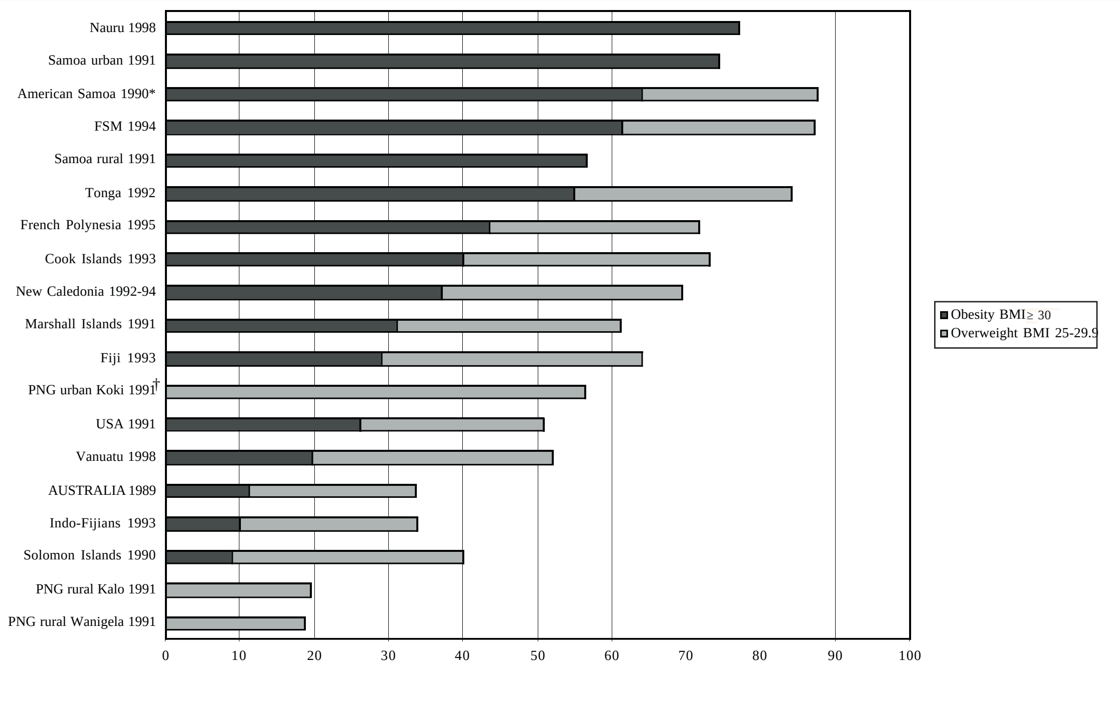
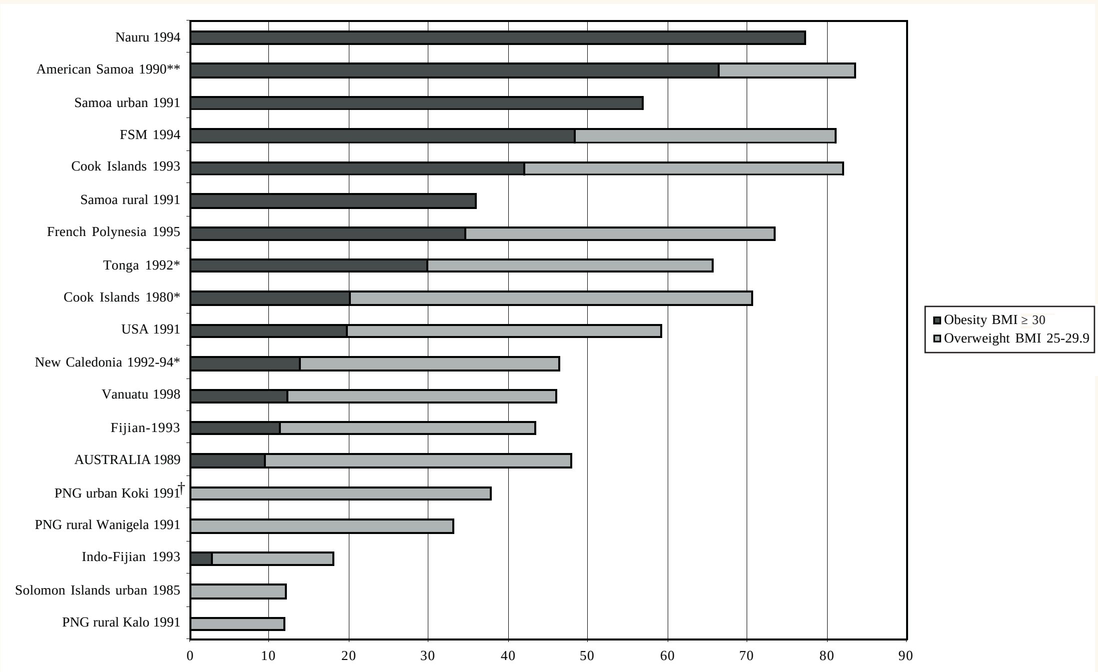


Figure 6.1: Prevalence of overweight and obesity in Pacific Island countries and territories, FEMALES



* Cook Islands 1980; New Caledonia; Tonga: Overweight BMI 27-32; Obesity ≥32
** American Samoa: Overweight BMI 27.8-31.0; Obesity BMI≥31.1
† PNP Urban Koki: overweight and obese

Figure 6.2: Prevalence of overweight and obesity in Pacific Island countries and territories, MALES

Obesity is a recognised key risk factor for diabetes, cardiovascular disease, hypertension, and other non-communicable diseases (NCDs). For women, the risk of developing Type 2 diabetes increases proportionately with greater BMI and women who gain 8.0 to 10.9 kilograms are 2.7 times more at risk compared with those of stable weight (394). Associations between obesity and morbidity and/or mortality are influenced by age of onset of obesity, duration of obesity, threshold levels of obesity, rates of change in weight and distribution of body fat. Abdominal visceral body fat deposition conveys a greater risk than peripheral or subcutaneous fat distribution (4).

Genetic differences in body composition and body fat distribution could also be responsible for differing susceptibility to NCDs among different island groups. Other factors such as hormonal influences, physical activity and alcohol may influence body composition as well. Future research will help to determine if differences in body composition and fat distribution are factors in risk levels for NCDs among peoples of the Pacific.

Assessment of Obesity

The criteria used to classify obesity have varied over the past 40 years. Most early surveys and studies conducted by the SPC in the 1960s and 70s used per cent of *ideal* body weight based on the Metropolitan Life Tables (395) to classify obesity. The *desirable* or *ideal* (or *standard*) weight for height was that of insured persons with the longest lifespan. In general, 120–139% of *ideal* or *standard* body weight was considered overweight (396) or 'moderately' obese and 140% or greater of *ideal* body weight was classified as obese or 'severely' overweight (397). These commonly used criteria were associated with increased health risks.

During the 1970s, Quetelet's rule or ***Body Mass Index (BMI)*** was adopted as an appropriate approximation of excess weight or underweight in population studies. It is calculated as follows:

$$\text{Body Mass Index} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

The levels of BMI that were proposed for defining overweight and obesity in early Pacific Island studies conducted by the SPC and others roughly corresponded to the Metropolitan Life 'Ideal' Body Weight Tables (396) as described in Table 6.1.

Table 6.1: Relationship of Body Mass Index (BMI) to per cent 'ideal' body weight

	'Ideal' Body Weight (%)	BMI	
		Males	Females
Overweight (moderate obesity)	120 to 139%	27 to 31	25 to 30
Obesity (marked obesity)	≥ 140%	≥ 32	≥ 30

More recent recommendations (398,399) have established the following classification for overweight and obesity by BMI and waist circumference as noted in Table 6.2. Overweight and obese persons are considered at risk for developing associated morbidities or diseases such as hypertension, high blood cholesterol, Type 2 diabetes, coronary heart disease and other diseases (400).

Table 6.2: Classification of overweight and obesity by Body Mass Index (BMI), waist circumference and associated disease risk

	BMI kg/m²	Obesity class	Disease risk* relative to normal weight and waist circumference	
			Men ≤102 cm Women ≤88cm	Men >102 cm Women >88cm
Underweight	<18.5		Low (but risk of other clinical problems increased)	Low (but risk of other clinical problems increased)
Normal weight †	18.5 – 24.9		--	--
Overweight	25.0 – 29.9		Increased	High
Obesity	30.0 – 34.9	Class I	High	Very High
	35.0 – 39.9	Class II	Very High	Very High
	≥ 40	Class III	Extremely High	Extremely High

* Disease risk for type 2 diabetes, hypertension and CVD
† Increased waist circumference can also be a marker for increased risk even in persons of normal weight.
Source: (400)

Waist circumference is a simple and convenient measurement that closely correlates with BMI and is unrelated to height (120). It is a recognised indicator of intra-abdominal fat and total body fat (401). Increase in waist circumference is also indicative of increased risk for cardiovascular and other chronic diseases (402,403).

Other measurement tools that are used to assess obesity and body composition include waist-hip ratio, skinfold thickness, bioelectrical impedance, underwater weighing, dual-energy X-ray absorptiometry (DEXA), isotope dilution, ultrasound, magnetic resonance imaging and doubly labelled water isotopes. These measurement techniques are important in determining if there are ethnic differences in body composition, and if these variations reflect differences in the risk of chronic, non-communicable diseases.

Numerous surveys and studies related to changes in BMI and prevalence rates of overweight and obesity have been conducted over the past four decades. These are discussed below for PICTs and are presented in chronological order. The most current prevalence rates of obesity and overweight are also reviewed. The BMI data and prevalence rates are provided in Table 1, Appendix 4.

Comparison of the surveys and studies carried out in the Pacific over the past 20 to 40 years will need to be interpreted with caution. The various surveys and reports were conducted at different time periods, may have used different age groupings, and may have employed different criteria and cut-off levels for overweight and obesity. In the following discussion, where possible those differences are noted. For the majority of studies, overweight is classified as BMI ≥25 and obesity as BMI ≥30 unless otherwise indicated.

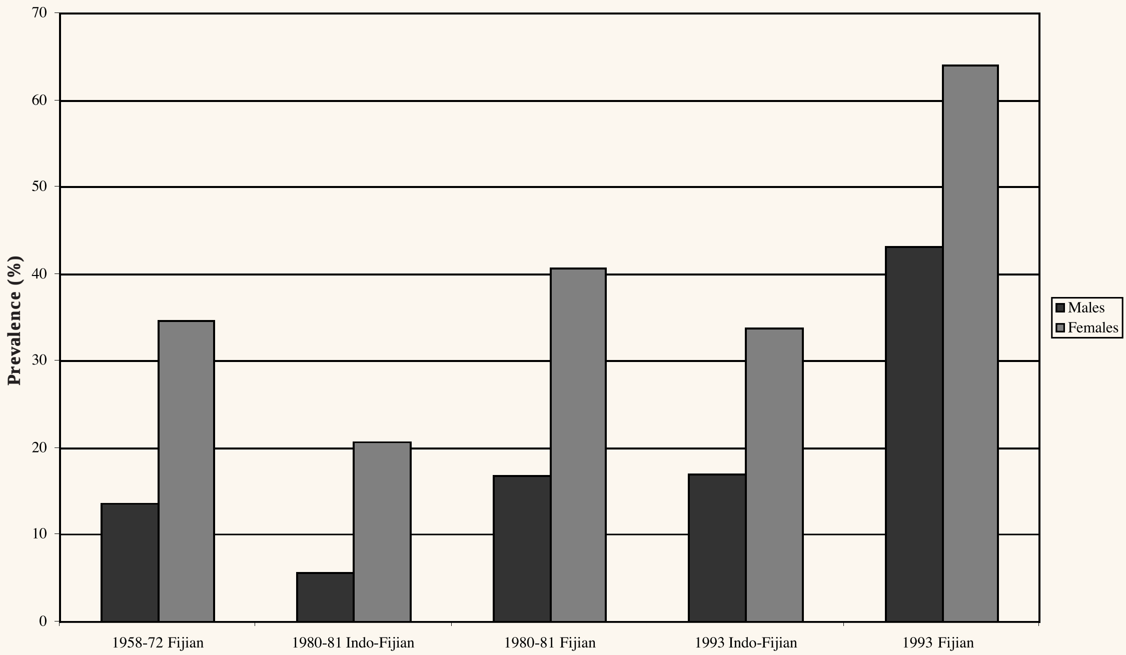
Melanesia

Fiji Islands

Summary

- There have been striking increases in mean Body Mass Index and the prevalence of overweight and obesity among Fijian and Indo-Fijian males and females between 1958 and 1993.
- Fijian women have the highest rates of overweight/obesity, followed by Fijian men.
- Indo-Fijian women also have higher rates of overweight/obesity than Indo-Fijian males.

Between 1958 and 1972 senior students of the Fiji School of Medicine carried out nutrition surveys in coastal and inland villages in Fiji Islands (404,405). The results of height and weight measurements indicated that Fijian adults in this population had mean BMI that were, in general, below the cut off for overweight (Table 6.3) and that BMI did not increase dramatically with age. Twenty-three per cent of women were overweight, (120 to 139% of standard body weight (SBW) and a further 11% were considered obese (≥140% of SBW). Among the men, 11% were overweight, and 3%, were classified as obese. Figure 6.3 illustrates the changes in the prevalence of overweight and/or obesity in surveys undertaken among Fijians between 1958 and 1993.



Sources: (33,36,404)

Figure 6.3: Prevalence of overweight/obesity* in Fiji Islands, 1958 to 1993

* WHO definition

Several surveys undertaken during the 1980s investigated the differences in rates of obesity and diabetes between Fijians living in rural and urban communities. The mean BMIs determined in these studies are summarised in Table 6.3.

Table 6.3: Rural and urban differences in Body Mass Index (BMI) among Fijians and Indo-Fijians

	Year of Survey	N	RURAL Mean BMI (sd)	N	URBAN Mean BMI (sd)
Males					
Fijians – a	1958–72	1229	23.7		na
Fijians – b	1980	242	25.5 (3.7)	401	25.8 (0.8)
Fijians – c	1980–81	702	24.9	104	27.3
Fijians – d	1983	497	25.5	38	26.1
Fijians – e	1983	142	24.8 (0.3)	114	26.5 (0.4)***
Fijians – f	198?	87	25.4 (3.3)	35	30.1 (5.2)***
Indo-Fijians – b	1980	214	21.5 (3.8)	384	22.8 (3.9)***
Indo-Fijians – d	1983	1272	23.9	267	24.5
Females					
Fijians – a	1958–72	1350	24.6		Na
Fijians – b	1980	235	26.3 (4.7)	462	27.9 (5.8)***
Fijians – c	1980–81	763	25.5	144	27.6
Fijians – d	1983	881	27.1	52	27.7
Fijians – e	1983	316	27.0 (0.4)	315	28.3 (4.0)**
Fijians – f	198?	109	25.8 (5.1)	71	30.9 (5.9)***
Indo-Fijians - b	1980	238	23.5 (5.8)	452	23.9 (5.9)
Indo-Fijians - d	1983	1919	25.0	141	25.4

a. Hawley et al., 1978 (404)
b. Zimmet et al., 1983 (280)
c. Johnson and Lambert, 1982 (33)
d. Hoskins et al., 1987 (352)
e. Nye et al., 1986 (150)
f. Russell-Jones et al., (151)

**P<0.01, *** P <0.001

Zimmet and colleagues (280) conducted a study in 1980 into the prevalence of diabetes which included over 2600 Fijians and Indo-Fijians living in rural and urban centres in Fiji. This survey revealed that urban-living individuals had higher BMIs than rural residents for both genders and ethnic groups. However the differences were significant only for Fijian women and Indo-Fijian men (Table 6.3).

The first National Food and Nutrition Survey of Fiji was conducted in 1980 and 1981 (33). Approximately 5000 individuals were included, 44% of whom were below the age of 15 years, and small numbers were Indo-Fijians and several other ethnic groups. Only data for Fijians are reported here.

The mean BMIs of both male and female Fijians were higher than in the 1958–72 surveys and urban Fijians had greater BMIs than their rural counterparts. The survey classified 16.8% of males and 40.6% of females as overweight (≥120% of ideal body weight) as seen in Figure 6.3.

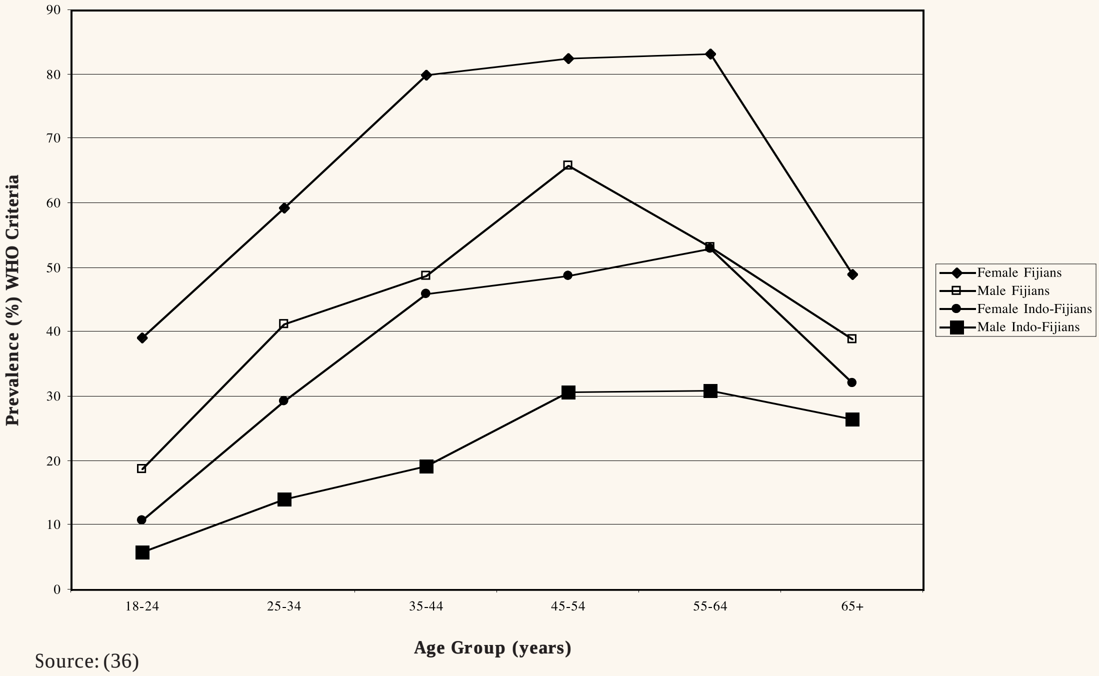
Another large study of over 5000 Fijians conducted in 1983 found little difference between urban and rural residents (283). The rural Fijians and Indo-Fijians were recruited from randomly selected villages that were located at least five miles from a town. The much smaller sample of urban Fijians and Indo-Fijians were from two towns on the main island. Table 6.3 shows that Fijians in general had higher BMIs than Indo-Fijians and the women had higher BMIs than the men, but these differences were not statistically significant.

A small study, also in 1983, compared anthropometric measures, blood pressure and blood lipids in rural and urban Fijians (150). The rural population came from three villages on the island of Qamea, approximately 160 miles from Suva, the government and economic capital of Fiji. Qamea, at the time of the survey, had no roads, no motorised vehicles, no electricity or easy access to imported consumer goods. The urban area was the settlement of Nabua, which was within the city limits of Suva, had electricity, was on a main bus route and had easy access to goods and services. The mean BMIs of the Suva Fijians were significantly higher than the BMIs of rural Fijians for both males and females as shown in Table 6.3.

Rural-urban differences were compared in a survey conducted in the late 1980s by Russell-Jones et al. (151) among Fijians over 40 years of age. The rural group was from a very remote central highland interior of Viti Levu, the largest and main Fijian island. The urban group came from a suburb of Suva. This study found highly significant differences between rural and urban Fijians. Urban females had the highest BMI of any group (Table 6.3).

A second National Nutrition Survey was carried out in 1993 (36), in which approximately 2400 adults over 18 years of age participated. This survey showed a marked increase in the proportion of males and females overweight and/or obese compared with earlier surveys (Figure 6.3). Overweight and obesity were defined in two ways in this survey. This discussion uses the WHO classification of overweight defined as BMI 25 to 29.9 and obesity as BMI ≥ 30. The prevalence of overweight and obesity was markedly higher in females compared with males and in Fijians compared with Indo-Fijians.

Figure 6.4 shows the high prevalence of overweight/obesity (BMI ≥25) by age found in both gender and ethnic groups. Overweight/obesity in males increased with age, being highest in the 45–64 year age groups. Both Indo-Fijian and Fijian women experienced more than twice the proportion of overweight/obesity as males. More than three-fourths of Fijian women were characterised as overweight in age groups from 35 to 64 years. Indo-Fijian women also experienced a higher proportion of overweight/obesity in these age ranges.



Source: (36)

Figure 6.4: Prevalence of overweight/obesity* in Fijian and Indo-Fijian females and males, 1993 National Nutrition Survey (* BMI ≥25)

New Caledonia

Summary

- Two major nutrition and health surveys were carried out in New Caledonia: one in 1979 (285) and a second in 1992–94 (370). Those surveys revealed an increase in the prevalence of overweight in both Melanesians and Polynesians over this time period.
- In all ethnic groups, females experienced higher rates of overweight than males.
- The highest rates of obesity were among Polynesians, followed by urban Melanesians.

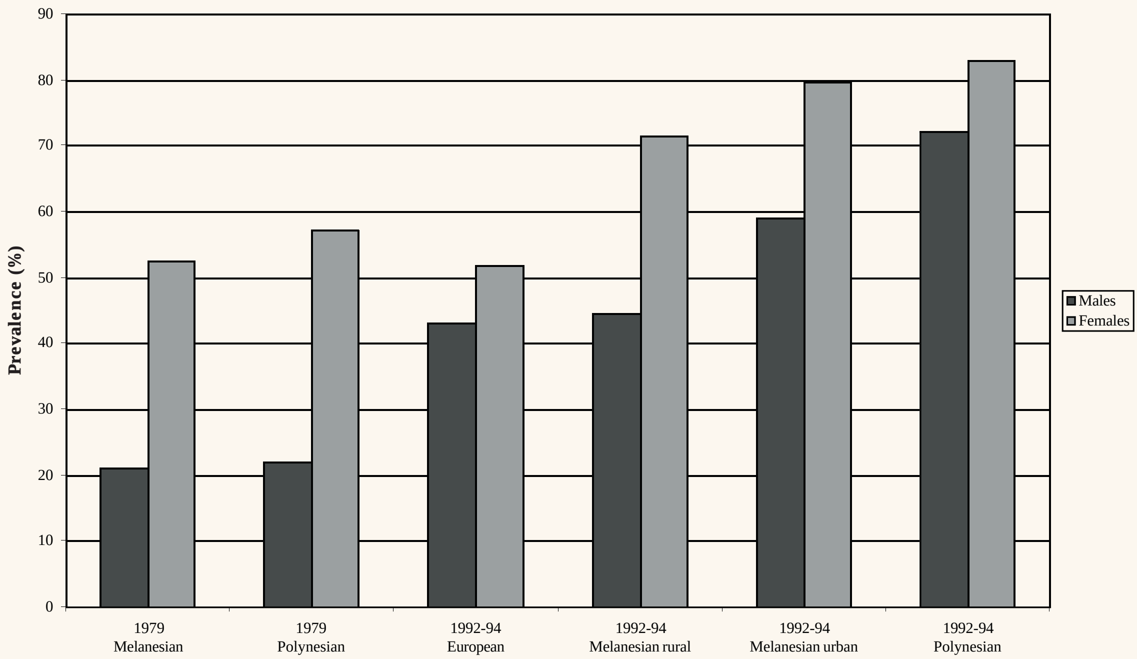
In 1979, three communities in New Caledonia took part in a survey of the prevalence of diabetes (285). One group included Melanesians who lived a traditional way of life as subsistence farmers in rural villages on the north east coast of mainland New Caledonia. A second group comprised Melanesians living on Ouvea, an island approximately 100 km from mainland New Caledonia. The third group was made up of part-Polynesians, originally from Wallis Island, also residing on the island of Ouvea. Both groups on Ouvea were involved in agriculture and fishing.

The mean BMI for Melanesian and Polynesian males were not significantly different. Among females, however, both Polynesian and Melanesian Ouveans were significantly heavier than Melanesian females living in the rural mainland north coast villages. There was little difference in the prevalence of overweight (BMI ≥ 27), between Melanesian and Polynesian males, whereas the rate of overweight (BMI ≥ 25) was significantly greater among Polynesian females compared with Melanesian females (Figure 6.5). Figure 6.5 compares the 1979 survey with the subsequent survey in 1992–94.

In the 1992–94 survey, nutritional status (BMI and waist-hip ratio) was assessed among Melanesians, Polynesians and Europeans in rural and urban New Caledonia (370). The survey included 8875 adults aged 30 to 59 years and was part of a large diabetes-screening programme. The results of the survey indicated that female Polynesians had the highest mean BMI (32.0 ± 6.8) of all the gender/ethnic groups. Both Polynesian and Melanesian females had higher BMIs than males, but this was not observed among Europeans.

Among the gender/ethnic groups, the prevalence of overweight (BMI ≥27 for men, or ≥25 for women), was highest among Polynesian women, followed by urban Melanesian women (Figure 6.5). The rates of overweight were higher among urban Melanesians compared with rural villagers. Rates of overweight among Europeans did not differ markedly between rural and urban residents.

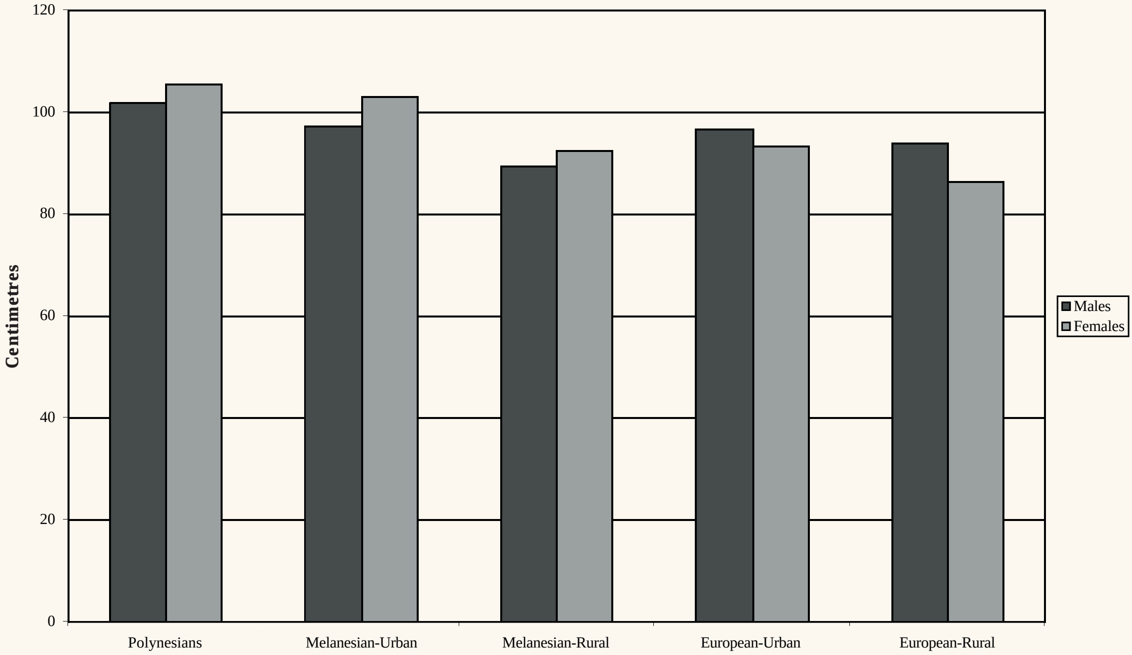
Figure 6.5 highlights the increase in the prevalence of overweight during the 15 years between the 1979 and the 1992–94 surveys. This comparison needs to be interpreted with caution. The surveys were not performed on the same individuals (but the survey sites were similar for rural New Caledonia; the northern provinces and one of the Loyalty Islands). A major difference between the two surveys was that the 1979 survey included adults 20 years and older, and the 1992–94 survey included adults between 30 and 59 years of age.



Sources: (285) (adults ≥ 20 years)
(370) (adults 30–59 years)

Figure 6.5: Prevalence of overweight* in New Caledonia in 1979 and 1992–94
(*overweight: females BMI≥25; males BMI≥27)

Figure 6.6 reveals differences in waist circumference by gender and ethnic group in the New Caledonia 1992–94 survey. Again, Polynesian women have the highest values, followed by urban Melanesian females. Urban Melanesians of both genders also had larger waist circumference values than rural Melanesians.



(Age = 30 to 59 years)
Source: (370)

Figure 6.6: Mean waist circumference in New Caledonia by gender and ethnic group, 1992–94

Papua New Guinea

Summary

- Surveys over the past 20 years have revealed low rates of overweight or obesity in rural and highland areas of Papua New Guinea.
- Health surveys in the 1990s, however, found over 30% of both males and females in the urban settlement of Koki to be obese.
- This obesity in Koki is also associated with alarmingly high prevalence rates of diabetes.

One of the first studies of nutrient intake and energy expenditure was undertaken in 1969–71 by Norgan and associates (51). Two communities were included in the survey. The first community, Kaul, consisted of four villages several kilometres inland on the island of Karkar.

> *The people were mainly subsistence farmers. The yield of the staple foods (taro and banana) was fairly high and the work was not too demanding, so that there was a reasonable amount of extra time for such activities as house-building, canoe-making, pig husbandry and hunting. The people of Kaul were smaller in stature and lighter in weight, with less variability in body build, than most European populations. There were virtually no endomorphs, obvious malnutrition is uncommon and the general health of the people is moderately good by European standards.* (51)

The second survey area, Lufa, comprised seven villages near a government station. The people of Lufa were also subsistence farmers with

> *gardens often situated in secondary forest and were occasionally up to four kilometres from the villages and from 300 meters higher to 1000 meters lower. Physically they were of approximately the same height and mass but were much more muscular…there were no endomorphs…overt malnutrition was uncommon.* (51)

BMI values estimated from mean weight and height values are provided for males and females in Tables 6.4 and 6.5 respectively.

Martin and co-workers carried out health surveys in 1977 among rural villages, in urban communities, and among young civil servants in the capital city of Port Moresby in 1979 (160). As seen in Table 6.4, urban residents had greater BMIs than civil servants and both were heavier than the rural residents. The civil servants were on the whole younger than the rural and urban residents.

Table 6.4: Mean Body Mass Index (kg/m²) of Papua New Guinea MALES, 1968–69 to 1991, by community

Community	Year	Reference	N	Age	BMI (sd) rural	BMI (sd) urban
Coastal – Kaul	1968–69	(51)	51	17-48	21.9	
Highlands – Lufa	1968–69		43	17-48	22.7	
Urban – Koki	1977	(160)	130	>18		27.1 (0.3)
Civil servants	1979		80	18-34		23.8 (0.3)
Rural – Kalo	1977		40	>18	22.4 (0.4)	
Semirural – Gamusi (non-Austronesian)	1983	(161)	97	≥ 20	22.0 (0.2)	
Semirural – Gimisave (non-Austronesian)	1983		47	≥ 20	22.2 (0.3)	
Rural – Gamog	1985–86	(164)	92	≥ 20	21.0	
Semi-rural – Marup	1985–86		129		21.8	
Semi-rural – Kaul	1985–86		78		22.5	
Coastal rural – Napapar	1985–86		126		24.4	
Coastal peri-urban – Matupit	1985–86		126			24.30
Highlands peri-urban – Masilakaiufa	1985–86		136			23.50
Rural- Bougainville	1988–89	(245)	50	≥ 18	23.6 (2.5)	
Urban – Bougainville	1988–89		50	≥ 18		25.7 (3.8)
Mine workers – Bougainville	1988–89		50	≥ 18		26.0 (4.1)
Kitavan	1990	(245)	119	20-86	20 (2.2)	
Rural – Kalo	1991	(167)	92	≥ 25	25.8	
Rural – Wanigela	1991		163		27.1	
Urban – Koki	1991		401			29.2

Table 6.5: Mean Body Mass Index (kg/m²) of Papua New Guinea FEMALES, 1968–69 to 1991, by community

Community	Year	Reference	N	Age	BMI (sd) rural	BMI (sd) urban
Coastal – Kaul	1968–69	(51)	69	17-48	20.7	
Highlands – Lufa	1968–69		41	17-48	22.0	
Urban – Koki	1977	(160)	46	>18		29.4 (0.7)
Civil servants	1977		38	18-34		24.2 (0.6)
Rural – Kalo	1977		65	>18	22.4 (0.4)	
Rural – Gamusi (non-Austronesian)	1983	(161)	91	≥ 20	21.3 (0.3)	
Semi-rural – Gimisave (non-Austronesian)	1983		73	≥ 20	22.3 (0.3)	
Rural – Gamog	1985–86	(164)	88	≥ 20	20.1	
Semi-rural – Marup	1985–86		143		20.8	
Semi-rural – Kaul	1985–86		107		21.9	
Coastal-rural – Napapar	1985–86		143		23.9	
Coastal – peri-urban – Matupit	1985–86		147			25.40
Highlands – peri-urban – Masilakaiufa	1985–86		143			22.40
Kitava	1990	(165)	43	20-86	18.0 (2.2)	
Rural – Kalo	1991	(167)	106	≥ 25	26.1	
Rural – Wanigela	1991		378		25.3	
Urban – Koki	1991		349			30.9

The two villages of Gamuri and Gimisave in the Asaro Valley, not far from the town of Goroka, were chosen for a prospective study of non-communicable diseases in 1983 (161). These areas were chosen because extensive genetic studies had shown that inhabitants of this area were of non-Austronesian Melanesian ancestry. It was hypothesised that populations living in coastal areas of PNG were more affected genetically by the Austronesian migrants who passed through New Guinea during their colonisation of the Pacific approximately 3000 to 5000 years ago. Highlanders of PNG, on the other hand, were secluded from the Austronesian genetic admixture and this may result in a lower susceptibility to Type 2 diabetes. Both villages were involved in coffee production and a cash economy. Of the two villages, Gamusi was more remote in the Highlands and the diet was more traditional than the village of Gimisave, although both villages had some western influences in the diet.

The prevalence of diabetes in both villages was zero, although in the less traditional Gimisave, two-hour plasma glucose concentrations were significantly higher than in Gamusi (also see Chapter 5, Diabetes Mellitus). There were no significant differences for the males between the villages in mean BMI (Table 6.4), triceps skinfolds, subscapular skinfolds or the sum of the skinfolds. The females in Gamusi, however, had significantly lower BMI (Table 6.5), triceps skinfolds, subscapular skinfolds and sum of skinfolds compared with the females of Gimisave.

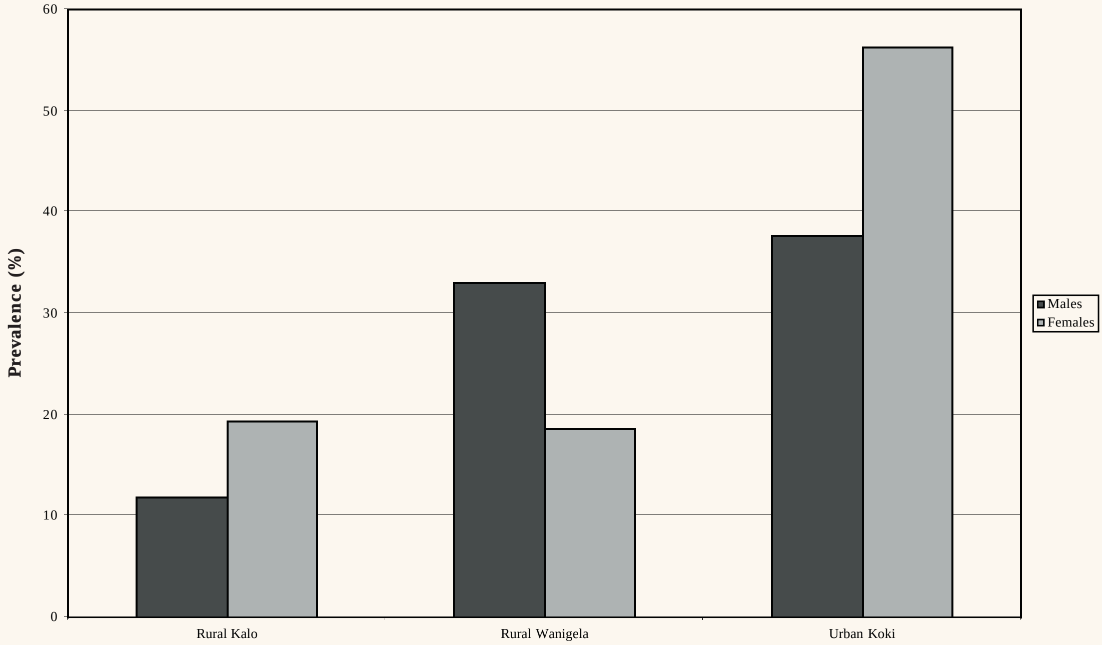
Surveys of non-communicable diseases were conducted in six communities in Papua New Guinea during 1985–86 (164). The communities included a rural village (Gamog) and two semirural villages (Marup and Kaul) on Karkar Island; two coastal villages (Napapar – rural, and Matupit – peri-urban) in East New Britain Province and a village (Masilakaiufa) close to the town of Goroka, the administrative capital of the Eastern Highlands region. Communities were classified semi-rural if they were rural but had easy access to towns or imported consumer goods. Peri-urban communities were those close to a major town. Tables 6.4 and 6.5 show that the lowest mean BMI values were reported from the rural and semi-rural villages (mean BMI ranged from 20.1 to 22.5 kg/m^2), while the highest BMIs were found in the coastal communities (mean BMI ranged from 22.4 to 25.4 kg/m^2).

A small study of cholesterol levels was carried out in Bougainvillian males in 1988–89 by Iser (245). Three groups, each composed of 50 men, were studied. One group maintained a traditional way of life in villages at least 20 km from the main town. The urban group comprised manual labourers and office workers from the town of Arawa. A third group was composed of mine workers and catering staff who obtained all of their meals during working hours at the company canteen. Only men who had lived in these communities for two years or more were included in the study. As might be expected, the mine-workers had the highest mean BMI, followed by the town men. The village men had significantly lower BMI than either of the other two groups. BMI was strongly correlated to serum cholesterol levels for the overall group, the town men and the miners, but not the village men, when analysed by group.

Lindeberg and colleagues (165) examined subsistence horticulturists aged 20 to 86 years in Kitava, Trobriand Islands in 1990 for cardiovascular risk factors. The dietary habits of these traditional farmers were virtually unaffected by western imports. The average amount of money spent on imported food was USD3.00 per year. BMI (Table 6.4), waist circumference, triceps skinfold measurements, mid-arm circumference and arm-muscle circumference were all significantly below Swedish norms. Only four out of 203 Kitavans had BMI above 25.

A more recent survey conducted in 1991 by Dowes et al. (167) compared prevalence rates of diabetes and obesity in three PNG communities. The urban centre was Koki, a relatively affluent suburb of Port Moresby, the capital of Papua New Guinea. Two rural centres were also chosen. The village of Wanigela is about 200 km east of Port Moresby and many of the residents of Koki originated from there. The second village of Kalo is on the coast about mid way between Wanigela and Port Moresby. In Kalo there are several small stores and good access to the nearby government station. The study found an alarmingly high prevalence of diabetes among urban Papua New Guineans living in Koki (27.5% in men and 33% in women) (see Chapter 5, Diabetes Mellitus) and significantly higher BMIs than in either of the rural villages as shown in Tables 6.4 and 6.5.

The prevalence of obesity (167) was higher in the urban Koki settlement compared with the rural village of Kalo as shown in Figure 6.7. Males in the rural village of Wanigela had much higher rates of obesity compared with rural Kalo which is surprising given the similarity of the lifestyles of the two communities. There was little difference between the rates of obesity among the Wanigela females and the rural Kalo women.



Source: (167)

Figure 6.7: Prevalence of obesity* in females and males in three communities in Papua New Guinea, 1991

(*cut-off level for obesity not provided)

Solomon Islands

Extensive anthropometric and medical studies were performed in Solomon Islands between 1966 and 1970 and follow-up examinations were carried out in 1978 as part of the Harvard Solomon Islands Project (56). The initial surveys included 1390 adults over the age of 15 years in six communities in Solomon Islands. Three villages were on the island of Bougainville (now part of Papua New Guinea) — Aita, Nasioi and Nagovisi. Bougainville had seen heavy fighting during World War II and the development of large copper mining operations since 1968. The other three villages (Lau, Baegu and Kwaio) were on the island of Malaita, which was never occupied during the war and has seen very little European settlement.

From 1966–1970 all six groups were living in tribal villages in rural areas, where motor vehicles, electricity and other western conveniences were absent. Homes were constructed of local materials and coconut was used by all groups, but in small quantities. Some of the villages had greater contact with western culture than others. The investigators ranked the communities on the basis of indices of acculturation such as: length and significance of western contact; access to medical care; education and cash economy; imported foodstuffs and salt intake. Table 6.6 provides mean Body Mass Index (BMI) as calculated from mean weight and height for each group and mean waist circumference (224). There were no significant differences between the groups in either BMI or waist circumference.

Table 6.6: Mean Body Mass Index (kg/m²) and waist circumference of Solomon Island males and females by level of acculturation, 1966–70

Acculturation group	N	BMI (kg/m²)	Waist circumference (cm)
MALES			
1. Kwaio	127	21.8	75.6
2. Aita	81	23.3	77.5
3. Baegu	126	22.0	77.0
4. Lau	77	24.4	80.6
5. Nagovisi	109	23.4	77.9
6. Nasioi	59	22.0	75.5
FEMALES			
1. Kwaio	114	20.9	76.8
2. Aita	88	23.2	79.6
3. Baegu	111	20.9	78.3
4. Lau	101	23.6	82.9
5. Nagovisi	101	21.1	76.8
6. Nasioi	63	20.7	75.6

Level of Acculturation: 1= least acculturated; 6= most acculturated
Source: (224)

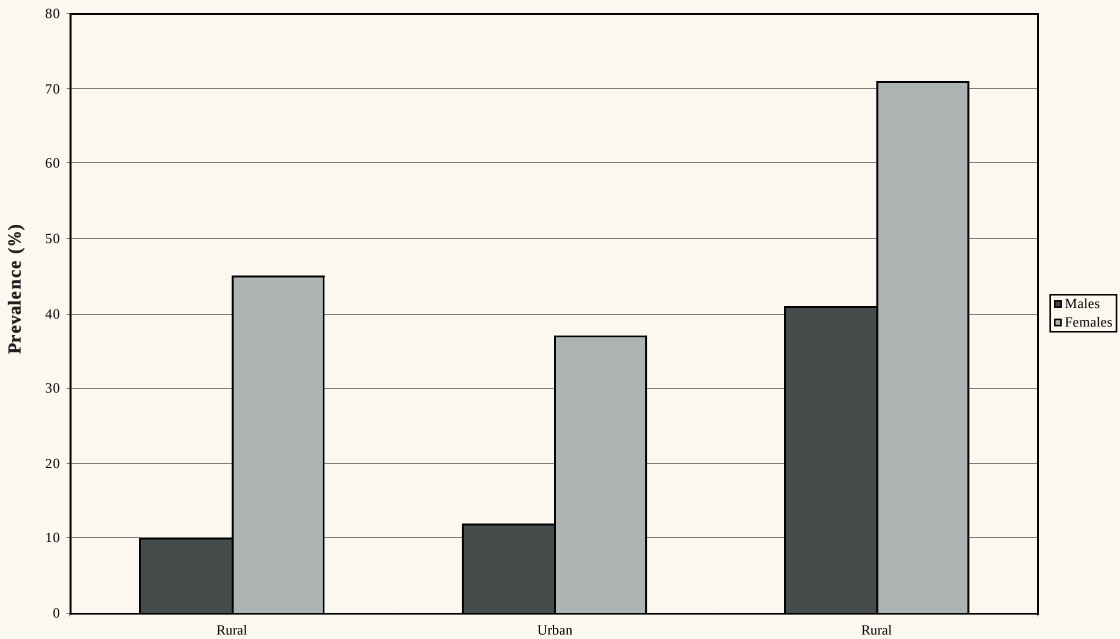
The follow-up examinations took place 8 to 12 years after the initial surveys. The researchers reported no overweight or under nutrition in any of the groups, but described a different pattern of weight with ageing in the adult years (406). In the least acculturated villages, women experienced weight loss beginning in their 20s, the beginning of their reproductive cycle. For women in the more acculturated communities, however, the pattern was reversed. Weight gain increased during the adult years. The males in the least acculturated villages did not show as dramatic a decline in weight with age as the females. Men in two of the more acculturated villages had weight increases, particularly in the early adult years (data not shown).

Skinfold thickness measurements showed similar patterns. Among women in the least acculturated villages, there was a decrease with age in subcutaneous fat in the trunk region. There was an increase in trunk fat with age among women in the villages with greater western contact. The males showed a similar pattern but not as extreme as among the females. With the men, increases in triceps skinfold coupled with decreases in upper arm circumference suggest a decline in muscle mass with age. This tendency to lose muscle mass with age was detectable, but less pronounced, among the women (406) (data not shown).

A cross-sectional survey of diabetes, obesity and dietary intake was carried out in the Western Province of Solomon Islands in 1985 by Eason and associates (57). The survey included 1500 individuals living in three distinct communities. One group comprised Melanesians living in a traditional village accessible only by boat (Paradise). A second group included Melanesians living in the urban community of Munda. Micronesians who had migrated from the Gilbert Islands and settled in a fishing village 16 kilometres from the urban centre of Munda made up the third group.

In the 25 to 54 year age ranges, mean BMI values among the Melanesian groups ranged from 23 to 24 kg/m^2 for males and 24 to 25 kg/m^2 for females. The Micronesians had consistently higher mean BMIs in those age ranges with BMIs of approximately 26 reported for males and 27 to 28 for females.

Age-standardised rates of overweight (BMI ≥27 for males and ≥25 for females) were significantly higher in women than in men ($p < 0.01$) and among Micronesians compared with Melanesians ($p<0.01$) (Figure 6.8).



Source: (57)

Figure 6.8: Prevalence of overweight* in the Western Province, Solomon Islands, 1985

*Overweight = BMI ≥25 for females; BMI ≥27 for males

The Solomon Islands National Nutrition Survey was conducted in 1989–90 and included 5400 women of different ethnic groups (407). The survey also included children less than 5 years but did not include men. The sample was designed to reflect the population on a national basis, by province and by income level. Small numbers of Polynesian and Micronesian women were included to represent the population of those two groups in Solomon Islands.

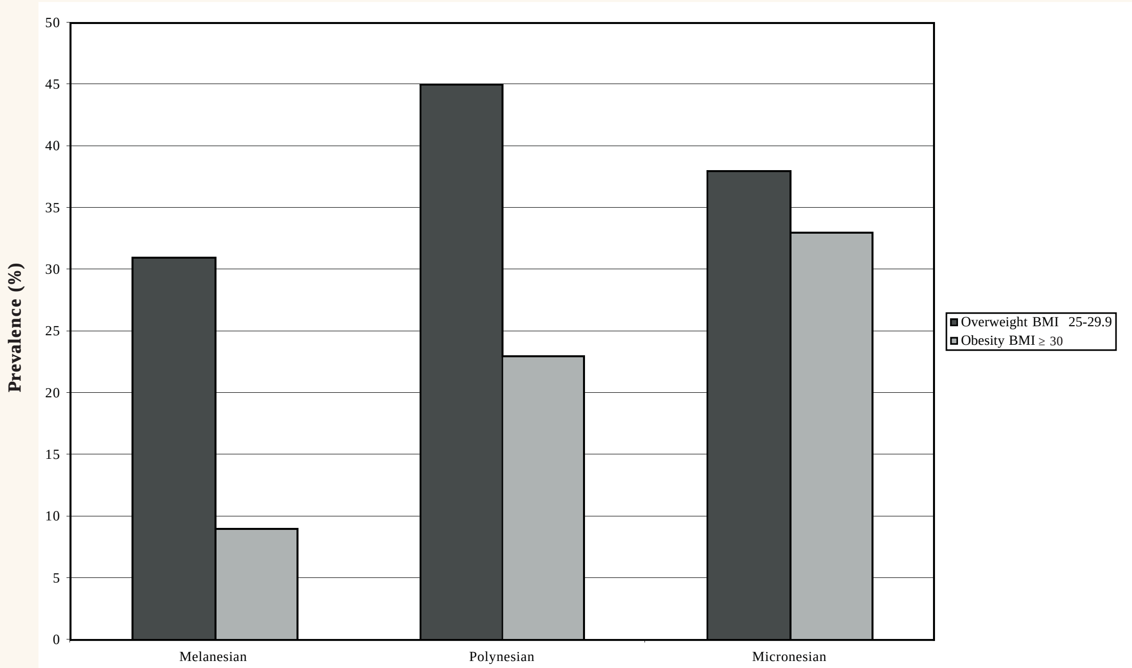
Mean BMIs at all ages were considerably lower for Melanesian women than for Polynesian or Micronesian women as shown in Table 6.7. It should be noted that the sample sizes for the Polynesian and Micronesian women were comparatively small.

Table 6.7: Mean Body Mass Index of Solomon Island FEMALES by age group and ethnic group

FEMALES	N	Age	Mean BMI (kg/m^2)
Melanesian	1929	20-29	24.30
Polynesian	190	20-29	26.70
Micronesian	33	20-29	29.40
Melanesian	1300	30-39	24.90
Polynesian	119	30-39	28.70
Micronesian	20	30-39	28.60
Melanesian	750	40-49	24.40
Polynesian	65	40-49	27.90
Micronesian	8	40-49	30.40
TOTAL			
Melanesian	**3979**	**20-49**	**24.50**
Polynesian	**374**	**20-49**	**27.50**
Micronesian	**61**	**20-49**	**29.30**

Source: (58)

Rates of overweight and obesity were also lower in Melanesian women compared with Polynesian and Micronesian women. Figure 6.9 reveals that approximately 70% of Micronesian and Polynesian women were either overweight or obese as compared with 40% of Melanesian women. Overweight and obesity tended to peak in the 30 to 39 year age groups (data not shown).



Source: (58)

Figure 6.9: Prevalence of overweight and obesity in Solomon Island FEMALES by ethnic group, 1989–90

Vanuatu

Summary

- Nutrition and health surveys over the past two decades have shown a steady increase in the prevalence of overweight and obesity among ni-Vanuatu at various levels of urbanisation.
- Rates are highest in urban areas, intermediate in intermediate areas and lowest in rural areas.
- The highest rates of obesity are found among urban women (28%) and the lowest rates among rural males (0%).
- Females experience more obesity while males have higher rates of overweight.

In 1975, Jabre et al. (408) conducted a health survey in Tagabe, a suburb of Port Vila, the capital city of Vanuatu. The community was described as relatively unstable, where individuals came to the city for a short period of time to earn money for a specific purpose and then returned to their home islands. Ninety-three adults were weighed and measured. The estimated Body Mass Index (n = 93) was 24.1 kg/m^2 for females and 24.4 kg/m^2 for males. Obesity was classified as a weight-to-height ratio of two standard deviations above the mean. Using this classification, 28.5% of females and 27% of males were considered obese.

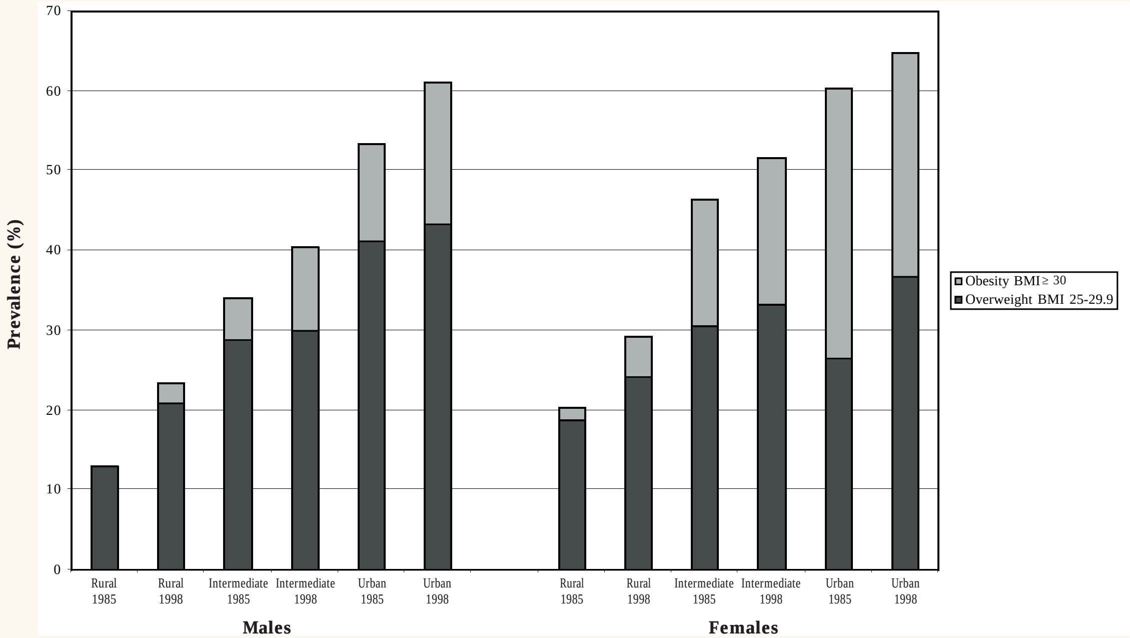
Finlayson and colleagues (173) conducted one of the first non-communicable disease (NCD) surveys in Vanuatu in 1984. They examined 243 people in Port Vila, and 77 adults in Norsup, the largest town on Malekula Island. Residents of Port Vila tended to be employed and consuming a fairly westernised diet whereas the people of Norsup were mainly involved in subsistence agriculture and fishing. The survey population consisted of individuals who attended the Port Vila or Norsup hospital outpatient departments with minor illnesses, or their friends or relatives.

This survey found that 15% of the men and 26% of women were classified as obese (BMI ≥ 30). Mean BMIs were 25.0 ±0.3 kg/m^2 and 25.8 ± 0.8 kg/m^2 for males and females respectively. The differences in mean BMI between urban and rural individuals were not significant, 25.8 kg/m^2 and 24.2 kg/m^2 respectively.

A second NCD survey was carried out in 1985, in three populations at different levels of modernisation (174,175). The urban group included all civil servants in Port Vila. An intermediate group consisted of residents of the island of Nguna about a half-hour boat ride from the mainland. The rural group comprised adults from remote villages in the Middle Bush area on the island of Tanna.

The results of this survey indicated that both male and female civil servants in Port Vila were significantly heavier than either the Nguna or the Tanna ni-Vanuatu. Mean BMIs increased with age in both Port Vila and Nguna but not in Tanna.

There were significant differences in the rates of overweight and obesity between the three groups. Of Port Vila urban residents, 53% of males and 60% of females were classified as either overweight or obese (BMI ≥25), while only 13% of rural Tanna males and 20% of rural females were above this level. As might be expected, the prevalence of overweight in intermediate Nguna was midway between Port Vila and Tanna, with 34% of males and 46% of females classified as either overweight or obese. None of the Tanna males and less than 2% of females were classified as obese (BMI ≥30). Figure 6.10 shows the differences in rate of overweight and obesity in the 1985 survey and compares them with a subsequent survey in 1998.



Sources: (62,174)

Figure 6.10: Prevalence of overweight and obesity* in Vanuatu by gender and level of urbanisation, 1985 and 1998

* WHO definition

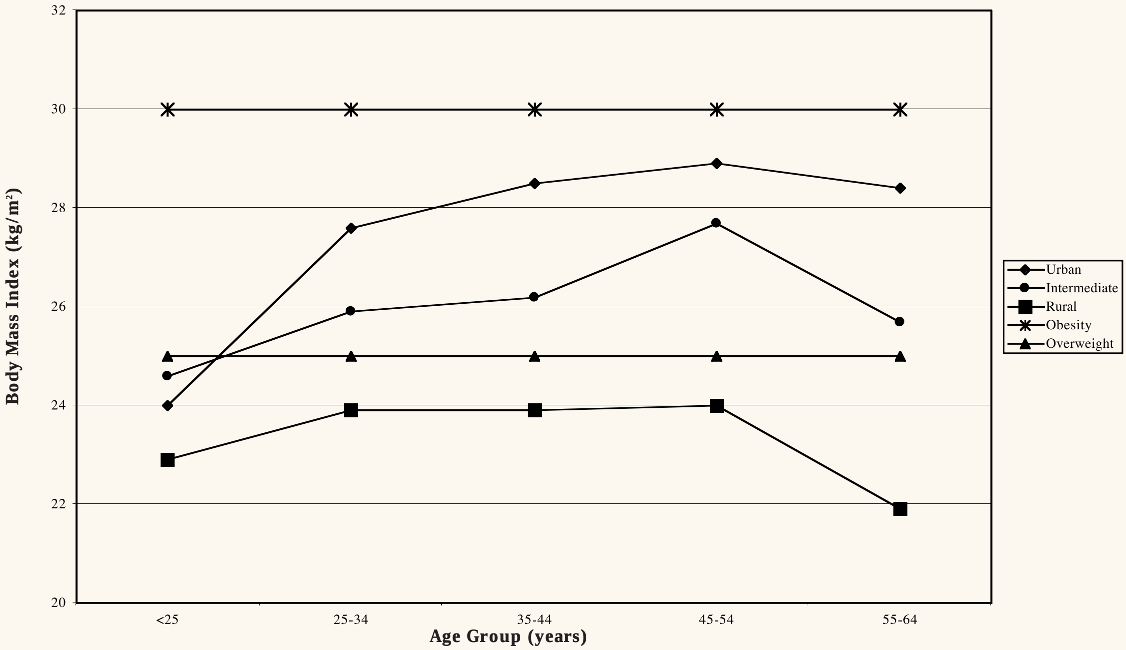
Mean waist circumference was significantly higher in urban males (88.4 cm) compared with either intermediate (83.4 cm) or rural (81.4 cm) males. Urban females also had significantly greater mean waist circumference (91.6 cm) as compared with rural females (86.2 cm). The difference in waist circumference between urban and intermediate females (91.6 vs. 90.6 cm) however, was not significant. The waist circumference associated with substantial increased risk of disease is ≥102 cm for males and ≥88 cm for females (120).

A National Nutrition Survey of Vanuatu was carried out in 1996 (61). Children under 5 years of age and women 15 to 49 years were included in the examinations. Males were not included. Nine per cent of women were classified as obese (BMI ≥30) and 26% were classified as overweight (BMI 25–29.9). After adjusting for under-representation of urban women in the sample, the prevalence rate of overweight obesity was 38.6%.

The most recent health and nutrition examinations were undertaken in the 1998 Vanuatu Non-Communicable Disease Survey. The sites chosen for this survey were similar to the 1985 survey, including urban, rural and intermediate communities. Approximately 1600 adults aged 20 years and over were evaluated for obesity, hypertension and blood glucose levels.

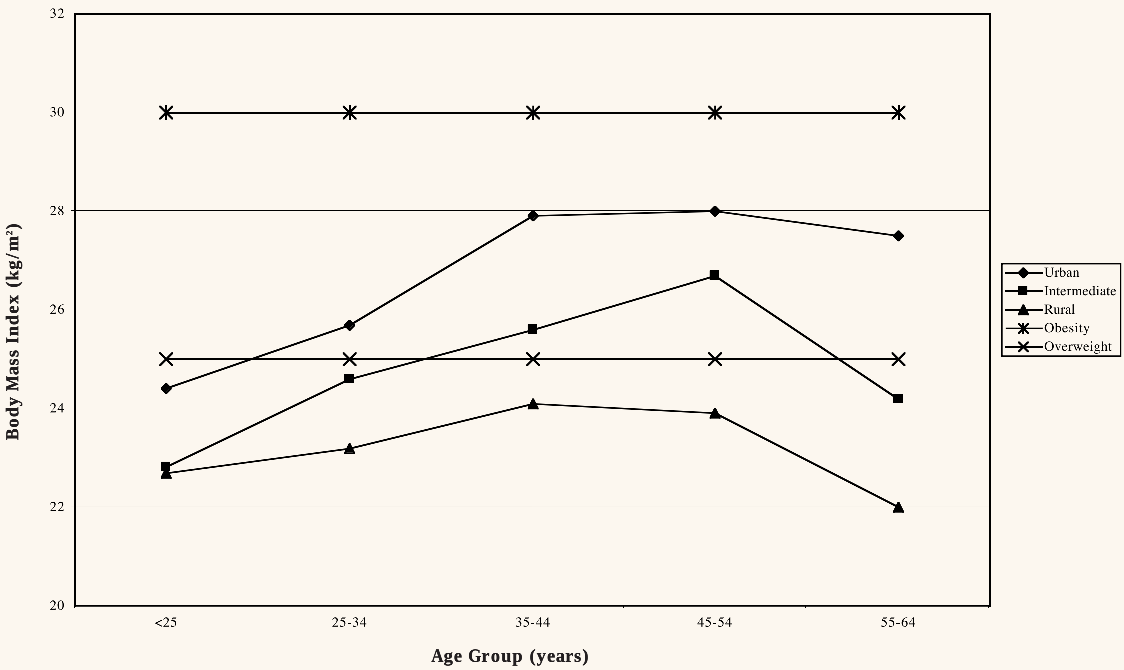
The prevalence of obesity increased for both genders at all three levels of urbanisation compared with the 1985 survey (Figure 6.10). Urban females had the highest rates of overweight/obesity combined but lower rates of obesity compared with the 1985 survey. The greatest increases in prevalence were found among the rural groups. Among the rural men, the prevalence increased by 80% from 1985 to 1998 and for rural women the increase was 44%. The increases in the intermediate and urban groups ranged from 7 to 19%. Importantly it should be noted that over 60% of both males and females in the urban setting were either overweight or obese.

Figures 6.11 and 6.12 illustrate the increase in BMI with age for females and males in the urban and intermediate communities. BMIs increase in the early adult years until about middle age and then plateau or decrease slightly in the older age groups. In the rural areas, mean BMI increases very little with age and does not reach the cut-off level for obesity (BMI ≥25).



Source: (62)

Figure 6.11: Mean Body Mass Index of ni-Vanuatu FEMALES by age group, 1998



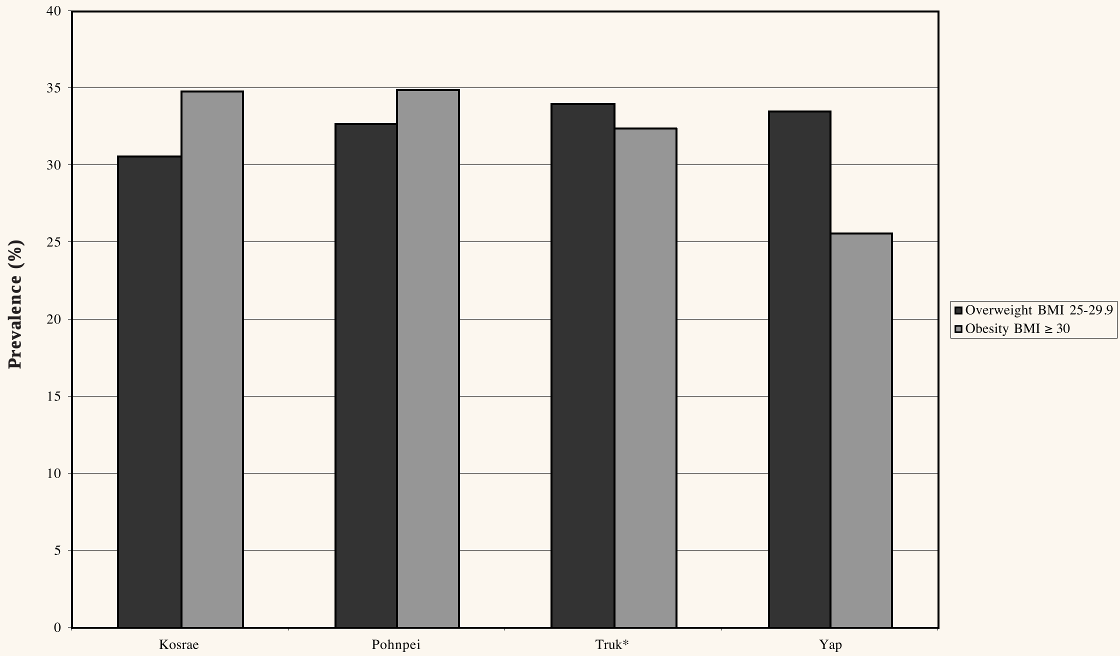
Source: (62)

Figure 6.12: Mean Body Mass Index of ni-Vanuatu MALES by age group, 1998

Micronesia

Federated States of Micronesia

The 1987–88 National Nutrition Survey of the Federated States of Micronesia (66,409) reported height, weight and BMI for 3588 women aged 15 to 49 years. The mean BMI for the women was 28 kg/m^2. Overall more than 60% of the women were classified as overweight or obese as shown in Figure 6.13. In Kosrae over 90% of the women between 40 and 49 years had BMIs above 25 kg/m^2.

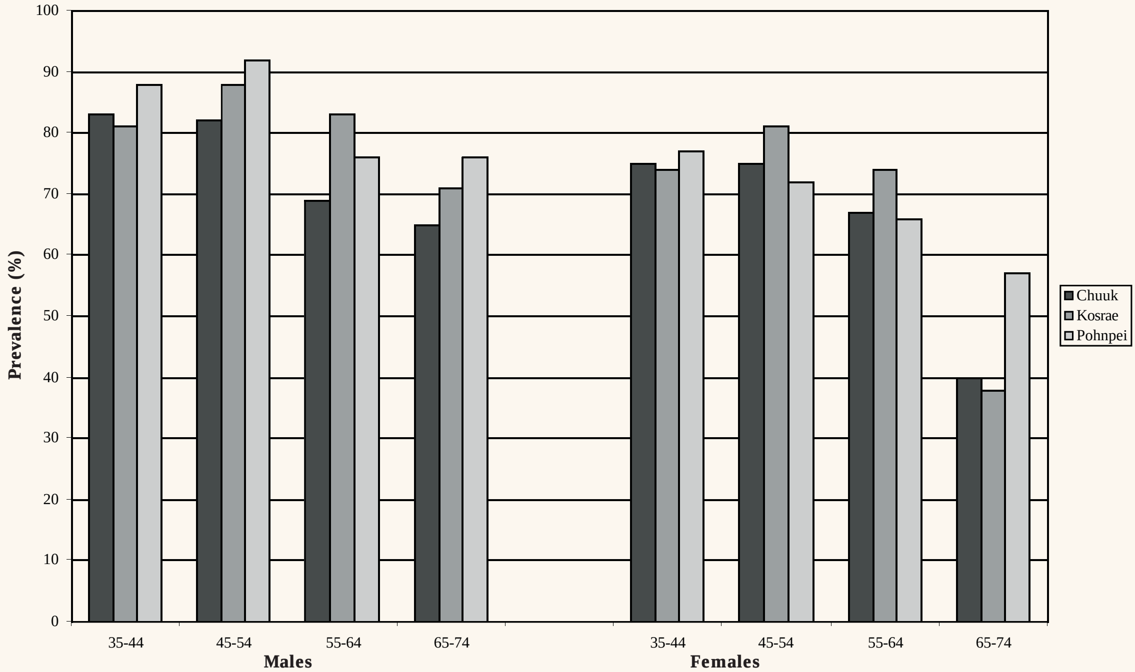


Source: (66)

Figure 6.13: Prevalence of overweight and obesity by state in the Federated States of Micronesia, 1987–88

* Now Chuuk

Auerbach et al. of the US Public Health Service (180) carried out a non-communicable disease survey in FSM including approximately 5000 adults. The survey, conducted in 1992–94, reported obesity in 72% to 92% of the 35 to 44 and 45 to 54 year age groups (Figure 6.14). This survey defined obesity for males as BMI ≥27.8 and for females BMI≥ 27.3 kg/m^2.



Source: (180)

Figure 6.14: Prevalence of overweight* in three regions of the Federated States of Micronesia, 1994

*overweight BMI ≥ 27.8 kg/m² in males, ≥ 27.3kg/m² in females

Guam

A 1958 report of mean weight and height measurements of Guam mothers indicated that the estimated BMI for all age groups was 27 kg/m². Mean BMI increased from 24 kg/m² in the 16 to 24 year age group to 36 kg/m² in the women in the 35 to 44 year age group (410).

In 1967–68, studies were conducted among three groups of Chamorros living a traditional lifestyle on the island of Rota, a more westernised way of life in Guam, or residing in California (255). The study did not report height or weight measurements or BMI but did estimate per cent body fat from triceps and subscapular skinfold measurements. Interestingly, there was little difference in the per cent body fat between the three groups (Table 6.8). In fact, the males living in traditional Rota had slightly more body fat compared with the Californian Chamorros, and the females in Rota had substantially more body fat than the Californian Chamorros.

Table 6.8: Estimated per cent body fat in Chamorros, 1967–68

	Per cent body fat	
	Males	**Females**
Rota – traditional	21	30
Guam – urban	17	21
California	18	22

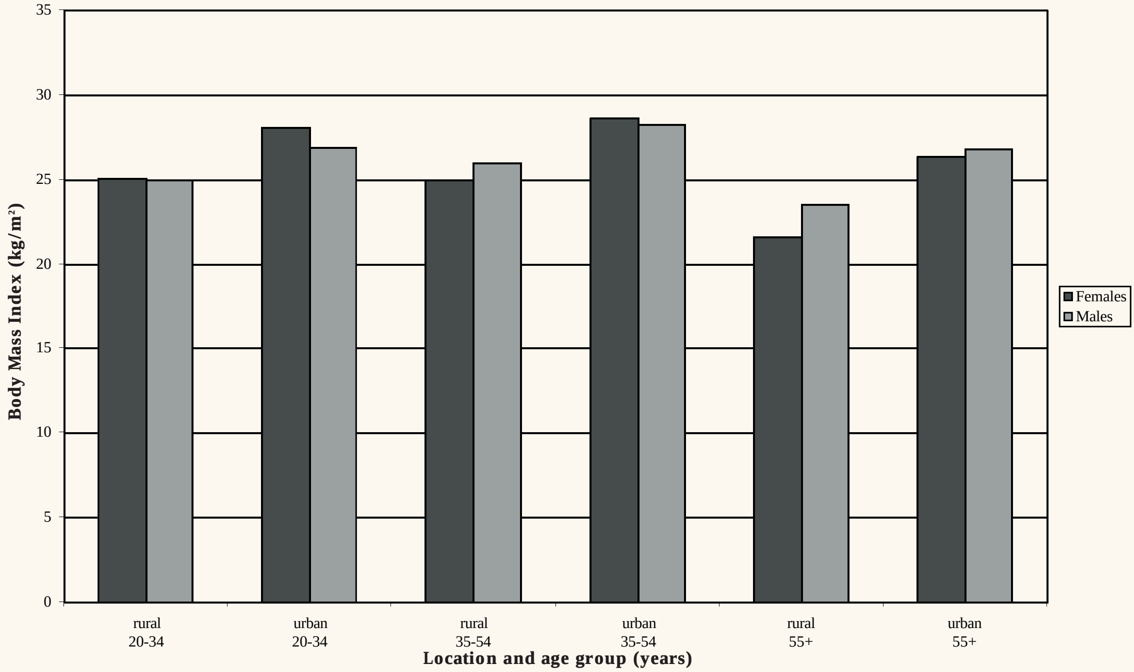
Source: (255)

Residents of Guam participated in a Behavioral Risk Factors Survey in 1991 and 1996 (139). The survey was based on a combination of person-to-person and telephone interviews. Respondents self-reported weight and height information to trained interviewers. Approximately 24% of respondents reported being overweight in 1991 (29% of males and 19% of females) and that proportion rose to 29% in 1996.

There are no other recent data related to overweight and obesity for Guam.

Kiribati

A population-based diabetes and cardiovascular disease survey was conducted in 1981 in Kiribati (411). The survey revealed significantly lower Body Mass Index (BMI) and triceps skinfolds in rural-living individuals compared with urban residents. Figure 6.15 provides BMI for urban and rural males and females. For most groups (except for the 55+ year old rural residents) mean BMIs were over the overweight cut-off, but less then the cut-off for obesity.



Source: (411)

Figure 6.15: Mean Body Mass Index (kg/m²) in rural and urban Kiribati, 1981

Marshall Islands

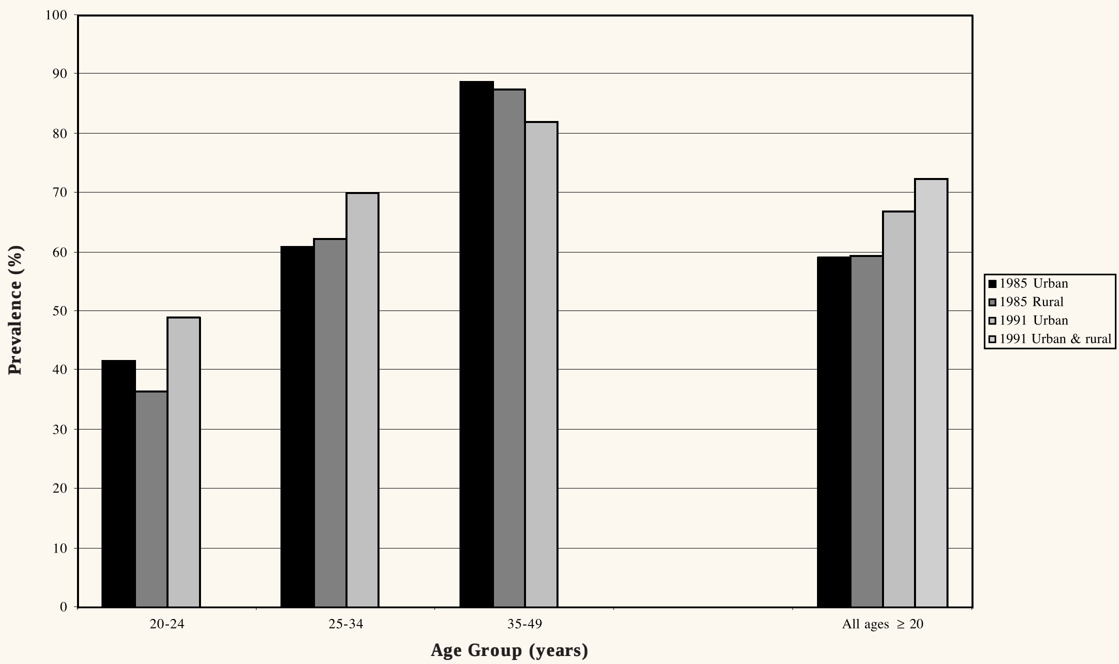
In 1948 to 1950, the United States Navy conducted a health survey of more than 22,000 inhabitants of the Marshall Islands, the Caroline Islands and the Northern Mariana Islands (183). Over 6000 children and adults were seen in the Marshall Islands. This was estimated to be about 70% of the entire population. The median age was 23.6 years. Mean height for males in the 25 to 34-year age group was 66 inches (168 cm) and for females was 60 inches (152 cm). Weight was reported by height categories. The estimated BMI calculated from the mean weight and height categories was 23 kg/m^2 for both males and females.

Two NCD surveys were conducted on the Marshall Islands focusing on women of childbearing age. The first survey in 1985 (184) revealed that 34% of non-pregnant women were classified as overweight (BMI 25 to 30) and a further 22% were considered obese (BMI ≥ 30). Obesity was more common in urban areas, but women in rural areas were also often classified as overweight. The prevalence of overweight and obesity increased dramatically with age as nearly 90% of women in the 35 to 49 year age range had BMIs greater than 25 kg/m^2 (Figure 6.16). Figure 6.16 compares the 1985 survey with two subsequent surveys.

A second survey of women's health reported in 1991 (76) showed slight changes from the 1985 survey. Mean BMI values did not change appreciably during that time; 27.1 ± 5.6 kg/m^2 in 1985 to 27.6 kg/m^2 in 1991, although the range of values was not provided in the 1991 data. The 1985 and 1991 mean BMIs were, however, considerably higher than the mean BMI of 23.2 kg/m^2 in 1948-50. The proportion of women who were overweight or obese also increased slightly over this time period. Those who were obese rose from 59% in 1985 for both rural and urban women to 67% in 1991. It is interesting that in the older age group, there was slightly less obesity in 1991 compared with the earlier surveys as shown in Figure 6.16. The 1991 survey did not provide data regarding urban/rural differences in prevalence of obesity.

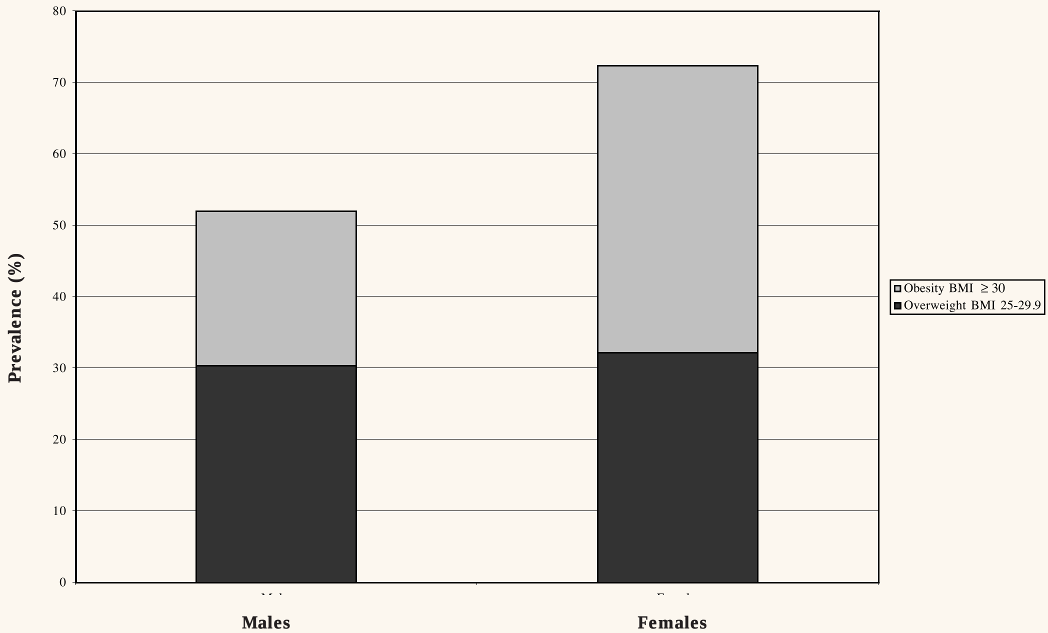
A small dietary survey was conducted in 1993 of Rongelapese people living on Mejatto Island (412). Fifty-six per cent of the women (n=41) and 63% of the men (N= 43) were overweight or obese (BMI ≥ 30).

A study of over-nutrition and under-nutrition was undertaken in the Marshall Islands in 1996–97 by Gittelsohn (186). Over 400 adults ≥ 18 years from urban and remote communities were assessed for overweight. Figure 6.16 shows that among women of all ages, overweight and obesity has steadily increased since the 1985 survey. Figure 6.17 also reveals that obesity was significantly more pronounced among females than males. Obesity rates were similar between rural and urban areas and lower socio-economic status appeared to be related to higher rates of obesity, particularly among the middle-aged adults, 18 to 50 years (data not shown).



Sources: (76,184)

Figure 6.16: Prevalence of overweight and obesity in Marshall Island FEMALES, 1985, 1991 and 1996–97



Source: (186)

Figure 6.17: Prevalence of overweight and obesity in Marshall Island females and males, 1996–97

Nauru

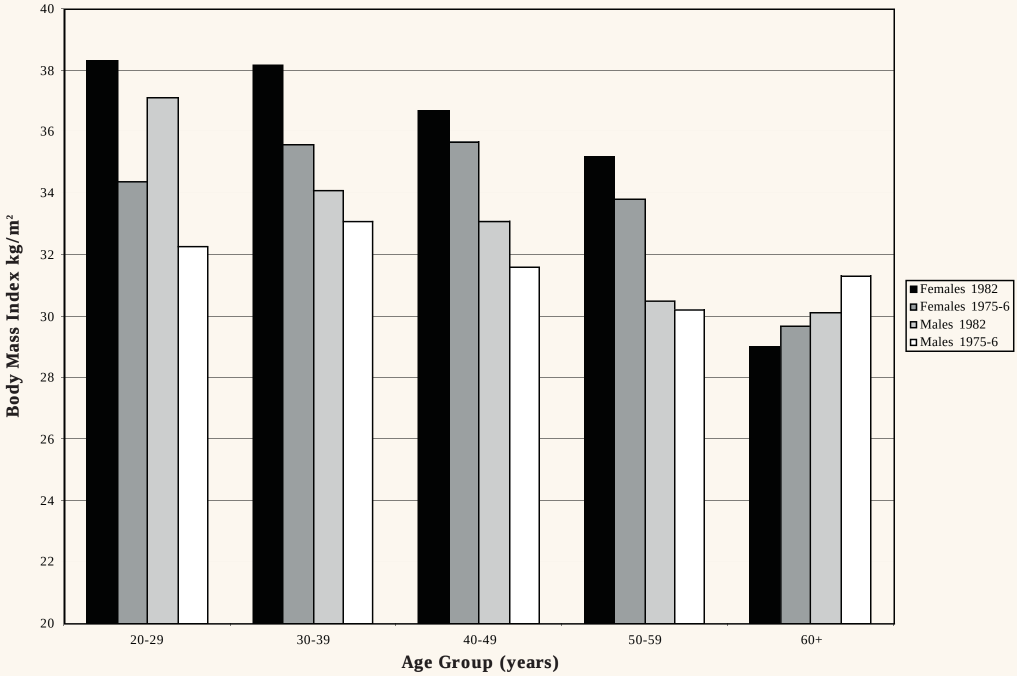
Summary

- Nauruans are reported to be one of the most obese populations in the Pacific Islands with mean BMIs well above the cut off for obesity (≥ 30 kg/m²).
- The most recent mean BMI values for Nauruan men and women have been reported as 34.2 ± 0.3 and 34.9 ±0.3 kg/m² respectively.
- Over 75% of both males and females are considered to be obese (BMI≥30 kg/m²).

Nauru is a small atoll island less than 15 square km, with one of the highest per-capita incomes in the world. The wealth is realised from the rich phosphate deposits that have been controlled by the Republic of Nauru since 1970 but are now all but exhausted. The lifestyle of Nauruans is completely westernised; almost all food is imported, almost all transportation is motorised and thus rates of physical activity are low.

High rates of obesity have been reported in a series of health surveys conducted in Nauru by the International Diabetes Institute. The first surveys were carried out in 1975/76 (317, 318), a follow-up survey conducted in 1982 (413), and the most recent survey in 1987 (254). A more recent survey was carried out in 1992, however the results have not been published, due to the low response rate to the survey.

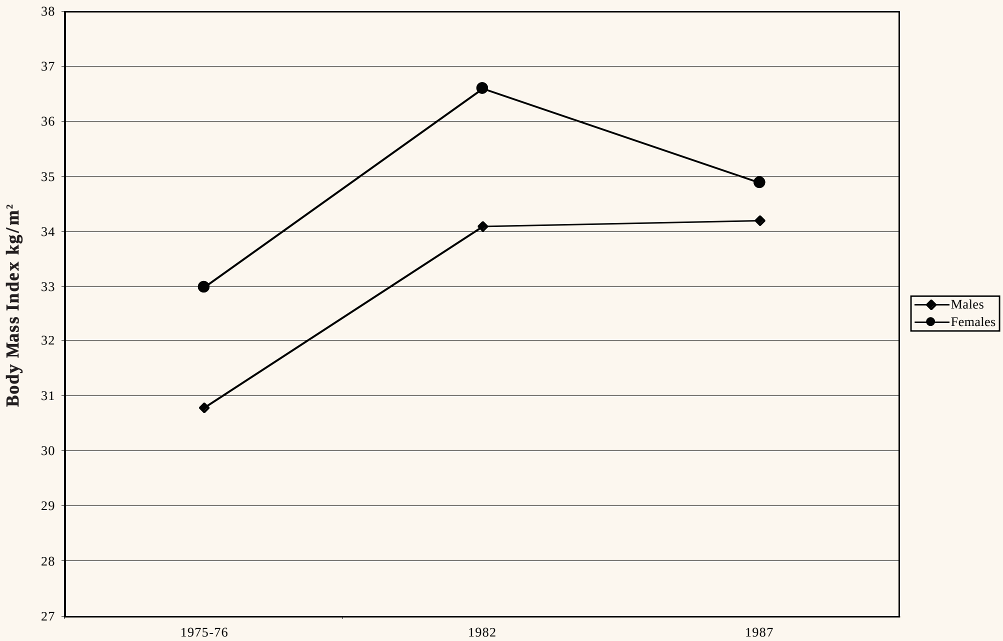
There were 366 persons included in the 1975/76 survey who were still available for the 1982 examination. The Nauruans experienced dramatic weight gains (mean increase in BMI was 3.4 ± 0.3 kg/m² in males and 3.6 ± 0.3 kg/m² in females). The greatest gain in weight was seen in the age group under 29 years. Multiple regression analysis showed that a decrease in weight gain was associated with increasing age (Figure 6.18), being at least 60 years old, presence of diabetes, higher triglycerides levels, and low uric-acid levels.



Source: (254)

Figure 6.18: Mean Body Mass Index (kg/m²) of female and male Nauruans by age, 1975–76 and 1982

The mean BMI in the 1987 survey was based on the total sample available for the survey. There did not appear to be a substantial change in BMI from the 1982 to the 1987 survey for males, but for females there appeared to be a slight decline in BMI, as shown in Figure 6.19. The prevalence of overweight and obesity was not reported for the 1987 survey.



Sources: (254,317,318,413)

Figure 6.19: Mean Body Mass Index (kg/m²) in Nauru, 1975–76, 1982 and 1987

Further analysis of the 1987 survey data showed that BMI was significantly associated with a number of risk factors related to cardiovascular disease (254). In men, BMI was significantly associated with fasting insulin, two-hour insulin, fasting glucose, two-hour glucose, fasting triglycerides, total cholesterol and uric acid, but not with systolic and diastolic blood pressure and HDL cholesterol. In women, BMI was associated with all the risk factors except total cholesterol, and systolic blood pressure. Waist/hip ratio was also significantly associated with a number of these risk factors; more so in women than in men. Neither BMI nor waist/hip ratio, however, explained more than seven per cent of the variance in these risk-factor levels.

There may be several reasons for the weak association of body fat measures and cardiovascular risk factors among Nauruans. One may be that only 6% of the men and 7% of the women in the survey had BMIs in the normal range (<25 kg/m^2). This would reduce the power of the analysis to determine differences between normal and obese individuals. BMI measures may not be reliable to predict cardiovascular risk in very obese groups, perhaps because all are at risk. There also may be a 'ceiling' or a threshold level of body fat or of fat distribution above which additional fat has less of an influence on metabolic disturbances or above which additional adverse effects are difficult to demonstrate (254).

Commonwealth of the Northern Mariana Islands

Summary

- There are few recent data related to prevalence of overweight or obesity in adult persons in CNMI.
- High rates of obesity have been reported among children – 39% of 5 to 11 year old school children were classified as either overweight or obese.

Between 1948 and 1950, the United States Navy conducted a large health survey of over 22,000 inhabitants of the Marshall Islands, the Caroline Islands and the Northern Mariana Islands (183). Approximately 5000 children and adults in Saipan were examined. The median age was 17.3 years. The mean height for males in the 25 to 34 year age group was 65.4 inches (166 cm) and for females was 60.9 inches (155 cm). Weight was reported by height categories. The estimated BMI, calculated from mean weight by height categories was 24 kg/m^2 for males and 26 kg/m^2 for females.

The CNMI National Food and Nutrition Policy and Ten-Year Plan of Action (414) states:

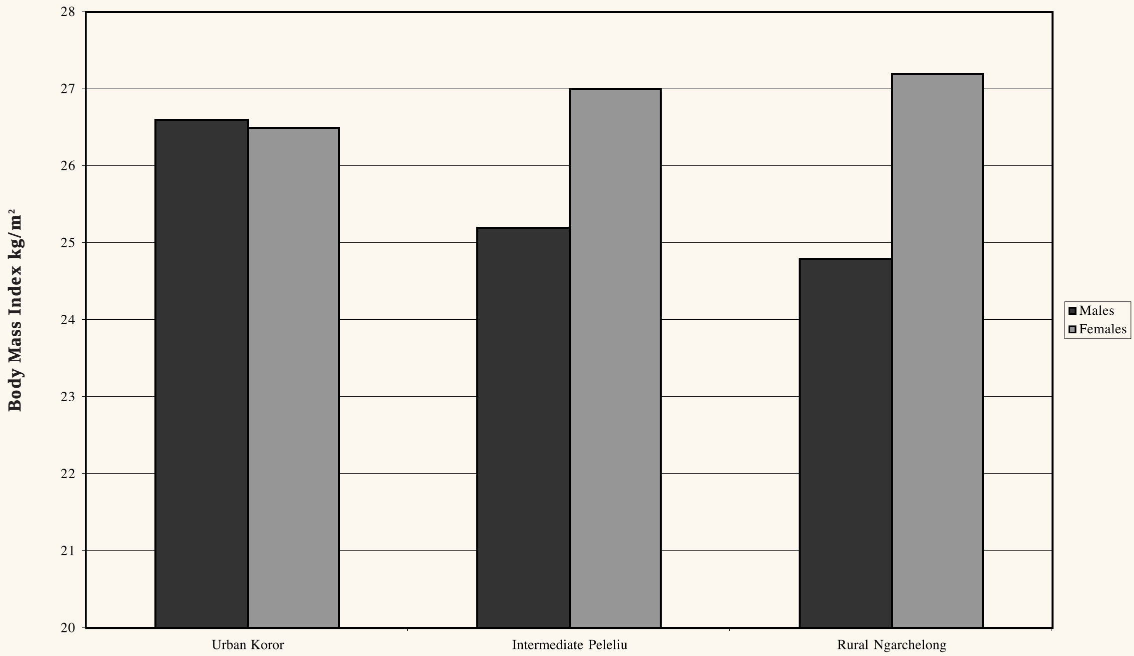
> *Obesity is a primary public health concern for the CNMI and a major contributing factor with a variety of non-communicable diseases such as diabetes, hypertension, heart disease, stroke and breast cancer. In 1992, a non-communicable disease survey was performed using the Department of Public Health Central Database. There were 477 obese patients of which 291 were females.........One thousand seven hundred (1700) women had recorded weights over 180 pounds (82 kg)....Obesity ranked as the 9th leading 'purpose of visits to outpatient clinics for females. Most of the obesity seen in the CNMI has its onset in childhood and is associated with high-fat and high-calorie diets.* (414)

The CNMI National Nutrition Policy further revealed that 11.5% of 3 to 4 year olds are overweight (> 95th Weight for Height percentile) compared to an expected 5%. Also that 39% of 5 to 11 year olds were either overweight or obese. These rates were prevalent in all four CNMI ethnic populations: Chamorros, Carolinians, other Micronesians and Filipinos.

Palau

Over 10,000 inhabitants of Palau were included in a health survey conducted by the United States Navy between 1948 and 1950 (183). The median age of Palauans was 23.6 years. The mean height reported for males in the 25 to 34 year age group was 64.7 inches (164 cm) and for females was 60.1 inches (153 cm). Weight was reported by height categories. The estimated BMI, calculated from mean weight by height categories was 24 kg/m^2 for both males and females.

Health surveys were carried out in 1968–70 among 510 adults in three communities in Palau (191). The administrative centre of Koror was the urban setting; intermediate communities were in Peleliu, a rural island with frequent boat service to the commercial centre; and the rural villages were in Ngarchelong, which had minimal access to urban centres. The mean BMI, as estimated from mean weight and height measurements, for males, was highest in the urban area compared with the rural and intermediate communities as shown in Figure 6.20. This was not true for females, however. Females in the rural villages had the highest BMI compared with the urban or intermediate villages.



Source: (191)

Figure 6.20: Mean estimated* Body Mass Index (kg/m^2) in Palauan females and males by level of urbanisation, 1968–70

* Self reported: estimated BMI = mean weight (kg)/mean height (m^2)

The lowest levels of per cent body fat, as estimated by triceps and subscapular skinfold measurements, were reported among the rural participants for both females and males compared with individuals living in intermediate and the urban communities. Since these researchers did not report BMI, they did not comment on the higher BMI yet lower skinfold measurements among the rural women. The rural women were shorter than the urban women, and they may have also had greater muscle mass and thus higher BMI and lower per cent body fat.

This survey also reported the lowest levels of blood pressure, serum triglycerides, serum cholesterol and serum glucose among rural villagers and highest levels among the urban residents (255).

There have been no recent data regarding overweight and obesity from Palau.

Polynesia

American Samoa and Samoa

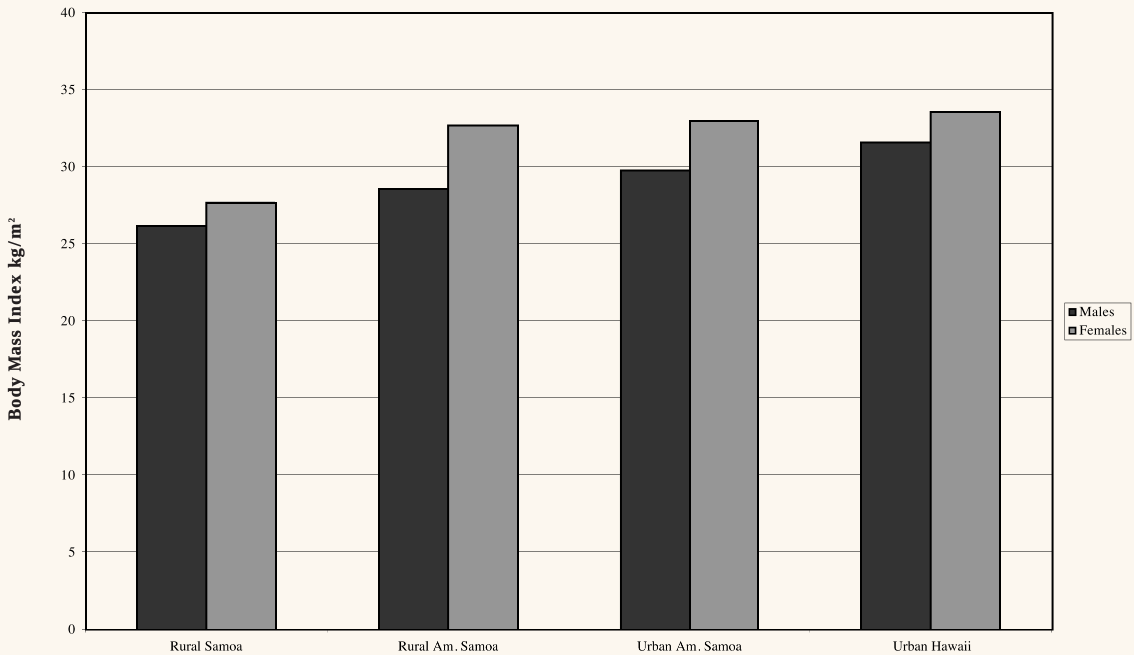
Summary

- Studies in the 1970s showed that Samoans living in Hawaii or in California were among the heaviest population in the world.
- In the 1990s the prevalence of obesity was over 64% for both males and females. These are some of the highest rates in the Pacific – and perhaps the world.

A number of NCD surveys have been conducted in American Samoa and Samoa (formerly Western Samoa) over the past three decades. Several of these studies have compared Samoans living in Samoa, American Samoa, Hawaii and California.

A series of studies was carried out among Samoans beginning in 1975 as part of the Pennsylvania State University Samoan Migration Project (415, 416). These investigations compared obesity and cardiovascular risk factors among Samoans living at differing levels of urbanisation. Samoans living on Upolu, Samoa were considered as having the most traditional lifestyle. Adults from American Samoa included those from the Manu'a islands who lived a rural lifestyle but had easy access to western goods and those from the central area of Tutuila, which is the centre of commerce and government. Samoans living in several areas on Oahu, Hawaii and in the San Francisco area of California were considered the most westernised.

The earliest studies conducted by McGarvey (416) clearly showed the steady increase in BMI from Samoa to American Samoa to Hawaii as seen in Figure 6.21. It should be noted that the mean BMI of all groups was greater than the cut-off commonly used to define overweight – BMI ≥25 kg/m².



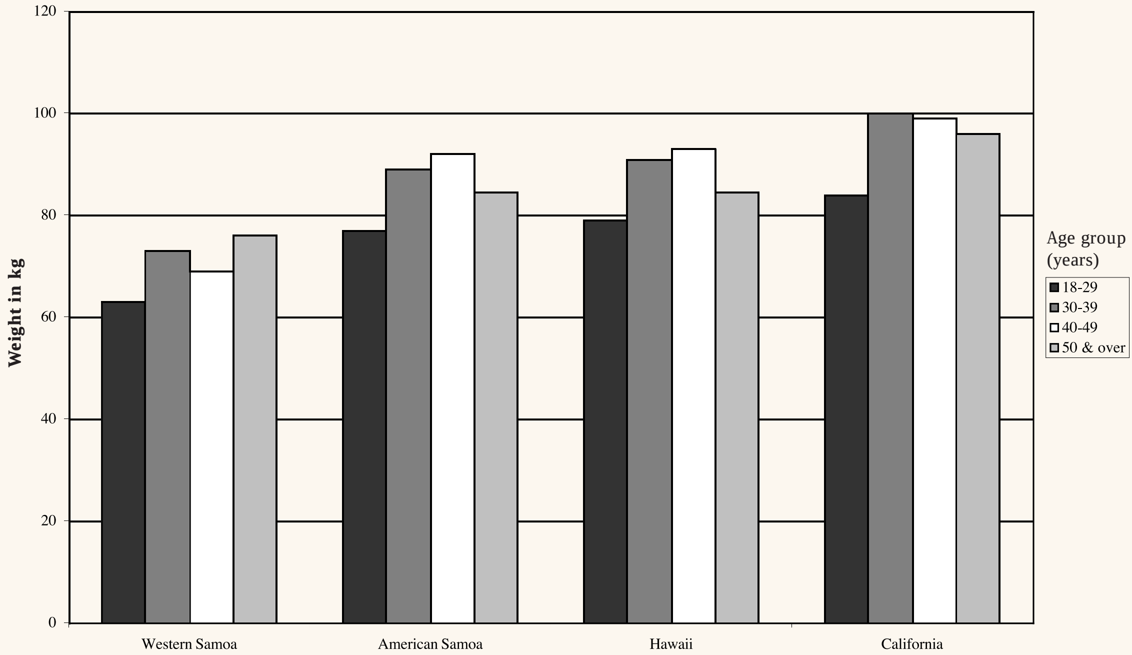
Source: (416)

Figure 6.21: Mean Body Mass Index of Samoans by gender and level of urbanisation, 1975–77

McGarvey (416) also showed an alarmingly high prevalence of overweight and obesity among urbanised Samoans and that obesity in urbanised Samoans was beginning at younger ages, particularly among the women.

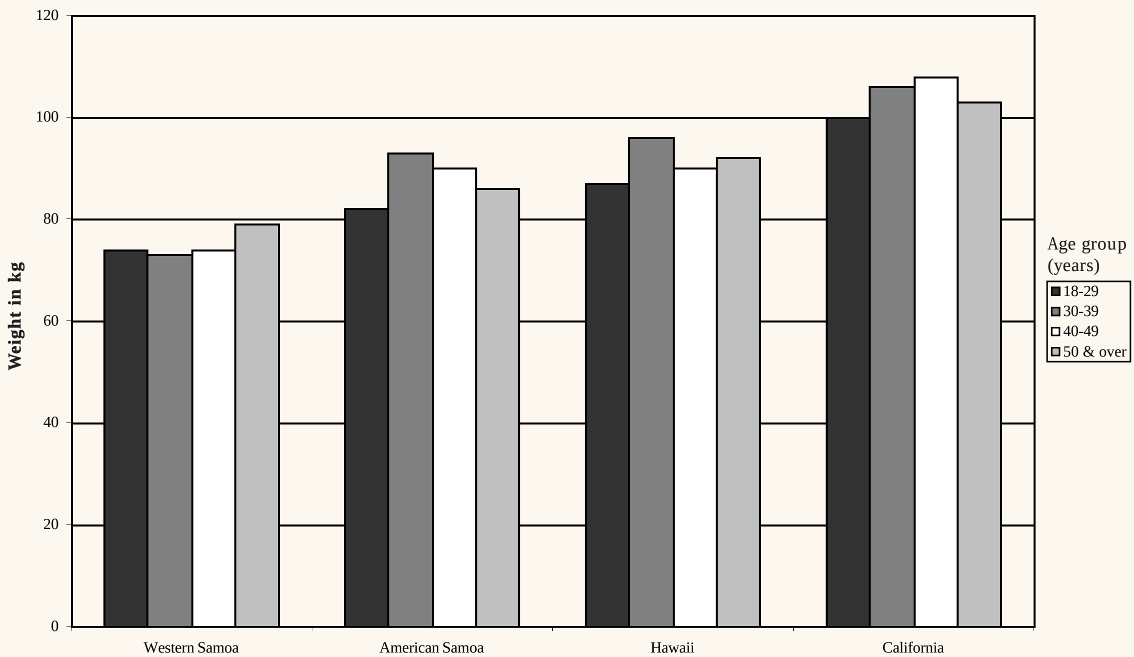
A further study of a small group of Samoans living in San Francisco compared the weight of U.S. Samoans with those living in Hawaii, American Samoa, and Western Samoa (222). Figures 6.22 and 6.23 show that the San Francisco Samoan females and males weighed significantly more than the other groups. In fact, the mean weight of males in San Francisco was over 100 kg, and the mean weight of females over 90 kg in all age groups. The investigators concluded:

> *our work so far has led us to believe that Samoans who have moved to California may represent the world's fattest and heaviest sub-population.* (222)



Source: (222)

Figure 6.22: Mean weight (kg) in four FEMALE Samoan groups



Source: (222)

Figure 6.23: Mean weight (kg) in four MALE Samoan groups

A five-year longitudinal study was conducted on 180 males and 424 females from Manu'a and Tutuila (416). The age groups with the greatest gain in BMI over the five-year period were in the 18 to 35 year age range (1.9 ± 2.7 kg/m^2 for males and 2.7 ± 2.7 kg/m^2 for females). Samoans in the 55 ± age group, experienced loss in BMI, –0.05 ± 1.9 for males and –0.07 ± 2.5 for females (data not shown).

The five-year incidence of obesity (BMI≥ 32.2 for females and ≥ 31.1 for males) was greatest for males aged 18 to 34 years (38%) and females 18 to 34 years (30%). The criteria used to define overweight and obesity in this survey were translated from the 85th and 95th percentile weight distribution of the US National Health and Nutrition Examination Survey, 1976–1980 (250):

Overweight:	BMI ≥ 27.3 for females
	≥ 27.8 for males
Obesity:	BMI ≥ 32.3 for females
	≥ 31.1 males

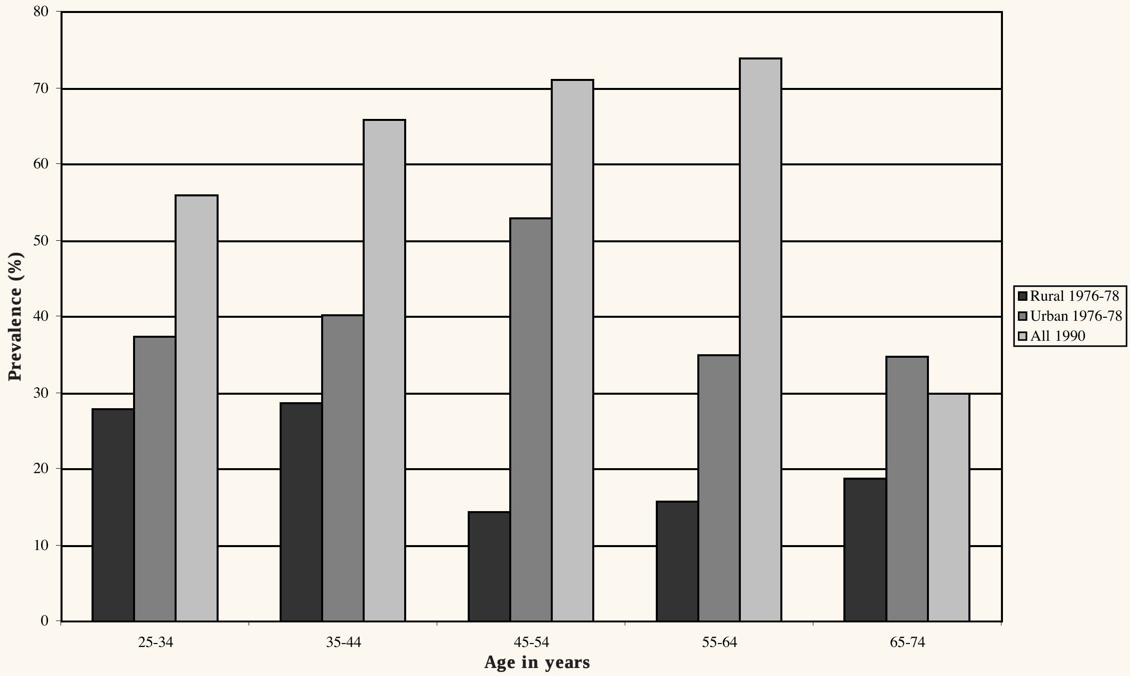
The incidence of obesity in the Samoan population would be higher had the lower cut-off level for obesity been used (BMI ≥ 30 kg/m^2).

These same researchers (417) again examined Samoans in 1990 and compared the rates of overweight and obesity with those in the 1976–78 survey. The 1990 sample consisted of 479 females and 351 males, aged 25 to 74 years, recruited from 34 villages throughout American Samoa. Participants in this study were recruited from the same villages as in the 1976–78, survey but the selections were not randomly chosen.

Figures 6.24 and 6.25 highlight the dramatic increases in the proportion of American Samoans severely overweight (BMI ≥ 32.2 for females and ≥ 31.1 for males) in the 1990 examination compared with that of the rural and urban groups included in the 1976–78 surveys. The proportion of obesity among females was significantly greater than among males in all age groups except the 45–54 and the 65–74 year age groups.

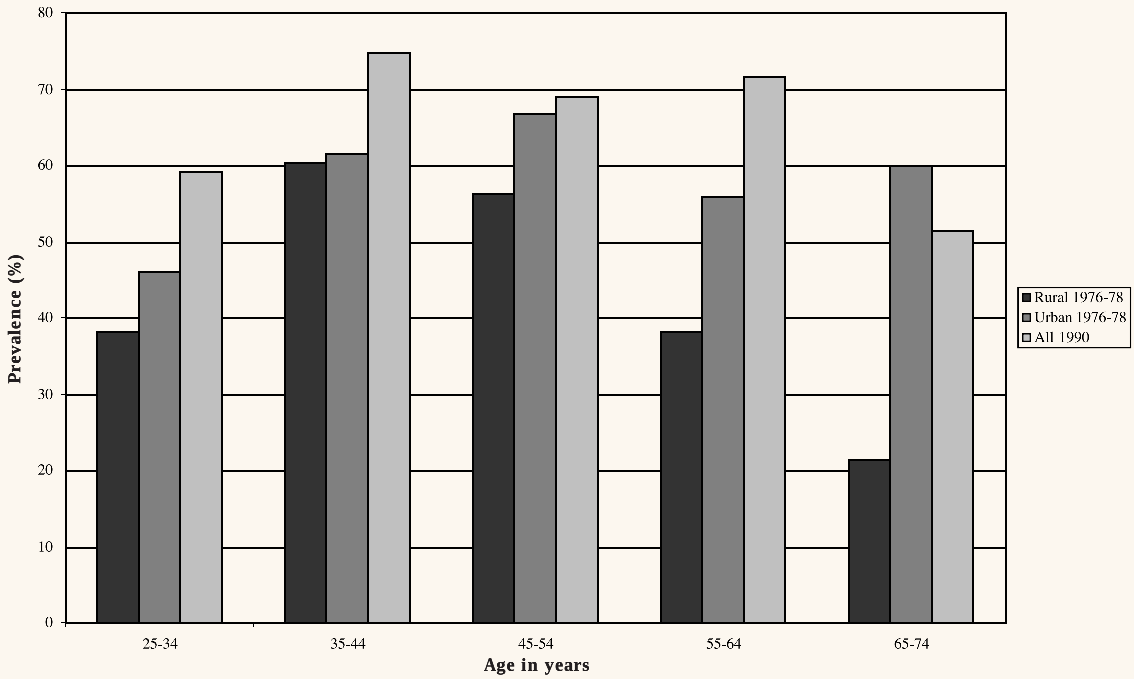
The proportion of obese males was consistently and significantly greater in 1990 than in 1976–77 in all age groups except the oldest. The increase was greatest in the 45–54 year age group where the increase from rural 1975–77 to all 1990 was more than 500%.

These obesity prevalence rates are among the highest in the Pacific and the world (3).



Source: (417)

Figure 6.24: Prevalence of obesity* in American Samoan FEMALES, 1975–77 and 1990
*Obesity = BMI ≥ 32.2 kg/m2



Source: (417)

Figure 6.25: Prevalence of obesity* in American Samoan MALES, 1975–77 and 1990
*Obesity = BMI ≥ 31.1 kg/m2

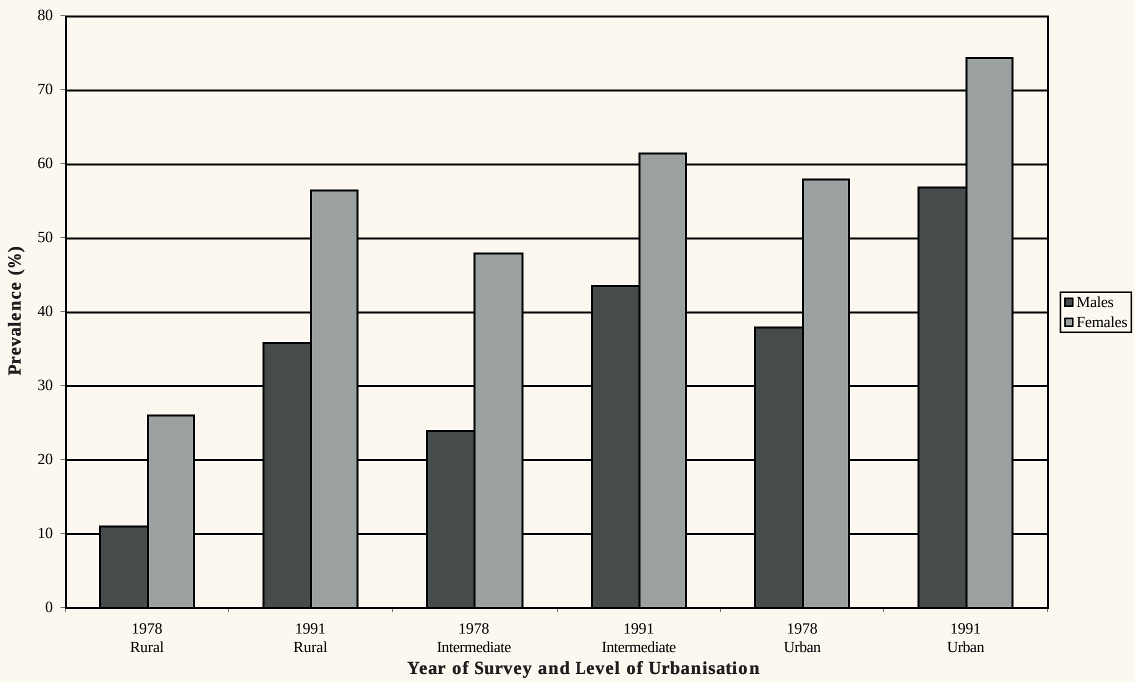
Samoa (formerly Western Samoa)

Summary

- Rates of obesity have increased in rural communities by 200 to 300% between 1978 and 1991.
- Rates of obesity are highest among urban women (74%) and lowest among rural men (36%).

The International Diabetes Institute (328,418) conducted a survey of non-communicable diseases in Samoa in 1978, with a follow-up study in 1991. The three areas included in the survey were chosen to reflect varying degrees of urbanisation. Apia, on the island of Upolu is the commercial and government centre of Samoa and represents the most urbanised population. The intermediate community, Poutasi, located about 30 minutes from Apia is considered rural, yet there is easy access to Apia and to imported goods. Tuasivi on the island of Savai'i is considered the most rural, but ferry and air access to Apia has improved since 1978. All residents of those defined areas aged between 25 and 74 years were invited to participate in the survey. Of 1489 adults who were included in the 1978 survey, 369 participated in the 1991 survey. In total, 1786 Samoans took part in the 1991 examinations.

Figure 6.26 illustrates the dramatic increase in the prevalence of obesity (BMI ≥30) from the 1978 survey to the follow-up examinations in 1991. The figures emphasise the higher rates of obesity among women compared with men and the higher rates of obesity in urban areas than in rural communities. The greatest increases, however, were seen in the rural areas where the rates increased by more than 300% among the males and 200% among the females. Although the rates of increase in the urban areas were not as dramatic as in the rural areas, the prevalence of obesity is still significantly higher in the urban areas for both males and females.



Sources: (328,418)

Figure 6.26: Prevalence of obesity among Samoan females and males, 1978 and 1991

Greksa (419) reported fitness levels and work capability of manual labourers in American Samoa. The study included 284 males aged 18 to 60 years who were a subsample of individuals examined during several surveys carried out to evaluate the consequences of urbanisation on the health of Samoans (219). Mean height was 170.8 cm; mean weight 85.1 kg; triceps skinfolds 20.4 mm; and BMI calculated from mean height and mean weight was 29.2.kg/m^2. The maximal energy-producing capacity of an individual was measured. The results suggest that body fatness indirectly affects work capability through its negative impact on maximal energy-producing capacity. The investigators also concluded that, despite their low maximal energy-producing capacity, Samoan manual labourers, may have adequate work capability.

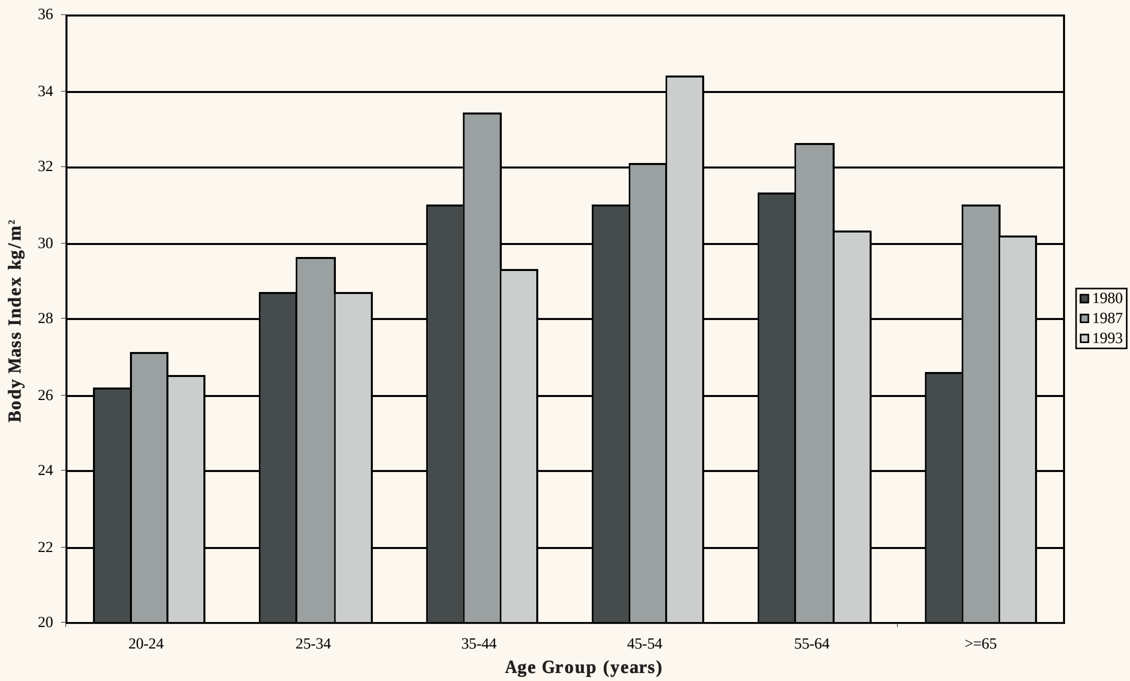
Cook Islands

Summary

- 40% or more of males and females living on Rarotonga are classified as obese.
- This obesity may begin as early as infancy.

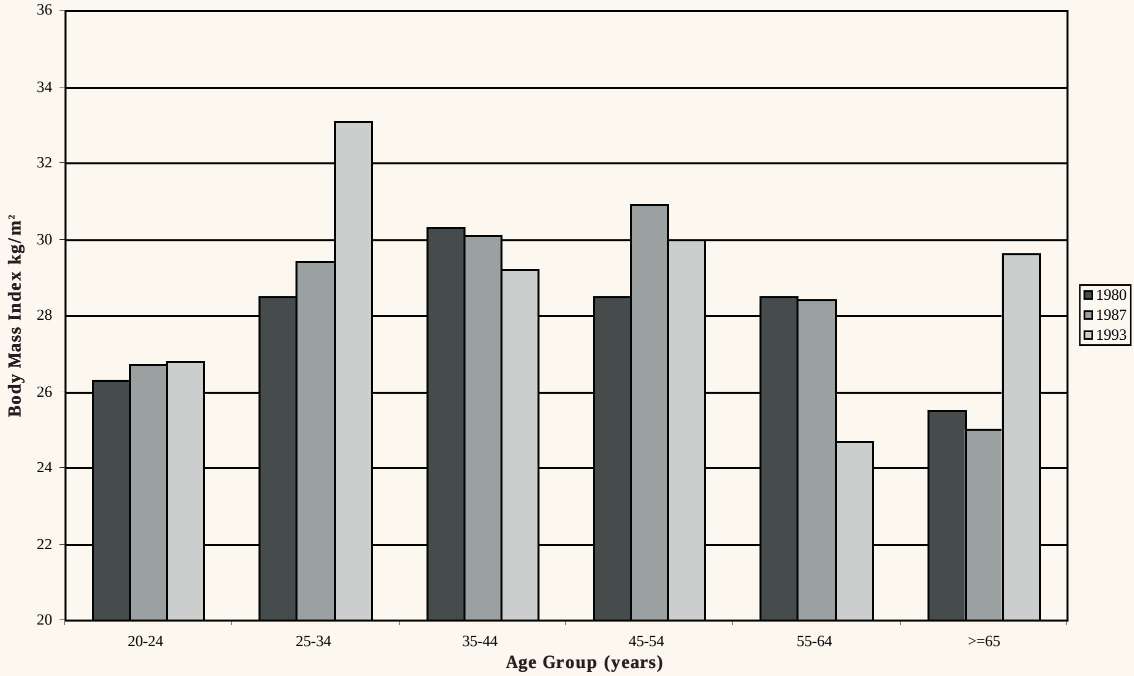
One of the earliest nutrition surveys conducted in the 1950s in the Cook Islands included 365 people of all ages from the village of Arorangi on the island of Rarotonga (420). This survey provided height and weight measurements for 81 females and 82 males 21–60 years of age. The BMI ranged from 28 to 31 kg/m^2 for females and from 25 to 27 kg/m^2 for males. Subjective ratings of nutritional status were also assigned in this early survey.

> *Most of the people are graded 3–4, that is, average to good. Only one person was so outstanding as to deserve 5 and only three so poor as to deserve 1…..Posture was reasonably good, as was muscular development. Obesity was the rule, especially in women.* (420)



Sources (85,198,200)

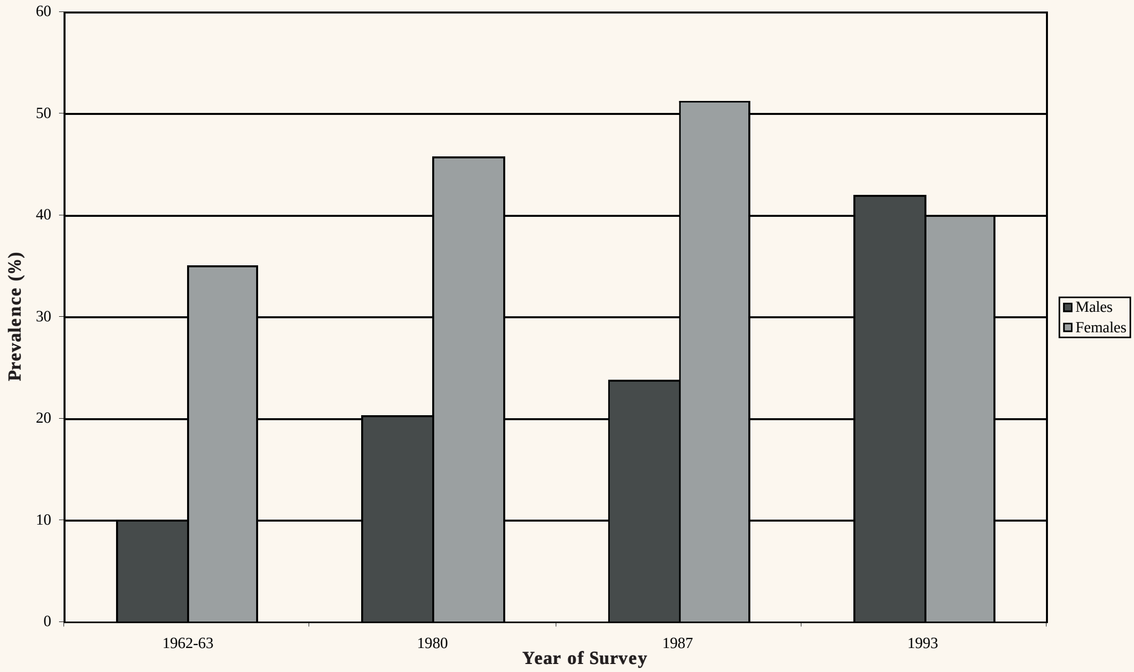
Figure 6.27: Mean Body Mass Index of Cook Island FEMALES by age group, 1980, 1987 and 1993



Sources (85,198,200)

Figure 6.28: Mean Body Mass Index of Cook Island MALES by age group, 1980, 1987 and 1993

In 1962–1963, Prior and co-workers (84,324) investigated the health status of two communities in the Cook Islands. One group lived on the isolated coral atoll of Pukapuka, and the other lived in the urban centre on Rarotonga. Twice as many Rarotongan men (13%) as Pukapuka men (6%) were overweight or obese (≥120% ideal body weight). More women were overweight or obese than men and more Rarotongan women (46%) were overweight than Pukapuka women (23%). Data for urban and rural groups together are presented in Figure 6.29 and are compared to subsequent surveys.



Sources (84,85,198,200)

Figure 6.29: Prevalence of obesity in Cook Island females and males, 1962–63, 1980, 1987 and 1993

The SPC conducted two surveys in the Cook Islands during the 1980s. The first survey in 1980, (198) included 1127 Cook Islanders on Rarotonga, the largest and most densely populated of the Cook Islands. In all age groups, the mean BMI was above 25 kg/m^2 – the usual cut-off level for defining overweight. The mean BMI for females was 29.1 kg/m^2 and for males was 27.9 kg/m^2 (Figures 6.27 and 6.28). The prevalence of obesity for men (BMI ≥32) was 20%, while almost half of the women (46%) were obese (BMI ≥30) as seen in Figure 6.29.

A smaller survey was carried out during that same year on Manihiki Atoll by Weinstein and co-workers (325). Although the island is geographically remote, islanders enjoyed a good income from the sale of copra and pearl shell. Most food was locally grown but was also supplemented with imported foods. The prevalence of reported obesity was similar to the rates in Rarotonga – 20% of males and 50% of females (data not shown).

The SPC carried out a second survey in 1987 on Rarotonga that included 1277 adults 20 years of age and over (200). Thirty-six per cent of the sample had participated in the 1980 survey. The mean BMI for all men was significantly higher in 1987 (28.4 kg/m^2) compared with the 1980 survey (28.0 kg/m^2). For women, the mean BMI was also higher in 1987 (31.0 kg/m^2) than in 1980 (29.1 kg/m^2). Figures 6.27 and 6.28 reveal higher BMIs in most age groups.

There was an increase in the proportion of males and females classified as obese (BMI ≥ 32 for men and ≥ 30 for women) from 1980 to 1987 but these differences were not statistically significant. Approximately 24% of the men and 51% of women were classified as obese in 1987, compared with 20% and 46% respectively in 1980 as shown in Figure 6.29.

A similar health survey was conducted in 1993 in two villages on Rarotonga. Tutakimoa is located near the administrative centre of Rarotonga and Muri was a village located on the far side of the island. The mean BMI for men did not change appreciably from 1987 to 1993 (from 29 to 30 kg/m^2) or for women, (from 31 to 30 kg/m2) as seen in Figures 6.27 and 6.28. While the prevalence of obesity for women decreased over this time period from 51 to 40%, the prevalence for males actually increased from 24%

to 41% as shown in Figure 6.29. These findings, however, should be interpreted with caution. The sample size of the 1993 survey was relatively small (48 men and 84 women) compared with the other two surveys. Also the criteria for classifying obesity in men decreased from a BMI of 32 kg/m^2 to 30 kg/m^2. We would therefore expect more men to be classified obese in 1993 than in 1987.

There is also concern that obesity may begin early in life – as early as infancy. The 1998 Rarotonga Infant Growth Monitoring Project (421) reviewed the growth of 613 infants aged 0 to 23 months born in Rarotonga between 1 January 1995 and 30 April 1998. The analysis found that 13% of infants were macrosomic (birth weight >4000 gms) and that 30% of infants aged 0 to 5 months and 20% of infants aged 6 and 7 months were overweight compared with National Center for Health Statistics and WHO (NCHS/WHO) reference standards (398). It is not known if this analysis reveals true overweight due to maternal weight or infant feeding practices or physiological differences in body composition.

French Polynesia

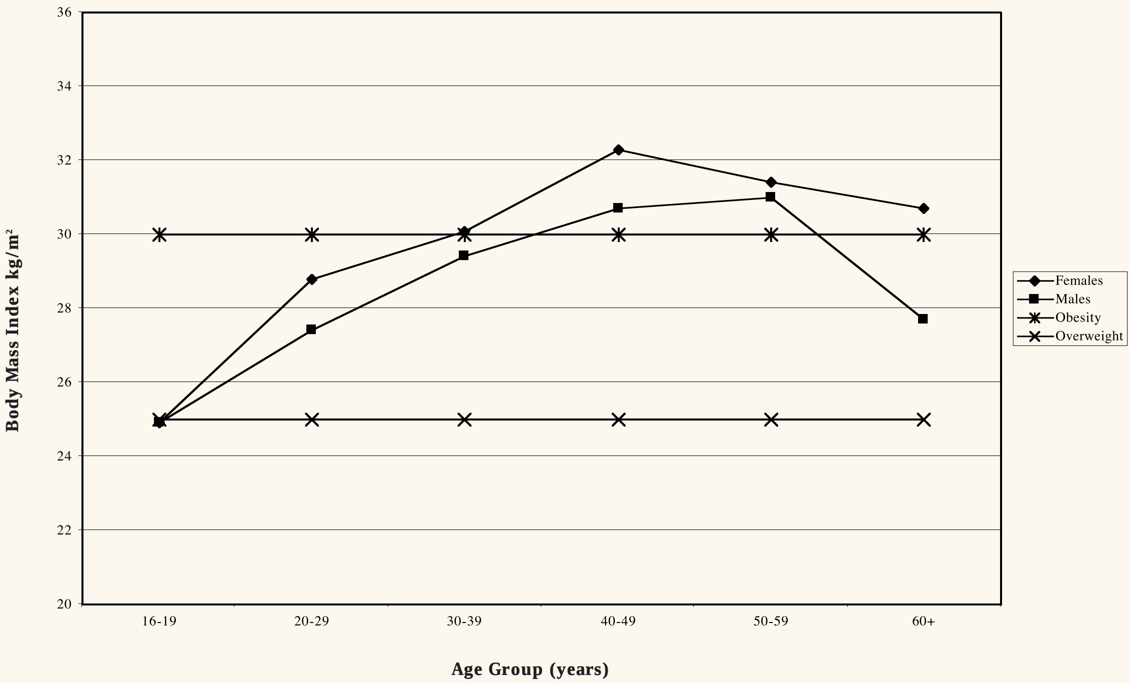
Summary

- Over 70% of both males and females in French Polynesia are reported to be overweight or obese.
- Females experience higher rates of obesity and severe obesity than males.
- Urban/rural differences appear to be diminishing.

Two non-communicable disease surveys have been conducted in French Polynesia. The first was in 1983 and included over 4500 adults employed in private business or in public service positions in Tahiti (205). The second survey was carried out in 1995 in six districts in the territory by the Ministère de la Santé et de la Recherche (19).

The 1983 Tahiti survey included adults aged 18 to 59 years with more males (2903) than females (1670). The unadjusted prevalence rates of overweight and obesity were 35.9% and 21.3% respectively for males and 20.2% and 15.4% respectively for females. The survey report does not provide the ethnic composition of the sample. The 1983 census for Tahiti indicates that Polynesians make up 80% of the island followed by 14% Europeans (422).

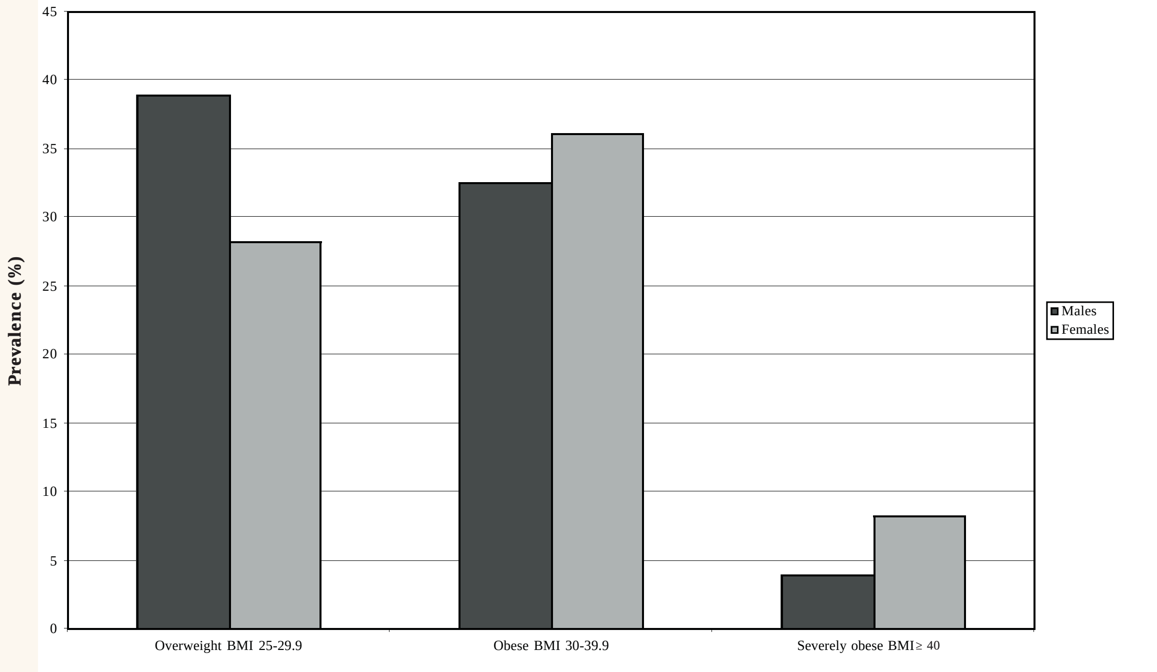
In the 1995 survey, 1273 individuals 16 years of age and over were included in the examinations, 82% of whom were Polynesian. The mean BMI for females was 29.8 ± 7.2 kg/m^2 and for males was 28.8 ± 5.7 kg/m^2. Figure 6.30 shows the steady weight gain experienced by both females and males beginning in their early 20s and continuing up through the middle adult years, with a slight decline in weight in the later adult years.



Source: (19)

Figure 6.30: Mean Body Mass Index in French Polynesia by gender and age group, 1995

Figure 6.31 provides the prevalence of overweight, obesity and severe obesity for females and males for all ages combined (not age-adjusted). Over 70% of both males and females are overweight or obese. The age-adjusted prevalence of obesity (BMI ≥30) was 43.4% for females and 34.6% for males. Of concern are the larger proportions of women in the obese and severely obese categories. There were no apparent differences in the prevalence of obesity and overweight between rural and urban areas. The investigators suggest that this lack of difference may be due to similar lifestyle factors in rural and urban areas. This survey also reported high rates of diabetes (see Chapter 5, Diabetes Mellitus).



Source: (19)

Figure 6.31: Prevalence of overweight and obesity in French Polynesia by gender, 1995

Niue

Summary

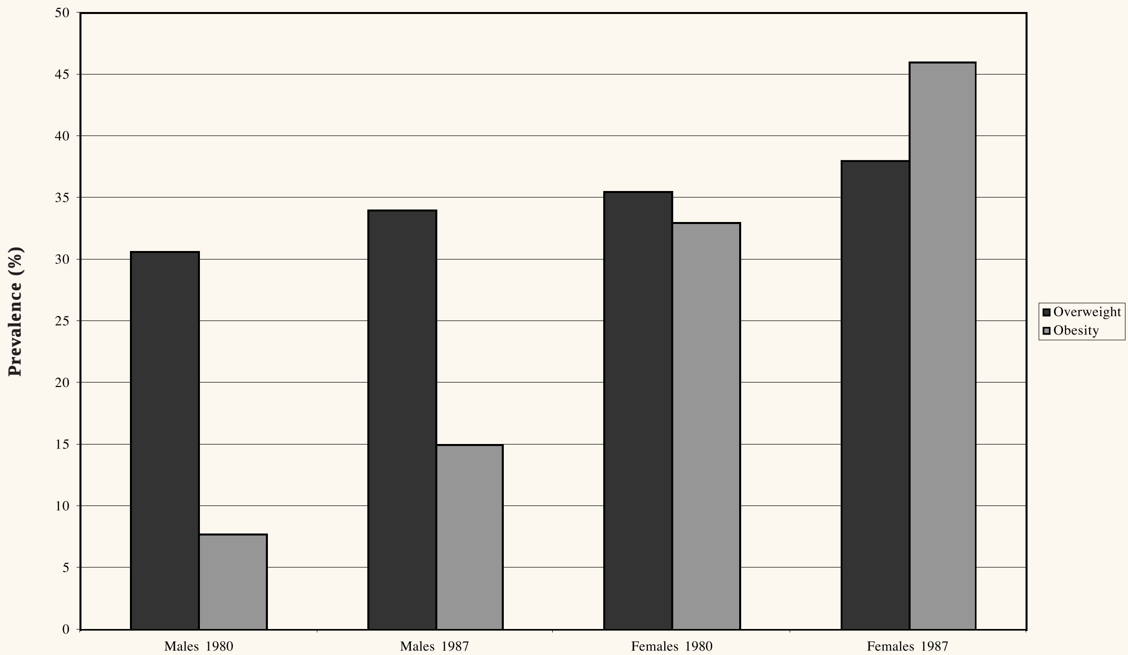
- Prevalence rates of obesity increased dramatically for males and females between 1980 and 1987.
- Rates of obesity are considerably higher for females (46%) compared with males (15%).

The mean weight measurements of a small number of Niuean adults were provided in a 1953 nutrition survey report as 69 kg for males and 66 kg for females (88). The mean BMIs calculated from mean weight and mean height values were 25 kg/m^2 for males and 27 kg/m^2 for females. It would thus appear that as early as 1953 overweight was beginning to be a concern among women.

A 1980 cardiovascular disease and diabetes survey conducted by SPC (198) included 1149 adults aged 20 years or older. This was estimated to be 96% of the eligible adult population. The results shown in Figure 6.32 reveal that females were much more likely to be obese (33%) compared with males (8%). The cut-off level for obesity for females was BMI ≥30 kg/m^2 and for males BMI ≥32 kg/m^2.

A National Nutrition and Dietary Survey was conducted in Niue in 1987 in which 748 Niuean adults participated (89). The mean BMIs for females were higher than for males and ranged from 29 kg/m^2 in the 20–29 year age group to 32 kg/m^2 in the 40–49 year age group. Mean BMIs for males ranged from 27 to 29 kg/m^2 for the same age groups.

Females experienced more obesity than males both in 1980 and in 1987 as shown in Figure 6.32. The figure also highlights the dramatic increase in obesity from 1980 to 1987, particularly for the women.



Sources (89,198)

Figure 6.32: Prevalence of overweight and obesity in females and males in Niue, 1980 and 1987
Overweight – females BMI 25–29.9; males = BMI 27–31.9
Obesity – females BMI ≥30; males BMI ≥32

Tokelau

Summary

- A dramatic increase in weight was reported for Tokelauan males and females between 1968–71 and 1980–82.
- Weight gain occurred among Tokelauans who remained in Tokelau and those who migrated to New Zealand.
- Tokelauans who migrated to New Zealand were heavier at almost all ages than non-migrants.
- Among men, migration resulted in increased central-body fat distribution.

W. Burrows, a visitor to Fakaofo in the Tokelau Islands in 1923, described the physique of the islanders:

> *The natives of the Tokelau groups do not present uniform physical characteristics. They are a big people, but unlike the Samoans, do not seem to 'run to fat'. It is a rare thing to see either an old man or old woman who has become ungainly, and the women especially keep their figures to an advanced age....They appear to be a healthy race…One factor in the lives of the people that tends to keep them fit is the fact that they are compelled to put out in their canoes almost daily to obtain fish.* (423)

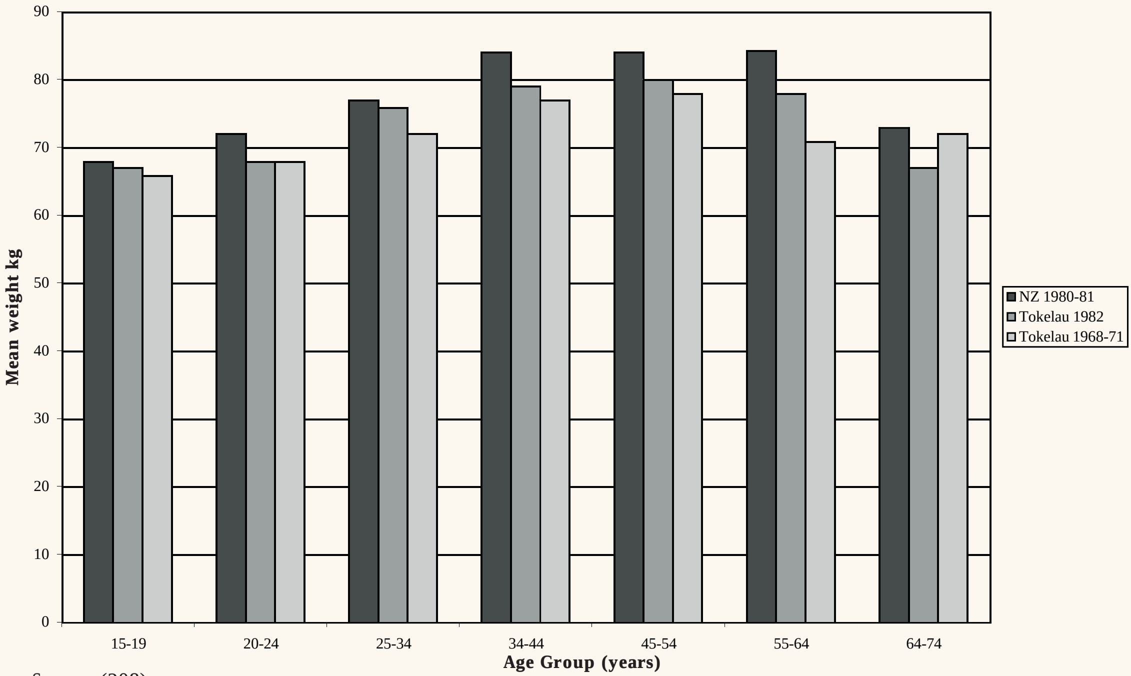
The Tokelau Island Migrant Study was a long-term research project designed to investigate the degree of changes in disease patterns that would take place when Polynesians from the Tokelau Islands immigrated to New Zealand (208). One of the questions asked by the New Zealand investigators was: would the Tokelauans who migrated to New Zealand develop obesity, diabetes and risk factors for coronary heart disease at higher rates than those atoll-dwellers who remained on their home islands?

The studies were carried out in three rounds of expeditions to the Tokelau Islands and three survey rounds in New Zealand. Table 6.9 provides the numbers of adult Tokelauans seen in Tokelau and in New Zealand and the dates of each of the expeditions.

Table 6.9: Tokelauans seen in Tokelau and in New Zealand in the Tokelau Island Migrant Study

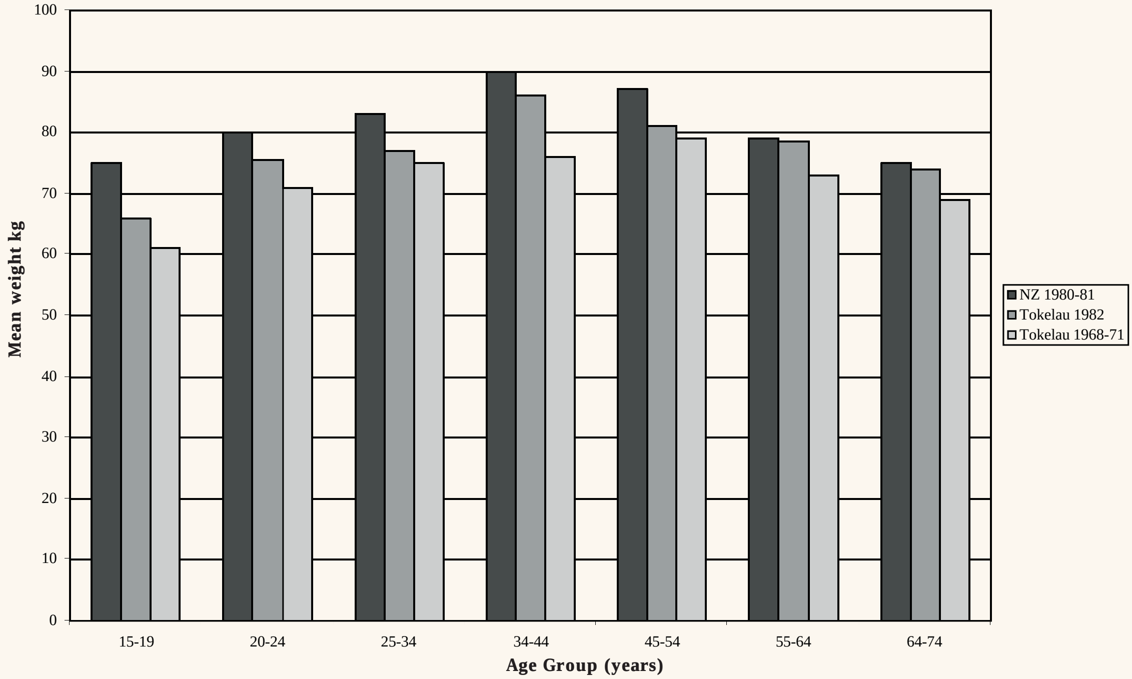
	Adults seen (≥ 15 years)	
	Tokelau	New Zealand
Round I	1968–71	1972–74
	900	914
Round II	1976	1975–77
	842	1187
Round III	1982	1980–81
	810	1381

Figures 6.33 and 6.34 below compare the mean weight for females and males by age group for the baseline Round I survey in Tokelau (TOK Round I) with the Round III in Tokelau and Round III in New Zealand. The figures illustrate that there was substantial weight gain for both females and males between Round I and Round III in both environments. The figures show that Tokelauans who migrated to New Zealand were heavier at almost all ages than the non-migrants. Weight gain among the women increased up to 35 years, was maintained till about 55 years and then dramatically declined. For the men, weight gain increased up to age 45 and then saw a gradually declined. Estimates of BMI were not available nor comparisons of the mean height of migrant vs native Tokelauans.



Source: (208)

Figure 6.33: Mean weight by age for Tokelauan FEMALES by date and location



Source: (208)

Figure 6.34: Mean weight by age for Tokelauan MALES by date and location

Stepwise multiple regression analysis was performed for females and males using BMI as the dependent variable and age, years in New Zealand, and several sociological factors, as independent variables. Age and years in New Zealand were highly significant predictors of obesity in both genders at all three Rounds. The longer migrants had lived in New Zealand, the greater the BMI. For women, those 'less assimilated' tended to have larger BMI. One explanation for this was that the 'less assimilated' women might have retained the tradition of feasting and/or also had a lack of concern regarding obesity. The 'more assimilated' women, on the other hand, may have adopted more western ideas about weight control and had more awareness of nutritional advice regarding low-calorie food choices.

A study of body-fat distribution was carried out on a subset of Tokelauans in the Round II expeditions (424). In Tokelau, 145 women and 135 men took part; in New Zealand, 185 women and 245 men participated. The fat patterns were described using four skinfold measurements: triceps, subscapular, suprailiac and medial-calf. Analysis of variance was performed to determine the effect of age and migration on the pattern of fat distribution. In men, migration led to significantly more central distribution of fat (subscapular and suprailiac) compared with fat deposited in the extremities (triceps and medial-calf). Migration in men also effected a greater fat distribution in the upper portions of the body (triceps and subscapular) compared with the lower body (suprailiac and medial-calf). In women, migration was strongly associated with both increased upper and lower body fat distribution.

The same researchers (425) carried out a similar study on Tokelauan children aged 5 to 17 years of age. This investigation, also part of the Round II surveys, included 175 boys and 160 girls in Tokelau and 225 boys and 198 girls in New Zealand. Skinfold thickness measurements were performed at the same sites as in the above study. The study found that triceps skinfold thicknesses of the migrant children were higher than those of the island children and compared closely to those of US white children. Subscapular skinfold thicknesses were also higher among the migrant children and both groups of Tokelauans had higher thicknesses than the US sample. Migration had an effect of increased skinfold thicknesses on both boys and girls, but the most pronounced effect was among the females. The migrant children had more fat deposited in the trunk region and less in the extremities than the non-migrant children.

Tonga

Summary

- Over 60% of Tongan women in their middle-aged years are obese.
- Over 70% of Tongan men are either overweight or obese in their middle-aged years.

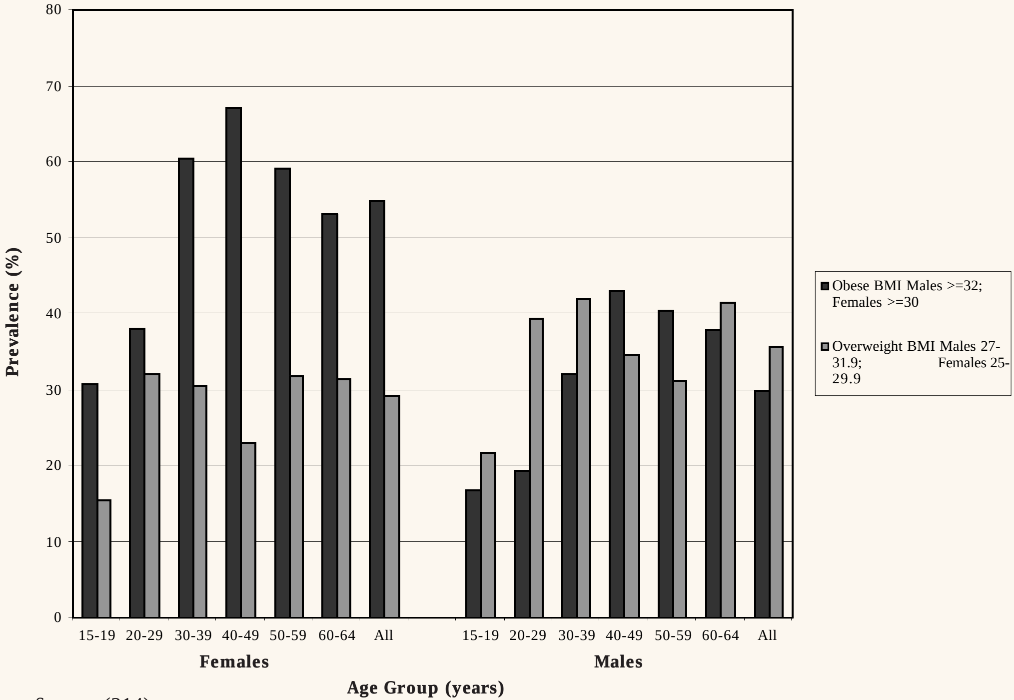
Researchers from the University of Tokyo carried out two physiological and nutritional surveys among two groups of Tongans aged 30 years and over (212). The first examinations, in 1977, selected 108 adults from the more remote island of Uiha. The second survey, in 1979, selected 148 individuals from Kolofo'ou, Nuku'alofa, the metropolitan centre of Tonga. Actual weight measurements were not provided, thus BMI could not be estimated. Mean weight values for all female age groups were greater than 80 kg except for the age group above 70 years. Mean weight values for males for all age groups appear to be greater than 85 kg for rural males and close to 100 kg for urban males.

Metabolic studies were performed in this study on a subset of 5 males and 4 females who weighed over 100 kg. Basal metabolism in the males was high and compared to that of athletes. A higher basal metabolism was reported for females than males although the researchers suggested that emotional stress during the examination might have been one explanation for this. Metabolism during bicycle exercise was higher in Tongan males and females compared with Japanese male farmers. The researchers suggested that Tongans' obesity is associated with larger muscularity which might be due to frequent isometric muscular work such as digging and cultivating gardens, cutting trees and coconut shells and very slow-paced walking (212).

Other investigators, also from the University of Tokyo (213) carried out a survey of cardiovascular disease in 1983 in Tonga. The survey included 102 adults ranging in age from 21 to 91 years. It is not clear if these individuals were also part of the above 1977 and 1979 surveys. Mean height and weight values for males and females were reported together as 173.9 ± 6.3 cm and 87.4 ±15.2 kg respectively. These calculate to a BMI of 28.9 kg/m2. Prevalence rates of obesity were not provided in the report.

The 1986 National Nutrition Survey of the Kingdom of Tonga included 1605 women aged 15 to 49 years and 672 men aged 20 to 49 years (108,426). The mean BMI for females was 29.5 ± 5.9 kg/m^2 and for males was 27.6 ± 3.8 kg/m^2. There was little difference between the mean BMIs of rural and urban Tongans. There was a higher prevalence of obesity and overweight among women than among men. Of the women, 78% were either overweight or obese and 39% were obese. Forty-eight per cent of men had BMIs ≥ 27 (overweight) and 10% were considered obese (BMI ≥ 32) (data not shown).

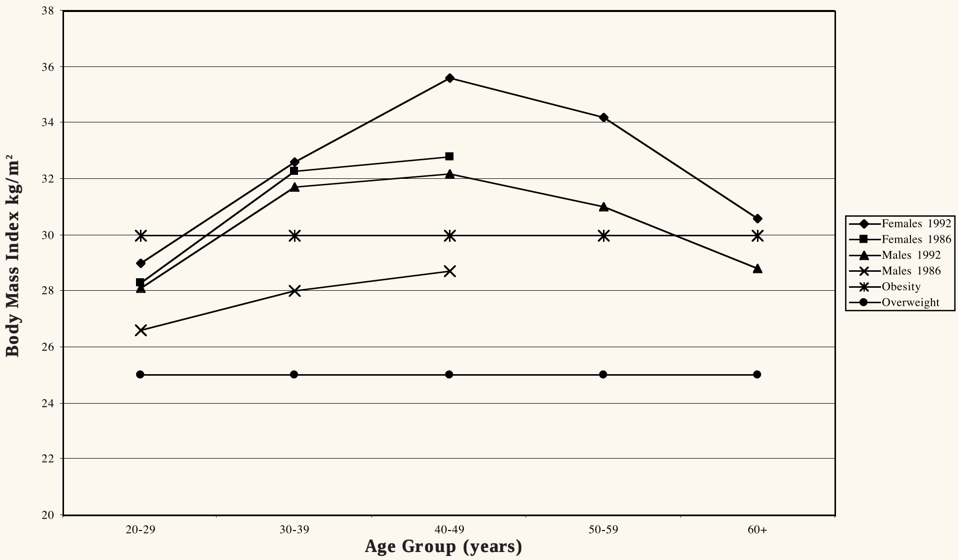
A survey of non-communicable diseases and nutrition was conducted in 1992 and included approximately 1000 Tongan adults (214). Figure 6.35 shows that among females, the rates of overweight (BMI 25–29.9 kg/m^2) and obesity (BMI ≥30 kg/m^2) rise dramatically with age to over 90% in the middle-age years. In those middle-year age groups, the rates of obesity were over 60%. Overweight and obesity appear to be lower among males, but this may be due to the higher cut-off criteria for overweight and obesity. In men, overweight was defined as BMI 27–31.9 kg/m^2 and obesity as BMI ≥32 kg/m^2. Using these criteria, rates of obesity for men are over 30% in the middle-age years and total overweight or obesity rises to more than 70%. Actual BMI values were not provided in this report.



Source: (214)

Figure 6.35: Prevalence of overweight and obesity in Tongan males and females, 1992

A sub-study of the 1992 NCD survey was conducted in Tonga to look at attitudes regarding body size perception and preferences (427). This sub-study covered 243 men and 299 women, including a small number involved in a weight-loss programme. Figure 6.36 compares mean BMIs in this sub-study by gender and age group with the 1986 National Nutrition survey. As noted, the 1986 survey included adults only up to the age of 49 years. Figure 6.36 reveals much higher BMI in 1992 in men at all age groups compared with the 1986 survey. In women, the greatest differences were seen in the 40–49 year age group.



Source: (428)

Figure 6.36: Mean BMI (kg/m^2) of Tongan females and males by age group, 1986 and 1992

Tuvalu

Summary

- Early health and nutrition surveys indicate that obesity may be increasing among women.
- There have been no recent data on prevalence of overweight and obesity in Tuvalu

An early nutrition survey was conducted in 1953 by Holmes (68). The mean BMIs calculated from mean weight and mean height measurements were 25.5 kg/m² for females and 26.5 kg/m² for males.

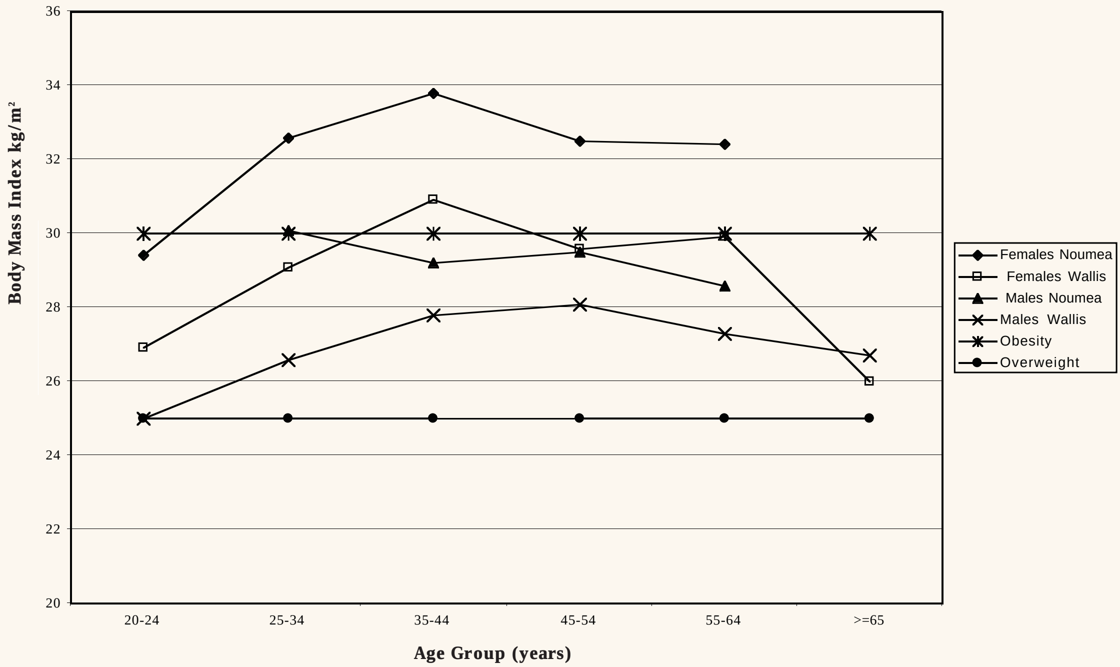
A survey of the prevalence of diabetes was undertaken in Tuvalu in 1976 (429). The mean BMI for women (n=308) was 29.0 kg/m² and for men (n=269) was 26.6 kg/m² (114).

The 1983 UNICEF Primary Health Care Study found that 75% of women over 29 years of age were either overweight or obese (430).

Wallis and Futuna

In 1980, a survey of non-communicable diseases was conducted by SPC among Polynesians residing on Wallis Island and Wallisians who had migrated to Noumea, New Caledonia (216). The 305 females and 274 males residing in the Wallis Islands were recruited from randomly selected rural villages. The Wallisian men in the city of Noumea (n=253) worked in the nickel factory and the women (n=311) came from communities where nickel factory workers were known to live.

Figure 6.37 shows the differences in BMI between Wallisians living in Wallis Islands and those living in Noumea. The Wallisian women living in Noumea were significantly heavier at every age group than the women living on Wallis Island. For the men, only the 25–34 age group of Wallisian men in Noumea was significantly heavier than the Wallis Island men.



Source: (216)

Figure 6.37: Mean BMI (kg/m²) of Wallisian females and males by age group and level of urbanisation

The prevalence of obesity was greater in Noumea than in Wallis. Sixty-six per cent of the Noumea Wallisian females were obese (BMI ≥30) compared with 46% of the Wallis Island females. Of the men, 23% of the nickel factory workers were rated obese (BMI ≥32) compared with 13% of the subsistence farmers in Wallis.

In 1996, Bezannier and Tauvale (335) conducted health surveys in 10 villages in the Mua district of Wallis Island. eight measurements were taken of over 1300 Wallisians aged 20 years and over. Height was not measured. The mean weight for males was 85.2 kg and for females was 81.8 kg. Lifestyle played a significant role in the weights of Wallisians. Those with significant excess weight were tradesmen and white-collar workers and State or Territorial sector labourers. Those with slight excess weight were private sector labourers and farmers.

Discussion

Obesity, which is a world-wide phenomenon (391), substantially increases the risk of morbidity from hypertension, diabetes, coronary heart disease, dyslipidemia, stroke, gall-bladder disease, osteoarthritis, sleep apnoea and respiratory problems, as well as breast, prostate, colon and endometrial cancers (400). Many of these lifestyle diseases are reaching alarming proportions in PICTs and there is much evidence that obesity plays a major role in their aetiology. The prevention and management of obesity has to be a key strategy in the prevention and control of non-communicable, so-called lifestyle, diseases.

Mortality

Obesity is widely accepted as a key risk factor for early mortality in industrialised countries (263,390,431,432). Yet this association between obesity and increased mortality in PICTs is less clear. Some studies in the Pacific have not shown this association.

An analysis of mortality records between 1976 and 1981 in American Samoa concluded that weight was not a statistically significant predictor of all-cause mortality, or mortality from cardiovascular disease (218). Crews (218) compared risk factors such as age, weight, height, BMI, per cent of desirable weight, and systolic and diastolic blood pressure among survivors and decedents who had taken part in health surveys conducted in 1975–76 (219). Death registration in American Samoa is reported to be nearly 100% complete.

The relative risk of mortality from cardiovascular disease (CVD) and from all causes adjusted for age and sex showed a J-shaped function (263,433). Compared to those with body weights 90–119% of desirable body weight, those below 90% desirable weight, had one-and-a-half times the risk of dying from CVD, while those above 160% of desirable body weight were at three times the risk. When the lower weight group was removed from the analysis, however, there was no statistically significant trend of increasing mortality with higher ranks of desirable weight.

When logistic regression models were fitted for total and CVD mortality by sex, age and diastolic blood pressure were independent predictors of mortality from all causes, but per cent of desirable weight was not. Although the sample size of this study was quite large, the study suffered from a number of limitations. Several risk factors were not included in the analysis, such as smoking, or alcohol and nutrient intake. These factors are known to be important confounding factors in determining relationships between weight and mortality.

The mean BMI in this study for survivors and decedents was greater than 30 kg/m^2, which is above the level categorised as obese. Therefore the average Samoans in this study may have had weights above some threshold level after which the effects on the cardiovascular system are no longer increased. It is also possible that the follow-up period of six years was too short for the cardiovascular sequelae of obesity to become evident. Another explanation is that the obese Samoans are younger than other populations and have not yet experienced the effect of obesity on cardiovascular disorders.

Crews (218) suggested that among Samoans, there is less effect of obesity on CVD mortality. Samoans may be more efficient in processing food energy into body fat and also able to tolerate larger amounts of body fat without the detrimental effect on cardiovascular health seen in other populations. There may be mechanisms involved that provide a protective effect against the development of cardiovascular disease. Further research into the effect of obesity on long-term health sequelae will be needed to answer these questions.

Other researchers (247) have also suggested that there is a weak association between BMI and mortality in three other ethnic groups. Survival status and cause of death was determined for 1400 Nauruans who had participated in a 1982 survey, and 1279 Fijians and 1182 Indo-Fijians who were examined in surveys in Fiji in 1981. Mortality data were collected from death certificates through February 1992.

BMI was not significantly associated with mortality in any sex/age group after controlling for age, smoking and diabetes status. The survivors had significantly higher BMI and triceps skinfolds than the decedents (BMI 33.4 vs. 31.4 kg/m^2 and triceps 26.8 vs. 22.3 mm). There was even some tendency for reduced risk of mortality in the more obese individuals. In men, an increased risk of mortality from cardiovascular disease was found with increasing BMIs only in Indo-Fijian men. There was increased risk with increasing BMI among Nauruan women, but among Fijian and Indo-Fijian women the cardiovascular risk was greatest in the leanest women.

This mortality analysis also may suffer from a number of weaknesses. The power of the analysis may be reduced due to small sample sizes. The number of deaths in each sex, ethnic group and BMI category may have been too small to detect a difference. For instance, there were only two deaths among Nauruan females who had BMI less than 25 out of a total of 82 deaths of Nauru females. Additionally, as the majority of Nauruans are obese, the strength of the association between obesity and mortality becomes obviously weaker (fewer non-obese comparisons). Accidents are known to be the leading cause of death among adult Nauruans, yet the study reported only one death due to a cause not potentially associated with obesity. Accuracy of the records of cause of death may be in question. The reliability of triceps skinfolds values performed on very obese subjects is also questionable.

Differences in Body Composition

Body Mass Index (BMI), also known as the Quetelet's Index has been generally regarded as the most practical and accurate estimate of body fat and should be used to assess overweight and obesity and to monitor changes in body weight (400). Recent studies in the Pacific have suggested, however, that there may be ethnic differences in body composition and that criteria used to assess obesity may need to be tailored specifically to the ethnic group with which they are to be used.

Percentage body fat was determined in women of Polynesian and European origins residing in New Zealand (434). The 40 Polynesian women who participated in the study identified themselves as Samoan (22), Maori (12), Tongan (3), Niuean (2) and Cook Islanders. Forty-two other women identified themselves as Caucasian. Body fat was determined by measurement of total body water (TBW) which is considered the gold standard in terms of estimated body fat composition. Other standard measurements, such as BMI, waist circumference, waist-hip ratio and skinfold thickness were also performed.

The studies found that at the same level of per cent body fat (42%), a BMI of 30 kg/m2 for New Zealand European women corresponded to a BMI of 34 kg/m2 for Polynesian women. At a fixed BMI, Polynesian women had lower per cent body fat than New Zealand European women by 3.6%. Differences were also noted in the distribution of fat as estimated from skinfold thicknesses. The study found that the Polynesian women had more central subcutaneous fat and less peripheral fat, particularly those at the lower per cent body fat than the European group. The researchers also noted that skinfold thickness measurements were more difficult to perform, especially in very obese individuals, more uncomfortable for the subjects and less repeatable than waist measurements.

Girth measurements correlated better with percentage body fat than did skin fold estimations, suggesting that they may be a better index of weight loss or gain than repeated skinfold measurements. (434)

Also skinfold measurements are an estimate of subcutaneous fat only, whereas girth measurements include visceral and subcutaneous fat, plus lean tissue.

Resting metabolic rate (RMR) was also determined on these same women (435). The results showed that the Polynesian women had significantly lower RMR compared with their European counterparts (6783 ±904 vs 7281 ±901 kJ/d, P=0.023) after adjusting for fat-free mass alone or fat-free mass (lean tissue) and fat mass (body fat) together, in a statistical model.

A number of factors have been shown to influence resting metabolic rate. Resting skeletal muscle metabolism is related to RMR and possible influencing factors may be thyroid hormone levels, muscle-fibre types and tone, the sympathetic nervous system and catecholamine levels. The skeletal muscle makes up a large portion of fat-free mass and in the above study, was the best single predictor of resting energy expenditure.

Several studies compared body composition differences between Polynesians and Caucasians using bioelectrical impedance and dual energy x-ray absorptiometry (DEXA). In one study, Swinburn et al. (436), found that body-fat levels as estimated by bioelectrical impedance were significantly and consistently lower among 129 Cook Islanders when compared with a group of 493 Australian Caucasians. Although bioelectrical impedance is not considered a reference method for determination of per cent body fat, the differences between the Polynesians and Caucasians were significant in each BMI and gender category.

The same investigators (437) measured ethnic differences in body composition as assessed by bioelectrical impedance between 149 Samoans residing in Auckland, New Zealand; 3608 Danish citizens; 206 Australian Aborigines; and 243 Torres Strait Islanders. This study found that the Samoan Polynesians had lower resistance (i.e. less body fat) for any given weight than any of the other ethnic groups.

Determination of body composition by dual energy x-ray absorptiometry (DEXA) is considered highly reliable and repeatable. Swinburn (438) used DEXA to compare body composition between 185 Samoans, 189 Maori and 241 Caucasians. The DEXA studies also found significant ethnic differences in the relationship between per cent body fat and BMI:

At any given BMI level, the Maori and Samoan subjects had significantly less fat than the Caucasians. There were no statistical differences between the Maori and the Samoan groups. (438)

The implications of these studies raise several concerns. The use of existing BMI charts or cut-off levels for assessing overweight/obesity in a population, or the classifying of individuals, may need to be modified for specific ethnic groups. Swinburn (438) has suggested that for Polynesian people a BMI of ≥26 kg/m^2 be used instead of 25 kg/m^2 as the cut-off level for overweight and a BMI of ≥32 kg/m^2 be used instead of ≥30 kg/m^2 to define obesity. The SPC has historically used a cut-off of BMI ≥27 for overweight and ≥32 for obesity for men and ≥25 and ≥30 for women.

While these cut-off levels may reflect an equivalent level of body fat compared with Caucasians, it is unclear if they would be equivalent in terms of health risks. In other words, even though a Samoan male with a BMI of 32 may have the same proportion of body fat as a Caucasian with a BMI of 30, there is no data to suggest that his level of health risk is the same. While the Samoan may have more lean body tissue and less body fat, genetic and environmental factors may place him at higher risk for diabetes and cardiovascular diseases. Longitudinal studies among Pacific ethnic groups will be required to determine the health risks associated with varying levels of BMI and estimates of body composition.

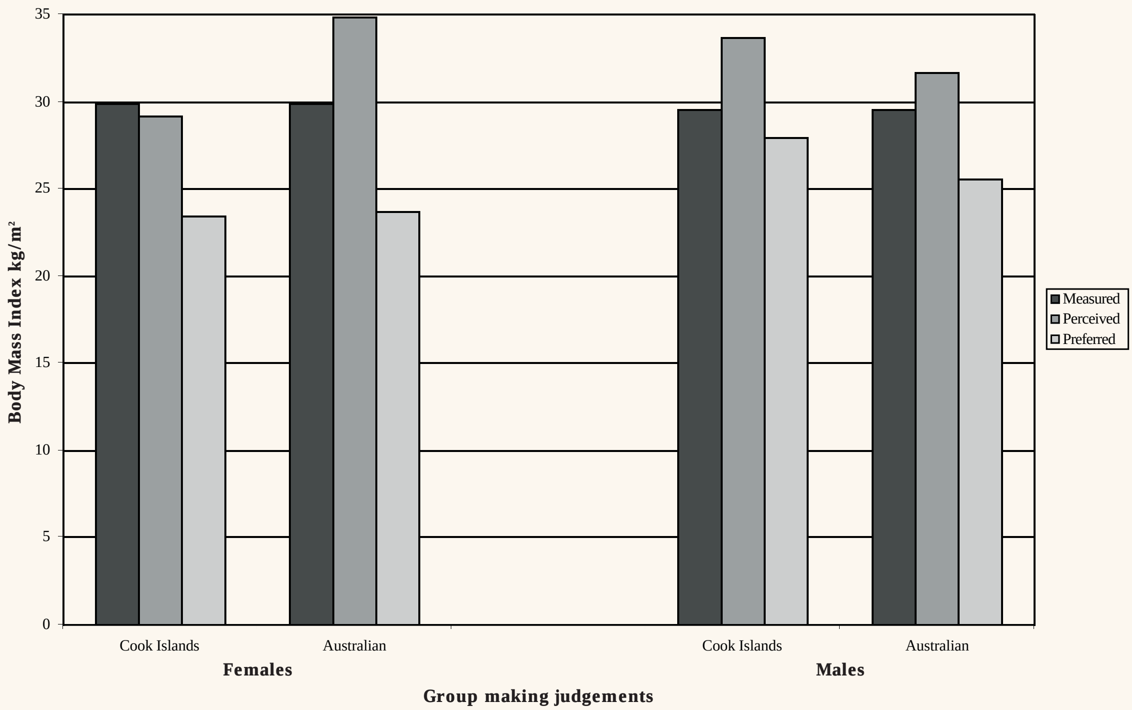
Body Size Perception and Preferences

Several recent studies in the Pacific have questioned whether the western preoccupation with the ultra-slim body has also brought with it a distorted perception of body size and a preference for thinness. Cook Island adults (83 women and 49 men) in the village of Tutakimoa on the main island of Rarotonga were interviewed regarding preference and perception of body size (439). A sample of Australians was also interviewed, selected and matched for gender, age and BMI with the Cook Island group.

The study participants were asked to choose from the series of photographs (with body images representing a range of BMIs) which image represented their own body size (perceived) and which body size they would prefer to be (preferred). They were also asked to identify which size they considered the most healthy and most attractive for their own sex and for the opposite sex. These were averaged to give an 'ideal' body size for each sex. BMI was calculated for each participant based on actual weight and height measurements.

The results showed that the Cook Island women were the most accurate in identifying their current body size (perceived) compared with their measured body size as seen in Figure 6.38. Australian women, on the other hand, significantly overestimated their body size compared with their BMI. Men in both ethnic groups with BMIs below 25 were also accurate in their assessment of their body size (data not shown).

Cook Island and Australian women both had similar body size preferences (BMI 23–24 kg/m^2). Australian women of all sizes preferred a body size smaller than their perceived body size. Of the Cook Island women, those with BMIs less than 25 were satisfied with their size. Cook Island men preferred a larger body size than Australian men (BMI 27.9 vs 25.5 kg/m^2). Both male and female Cook Islanders choose larger sizes as the 'ideal' male and female size.



Source: (439)

Figure 6.38: Measured, Perceived and Preferred Body Sizes for Cook Islanders and Australians

A similar survey was conducted in Tonga by the same investigators (427). A small group of men (n=25) and women (n=64) involved in a weight-loss programme and other men (n=217) and other women (n=233) participated in the study of perceived and preferred body size.

Both groups of women slightly underestimated their perceived weight compared with their measured weight. The degree of underestimation was similar for both groups indicating that the weight-loss programme did not significantly influence perception of body size. The men in the weight-loss group, however, did significantly overestimate their perceived weight, whereas the community men did not (data not shown).

When asked about healthy and attractive body sizes, the Tongan men consistently chose larger body sizes for both males and females than the Tongan women. The men selected an 'attractive' male body size of approximately BMI 30 kg/m^2. The community women chose the 'healthy' female as having a body size close to their own preferred body size i.e. a BMI of 25. The women in the weight-loss programme chose the smallest sizes for 'attractive' and 'healthy' males and females (BMI 23 for women and BMI 24–25 for males) compared with the other community groups.

Another recent study included 160 adults residing in rural and urban communities in Samoa and 65 Samoans living in Auckland (440). Study participants were asked to provide a rating of their perceived current size, ideal size, most attractive size, most healthy size and the upper and lower limits of normal weight. The ratings were based on 10 images of ascending body size.

Perceived body size was higher among both men and women in Auckland compared with Samoa. Actually, BMI was also higher among the Auckland group but the study did not compare perceived body size with measured body size. Samoan women in Auckland rated smaller ideal body size, smaller attractive body size, and a lower upper limit for normal weight compared with the women in Samoa. Auckland men, however, expressed a larger size for ideal body size, attractive, healthy and lower limit of normal weight compared with their Samoan counterparts.

When asked about satisfaction with health and weight, most Samoans in Auckland and in Samoa were generally satisfied with their health, but dissatisfied with their weight. Approximately half of both groups were moderately or strongly negative about their weight. Over half of the women in Samoa (56%) and in Auckland (66%) had attempted to lose weight within the preceding year. Approximately 58% of the men in Auckland and 43% of the men in Samoa had also attempted to loss weight.

These studies relating to body perception and body composition may highlight several important points. Several Polynesian groups are adopting the preference of smaller body size as ideal and/or attractive, and this body size may be smaller than traditional values. This trend appears to be related to level of westernisation and is more pronounced among females. Women may have adapted to this aspect of acculturation faster than men. The accuracy of perception of body size, especially among Cook Island women may reflect a positive self-body image.

Conclusions

- Rates of overweight and obesity in several PICTs are some of the highest in the world.
- In the majority of PICTs, more than 50% of adults are either overweight or obese.
- In several countries, over 40% of the women and 30% of the men are obese. Nauru, American Samoa, Samoa, Cook Islands, Tonga and French Polynesia all have rates at least three times those reported in affluent countries such as Australia.
- As Pacific populations become older, the more sedentary they become. Therefore, we can expect even greater increases in the levels of obesity in the future.
- Recent studies have shown that there are differences in body composition between Caucasians and Polynesians.
- For the same or less body fat, Polynesians may be more at risk of diabetes and CVD than Caucasians.
- There may be a need to define obesity differently for different Pacific Island population groups based on the risk of developing CVD and diabetes.
- The acceptance of a western lifestyle has meant an acceptance of western perceptions about body size and shape.
- Measures to prevent and control obesity should begin in adolescence, early adulthood and perhaps even infancy and childhood.
- Strategies used by communities and governments to prevent and manage obesity should consider environmental influences as well as individual and behavioural issues.

CHAPTER 7: Cancer

Summary

- Although incidence rates for most types of cancer in Pacific Island countries and territories (PICTs) are lower than in many of the industrialised countries, they do represent significant health problems, they appear to be rising and are, in a large part, preventable.
- Reporting procedures do not cover whole populations. Many cases remain undiagnosed or not reported.
- Cervical cancer is the most common cancer occurring among females in the majority of Pacific Island countries and territories, accounting for 20 to 30% of all cancers.
- Cervical cancer is strongly associated with sexually transmitted diseases (STDs) such as human papilloma virus infection. Promotion of safe sexual behaviour to prevent AIDS and STDs will also help to prevent much cervical cancer. Pap smear screening and early detection can prevent most of the morbidity and mortality associated with cervical cancer.
- Breast cancer is the most common cancer reported in women in the more economically developed PICTs: American Samoa, Cook Islands, Niue, and French Polynesia.
- Lung cancer accounts for approximately 30% of all cancer among men in PICTs.
- Up to 80% of lung cancer is due to cigarette smoking and more than half of the men in the majority of PICTs are regular smokers. Factors which may aggravate lung cancer include: a high quantity of cigarettes, starting to smoke at an early age, greater inhalation, high concentration of carcinogens in the tobacco smoke and perhaps low resistance to cancer due to a low consumption of fruit and vegetables.
- Smoking patterns of high school students indicate that smoking begins early in adolescence in perhaps a third of the students in some countries.
- Oral cancer is a significant health problem in Papua New Guinea, Solomon Islands, Guam, and Palau. Oral cancer is strongly associated with betel nut chewing and may also be aggravated by the use of lime when chewing the betel nut. Excessive alcohol intake and smoking also increase the rates of oral cancers.
- Liver cancer accounts for about 10% of all cancers in PICTs. There is a strong association between chronic hepatitis B infection, especially at a young age, and liver cancer. Most PICTs have begun mass immunisation of new-borns against hepatitis B to prevent chronic liver disease and cancer. Hepatitis B, however, may not be the only cause of liver cancer; excessive alcohol intake, drugs and environmental chemicals may also contribute.
- Prostate cancer is the most common cancer in American Samoa, Fiji and Palau and appears to be increasing in many countries.
- Oesophageal cancer rates are elevated in Melanesian men of New Caledonia and Polynesian men of French Polynesia. These high rates are likely related to excess consumption of alcohol and tobacco.
- High rates of cancer of the thyroid have been reported among females in New Caledonia (96/100,000) and Vanuatu (9/100,000). These are among the highest reported in the world and there is little known about the cause.

Mortality due to Cancer

Accurately assessing mortality from cancer is of critical importance in determining the magnitude and type of cancer problems in Pacific Island countries and territories (PICTs) so that prevention and control strategies can be designed and implemented. Unfortunately, in many PICTs the reporting of death by cause is incomplete and/or inaccurate. This makes it pointless to calculate mortality rates (per population) for comparison between island countries or with industrialised or other nations outside the Pacific region.

The proportional mortality presented in Table 7.1 below has been calculated from the mortality statistics of the respective PICTs. The proportional mortality has been calculated from the number of deaths from cancer derived from the total deaths. The proportional mortality was also calculated after excluding *Ill-defined* and *Other* causes of death. In some countries, these categories are a significant proportion of all deaths and comparison with other PICTs is more valid excluding these categories. This methodology was used by Taylor et al. in a 1985 review of cancer in PICTs (441).

For most PICTS, mortality data is from registration with a community-wide target population, even though coverage may be incomplete. For a few PICTS, however, only hospital mortality data is available.

Table 7.1: Cancer as cause of death in Pacific Island countries and territories

		Deaths				
	Year	Total	Cancer	%	%*	Rank as leading cause of death
MELANESIA						
Fiji Islands	1996	4606	365	7.9	10.0	3rd
New Caledonia	1991–96	5930	1334	22.5	25.9	2nd
PNG	1997	5636	262	4.6	4.7	6th
Solomon Islands	1997			9.1	9.1	4th
Vanuatu	1993	525	49	9.3	11.7	5th
MICRONESIA						
FSM	1989	886	32	3.6	3.6	4th
Guam	1997	865	84	9.7	9.7	3rd
Kiribati	1987–90	Cancer not listed among the leading causes of death				
CNMI	1991–96	501	95	19.0	19.0	1st
Marshall Islands	1996	233	16	6.9	9.5	3rd
Nauru	1994			12.1		4th
Palau	1997			18.8		2nd
POLYNESIA						
American Samoa	1997	259	42	16.2	17.1	2nd
Cook Islands	1997	128	15	11.7	12.6	3rd
French Polynesia	1996	1029	213	20.7	23.2	2nd
Niue	1995		30			
Samoa	1996	362	17	4.7	4.9	8th
Tokelau	1993–97	58	3	5.2	5.2	3rd
Tonga	1996				15.0	2nd
Tuvalu	1993	94	3	3.2	5.3	6th
Wallis and Futuna	1998	44	8	18.2	29.6	1st

*Excluding «Ill-defined» and «Other»

Table 7.1 shows that, with a few exceptions, the less developed countries fall into the LOW cancer mortality category, and the more developed PICTs into the HIGH category. Some reasons for the higher proportion of cancer deaths in the more developed PICTs include:

- cancer rates have increased as a result of increased development and acculturation
- deaths due to other causes have decreased so the proportion of cancer increases
- diagnostic capability is better and there is more complete and accurate death registration
- life expectancy is longer, therefore more people live to an age when cancer is more common
- there is a higher proportion of non-indigenous individuals in the population who may have higher rates of cancer.

Incidence of Cancer

Estimating the incidence of cancer (number of new cases per 100,000 population over a specified time period) in PICTs over the past three to four decades has been difficult. Many island populations are small and therefore cancer incidence data is subject to inaccuracies unless data is collected over a long period of time. Complete collection is not always possible in some areas such as Papua New Guinea due to unknown population estimates and morbidity records. Standardisation of procedures for collecting cancer data may be difficult due to differences in medical systems, culture and language. Until recently, there has been no central cancer registry for the region. Therefore we must be very careful when interpreting rates per population, and comparing rates between different countries. Thus the old adage: *all data are wrong until proven otherwise* may be useful to keep in mind.

One feasible way of strengthening an understanding of the determinants and distribution of cancer in the Pacific is through effective registration of cases. In fact, cancer registration is viewed as the first stage in the fight against the disease. As population denominators are small in Pacific Islands and the number of cases are small, the prevalence and incidence rates become unreliable. However, pooling the data from many islands and countries via a regional cancer registry presents improved statistical validity and reliability.

The SPC Cancer Registry was born out of the amalgamation of the data from the Papua New Guinea and Fiji Islands cancer registries. These data and crude data obtained from other countries constituted a preliminary description of cancer in the Pacific in 1975 (442). Recommendations made at the Conference of Permanent Heads of Health Services in 1979 led to the establishment of a regional cancer registry. In 1980 the recommendations were approved by the South Pacific Conference and in 1981 the SPC Cancer Registry was inserted into the SPC work programme.

As a result, the first SPC cancer document was produced in 1985 (441), which covered the countries and territories of Papua New Guinea, New Caledonia, American Samoa, Fiji Islands, French Polynesia, US Micronesia, Cook Islands and Niue. The register was periodically updated. Other publications and technical reports followed. A further update was made in 1990 that included electronic transfer.

In 1998 a meeting and course for Cancer Registrars from thirteen Pacific Islands was organised by SPC in collaboration with the International Agency for Research on Cancer (IARC) and the Western Pacific Regional Office of the WHO that included an update of the regional register. The meeting recommended that technical support be provided to PICT cancer registries and cancer registry staff and that all data for the SPC regional registry be pooled.

The SPC cancer registry is by no means complete and requires much further work. Continued training of cancer registrars and improvements in cancer detection, pathology and histology along with accurate death certification data are required before a more precise account of cancer in the Pacific can be given.

Cancer registries have been established in several PICTs; the earliest in 1958 in Papua New Guinea. In 1985, Taylor et al. (441) reviewed cancer cases from cancer registries in several PICTs. Data collection for most PICTs occurred between the late 1970s and early 1980s. Taylor et al. also estimated the completeness of the data collection in each registry. In the following discussion, the cancer data presented by Taylor et al. (441) will be compared with recent data from PICT cancer registries. For comparison purposes, rates of major cancers in Australia are provided in Figure 7.24.

Melanesia

Fiji Islands

The first estimates of age-adjusted cancer incidence (provided here as rates per 100,000 population) were reported by Boyd (443) for the period 1966–1969. All cancer rates were relatively low for Fijians and Indo-Fijians and are presented in Figures 7.1 and 7.2 along with rates from subsequent time periods (1979–82 and 1997). Cervical cancer was the most common cancer among both Fijian and Indo-Fijian women. Breast cancer was the next most common type and was higher among Fijian women than among Indo-Fijian women. Among the Fijian men, stomach cancer was the most common form of cancer.

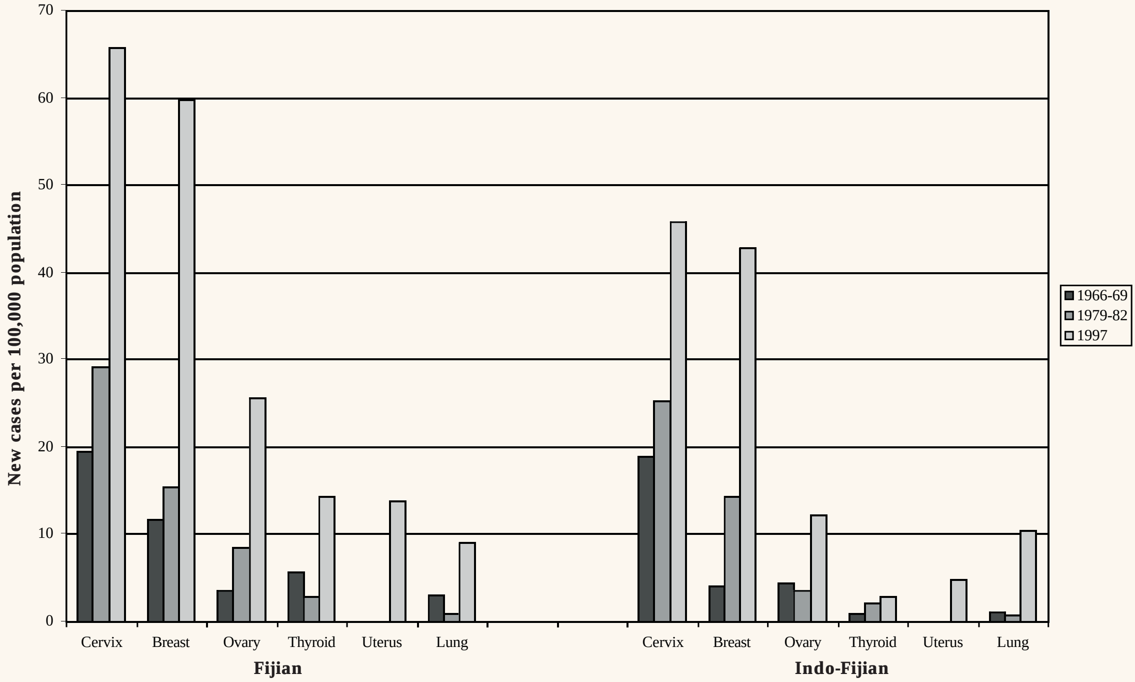
The incidence of cancer by cancer site was estimated by Taylor et al. (441) for a three-year period (November 1979 – October 1982). Data were obtained from the countrywide registry in Fiji Islands, which was begun in 1965 and judged to be 90% complete (441). The incidence of cancer for most sites among Fijians was quite low. The most common cancers (as a proportion of total cancers) among Fijian and Indo-Fijian females were those of the cervix and breast as shown in Figure 7.1.

The most common cancers in Fijian males were liver, lymphoma and colon/rectum (Figure 7.2). Cancer rates were also low for Indo-Fijians. Indo-Fijian males had low rates of cancer of the lung, stomach, colon, rectum, liver and pancreas. The most common cancers were leukaemia and bladder cancers (data not shown).

Figures 7.1 and 7.2 show a dramatic increase in cancer rates and a change in the pattern of types of cancers in Fiji Islands between 1966–69 and 1997.

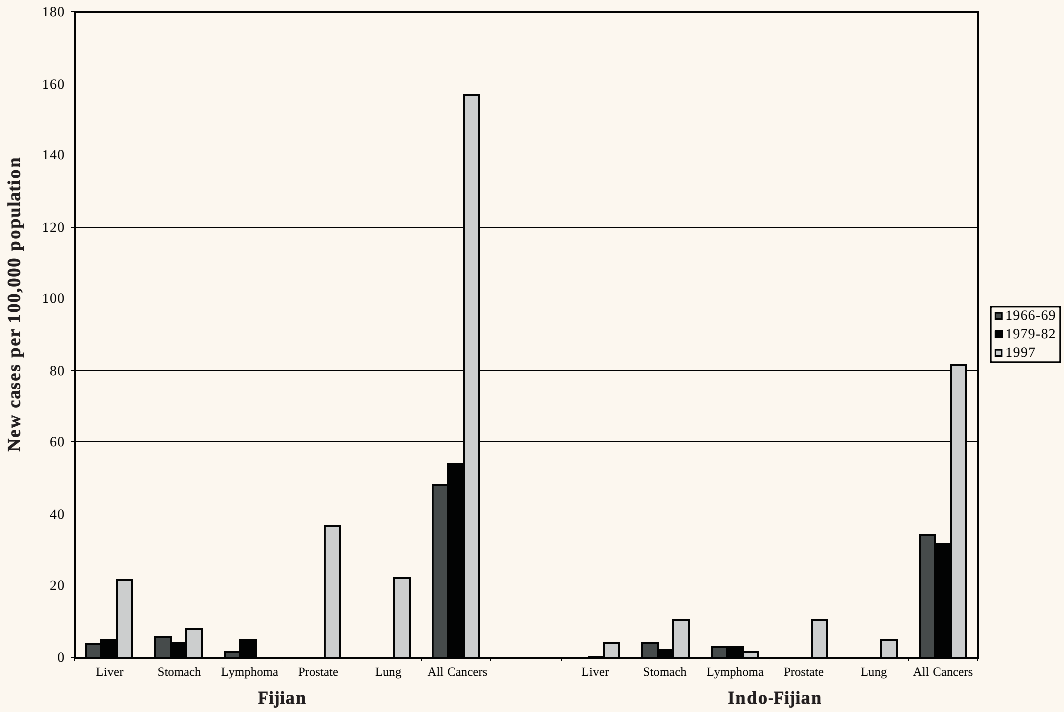
Noteworthy is a substantial increase in rates of breast and cervical cancer among both female groups. The apparent increase in cervical cancer was attributed to a cervical cancer screening programme conducted throughout Fiji Islands in 1980–81. Among both groups of females increases were also seen in ovarian, thyroid, uterus and lung cancers.

Among Fijian males, there has been a steep rise in the incidence of cancer of the prostate, lung, liver and colon/rectum. Sharp increases were also seen among Indo-Fijian males in cancer of the prostate, stomach, colon/rectum and lung, although the increase was not as great as among Fijian men.



Sources: (441,443).

Figure 7.1: Age-adjusted incidence of most common cancers in Fijian and Indo-Fijian FEMALES, 1966–69, 1979–82 and 1997



Sources: (441,443).

Figure 7.2: Age-adjusted incidence of most common cancers in Fijian and Indo-Fijian MALES, 1966–69, 1979–82 and 1997

Table 7.2 summarises the three most commonly reported cancers in Melanesian countries for females and males.

Table C2: Three most commonly reported cancers in Melanesian countries by gender

Melanesian country	FEMALES	MALES
Fiji Islands 1997		
Fijian	Cervix Breast Ovary	Prostate Lung Liver
Indo–Fijian	Cervix Breast Ovary	Prostate Stomach Lung/Larynx
New Caledonia 1996		
Melanesian	Thyroid Breast Cervix	Lung Colon/rectum Oesophagus
European	Colon/rectum Lung Breast	Lung Colon/rectum Oesophagus
Papua New Guinea 1984–88	Cervix Mouth/pharynx Breast	Mouth/pharynx Lymphoma Liver
Solomon Islands 1970–82	Genito-urinary (cervix) Skin Breast	Skin Lymphoma Digestive (Liver)
Vanuatu 1980–86 Melanesian	Cervix Thyroid Skin	Liver Skin Lymphoma

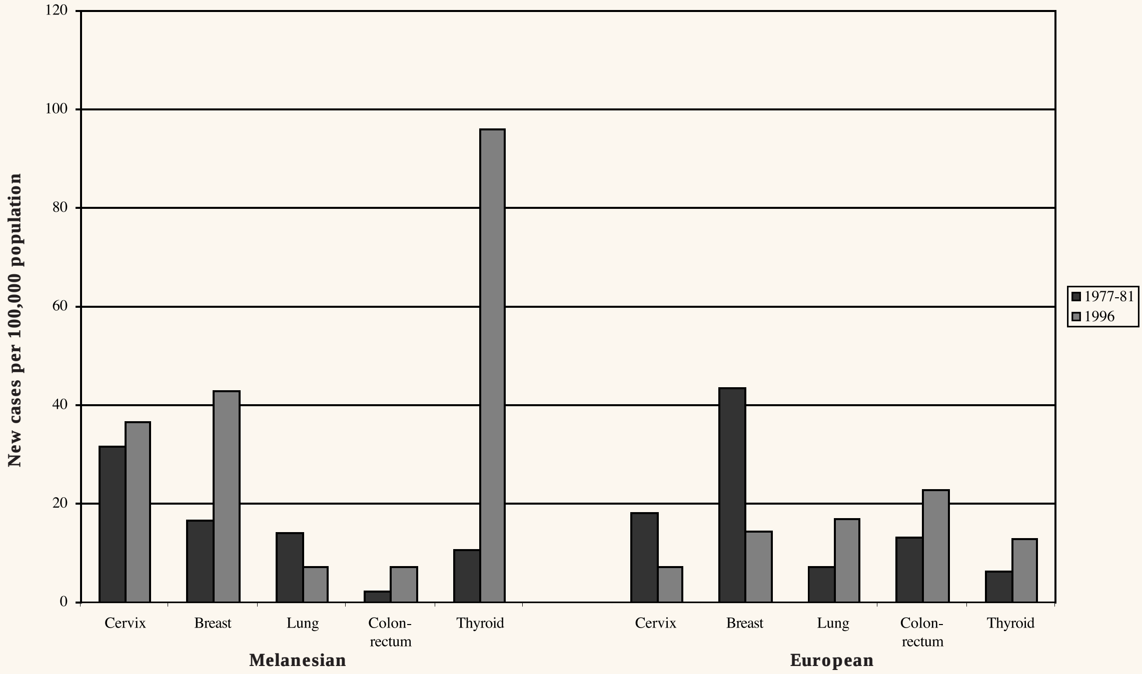
New Caledonia

The most common cancer sites for Melanesian females in New Caledonia in 1977–81 were thyroid cervix and breast as noted in Figure 7.3 (441). Melanesian women had higher rates of cervical and lung cancer than European women and European women had higher rates of breast cancer. Among the males, the highest incidence rate was for lung cancer for both Melanesians and European as seen in Figure 7.4. Melanesian men had higher rates of stomach and liver cancer than Europeans, but lower rates of mouth/pharynx, colon/rectum and prostate cancers.

Figures 7.3 and 7.4 also compare the 1977–81 incidence rates with 1996 rates. For Melanesian females there is an increase in cancer of the breast and cervix and a remarkable increase in the rate of thyroid cancer (an increase of almost 900%). Among the European women, it appears that cervical and breast cancers have decreased, while colon/rectum, lung and thyroid cancers have increased.

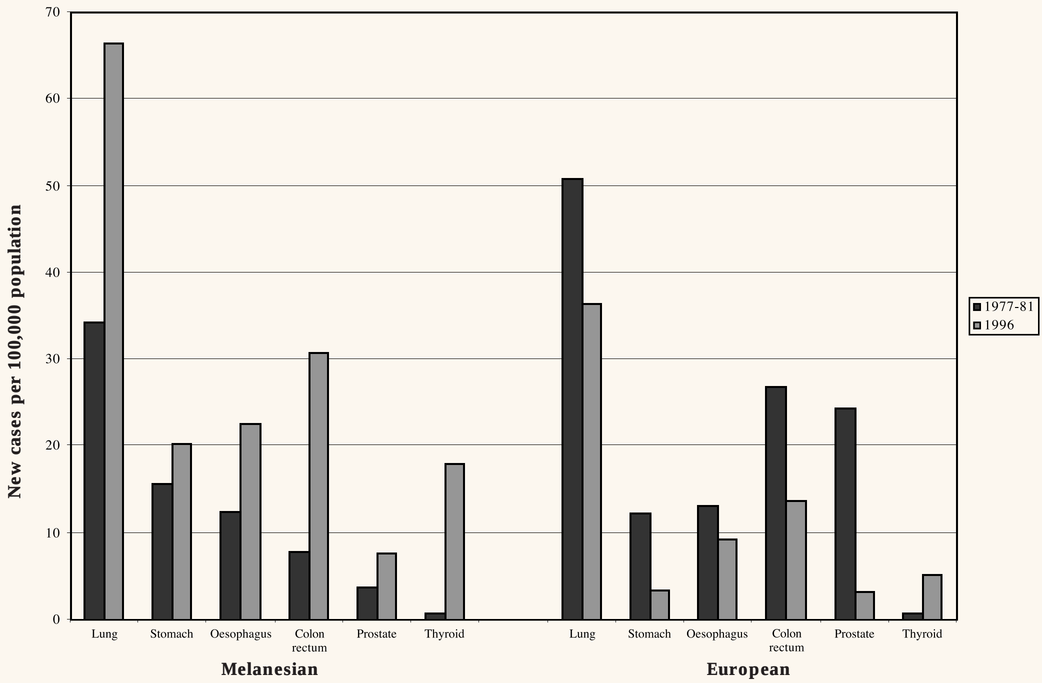
Cancer rates have also increased among the Melanesian men especially rates of lung and colon/rectum cancers. It appears that rates for European men have declined for most cancers.

The decline in cancer rates among Europeans males could be due to an influx of young males into the country, for military service for instance, thus diluting the incidence per 100,000 population. It is unlikely that cancer of the prostate is decreasing among European males in New Caledonia as it is rising dramatically in most other countries and territories. There could also be differences in enumeration and some re-arrangement of health services.



Sources: (441,444)

Figure 7.3: Age-adjusted incidence rates of common cancers in New Caledonia: Melanesian and European FEMALES, 1977–81 and 1996



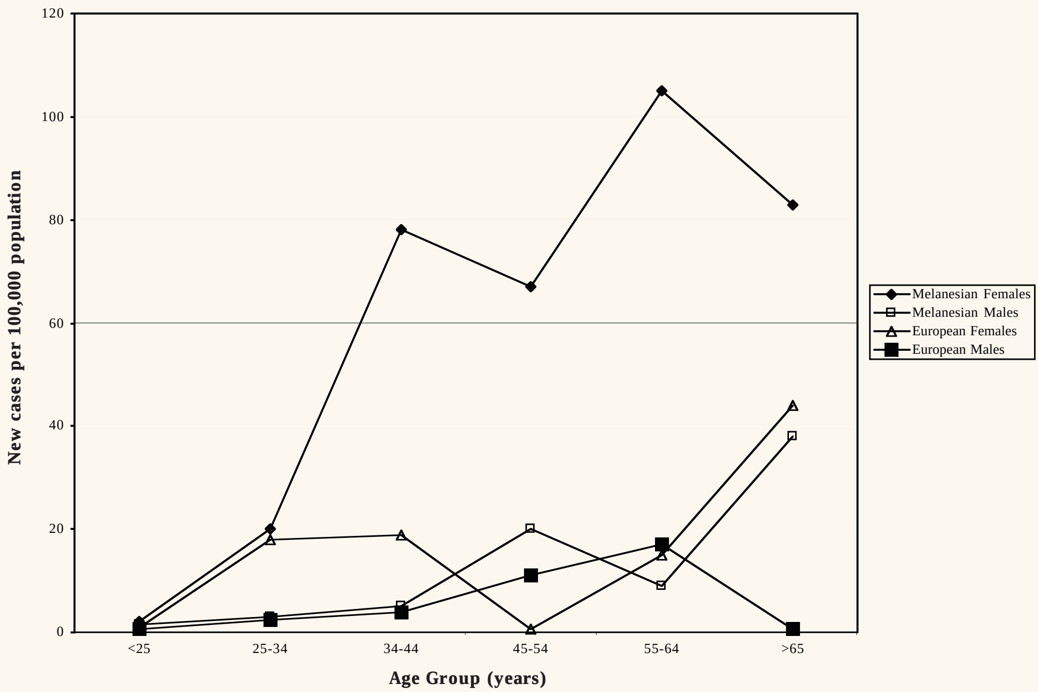
Sources: (441,444)

Figure 7.4: Age-adjusted incidence rates of common cancers in New Caledonia: Melanesian and European MALES, 1977–81 and 1996

The high incidence of thyroid cancer in New Caledonia received special study by Ballivet and colleagues (445). Thyroid cancer cases diagnosed from January 1, 1985 to December 31, 1992 were reviewed for demographic information and disease characteristics. Figure 7.5 shows the much higher rates among Melanesian females and Melanesian males compared with Europeans. The rates among the Melanesians females are considered to be the highest ever reported and among the Melanesian men, among the highest reported.

The high rates of thyroid cancers in New Caledonia could be partially attributed to increased diagnosis and enumeration, especially after the publication of the work of Ballivet (4). Physicians and surgeons may have had a greater awareness which lead to an over diagnosis of cases. Microcarcinomas (≤10 mm) are enumerated in New Caledonia. Improved clinical diagnosis and increased number of physicians and ear-nose-throat specialists in New Caledonia could also explain better detection, but do not explain these excessively high rates.

The causes of these high rates of thyroid cancer are unknown. Reproductive factors may play a role for women, but increased rates were observed for men as well. Ionising radiation is a well-established causal factor of thyroid cancer, but New Caledonia is far from three sites in the Pacific (the Marshall Islands, Mururoa, French Polynesia, and central Australia) where nuclear bomb experiments have been conducted. Nutritional factors have also been discussed because a deficiency or excess of iodine might induce benign thyroid disorders, which independently or as a consequence, cause thyroid cancer.



Source: (445)

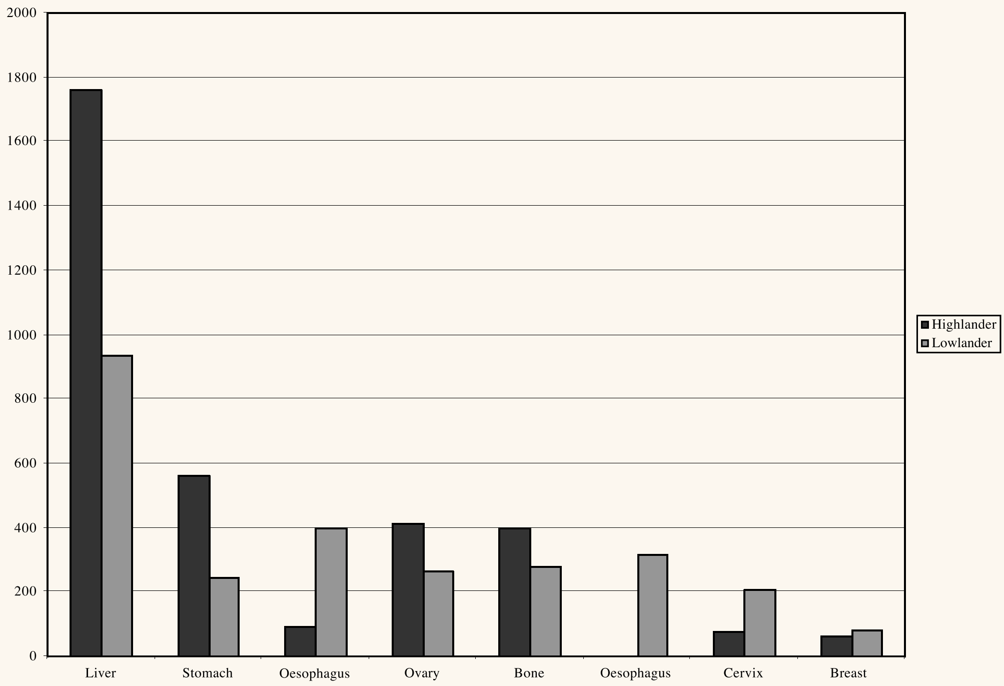
Figure 7.5: Incidence rates of thyroid cancer among Melanesian and European females and males in New Caledonia by age group

Dubourdieu and colleagues (446) reviewed cases of cervical carcinomas in New Caledonia over an 11-year period (1977–1987). They reported an incidence of 35.8/100,000 population among Melanesian women and a rate of 20.4 among European women. The rates for the Melanesian women are approximately three times those for Australian women for 1988 (143).

Papua New Guinea

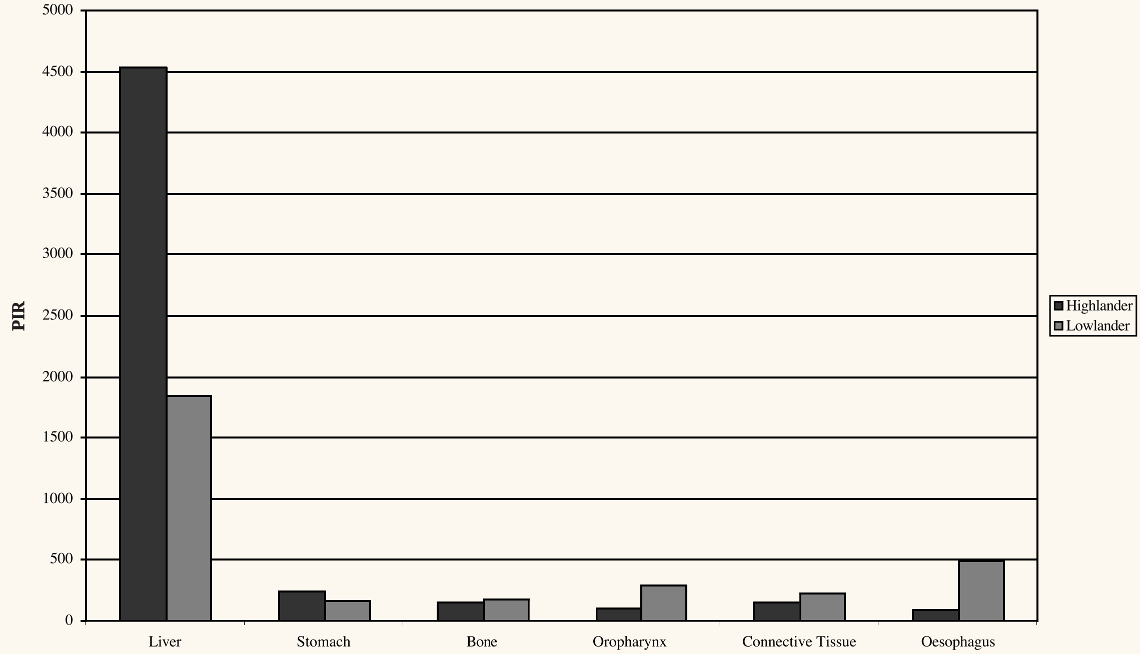
Taylor et al. (441) estimated the Proportional Incidence Ratio (PIR) of highlanders and lowlanders in Papua New Guinea for the years 1972 to 1978. The PIR is a measure of the proportional contribution of a cancer at a specific site to total cancers reported, in relation to a standard population – in this case, the European population of Los Angeles, USA. Adjustment for age and sex is incorporated into the calculation of the PIR. Thus if the PIR for a specific type of cancer is 100, this indicates that the population under study has the same proportional incidence as the standard population, adjusted for age and sex. Those populations with PIRs above 200 are considered high and those that are less than 50 are considered to have a low ratio for a specific cancer.

Figures 7.6 and 7.7 show that for liver and stomach cancer both highlanders and lowlanders have much higher PIR ratios than does the reference population. The PIR of mouth/pharynx cancer among the lowlanders is also higher than in the reference population.



Source: (441)

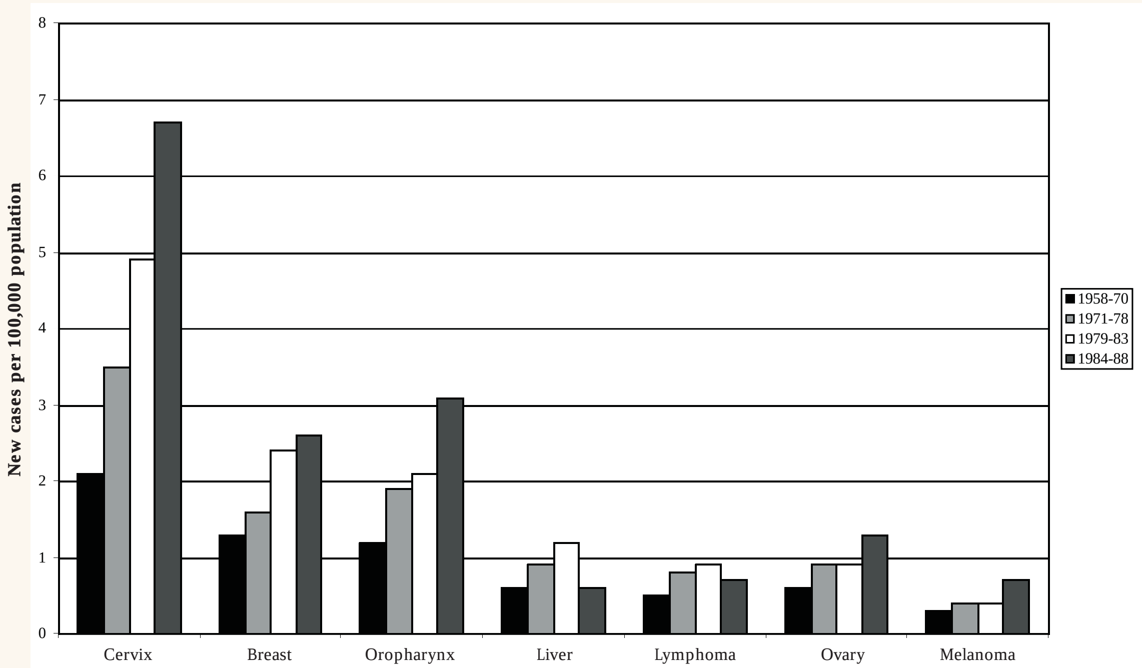
Figure 7.6: Proportional Incidence Ratio (PIR) of most common cancers in highland and lowland FEMALES in Papua New Guinea, 1972–78



Source: (441)

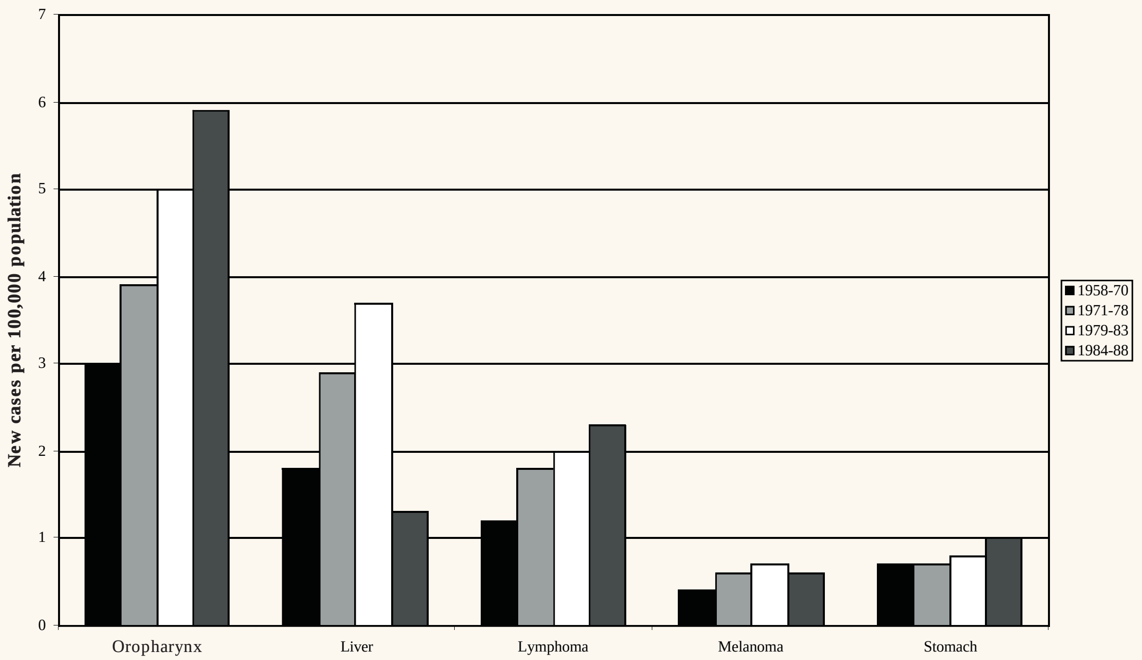
Figure 7.7: Proportional Incidence Ratio (PIR) of most common cancers in highland and lowland MALES in Papua New Guinea, 1972–78

Martin and co-workers (447) compared rates found in the Tumour Registry of Papua New Guinea for the years 1979–1988, with data collected at other time periods, 1958–1970 (448,449). The crude incidence rates for common cancer sites are provided in Figures 7.8 and 7.9. These rates will need to be interpreted with caution and could be affected to a greater or lesser extent by changes in enumeration.



Source: (447)

Figure 7.8: Crude incidence of common cancers among FEMALES in Papua New Guinea



Source: (447)

Figure 7.9: Crude incidence of common cancers among MALES in Papua New Guinea

All of these rates are extremely low compared with other PICTs, and especially as compared with highly industrialised countries such as Australia or the United States. Crude rates of some cancers did, however, increase over this time period. Between the 1958–70 and 1984–88 time periods, cancer of the cervix increased three times among women. Cancer of the cervix is associated with multiple sex partners, sexually transmitted diseases (STDs) and poor hygiene. It is suggested that with increased communications and development, traditional customs that restricted intercourse for long periods may be disappearing. This might have led to an increase in sex partners and STDs. This could explain the more rapid increase in cervical cancer in the highland area, where customs may be rapidly changing. Improved registration of cervical cancer could also explain the increased rates.

Although the crude rates of breast cancer doubled among women over this time period, the proportional incidence was actually constant. Oral cancer also doubled over this time period among women.

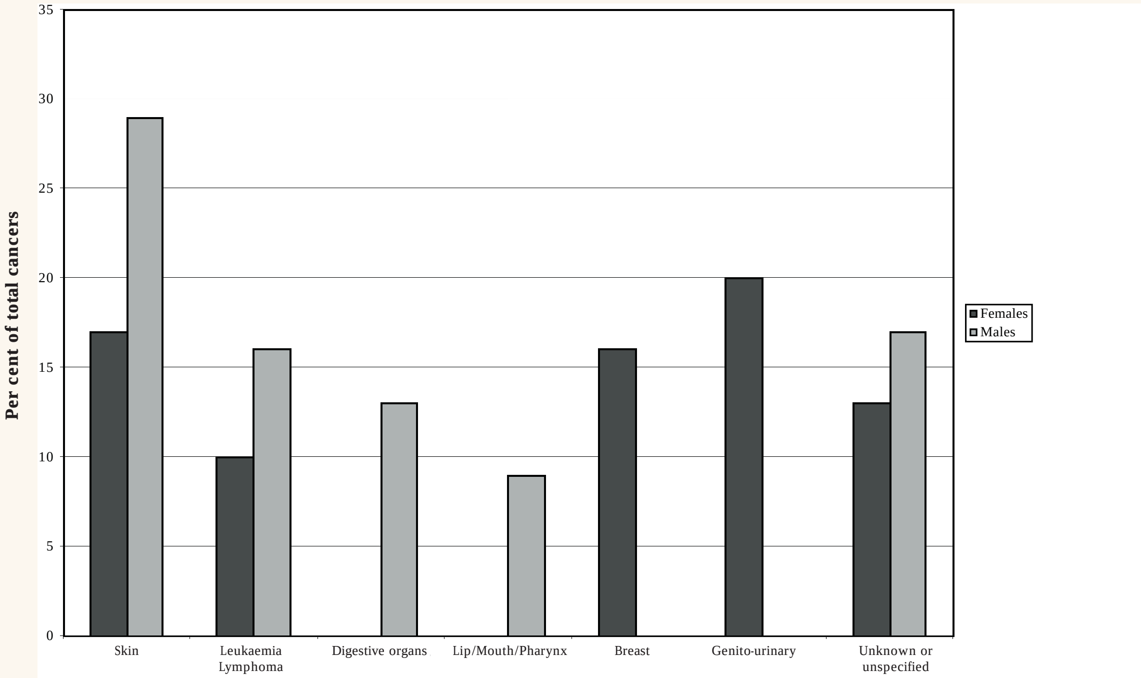
Cancer of the oral cavity, the most common cancer among men, was appreciably higher among men than among women, and was lowest in the highland regions. These differences are attributed to the chewing of betel nut, which is more usual among men especially in the coastal and island areas. Although the betel nut tree does not grow in the highlands, improved communications have made the betel nut more accessible and a rapid rise in oral cancer rates in the highlands has been observed. In PNG betel nut is chewed together with pepper and lime. Tobacco is not added to the quid as in other countries, particularly in southern Asia. This may account for the lower incidence of leukoplakia, as is commonly seen among Indian betel nut chewers. It is not clear whether the primary cause of the cancer is the betel nut or the slaked lime that is added to the quid. Researchers in the Solomon Islands found higher rates of oral cancer among betel nut chewers who regularly used lime (450).

Cancer of the liver was also more common in men and increased up until 1979–83 and subsequently declined. The fall in liver cancer was considered an artefact and is probably only apparent. The majority of cases of hepatoma are considered to be related to the hepatitis B virus rather than to cirrhosis (447).

The decrease in skin cancers is attributed to health workers' better management of foot ulcers, to which the lack of shoes probably contributes.

Solomon Islands

Taylor et al. (451) reviewed cancer data from the pathology reports at the Honiara Central Hospital for the years 1970–1982. Figure 7.10 reveals that among females, cancers of the genito-urinary tract (cervix), breast and skin together with lymphomas, were the most frequently found cancers. Among the men, cancers of the skin, digestive organs (liver) and mouth, together with lymphomas were the most commonly reported. These findings are similar to those in Papua New Guinea, but the pattern differs from that seen in Australia. Cancer of the liver and mouth were significantly more common in the Solomon Islands than in Australia, but lung and large bowel cancers much less frequent.



Source: (451)

Figure 7.10: Major cancer groups as percentage of total cancers occurring in the Solomon Islands, 1972–82

Wilson et al. (450) conducted a small case-control study of oral cancer in the Solomon Islands in 1983. Twenty persons with oral cancer and 73 controls were interviewed regarding risk factors for oral cancer – namely betel nut chewing. Although both cases and controls were betel nut chewers, the group identified as the highest consumers of betel nut had significantly greater risk of oral cancer compared with those who did not chew at all or chewed only occasionally. There was a five-fold difference in the relative risk of chewers who added lime to the quid as compared with those who did not add lime. The use of both tobacco and alcohol also increased the risk of oral cancer among betel nut chewers.

Exactly how betel nut, lime, tobacco and alcohol act to cause oral cancer remains unclear. Thomas and Maclennan (452) proposed that the powdered, slaked lime added to the chew causes the mean pH to rise to 10, at which level reactive oxygen species are generated from betel quid ingredients in vitro. Reactive oxygen species, together with sustained lime-induced cell proliferation, suggest a possible mechanism of carcinogenesis for this tumour.

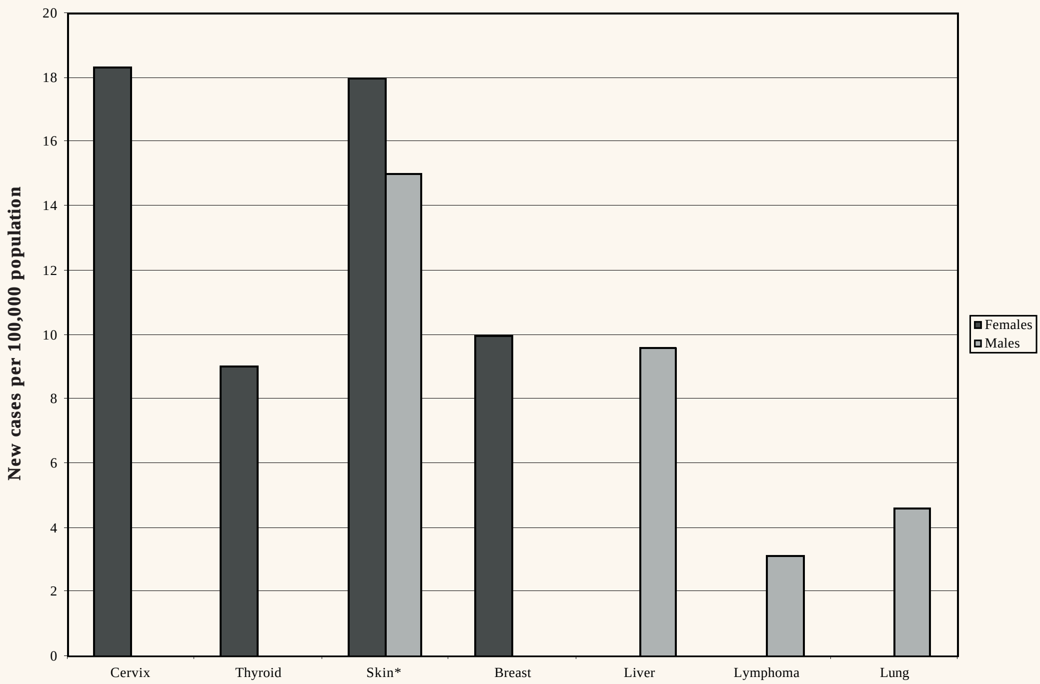
Vanuatu

Cancer incidence rates were estimated from pathology reports for the years 1981–83 (441). These numbers were quite small, 60 reports for females and 26 for males. For females, the most common cancers were of the skin, cervix, breast and thyroid. Among males, the most frequently reported cancers were skin, liver and respiratory.

A larger study conducted by Paksoy et al. (453,454) reviewed 269 pathologically confirmed cancer cases over a seven-year period (1980–1986). Figure 7.11 provides the age-standardised incidence rates for the total population of Vanuatu. Since the population breakdown of Vanuatu by race was not available, incidence rates of cancer in Melanesians were not calculated. Of the cancer cases, 88% were Melanesian. The most commonly reported cancers were cervix, skin, breast and thyroid among the females, and skin, liver, lung and non-Hodgkin's lymphoma among the males.

Since these findings are based on pathologically diagnosed cases, they should be regarded as minimum estimates. The hepatitis B virus (HBV) is closely related to the pathogenesis of liver carcinoma in the Pacific region. HBV antigens were demonstrated in 44% of the 18 cases where liver tissue blocks were available. Hepatitis B virus is endemic to Vanuatu. The Vanuatu Department of Health estimates that about 90% of people develop the virus at some stage during their lives.

The investigators commented on the high rates of thyroid cancers, particularly among women (453). They noted that Vanuatu is quite far from the atoll islands where nuclear tests had been carried out. Deficient or excess dietary iodine could be assessed as a possible risk factor. The investigators were not able to offer an explanation for the high proportions of thyroid cancer in Vanuatu.



Source: (453)

Figure 7.11: Age-standardised incidence rates of most common cancers in total population† of Vanuatu 1980–1986

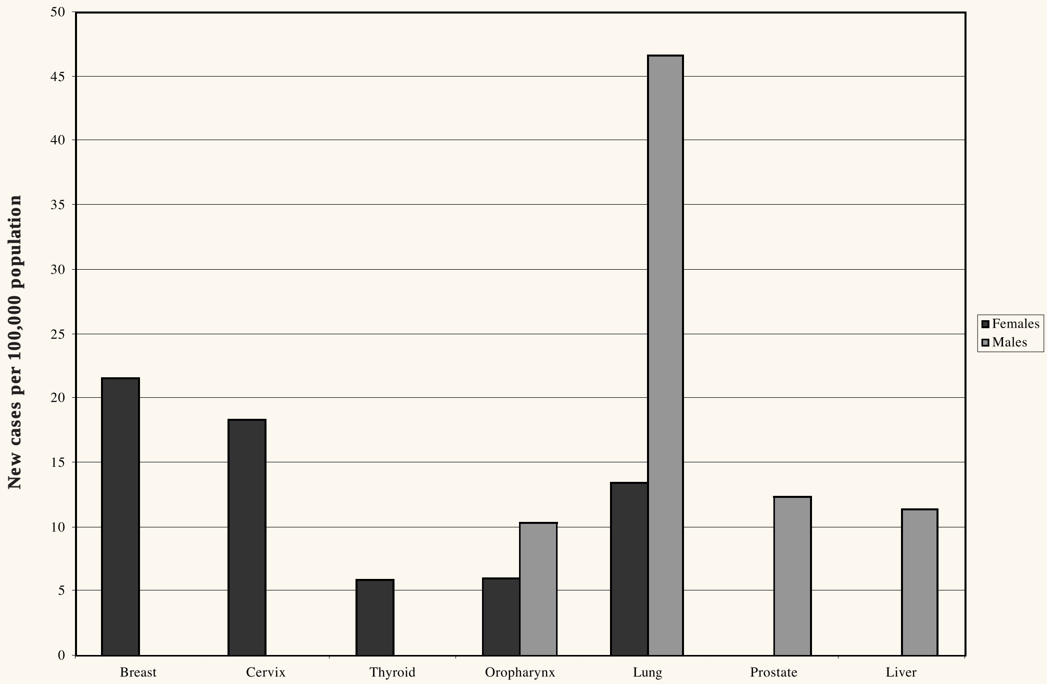
* Skin excludes melanoma

† 88% of cases were Melanesian

Bach (455) reviewed cancer cases in Vanuatu from 1984 to 1991. He also reported the most common cancers among women as breast, cervix and thyroid and among men as liver, lung cancers and lymphoma. These patterns did not change when the years 1987–1994 were reviewed (456).

Micronesia

Cancer cases were collected by Taylor et al. (441) for the time period January 1980 to December 1982. A trained cancer registrar reviewed cases for several island groups in Micronesia: FSM, Palau, Marshall Islands, Guam and CNMI. Cases included all races. Additional cancer cases for Micronesians were also obtained from the Cancer Registry in Hawaii. Figure 7.12 indicates that the most common cancer sites among females were breast, cervix and lung and for males were lung (3 times that for females), prostate and liver.



Source: (441)

Figure 7.12: Age-adjusted incidence of cancer in Micronesia (all races), 1980–1982

Commonwealth of the Northern Mariana Islands (CNMI)

Cancer is listed as the leading cause of death in CNMI for the years 1991–96 (457). Data regarding incidence of specific cancer sites, however, is not available at this time.

Guam

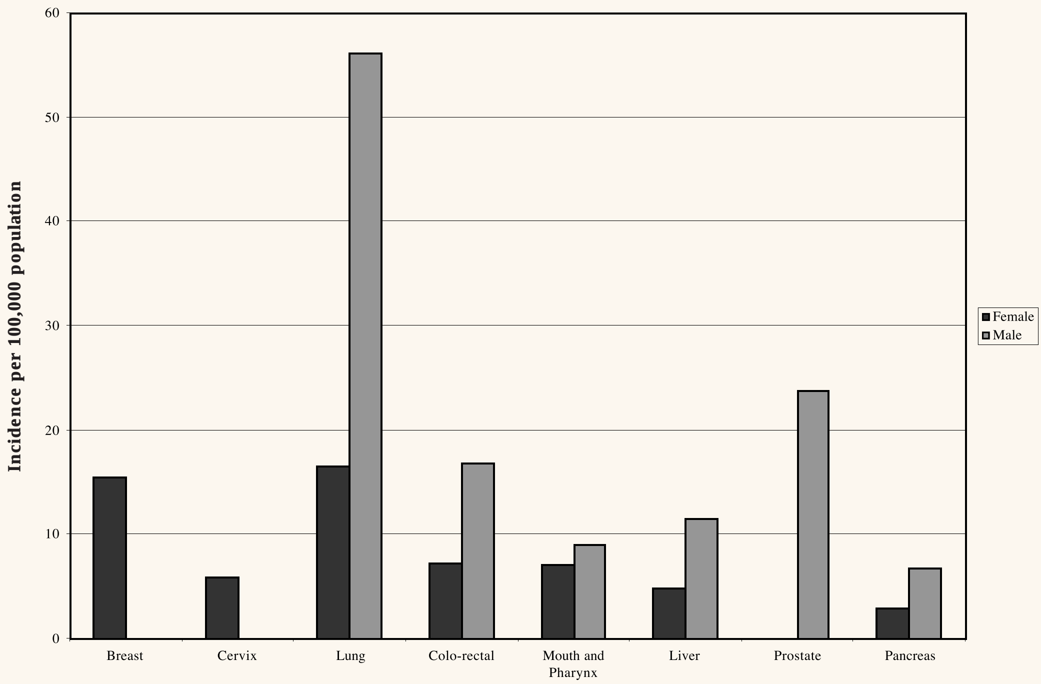
Haddock and Naval (458) reviewed all death certificates filed with the Office of Vital Statistics, Guam Department of Public Health and Social Services, from 1971 through 1995. All cases of cancer mentioned on the certificates were counted regardless of whether or not they were coded as the cause of death (approximately 8% of the cancer cases had not been coded as the official cause of death).

Figure 7.13 presents the incidence rates for cancer-associated deaths by site and by gender. The rates presented have been age-adjusted to the 1970 United States population. Overall, cancer rates were nearly 50% higher for males than for females and were substantially higher for many specific cancer sites. Lung cancer, the most common cancer in both genders, occurred more than three times more often among males than females.

When the Guam rates were compared with US incidence rates, Guam males had higher rates of mouth, lung and liver cancer (8 times as high) and lower rates of colon/rectum, prostate and bladder cancer and melanoma. Guam females had higher rates of mouth and liver cancer and lower rates of colon/rectum, breast, thyroid and lung cancer compared with US females.

Incidence rates differed between the several ethnic groups in Guam. Chamorro males experienced higher rates of mouth and nasopharyngeal cancers than other ethnic groups. The Chamorro males shared high rates of liver cancer with Filipino, Micronesian and Asian males, probably due to the high incidence of Hepatitis B in all of these groups.

The investigators advise caution in interpreting these data. Death registration may capture only 50% of the cancer actually diagnosed on Guam (459). The main concerns are that Guam residents are frequently referred off-island for medical care and that some deaths may have occurred and been recorded in other countries.



Source: (458)

Figure 7.13: Age-adjusted* incidence rates for cancer-associated deaths in females and males in Guam, 1971–1995 *Age-adjusted to the 1970 U.S. population

A survey of risk factors related to health was conducted in Guam in 1991 (139). A total of 402 adults were interviewed by telephone to determine the prevalence of risky health behaviours in the population. Table 7.3 summarises some of the findings of this survey.

More males than females were current smokers (had ever smoked more than 100 cigarettes and now smoke regularly), chewed betel nut, drank alcohol, and were binge drinkers. By ethnic group, Japanese and Koreans had the highest prevalence rates of cigarette smoking; more Chamorro and Micronesians chewed betel nut; and Chinese and Caucasians had the highest proportion of alcohol use. Binge drinking was highest among the Chinese, followed by Micronesians, Koreans, and Afro-Americans (data not shown).

Table 7.3: Prevalence of risky health behaviours in females and males in Guam, 1991

	Percentage	
Behaviour	**Females**	**Males**
Currently smoke cigarettes	25.9	33.4
Chew betel nut	22.5	29.7
Drink alcohol	42.1	71.8
Acute (binge) drinking	12.7	46.5

Source: (139)

Respondents were also asked about behaviours aimed at preventing disease risk. Over 70% of the adults had had a physical check-up within the previous year and 46% had had their blood tested for cholesterol level; however only 10% knew what the level was. Over 90% of Chamorro women had had a pap smear and overall, 66% of women had had a pap smear within the past year. Twenty-three per cent of females had had a screening mammogram.

Kiribati

A team of consultants (460) visited Kiribati in 1999 to determine the magnitude of the problems of NCDs in the communities. Interviews with I-Kiribati women's groups indicated that heart disease, diabetes and cancer were chief concerns and inferred high levels of cervical and breast cancer. The major risk factors identified were obesity, tobacco and alcohol use.

Marshall Islands

On 1 March 1954, a thermonuclear device with the code name of BRAVO was detonated at Bikini Atoll in the Marshall Islands as part of the United States' nuclear weapons' testing programme. Radioactive fallout from this device contaminated several atolls in the northern Marshall Islands, rather than drifting over the open seas to the north. As a result, 253 Marshallese, American servicemen and Japanese fishermen were exposed to varying doses of ionising radiation. The most significant long-term effect in the exposed population was an increased frequency of thyroid nodular disease including thyroid cancer, which has been attributed to the intake of radioiodines shortly following the detonation of the device. In 1993 and again in 1996, researchers from Japan, the UK and the US examined residents of Marshall Island atolls using neck palpation, fine-needle aspiration biopsy and high-resolution ultrasound imaging. The investigators presented their findings among three groups: those who were born before the BRAVO test on 1 March 1954, those born before the end of the US testing programme (1 March 1959) and those born between 1 March 1959 and 31 December 1964. Table 7.4 shows the results of the examinations of these three groups.

Table 7.4: Results of thyroid examinations of Marshall Island residents, 1993–96 (Absolute numbers and prevalence rates)

	Time of birth					
	Before 1/3/54		Before 1/3/59		1/3/59 to 31/12/64	
Size of study population	815		1062		260	
	N	%	N	%	N	%
Benign solitary nodular goitre	191	23.4	230	21.7	22	8.5
Benign multiple nodular goitre	45	5.5	53	5.0	5	1.9
Thyroid cancer (total)	18	2.2	19	1.8	4	1.5

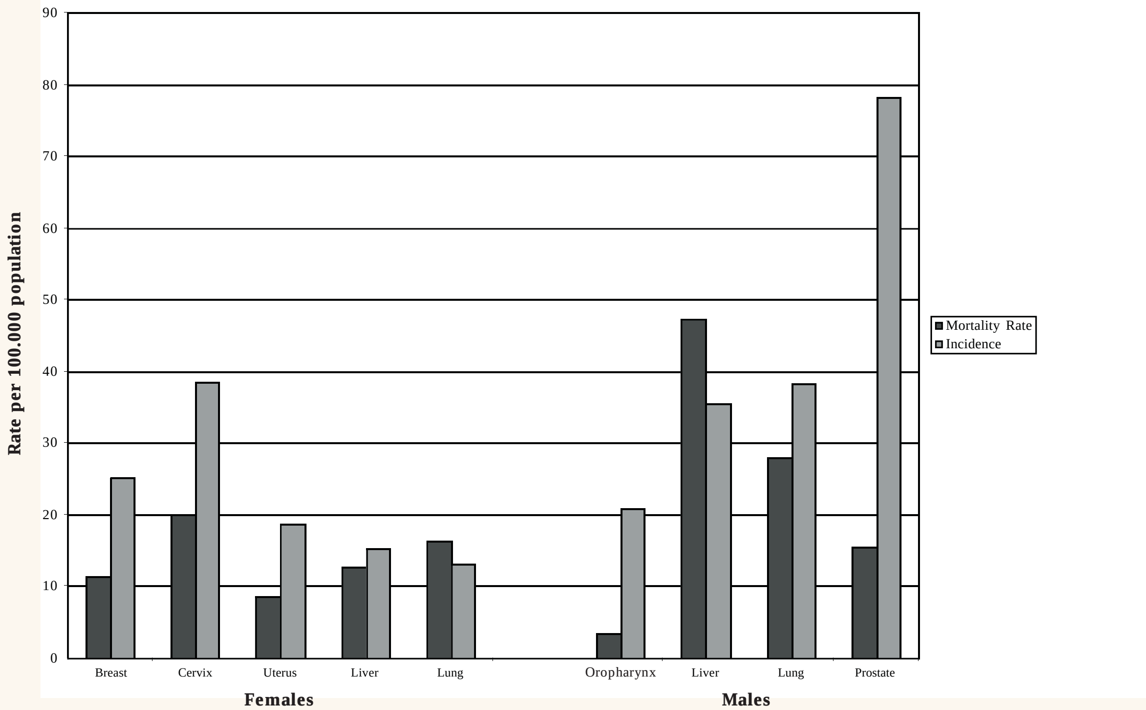
Source: (81)

The investigators calculated a frequency of thyroid cancer in the total study population of 2% (all but 3 cancers occurred in women). This rate is similar to cancer rates observed among atomic bomb survivors in Nagasaki (0.8%) compared with 0.1% in unexposed Japanese. These rates also compare with high rates reported among other groups, not exposed to radiation; Filipinos living in Hawaii (2.7%) (461), and Melanesian females in New Caledonia (445).

The investigators showed a marginally significant correlation between palpable nodule prevalence among women and distance to Bikini atoll. The researchers concluded that, although radiation exposure might be one of the several factors involved in the high prevalence of thyroid cancer in this study population, other factors, such as the iodine content of the diet, may also be involved.

Palau

The cancer registry of the Republic of Palau (pers. comm. 1999) reported that the leading sites of cancer for the years 1991–95 among women were cervix, breast and uterus and among men were prostate, lung and liver (Figure 7.14). The mortality rates from these cancers were also reported. For females the leading cause of death by type of cancer was from cervix, lung and liver cancers and for men was liver, lung and prostate cancers.



Source: Republic of Palau, Ministry of Health (pers. comm. 1999)

Figure 7.14: Age-adjusted incidence and mortality rates* for leading types of cancers in the Republic of Palau, 1991–95

* per 100,000 population

Polynesia

American Samoa

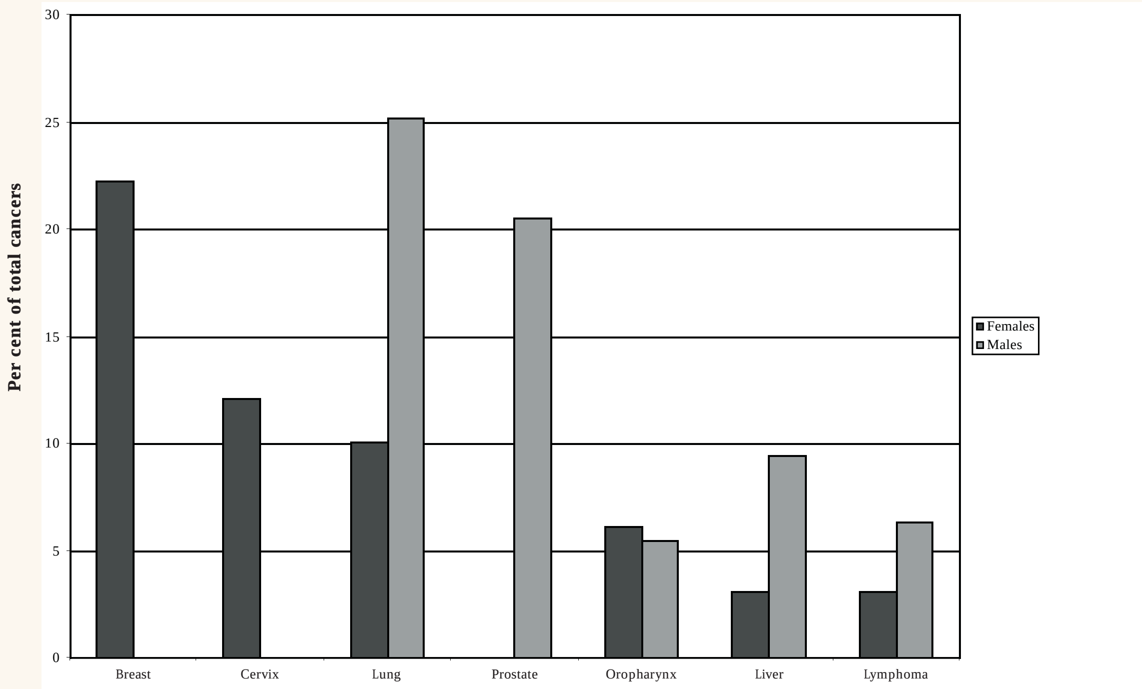
Crews (462) reviewed 4502 death certificates in American Samoa between 1950 and 1981. Multiple-cause mortality data were used to examine changing patterns of mortality in this period of transition, when mortality from infectious diseases was declining, whereas mortality from chronic diseases was increasing. Crews suggested that the first disease to increase in frequency was cancer and that it was a result of increasing lifespan in the presence of modernisation.

Crews obtained abstracts of all newly diagnosed cancer cases in American Samoa from the pathology files of the L. B. Johnson Tropical Disease Hospital in Pago Pago, and from records of the cancer registries in Hawaii and Los Angeles County, USA (441). The cases were reviewed for the years 1976–1981. Cancer ascertainment in this country is complicated by the frequent movement of Samoans to Hawaii and the west coast of the United States.

Breast, cervix and lung cancers were the most common cancers among females, while cancers of the lung, prostate and liver were the most frequently reported among males (Figure 7.15).

Calculation of the proportional incidence ratio indicated that American Samoan females had excessive rates of cancer of the stomach, liver, bone, pancreas and connective tissue and low rates of colon cancer compared with Los Angeles Europeans. American Samoan males had excessive rates of liver and stomach cancer and low rates of laryngeal, bladder, kidney, colon and central nervous system cancer and melanoma compared with US Europeans (441).

Mishra et al. (463,464) in 1996 reported cancer rates of American Samoans residing in Hawaii or referred to Hawaii for medical treatment. The most commonly encountered cancers among the American Samoan males were lung, prostate, stomach and liver cancers and among the females were cancers of the breast, uterus, cervix, thyroid, and leukaemia. Females were more likely to be diagnosed at an early age – 34.5% of females and 19.9% of males with cancer were diagnosed when they were between the ages of 0 and 44 years. Males were more likely than females to be diagnosed after metastasis had occurred (45% compared with 33.9% respectively).



Source: (441)

Figure 7.15: Proportion of major cancers among females and males in American Samoa, 1976–1981

Table 7.5 summarises the three most commonly reported cancers in several Polynesian countries and territories by gender.

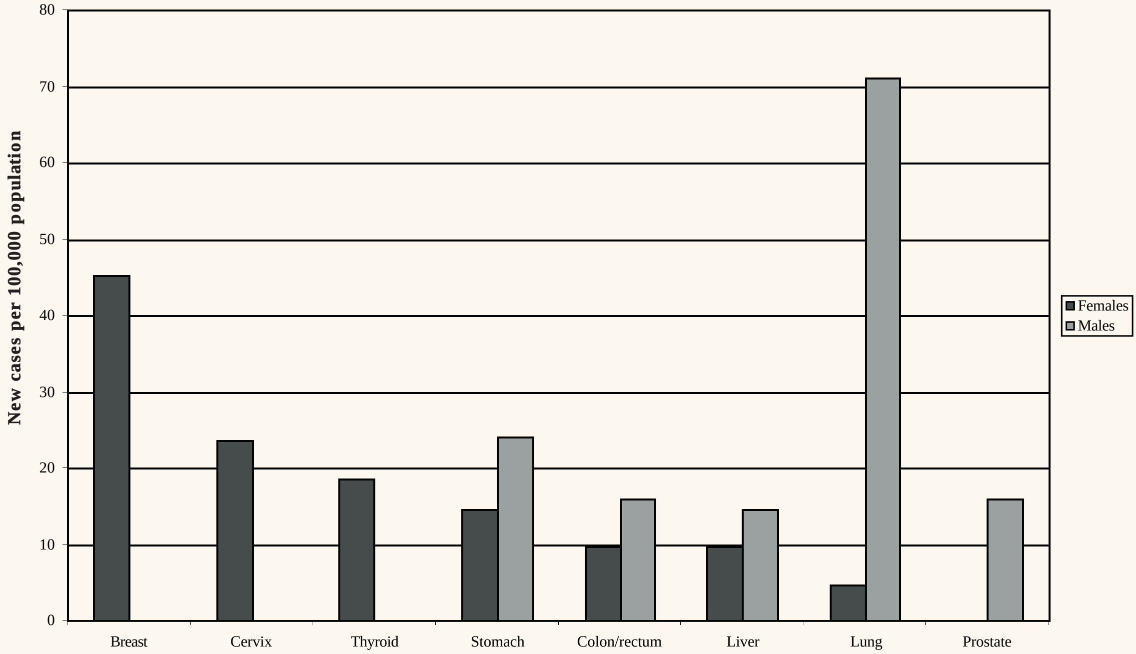
Table 7.5: The three most commonly reported cancers in Polynesian countries and territories by gender

Country/territory	FEMALES	MALES
American Samoa 1976–81	Breast Cervix Lung	Lung Prostate Liver
Cook Islands / Niue 1978–80	Breast Cervix Thyroid	Lung Stomach Prostate– (and colon)
French Polynesia 1990–95	Breast Lung Cervix	Lung Prostate Colon/rectum
Samoa 1980–88	Cervix Breast Uterus	Stomach Prostate Lung

Cook Islands and Niue

Most cancer cases in the Cook Islands and Niue are referred to New Zealand for treatment, therefore Taylor et al. (441) obtained data regarding cancer cases from the New Zealand Cancer Registry. Cancer data were combined for Cook Islands and Niue and obtained for the years 1978–1980.

There were fewer than 100 cancer cases reported in that time period. Figure 7.16 shows that the most common sites for cancer among females were breast, cervix and thyroid and for men were lung, stomach, colon and prostate.



Source: (441)

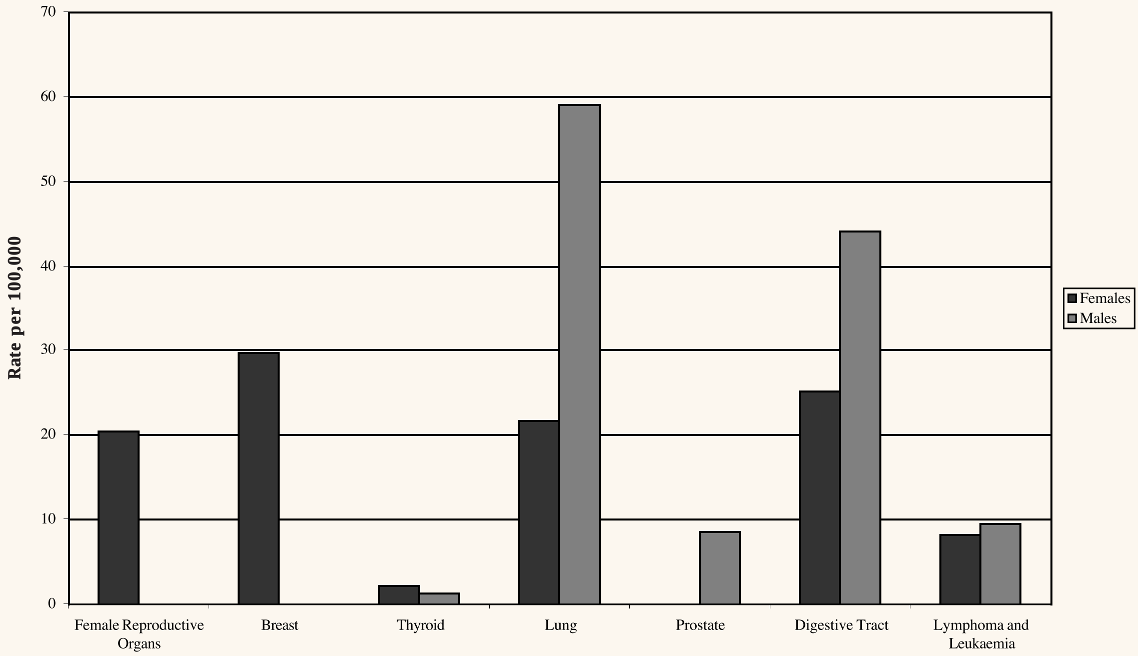
Figure 7.16: Age-adjusted incidence of cancer in females and males in Cook Islands and Niue, 1978–1980

A total of 93 cancer cases were reported at Rarotonga hospital from 1991 to 1996 by the Ministry of Health (465). The most common cancers among females were of the breast, cervix and ovary, while among males were of the stomach, lung and prostate. Thus the pattern of common cancers has not changed dramatically since the 1978–80 case review by Taylor et al. (441).

French Polynesia

Taylor et al. (441) reviewed cancer cases in French Polynesia for the years 1979–1982. The cancer registry in French Polynesia was started in 1979. Data collected for these years 1979–1982 was considered incomplete because of the early stage of the registry's development (441). The most common cancers among women were cervical (26.3%) and breast (25.4%) and among men were lung cancer (37.3%), leukaemia (8.8%) and cancer of the mouth/pharynx (7.8%).

De Vathaire and Le Vu (466) reviewed death certificates from all islands and atolls in French Polynesia between 1984 and 1992. Figure 7.17 indicates that for females, breast, digestive tract and lung cancers were the leading causes of cancer deaths and among the males lung, digestive tract and lymphoma/leukaemia. There were, however, a high number of death certificates (25%) that reported a poorly specified or unspecified cause of cancer death. As cause of death in 1996, breast and lung cancer continued to be leading causes of cancer deaths among females, and lung and prostate cancer causes of cancer deaths among males (467).

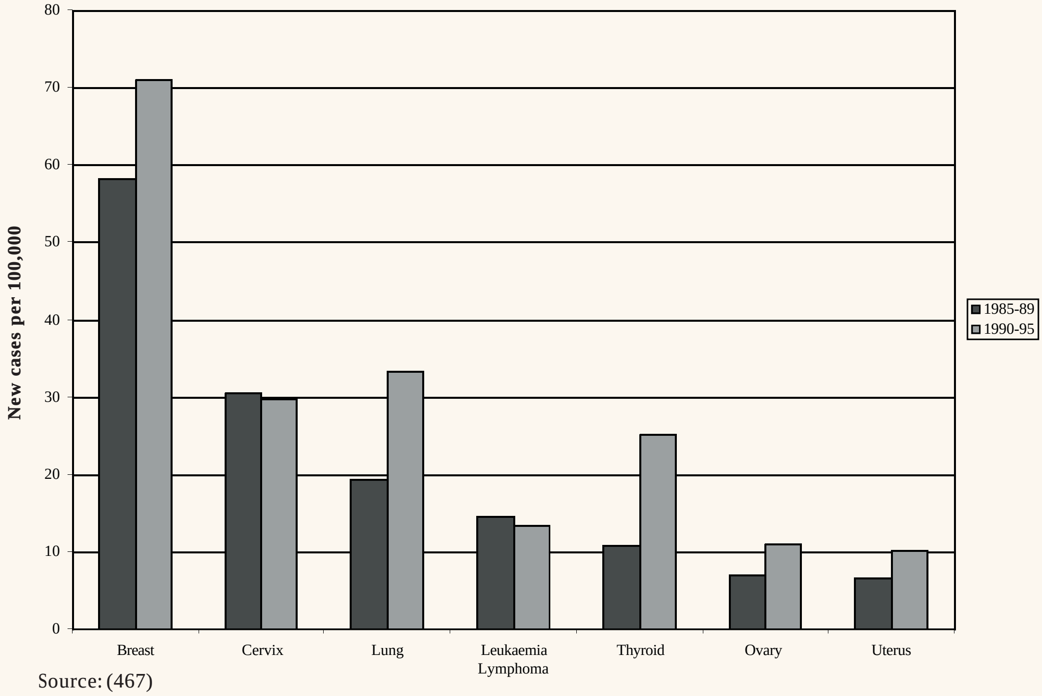


Source: (466)

Figure 7.17: Mortality rates of common cancer sites in French Polynesia, 1984–1992

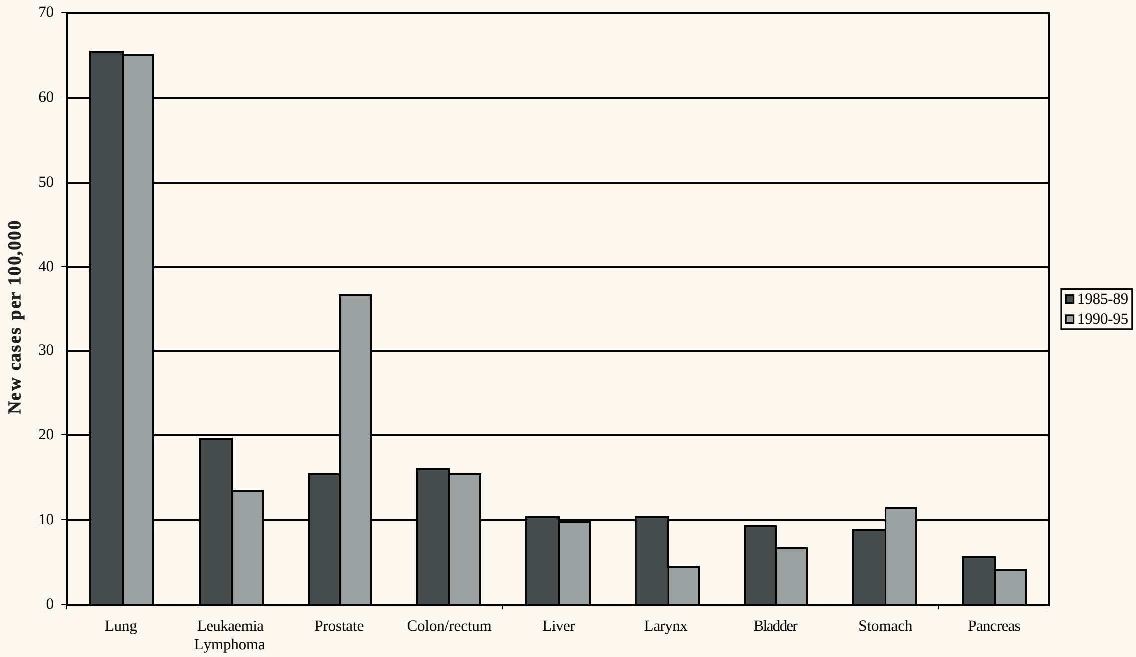
Cases of liver cancer were investigated by Boutin et al. (468,469) for the years 1980 to 1988. The 31 cases of primary liver cancer reviewed, revealed that men were at five times higher risk than women (RR 4.96), and that those aged over 50 years were at eight times the risk (RR 7.6) compared with those aged under 50 years. The presence of the hepatitis B surface antigen (HbsAg) conferred 43 times the risk of liver cancer, compared with absence of HbsAg. All of these risk factors were highly significant ($p<0.001$).

This study was able to identify one area of French Polynesia, the Austral archipelago, where the prevalence of HbsAg was 10.5 % and of hepatitis B virus infection was 64%. A resident of the Austral archipelago had a nine times higher risk of liver cancer compared with those living on other islands in French Polynesia. A vaccination programme against hepatitis B virus commenced in 1988 in French Polynesia. The French Polynesia Cancer Registry analysed the incidence of cancers at two time periods, 1985–89 and 1990–95 (470). The rates found are shown for the most common cancers in Figures 7.18 and 7.19. Overall cancer rates increased by 14% over this time period, with a greater rise among females than males.



Source: (467)

Figure 7.18: Age-standardised incidence of common cancers among FEMALES in French Polynesia, 1985–89 and 1990–95



Source: (467)

Figure 7.19: Age-standardised incidence of common cancers among MALES in French Polynesia, 1985–89 and 1990–95

The increase was mainly due to increases in breast, lung and thyroid cancers in women and prostate cancer in men. Breast cancer appeared to be affecting younger women. Cancer of the cervix was stable but remained high, 29.8/100,000 compared to a rate of 9.7/100,000 in France, and was increasing among younger women. Lung cancer was increasing among older women and decreasing among younger women. This was attributed to an overall decrease in tobacco use in those women aged over 15 years. The use of tobacco among women, however, was still high. In 1990, about 33% of women smoked (compared with 19% in France 1991–92) and among school students twice as many girls smoked as boys (470).

The incidence of thyroid cancer in women more than doubled over this time period; among the 55–64 year-old age group the increase was ten fold. It was suggested that this increase was not due to ionising radiation as a result of nuclear testing in French Polynesia, since other groups distant from nuclear test sites are also experiencing high rates of thyroid cancer. Hormonal and dietary factors were suggested as possible risk factors (470).

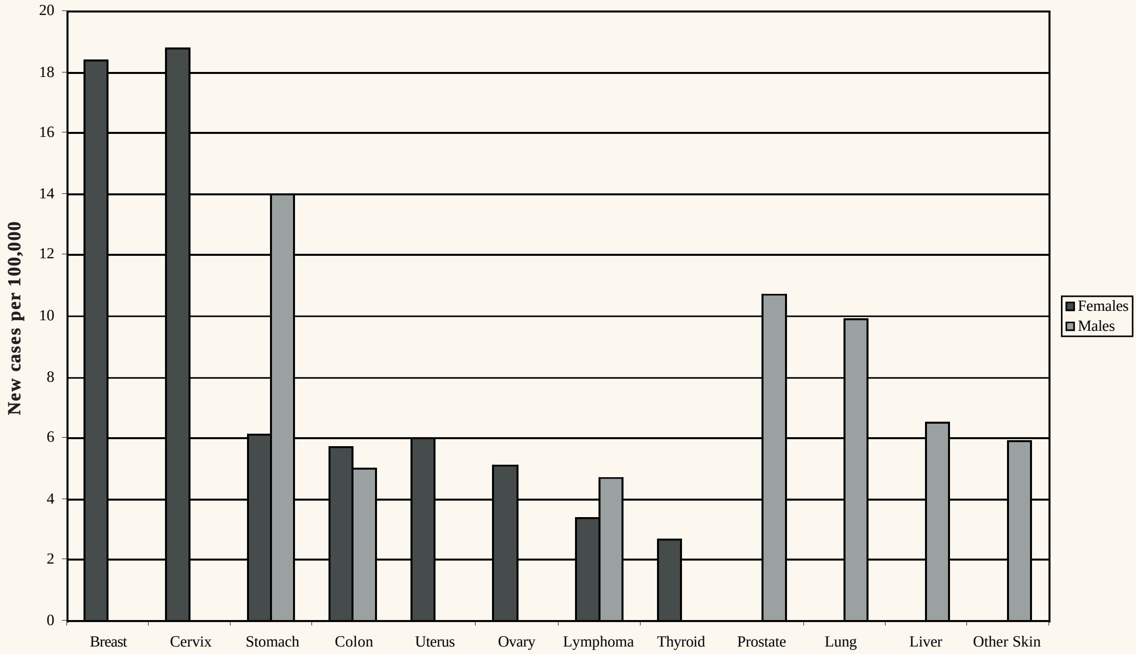
The incidence of lung cancer decreased slightly for younger men but continued to increase among men over 65. The percentage of male smokers continues to remain high, with 49% of men smoking in French Polynesia, compared with 37% in France.

The increase in prostate cancer among males more than doubled over this time period, which may be a reflection of the ageing of the population and/or improved diagnostic procedure. The rates in French Polynesia are similar to those in many industrialised countries and it is expected that these rates will continue to increase.

Samoa

Cancer cases diagnosed in the Samoa national hospital in Apia were reviewed for the periods 1 January 1980 to 30 June 1982 and 1 January 1983 to 30 June 1988 (471). Of the 706 cases, 62.5% had histological or cytological confirmation, but varied greatly by site. Overall the rates of cancers were quite low, which may be due, in part, to incomplete registration of cancer cases, patients being referred for treatment outside of Samoa or the fact that the more traditional-living Samoans, until recently have not been intensely exposed to carcinogens such as tobacco smoke.

Figure 7.20 indicates that among the women the most frequent cancers were of the breast, cervix and stomach and among the men were of the stomach, prostate, lung and liver. The rates of breast cancer are lower than among other Polynesian groups, and considerably lower than Australian rates. The rate of cervical cancer is higher than in Australia, but less than in many other PICTs. The incidence of stomach cancer among males is higher in Samoa than in most other PICTs and that of colon cancer is lower.



Source: (471)

Figure 7.20: Age-standardised incidence of common cancers in females and males in Samoa, 1980–88

The incidence of lung cancer among males is lower than in other Polynesian countries, but similar to that among Melanesians of Vanuatu. These low rates are somewhat surprising in light of the reports that 57% of adults in the urban areas are smokers (472). But it may be that regular smoking was adopted later in Samoa than in other Polynesian countries or territories, so the exposure period has been short, or it could be that there are possible dietary factors that play a role.

It is possible that the number of cases of liver cancer has been under reported. Infection with hepatitis B is reported as endemic in Samoa, where 10% of blood donors were found to be HbsAg positive. The diagnosis is based on examination, so that without biopsy, it is possible that there has been selective under-registration of liver cancers.

Tokelau, Tonga and Tuvalu

No data is available for these countries.

Risk Factors Related to Cancer

Many cancers that are common in western populations – and that are increasing in Pacific Island communities – are due to environmental factors. These cancers are largely preventable.

> *Although genetic predisposition varies, the key factors that determine whether or not people develop cancer are environmental.* (137)

Cigarette smoking and tobacco use, excessive intake of alcohol, poor diets, sedentary lifestyle, infection with hepatitis B and C virus, exposure to sunlight, ionising radiation, unsafe sexual practices and environmental chemicals are all elements strongly related to increased cancer risks and can be changed. However, it will take major commitments by communities and governments to institute policies, programmes and interventions that will address the risk factors and effect reductions in these diseases.

Cigarette Smoking and Tobacco Use

Cigarette smoking is the leading cause of morbidity and mortality in many industrialised countries today (143). It plays the major role in serious diseases, including lung and a range of other cancers, heart attack, stroke, and chronic lung disease. Smoking is the single most important cause of lung cancer (473). Cigarette smoking is becoming a major health problem in many developing countries, where economic development is accompanied by increasing use of products imported from western countries. As smoking rates in the industrialised countries are declining, cigarette manufacturers are putting more effort into promoting their products, particularly among the youth, in developing countries.

Smoking rates in many PICTs are now equal to or higher than those of neighbouring westernised countries. These high rates are accompanied by increasing rates of lung cancer and other smoking-related diseases. Tuomilehto et al. (472) and Collins et al. (474) reported smoking rates in several PICTs that had participated in diabetes-cardiovascular disease surveys between 1975 and 1994. Rates among adults 20 years and over were reported for Kiribati, Niue, Nauru, New Caledonia, Papua New Guinea, Samoa, Tuvalu and Wallis Island. These rates are shown in Figures 7.21 and 7.22 for females and males respectively along with rates from other surveys and PICTs, and, for comparison, rates in Australia.

These data indicate that anti-smoking campaigns need to begin no later than the upper primary school grades.

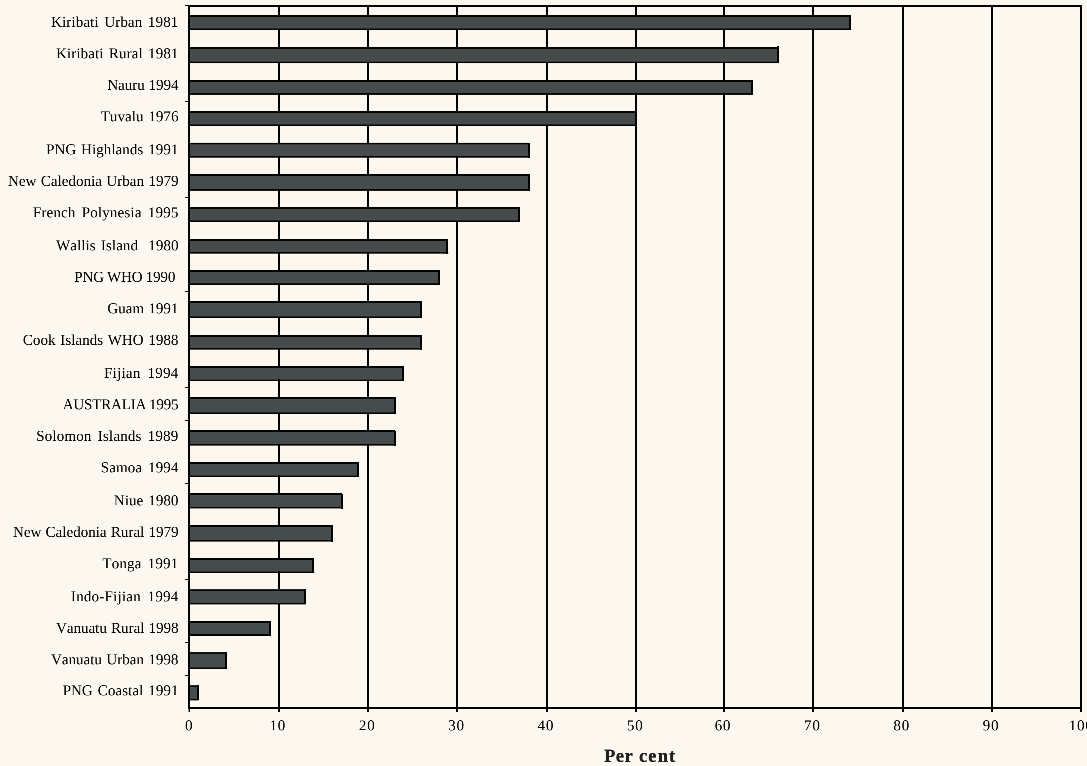


Figure 7.21: Prevalence of smoking* among FEMALES in Pacific Island countries and territories

* Smoking includes cigarettes, pipes and twists of tobacco

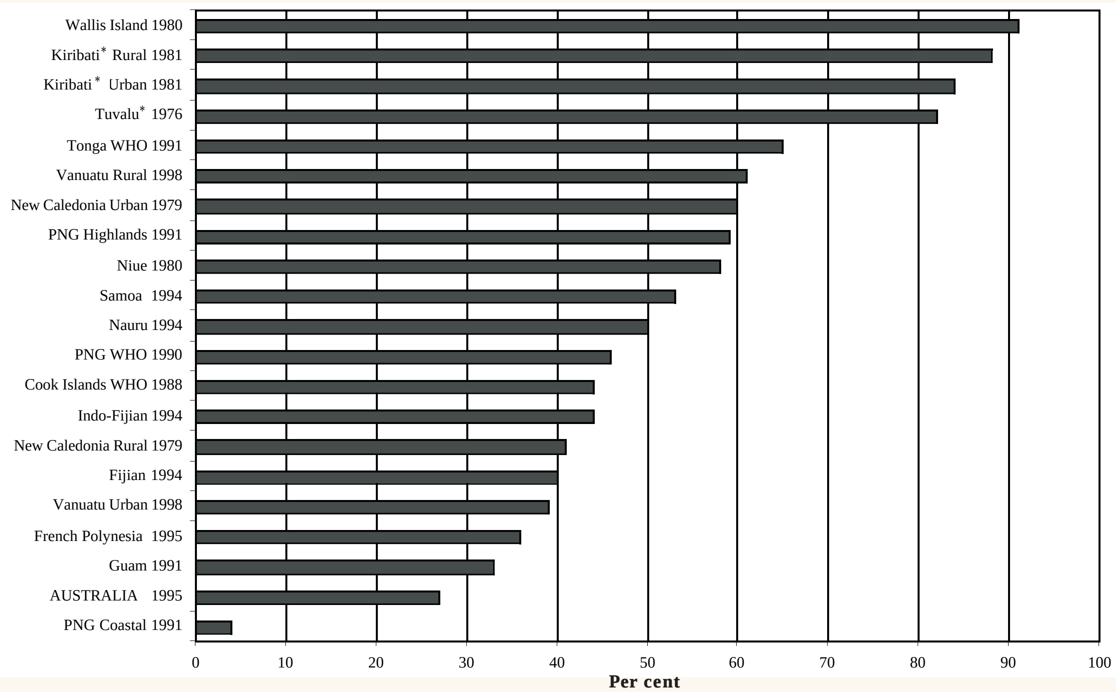


Figure 7.22: Prevalence of smoking* among MALES in Pacific Island countries and territories

* Smoking includes cigarettes, pipes and tobacco twists

Smoking rates were highest on Wallis Island and in Kiribati and in general were higher in rural areas than in urban centres. There was a low prevalence of smoking in coastal Papua New Guinea and among females in Vanuatu. Ten of the 15 PICTs had higher rates of smoking than in Australia.

Rates were higher among men than women in each group, irrespective of age. There was no obvious association between age and prevalence of smoking – smoking decreased with age in some communities, whereas in other groups there was either no change or an increase with age (data not shown).

More men were heavy smokers (≥20 cigarettes per day) than women and they were mostly found in the urban centres of Nauru, Kiribati, New Caledonia and Samoa. Among the women, the greatest proportion of heavy smokers was found in Kiribati, Nauru and Tuvalu. The prevalence of smoking was higher in the lower income groups.

Of particular concern were the rates of smoking among diabetic patients. Given the increased risk of macrovascular complications such as stroke, coronary heart disease and peripheral vascular disease, it is imperative that patients with diabetes do not smoke. This level of smoking indicates that health education messages are not reaching these patients.

WHO (473) estimated smoking prevalence rates in nearly 200 countries world-wide. The Pacific countries included Cook Islands (adults 25 years and older), Papua New Guinea (age not specified) and Tonga (20 years and older). These rates are included in Figures 7.21 and 7.22.

In 1994, Meo and co-workers (475) interviewed over 900 adults between the ages of 15 and 70 in rural and urban Fiji Islands regarding the use of tobacco. The prevalence rates of smoking are provided in Figures 7.21 and 7.22 for females and males in each ethnic group. For both groups together, 45% of males and 22% of females smoked. More males in the rural areas smoked, 65%, compared with 42% in the urban centres. Among females these figures were 19% and 22% respectively (data not shown).

> *These overall high rates among males – the rate of 67% in the 31–45 age group – suggest that the current epidemic of cardiovascular disease in Fiji is likely not only to continue but to worsen for the foreseeable future, especially when one considers that the prevalence of smoking in individuals with ischemic heart disease presenting to hospitals in Fiji is already high at approximately 60%.* (475)

The number of cigarettes sold in Fiji Islands between 1956 and 1981 increased by 273% (277).

The National Nutrition Survey in the Solomon Islands in 1989 provided prevalence rates of smoking for women only (407) (Figure 7.21). Smoking was most common among the Micronesians (55%) and Polynesian (38%) women and least common among Melanesian women in Honiara (15%).

Smoking prevalence rates were reported in the 1998 Vanuatu Non-Communicable Disease survey (62). The rates of smoking among ni-Vanuatu women were low, but among rural men the rate was over 60%. The number of cigarettes smoked per day, however, was low. Only 9% of rural men and 21% of urban men smoked 10 cigarettes or more per day.

Figure 7.23 indicates that, over the past decade, there may be a decline in smoking prevalence among men. In several PICTs, where prevalence rates are available over time, rates have decreased for males but not for females. Hopefully, the decrease among males is a reflection of health promotion efforts and legislative policies in those PICTs. It is possible that the lack of decline among females reflects the fact that women may have taken up smoking later than men and may also be slower to quit the habit.

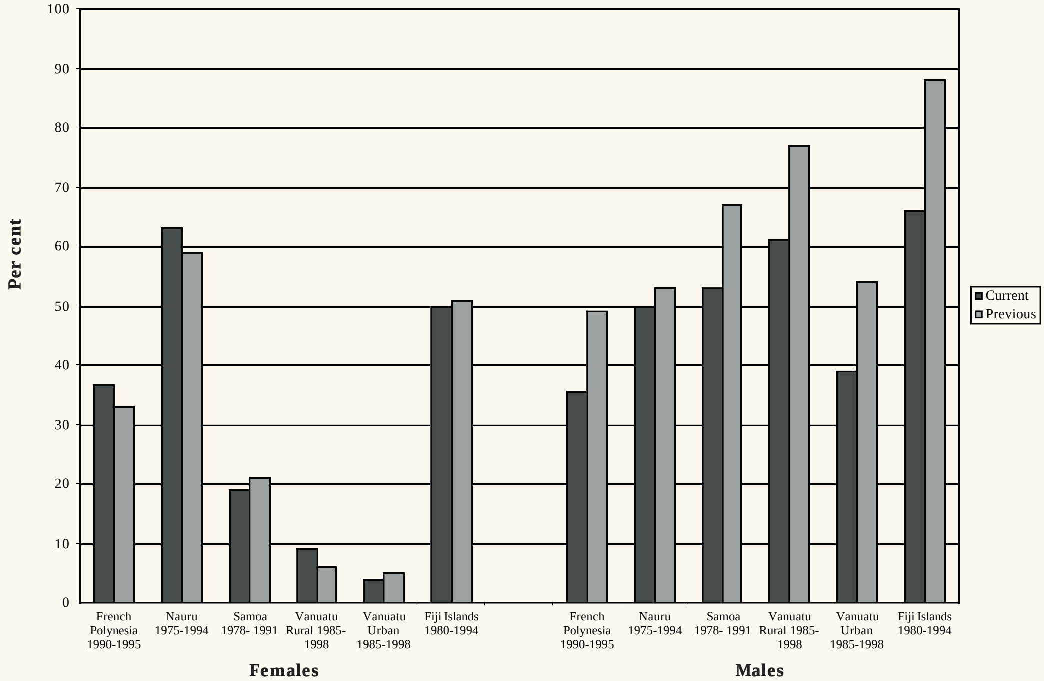


Figure 7.23: Change in smoking prevalence rates in several Pacific Island countries and territories

Many PICTs are concerned about the early age at which young people are starting to smoke. In a youth risk-behaviour survey (476), 29% of high school students in the CNMI reported being regular smokers (2 or more cigarettes per day) and having started smoking before the age of 13. More Chamorro students (40%) reported smoking than total students. When students in CNMI in grades 6–8 (approximately 11 to 13 years of age) were asked about smoking, 13% reported smoking two or more cigarettes per day and 65% had tried smoking at least a few puffs. Forty-two per cent of 8th graders had chewed tobacco or used snuff (477). In 1993, 3591 cigarettes were consumed per person, which was a higher consumption than in the United States (176).

A survey conducted in the Cook Islands included 74 students aged 15 to 19 years (478). Sixteen per cent of females and 17% of males reported smoking at least one cigarette a day. Twenty-six per cent of the regular smokers said they started smoking under the age of 11 years.

A 1992 survey of secondary school students in Suva, Fiji Islands, reported smoking in 46% of form 6 students (approximately 18 years of age).

These data indicate that anti-smoking campaigns need to begin no later than the upper primary school grades.

Betel-nut Chewing

Carcinoma of the tongue is common in all betel-nut-chewing areas of the world. This suggests a common cause of oral cancer (447). Rates of oral cancer are high in betel-nut-chewing parts of the Pacific: Papua New Guinea, Solomon Islands, Palau, and Guam.

In general, the betel nut chew consists of three parts; the kernel of the Areco nut, which is the stimulant component of the chew; the green leaves of the piper betel plant which have a spicy flavour;

and lime powder made from shell, coral rock or sea coral. A common method of use although there are many variations, is to chew the Areco nut to a pulp and expectorate some of the juice. Then the betel leaf and lime are added to the chew and this is chewed for a variable length of time. Some chewers smoke tobacco along with the chew. Some younger chewers, who do not add lime, indicated that they omitted it because they had heard that lime causes cancer (450).

Thomas and MacLennan (452) proposed that the powdered slaked lime added to the chew increases the mean pH to 10, at which level reactive oxygen species are generated from betel quid ingredients in vitro. Reactive oxygen species, together with sustained lime-induced cell proliferation, could provide a possible mechanism for carcinogenesis.

Obesity/Body Size

Obesity has been associated with total cancer mortality and cancer at several sites – breast, colon, thyroid and endometrium. The Boyd Orr cohort study followed over 3000 people who were born between 1937 and 1939 (431). Mortality analysis included deaths up to 30 June 1966. There were significant associations between childhood energy intake and total cancer mortality in adulthood.

Researchers in Hawaii (479) were able to link the incidence of colon/rectum cancer with body mass index in a cohort of more than 50,000 men born between 1913 and 1927 and living in Hawaii. They found that men who were above the median BMI in adult years had almost three times the risk of developing cancer of the sigmoid colon.

A case-control study of colon cancer conducted in Hawaii found that those males with the highest BMI and energy intake and lowest lifetime physical activity had three times the risk of colon cancer as those with the lower BMI and energy intake and higher physical activity. The same analysis grouping among women showed almost twice the risk.

These investigators (480) also examined breast cancer rates among women in a similar cohort of almost 40,000 women born between 1918 and 1943. The analysis found a negative association between adolescent body mass and premenopausal breast cancer – in other words a protective effect of obesity during adolescence on breast cancer. Adult weight and gain in body mass, however, were positively associated with the risk of postmenopausal breast cancer.

Associations were also found in this cohort with obesity and endometrial cancer in older women (60 years or older) (126). A case-control study by these same researchers (481) included 332 cases of confirmed endometrial cancer. The study found that women in the highest quartile BMI had more than four times the risk of cancer than women in the lowest quartile.

A case-control study of breast cancer cases in Hawaii showed that women with both a large body size and a high fat intake had increased risk of breast cancer (482).

The risk of thyroid cancer was also increased in males and females in Hawaii who gained weight during adult years. A weight gain of 14% during adult years was associated with 2.5 times the increase risk of thyroid cancer (482).

Dietary Factors

Components in the diet are estimated to account for up to 80% of cancers of the large bowel, breast and prostate (483). Lung cancer may even have a dietary component, although cigarette smoking is the major causal factor. The mechanisms by which dietary components could cause or prevent cancer are under intense investigation. Experimental studies with animals have shown that some factors, such as heterocyclic amines in cooked meat, act as carcinogens in the mammary glands and colon of rodents. Excessive alcohol and fat intake have been linked with several types of cancers. The process of preserving food by salting is known to be related to cancer of the stomach (137).

Other components of the diet have protective mechanisms against cancer (137). Antioxidants in foods may suppress spontaneous mutations, and elements in the diet can influence cell proliferation and the methylation of DNA (125). Which components of the diet and how they influence the development or prevention of cancer are, at the moment, uncertain and controversial (484,485).

Vegetables and Fruit

Epidemiological evidence suggests that a diet rich in vegetables and fruits may reduce the risk of various forms of cancer (486). It is believed that vitamins and minerals in foods contribute to a reduced risk of cancer. Naturally occurring dietary antioxidants such as ß-carotene, vitamin E, folic acid, vitamin C and selenium are considered the most important (53). Some of these components in the diet have been linked with reduced rates of cancer of the lung (54,55), breast (56), colon (56) and bladder (60). Other components found in vegetables and fruits such as phyto-chemicals and phyto-oestrogens, flavonoids and other carotenoids such as lycopene in tomatoes and lutein in green vegetables may also be major factors in the prevention of certain cancers, particularly cancer of the prostate (487).

Non-starch Polysaccharides (Fibre)

Non-starch polysaccharides (fibre) and vegetables are recognised as factors that reduce the risk of colon/rectum cancer owing to their effect of regulating bowel function. Non-starch polysaccharides are fermented in the large bowel, and this results in short-chain fatty acids, particularly butyrate, which may protect against cancer through the ability to arrest cell growth, promote differentiation, and select cells with damaged DNA for disintegration (125).

Numerous studies have suggested a decreased risk of colon cancer with increased intakes of fibre and/or vegetables (488–490). Yet one recent report found that fibre had no effect against colorectal cancer among nurses (491). It is possible that the dietary assessment tool used to measure fibre was not sensitive enough to measure differences in fibre intake among the women who developed colon/rectum cancer and those who did not develop cancer.

Fat Intake

For a number of years, dietary fat intake has been associated with increased risk of several types of cancers. Not only the amount of fat consumed but also the type of fat in the diet may be important factors in cancer development. Total fat intake and saturated fat intake have been strongly associated with cancers of the breast, colon and prostate (122). Some investigators have suggested that a high ratio of n-3 fatty acids (polyunsaturated fatty acids from fish and flaxseed oils) to n-6 fatty acids (from corn, sunflower oils) may be protective against breast cancer.

Alcohol Intake

Alcohol consumption has been related to cancer at a variety of cancer sites; mouth and pharynx, larynx, oesophagus, liver, breast, colon and rectum (137).

The Metabolic Syndrome

It has been suggested by several investigators (492,493), that there is link between insulin resistance and cancers of the breast, colon and rectum. The Metabolic Syndrome, formerly called syndrome X or the insulin resistance syndrome, is characterised by hyperinsulinaemia, dyslipidaemia, hypertension and atherosclerosis. The incidence of the syndrome runs parallel to that of breast cancer and colon/rectum cancer in most industrialised populations. The hypothesis proposes that the same factors that are associated with insulin resistance and hyperinsulinaemia – obesity, physical inactivity, alcohol consumption and a typical western diet (low in fruits, vegetables and fibre and high in animal and saturated fat, refined carbohydrates and highly processed foods) – are also associated with increased risk of breast and colon/rectum cancer.

These researches suggest that insulin stimulates the growth of tumour cells in both the breast and the colon. The mechanism involved may be an increase in the bioactivity of insulin-like growth factor 1 (IGF-1). Insulin plays a major role in regulating the production of insulin-like growth-factor-binding proteins (IGFBPs) which can either enhance or inhibit the effect of IGF-1. Case-control and cohort studies have shown that high serum levels of IGF-1 are associated with increased breast cancer risk (492). In vitro, insulin has been shown to exert a mitogenic (enhancing cell division) effect on colon cancer tissue and IGFBP has been shown to inhibit the growth of colon cancer cells.

Several large studies have shown a link between glucose intolerance and colon cancer. A study in Chicago reported that among 20,000 Caucasian adults who were followed for 12 to 20 years, higher plasma glucose levels were found among men who died of colon cancer and cancer of the rectum compared with survivors (494). High glucose values were also found among women who died of colon cancer, but not cancer of the rectum. A prospective study by Will et al. (495) included one million adults who were interviewed annually about personal habits and medical history. After adjusting for a number of colon cancer risk factors, the study reported that diabetic men had a significantly higher risk (30%) of developing colorectal cancer than men without diabetes. Diabetic women had a non-significant increased risk (16%). Diabetes was not associated with an increased case fatality from colorectal cancer in men or women, suggesting the progression of colon/rectum cancer is not hastened by diabetes.

In a large study of 5849 adults, high fasting blood glucose levels, and glucose and insulin levels two hours following an oral glucose challenge were significantly associated with an almost two-fold higher risk of colorectal cancer (RR = 1.8, 2.4, and 1.3 respectively). High waist-circumference measurements were also significantly associated with higher risk of colorectal cancer (RR= 1.9, 95% CI 1.1 – 3.3, p=0.02) (65).

Although these studies are preliminary, they

> *provide direct evidence of an association between elevated visceral adipose tissue level, its associated metabolic effects, and colorectal cancer.* (496)

These findings warrant serious investigation in many PICTs where obesity, diabetes and insulin resistance are found at remarkably high levels.

Physical Activity

Sedentary activity may be associated with increased risk of several cancers. Researchers at the University of Hawaii reported an increased prostate cancer risk with the proportion of life spent in jobs involving only sedentary or light work (497).

A study of physically active women in Hawaii found a modest reduction in their risk of endometrial cancer compared with inactive women (481).

Conclusions

Although there are obvious difficulties in obtaining adequate descriptive cancer data in a number of PICTs, it appears that there is enough information to draw some general conclusions:

- Cigarette smoking and/or betel nut chewing are the two most readily preventable risk factors in most PICTs. Reduction of these two risk factors would effect reductions in cancers of the lung, mouth/pharynx, bladder, kidney and pancreas.

- Although there appears to be a declining trend towards smoking, rates are still far higher than in neighbouring industrialised countries, at least among men. Legislation to control tobacco, and policies and campaigns aimed at reducing smoking, particularly among the youth, are necessary.

- Systematic screening for cervical cancer in susceptible groups could substantially reduce the morbidity and mortality. One Pap test in a lifetime in middle age will reduce mortality by 50%; whereas one Pap test every two years will reduce it by around 94%. Safe-sex education would also help to reduce rates of cervical cancer and could control the spread of sexually transmitted diseases (STDs).

- Early diagnosis and treatment of breast cancer through awareness of breast lumps among women will help reduce mortality from breast cancer, although obviously not as much as mammographic screening.

- A majority of liver cancers may be preventable now that effective vaccines against hepatitis B virus are available and widely distributed.

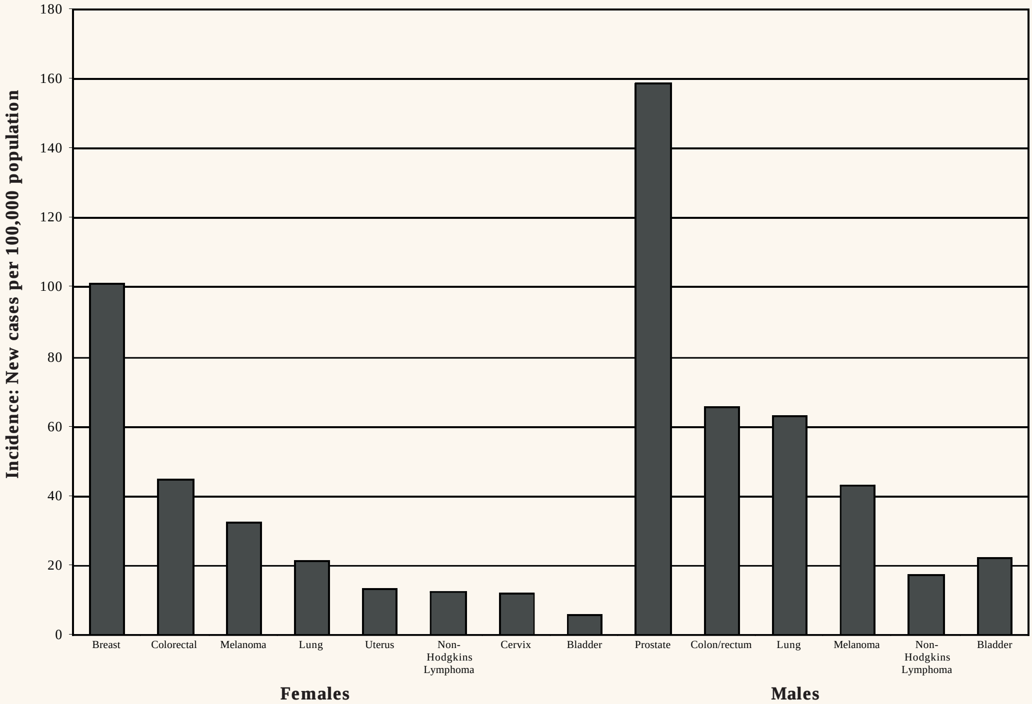
- Information about dietary factors that are known to be associated with risk of certain cancers needs to be communicated to Pacific Island communities. Food-based dietary guidelines, such as have been developed in industrialised countries, need to be developed for PICTs.

- Further research is needed in Pacific populations into the relationships between dietary factors such as the consumption of vegetables, fruit, fish, meat, fat, and alcohol, and cancers of the lung, breast, prostate, colon and rectum. There is ample evidence that dietary factors play a role in the development of these cancers.

- It is likely that stomach cancer rates will continue to fall due to changes in food preservation techniques and a reduction in the type and amount of salted foods consumed.

- Well-established cancer registries are needed in each PICT to provide health planners with information about the incidence of, and mortality from specific cancers – who is at risk and who is surviving or not surviving. This information is needed so that governments and ministries can establish appropriate policies, legislation, and programmes for the prevention, screening, and treatment of these cancers.

It is likely that we will see a changing pattern of cancer incidence rates in many PICTs over the next decades. As economic development brings with it modernisation and western influences, it is likely that the cancer profile will more and more resemble that of western countries with continued increases in rates of prostate and colon cancer, a gradual stabilising of breast and cervical cancer rates and a slow decrease in rates of stomach and liver cancers. Because of high rates of tobacco use currently in the Pacific, it is likely that incidence of and deaths from lung cancer will not decline to the extent currently seen in many western countries.



Source: (143)

Figure 7.24: Age-standardised incidence rates of major cancers in Australia, 1994

CHAPTER 8: Concluding Remarks

It is clear that the non-communicable diseases discussed in this report were uncommon in traditional Pacific cultures. However, they are now the diseases occurring in some Pacific communities in epidemic proportions and are now exceeding those rates found in affluent industrialised countries. The frequency of alcohol and tobacco use and the number of cancers appear to be rising, and are also becoming significant health problems. This is not a problem of the Pacific alone.

> *Globalisation of the Western lifestyle and diet involves parallel globalisation of disease such as hypertension, atherosclerosis and cancers of the breast, endometrium and colon. Obesity is no longer a marker of affluent populations. It is increasingly prevalent in less affluent countries [and is] associated with [an] increase in coronary artery disease and diabetes. It is now common in large cities of China where it is ascribed to decreased physical activity in addition to increased consumption of cheap vegetable oils and refined grains.* (492)

There is much evidence that the above diseases are more prevalent in towns and cities in the Pacific than in traditional villages. They have been described as the 'diseases of civilisation' and 'altered lifestyle' syndromes (498). A more appropriate description may be that they are diseases of change. Increasingly, Pacific Island people are migrating to towns, district centres and cities, and it is likely that this trend will not be reversed in the foreseeable future. While urban living offers opportunities for employment, cash income and involvement with western technology, it is accompanied by a decrease in physical exercise, a reliance on imported foods, and an increase in the 'lifestyle' diseases of western societies. Currently, however, the disease rates of urban and rural communities appear to be converging, indicating that urban lifestyles now exist in rural settings.

The factors associated with these diseases are many, complex and interrelated. For most of these diseases, an ethnic predisposition is often a component but not sufficient to be the major determinant (498). The high frequency of diseases shown in this report is the result of lifestyle change. The development of diabetes, ischaemic heart disease and hypertension follows familial lines as does the development of obesity and certain types of cancer. Yet for all of these diseases, environmental determinants appear to play the most important role.

Diet, physical activity and cigarette smoking appear as the most significant factors involved in the development of these chronic non-communicable diseases. Changes in several dietary factors, in addition to excess energy intake, are seen as the markers of the transition from a traditional to a western way of life. These same changes are implicated in the changing disease patterns. Dietary fat intake has increased in many PICTs and the source of the fat has changed, from predominantly coconut and fish to one derived from meat, eggs, margarine, butter and oil.

An increase in sugar intake may play a part in the development of obesity. Carbonated soft drinks have twice the energy content and almost three times as much simple carbohydrate as drinking coconuts. Sugar consumption is also responsible for replacing the consumption of other foods containing essential nutrients, such as fibre and/or trace minerals.

Reduced intake of dietary fibre is an important consideration in the changing dietary patterns in the Pacific. Low-fibre diets are associated with cancer of the large bowel, and high-fibre intake can lower serum cholesterol levels. High salt intake has been closely related to increased blood pressure in susceptible people. Excessive alcohol consumption is clearly a causal agent in the development of cirrhosis of the liver, but could also be a factor in the development of obesity, since alcohol is a concentrated, nutrient-free source of energy.

Studies of physical activity in most PICTs show markedly lower levels in towns and cities compared with rural areas. In urban centres employment is most often sedentary, cars and motorbikes are used instead of walking. In the rural areas as well, physical activity has declined as outboard motors have replaced canoes, and labour-saving technology becomes more available. Decreased physical activity without a similar reduction in energy intake, or with an increase in energy intake, leads to obesity. This interaction appears to be a consistent and repetitious factor in the development of most of the lifestyle diseases emerging in the Pacific today.

While it seems obvious that the traditional Pacific diet consisting of root vegetables, fish, coconut, tropical fruits and some green leaves is more healthful, and may be more enjoyable than the imported foods generally available in towns and cities, procuring a traditional diet is not always easy. The three factors of price, access and availability have greatly contributed to the successful introduction and acceptance of refined foods such as rice and flour. In competition, fresh root crops, greens, fruit and fish are often higher in price than imported foods and may not be available in urban markets. Transportation and distribution of highly perishable fresh foods from the garden or sea to the urban market place are difficult and expensive.

The dietary changes are a part of a larger, and irreversible, cultural shift towards choices of 'least effort'. Foods consumed every day in the Pacific years ago are now only consumed on special ceremonial occasions — mostly in addition to western foods and more out of respect than good nutrition.

Gaps in Existing Knowledge

A review of the factors associated with changing patterns of disease in the Pacific highlights gaps in existing information, and questions that still need to be answered. Areas in which further information is needed include the following.

Assessment and Monitoring of Non-communicable Diseases

Epidemiologic studies have been conducted over the past decade in a number of PICTs and have provided much important information about the prevalence of lifestyle diseases and influencing risk factors. NCD surveys have been conducted in American Samoa, Federated States of Micronesia, French Polynesia, Papua New Guinea, Nauru, New Caledonia, Samoa and Vanuatu. Current information regarding non-communicable disease prevalence, however, is lacking for several PICTs. Those countries and territories in need of current assessment include Commonwealth of the Northern Mariana Islands, Cook Islands, Fiji Islands, Guam, Kiribati, Marshall Islands, Niue, Solomon Islands, Palau, Tokelau, Tonga, Tuvalu and Wallis and Futuna.

Mortality and Morbidity Data

Adequate morbidity and mortality data are not available for many Pacific Island populations. Data on primary cause of death and underlying causes of death are required to calculate death rates by age and sex group. These rates are necessary so that the magnitude of, and change in, disease patterns can be fully documented. Death rates for heart disease, cerebrovascular disease, diabetes and cancers will provide important clues that relate to nutrition and other risk factors. It is necessary to regularly interpret morbidity and mortality rates to determine changes in these rates, and to which age or sex group preventive and/or treatment measures will need to be directed. Information about complications of disease is become increasingly important. The long-term effects of diabetes and hypertension on heart disease, stroke, renal disease, retinopathy, and amputations will absorb more and more of health care costs.

Disease Registries

The reasons for compiling disease registries depend upon the disease. Cancer is complicated and difficult to understand. Knowledge of the size and nature of the cancer problem in the Pacific is essential in planning and evaluating appropriate prevention and control measures. Cancer registries are the source of information on the incidence of, and survival from, cancer, and provide a focus for epidemiological studies. In some countries they will constitute the only available cancer information system (499).

Registers of diabetes, hypertension and heart diseases help to direct services and care to those most at risk. They enable follow-up and are a means of support, management, monitoring and evaluation. On small islands it is probably more appropriate for health workers to visit the patient than to ask the patient to visit the clinic (as is done in many western countries), for it is the management of these diseases that present the most difficulties and management is bilateral.

Costs of Non-communicable Diseases

Many PICTs are acutely aware of the costs of caring for individuals with chronic, long-term diseases. Medications, treatment and hospitalisations for complications related to NCDs, medical transfers out of the country as well as loss of productivity, all add up to make these diseases enormous burdens on the health care system. A conservative estimate of the cost of obesity-related disorders in New Zealand was NZD135 million (approximately USD77.7 million) or about 2.5% of total health care costs (500). Information about the costs of NCD could enable legislators and health planners to develop policies and programmes based on cost analysis and cost savings.

Relationship between Risk Factors and Disease

Further study into the associations between dietary factors and specific diseases is required in order to define appropriate health promotion messages. What is the optimum level of fat intake and in what proportions should saturated, polyunsaturated and mono-unsaturated fats be recommended? How does the source of fat affect disease patterns, particularly fats derived from coconut?

While the per capita sugar consumption in most PICTs appears to correlate with diabetes prevalence rates, the role of sugar in disease states is uncertain. Is high sugar consumption a factor in the development of obesity, and consequently other diseases? Sugar may be replacing foods containing other nutrients, such as fibre or minerals, which may offer a protective effect against certain diseases. What is the effect of dietary fibre on the increasing prevalence of diseases such as diabetes, heart disease and cancers such as cancer of the colon?

How strong is the relationship between salt intake and hypertension in the Pacific? Are elements such as potassium, chromium or zinc involved in the aetiology of either diabetes or hypertension? Potassium intake may be high in the traditional diet because of high content of potassium in coconuts and unprocessed foods. A better picture of the role of alcohol consumption and its effect on the development of cirrhosis and diabetes is necessary.

The relationship between specific types of foods and diseases also warrants attention. Again, what is the role of coconut in the present-day diet of Pacific Islanders and the association with NCD risk factors? Does fish consumption have a protective influence on disease patterns? The omega-3 fatty acids in fish have been shown to offer protection against a number of NCDs. Can an increased intake of vegetables and fruits have a beneficial effect on cancer or heart disease? What is the effect of increased intakes of meat on NCDs? Meat intake has been implicated in high rates of cancers, particularly of the colon. Captain Cook's quote (page 3) in the first Chapter mentions that intake of meat was very low while intake of roots, vegetables and fruits was high and yet the people were described as strong limbed and the tallest he had seen (8).

Food preparation may have an influence on certain diseases, specifically colon cancers. Cooking meats at a high temperature, such as grilling or frying produces heterocyclic amines, which are known carcinogens (137). The more traditional ways of cooking meat (or fish), baking or boiling, produce very few heterocyclic amines. Additionally, there is evidence that cooking and preparation skills are being lost in the acculturation transition.

More accurate data are needed on the association between the level of physical activity and lifestyle diseases. Decreased physical activity may be a more important factor than energy intake in the development of obesity, diabetes, hypertension, heart disease and certain cancers. Increased energy intake has been shown to be associated with increased prevalence rates of diabetes and hypertension in a number of Pacific surveys but not all.

Obesity is an important risk factor in the development of diabetes, hypertension and abnormal blood lipid levels. Yet the relationship between obesity and these diseases is not always close or significant. Additional research is necessary to explain the significance of obesity in these diseases, the stage or severity at which obesity becomes a health problem, and if there is a genetic predisposition to obesity similar to the 'thrifty gene theory' for diabetes. Perhaps those groups of people who develop obesity are metabolically 'more economical' in energy utilisation due to genetic factors, and therefore more easily store excess energy as fat. If this is so, what are the metabolic differences in these groups compared with the less 'efficient', slimmer groups? Or is it that Polynesians, for example, are bigger people and that the changes in the types of food consumed have not been accompanied by a correction in the proportions of the foods consumed?

Food Production and Food Processing

Research into ecologically sound agricultural technologies, livestock raising and fishing methods needs to be continued and expanded in order to increase the production of locally grown foods. New methods of preserving Pacific Island foods should be investigated. Answers need to be sought on how to increase national self-sufficiency in food production, and at the same time maintain traditional food patterns.

Food Availability and Food Costs

More information is needed on the types of foods available to both urban and rural populations and their cost in relation to income. It is important to determine whether Pacific Island urban dwellers are able to obtain a nutritious diet on their income.

Stress and Cultural Factors

Stress should be investigated in relation to hypertension, heart disease and alcoholism. Cassel (501) and Prior (502) have suggested that those Islanders who retain customs and cultural ties, even in the face of western influence, suffer less hypertension (256). The stress of urban living may be an influencing factor on the progression of NCDs and NCDs may be the diseases of crowding just as many communicable diseases are.

Many of the questions raised here have been raised before. They are difficult to answer, and research is expensive and time consuming to perform. Yet it is the responsibility of government leaders and their advisers to identify the major health problems in their countries, to establish priorities in order to find the answers to these questions and to act on the information so that these non-communicable diseases can be prevented and controlled.

All that is Healthy

> *The theme of Healthy Islands and Healthy Cities, I believe, is a little short of the total broad vision of the Pacific people's health. All our Pacific people are surrounded by tracts of large ocean; the ocean provides food and economic wealth for our people. Therefore, I suggest that the theme and setting for our community should be broadened [to] that of Healthy Islands, Healthy Cities and Healthy and Sustainable Oceans.* (503)

Leo Smith's (Minister of Health, Fiji Islands) statement above goes beyond health *per se* to an environment where all is healthy. Maybe Pacific Island governments should promote this 'all that is healthy' message at the same time as their warnings about NCDs.

To do this, governments should look more closely into the interrelated problems of health, nutrition and food supply. Many Pacific Island countries are currently investigating these issues. Strategies geared at addressing these concerns have been in progress in the Pacific and are worth examining.

- ***Development of National Food, Nutrition and NCD Policies and Plans of Action, and Policies and Programmes on Prevention and Control of Non-communicable Diseases.*** A number of PICTs have National Food and Nutrition Committees in place and Food and Nutrition Policies have been developed and put into practice. A food and nutrition policy has been defined as:

> *a coherent set of principles, objectives, priorities and decisions adopted by the State and applied by its institutions as an integral part of the National Development Plan, in order to provide all the population, within a specified time, with the food and other social, cultural, and economic conditions essential to satisfactory nutrition and dietary well-being.* (504)

- Nutritional health is not only a basic right, it is also a crucial part of social and economic development. Therefore, nutritional considerations should be integrated into national development plans. Food and Nutrition policies should be kept simple and flexible. They should be continually revised, adapted and evaluated. National Food and Nutrition Policies are an important step, but not the only step, in leading to greater national self-sufficiency along with improvement in health, prevention of disease, and development of human potential. Some PICTs have already developed National Food and Nutrition Policies and Plans of Action. Others are in the process of doing so.

- National NCD policies and programmes should be part of the national health plan and established within the Ministry of Health for planning, implementation, evaluation and coordination. Links should be established with a range of other relevant government and non-government agencies and organisations.

- Epidemiological surveillance and monitoring of NCDs should be conducted on a regular basis in all PICTs. Guidelines and standardised procedures related to data collection and analysis should be developed and available. Mortality and morbidity data should be collected and reported and utilised in the development of national policies and programmes.

- Strategies should be implemented to focus on primary prevention through improvements in lifestyle behaviours such as healthy eating patterns, sufficient physical activity, moderate use of alcohol and not smoking. Population approaches and environmental strategies should be emphasised. Community-based programmes should be promoted and supported.

- Programmes should be developed for the control of established diseases and the prevention of complications of these diseases. Guidelines should be developed for screening programmes, follow-up and management of existing diseases. Appropriate patient education materials and medications should be available and maintained in health facilities.

- Health officials should pursue multisectoral and multidisciplinary collaborations, particularly associations with agriculture, education, commerce, the environment, the food industry and the mass media.

- Training should be provided for health professionals, and health workers at various levels on several aspects of NCDs: preventive programmes, surveillance and screening, follow-up and monitoring, patient education, pharmacological and non-pharmacological treatment and health promotion.

REFERENCES

[**Note:** For the sake of brevity, the following abbreviations have been used in the references:

- **SPC:** South Pacific Commission until 6th February 1998, when it was renamed Secretariat of the Pacific Community, retaining the same acronym;
- **FAO:** Food and Agriculture Organization of the United Nations;
- **WHO:** World Health Organization.]

1. SPC. Diabetes, gout and hypertension in the Pacific Islands. Information document No. 43. SPC Noumea, New Caledonia; 1978.
2. Coyne T. The effect of urbanisation and western diet on the health of Pacific Island populations. In: Badcock J, Taylor R, eds. Information document No. 186. SPC, Noumea, New Caledonia; 1984.
3. WHO working group on integrated prevention and control of cardiovascular disease and diabetes. WHO, Manila; 1998.
4. King H, Zimmet P, Bennet P, Taylor R, Raper LR. Glucose tolerance and ancestral genetic admixture in six semitraditional Pacific populations. Genet Epidemiol 1984;1:315–28.
5. Serjeantson SW, Ryan DP, Thompson AR. The colonization of the Pacific: The story according to human leukocyte antigens. Am J Hum Genet 1982;34:904–18.
6. Bellwood PS. The peopling of the Pacific. Sci Am 1980;243(5):138–48.
7. Zimmet P. Diabetes definitions and classification. Medicine 1997;1–4.
8. Beaglehole JC. The journal of Captain James Cook on his voyage of discovery; the voyage of the Endeavour. Cambridge University Press, Cambridge; 1968.
9. Houghton P. Prehistoric New Zealanders. NZ Med J 1978;87(608):213–6.
10. Carter J, ed. Pacific Islands Yearbook, 14th edn. Pacific Publications, Sydney; 1981.
11. Ellis W. Polynesian researches during a residence of nearly eight years in the Society and Sandwich Islands, 2nd edn. Henry G. Bohn, London; 1853.
12. Ward RH, Hau'ofa E. South Pacific agriculture choices and constraints: South Pacific agricultural survey, 1979. Australian National University, Canberra; 1980.
13. Neubarth RG. Dental conditions in school children of American Samoa. Technical Paper No. 64. SPC, Noumea, New Caledonia; 1954.
14. Haberkorn G, Lepers C, eds. Pacific Island Populations. Report prepared for the International Conference on Populations and Development, 5–13 September 1994, Cairo. SPC Noumea, New Caledonia; 1998.
15. Demographics Section. Pacific Island populations. <www.spc.int>. SPC, Noumea, New Caledonia; 1999. electronic citation.
16. Turbott IG. Diets, Gilbert and Ellice Island colony. J Poly Soc 1949;58(1):36–46.
17. Holmes S. A report of a nutrition survey in three villages of the Cook Islands. Community Health Services, SPC, Suva, Fiji; 1954.
18. Hipsley EH, Clements FW. Report of the New Guinea nutrition survey expedition. Department of External Territories, Canberra, Australia; 1947.
19. Ministère de la Santé et de la Recherche. Enquête sur les maladies non transmissibles en Polynésie Française. Étude de la prévalence de l'hypertension, du diabètes, de la goutte et de l'obésité en relation avec les habitudes alimentaires. Direction de la Santé en Polynésie Française, Institut Territorial de Recherche Médicale Louis Malardé. Papeete, Tahiti, Polynésie française; 1998.

20. Pargeter K, Taylor R, King H, et al. Kiribati: A dietary study. SPC, Noumea, New Caledonia; 1984.

21. Matenga-Smith T, Ash K, Badcock J, et al. Cook Islands Dietary Study 1987. SPC, Noumea, New Caledonia; 1990.

22. Ringrose H, Pargeter K, Taylor R, Thoma K, King H, Zimmet P. Nutrient intakes of a Pacific population with a high diabetes prevalence-rate and marked obesity. Proc Nutr Soc Aust 1982;7:170.

23. Badcock J, Bach F, Taylor R, et al. Vanuatu dietary study 1985. Summary Report. Technical Paper No. 203. SPC, Noumea, New Caledonia; 1993.

24. Galanis DJ, McGarvey ST, Quested C, Sio B, Afele-Fa' amuli S. Dietary intake among modernizing Samoans: implications for risk of cardiovascular disease. J Am Diet Assoc 1999;99(2):184–90.

25. Tunidau-Schultz J, Toganivalu V, Seniolo S, et al. Report of the fifth decennial Naduri nutrition and health survey. National Food and Nutrition Committee, Suva, Fiji; 1996.

26. FAO. Food balance sheets: 1992–94 average. FAO, Rome; 1996.

27. Langley D. Dietary surveys and growth records in a Fijian village, Naduri, June 1952 – November 1953. Community Health Services, SPC, Suva, Fiji; 1953.

28. Wilkins RM. Dietary survey in a Fijian village, Naduri, Nadroga, November 1963. Community Health Services, SPC, Suva, Fiji; 1963.

29. National Food and Nutrition Committee. Dietary survey in a Fijian village, Naduri, November 1982. National Food and Nutrition Committee, Suva, Fiji; 1982.

30. O'Loughlin C, Holmes S. A survey of economic and nutritional conditions in Indian households. Community Health Services, SPC, Noumea, New Caledonia; 1954.

31. Wilkinson R. Dietary survey of an Indian settlement at Rakiraki. Community Health Services, SPC, Noumea, New Caledonia; 1964.

32. Wilkinson R. Dietary survey in a Fijian village. Community Health Services, SPC, Noumea, New Caledonia; 1963.

33. Johnson JS, Lambert JN. The national food and nutrition survey of Fiji. Report No. 6. UNDP, Suva, Fiji; 1982.

34. Taylor R, Badcock J, King H, et al. Dietary intake, exercise, obesity and non-communicable disease in rural and urban populations of three Pacific Island countries. J Am Coll Nutr 1992;11(3):283–93.

35. Crawford J, Willmott JV. Nutritional status of young Gilbertese children in a transitional economy. Trop Geogr Med 1971;23:250–7.

36. Saito S, ed. 1993 National nutrition survey, main report. NFNC, Suva, Fiji; 1995.

37. Malcolm S. Nutritional investigations in New Caledonia. Report No. 50. SPC, Noumea, New Caledonia; 1953.

38. Loison G, Jardin C, Crosnier J. Alimentation et nutrition dans le Pacifique Sud. Med Trop 1973;33(2):143–61.

39. Taylor R, Zimmet P. Preliminary report of 1980 Noumea/Wallis survey and interim report of 1979 Ouvea survey. SPC, Noumea, New Caledonia; 1980.

40. Institut Pasteur de Nouvelle-Calédonie. Rapport technique Enquête épidemiologique sur les facteurs de risque du cancer liés au mode de vie en Nouvelle-Calédonie. Institut Pasteur de Nouvelle-Calédonie, Nouméa, Nouvelle-Calédonie; 1991.

41. Tassie JM. Facteurs nutritionnels et diabète non-insulinodépendant suivant l'origine ethnique et l'environnement en Nouvelle-Calédonie. Université de Paris, France; 1995.

42. Meggitt MJ. The Enga of the New Guinea Highlands: some preliminary observations. Oceania 1958;28(4):253–330.

43. Venkatachalam PS. A study of the diet, nutrition and health of the people of the Chimbu area, New Guinea Highlands. Department of Public Health Monograph No. 1. Port Moresby, Papua New Guinea; 1962.

44. Hitchcock N, Oram ND. Rabia camp, a Port Moresby migrant settlement. New Guinea Research Bulletin 1962;14.

45. Oomen HA. Ecology of human nutrition in New Guinea: Evaluation of subsistence patterns. Ecology of food and nutrition 1971;1:3–18.

46. Sinnett P. Nutrition in a New Guinea highland community. Hum Biol Oceania 1972;1(4):299–305.

47. Date C, Fujita Y, Okuda T. Relation of dietary intake to health status in highlands of Papua New Guinea. Twelfth International Congress of Nutrition 1981; 42.

48. Martin FIR, Wyatt GB, Griew AR, Haurahelia M, Higginbotham L. Diabetes mellitus in urban and rural communities in Papua New Guinea. Diabetologia 1980;18:369–74.

49. Okuda T, Kajiwara N, Date C, et al. Nutritional status of Papua New Guinea highlanders. J Nutr Sci Vitaminol 1981;27:319–31.

50. Malcom LA. Need and demand for health and medical care in urban Lae, Papua New Guinea. PNG Med J 1973;16:157–67.

51. Norgan NG, Ferro-Luzzi A, Durnin JVGA. The energy and nutrient intake and the energy expenditure of 204 New Guinean adults. Philos Trans R Soc Lond B Biol Sci 1974;268(893):309–48.

52. Jeffries DJ. From Kaukau to Coke: a study of rural and urban food habits in Papua New Guinea. Australian National University, Canberra; 1979.

53. Harvey PW, Heywood P. Twenty-five years of dietary change in Simbu Province, Papua New Guinea. Nutrition Program, University of Queensland, Brisbane; 1992. unpub.

54. Joughin J, Kalit K. Food prices in Papua New Guinea: a guide to the changing urban diet. PNG Med J 1988;31(2):133–9.

55. Jansen AA, Wilmott JV. Nutrition and dietary survey of urban and rural populations in British Solomon Islands protectorate, part II: Solomon Islands special conditions. Community Health Services, SPC, Suva, Fiji; 1973.

56. Friedlaender JS, ed. The Solomon Islands project: a long-term study of health, human biology, and culture change. Clarendon Press, Oxford; 1987.

57. Eason RJ, Pada J, Wallace R, Henry A, Thornton R. Changing patterns of hypertension, diabetes, obesity and diet among Melanesians and Micronesians in the Solomon Islands. Med J Aust 1987;146(9):465–9.

58. Paterson J, Laura A, Harris R, et al. Solomon Islands National Nutrition Survey 1989: summary report. Government of Solomon Islands, Honiara; 1990.

59. Malcolm S. Nutritional investigations in the New Hebrides. Report No. 23. SPC, Noumea, New Caledonia; 1952.

60. Dye EL. A survey of nutrient intakes and food habits in a New Hebridean village. SPC, Noumea, New Caledonia; 1979.

61. Carlot-Tary M, Harvey P, Menere R. Second National Nutrition Survey. 1996 Report. Health Department, Republic of Vanuatu; 1998.

62. Carlot-Tary M, Hughes RG, Hughes MC. 1998 Vanuatu non-communicable diseases survey report. Technical Paper No. 217. SPC, Noumea, New Caledonia; 1999.

63. Hankin J, Reed D, Labarthe D, Nichaman M, Stallones R. Dietary and disease patterns among Micronesians. Am J Clin Nutr 1970;23(3):346–57.

64. Kincaid PJ. Nutrition survey. Trust Territory of the Pacific Islands – Health Services; 1973.

65. Fritz VS. Impact of changing roles of women on infant nutritional levels in Micronesia. Dept. of Community Development, School of Public Health, University of Hawaii, Manoa; 1982. Masters thesis.

66. Elymore J, Elymore A, Badcock J, et al. The 1987/88 national nutrition survey of the Federated States of Micronesia. SPC, Noumea, New Caledonia; 1989.

67. Pollock NJ. Food habits in Guam over 500 years. Pacific Viewpoint 1986;27(2):120–43.

68. Holmes S. Nutrition survey in the Gilbert Islands. Community Health Services, SPC, Suva, Fiji; 1953.

69. Willmott JV. Gilbert and Ellice Islands Colony: Report on a visit made by Nutritionist, South Pacific Health Service. Community Health Services, SPC, Suva, Fiji; 1968.

70. Thompson J. Feasibility study, Tarawa, Gilbert Islands. SPC, Noumea, New Caledonia; 1978.

71. Zimmet P, Beriki T, Taylor R. Diabetes and cardiovascular disease survey, Kiribati: preliminary report. Royal Southern Memorial Hospital, Melbourne; 1981.

72. National Health & Medical Research Council. Recommended dietary intakes for use in Australia. Australian Government Printing Service, Canberra; 1991.

73. de Brum O. Situation analysis of the Marshallese child. Office of Planning and Statistics, Majuro, Republic of the Marshall Islands; 1990.

74. Thomas P. Republic of the Marshall Islands report. Ministry of Health Services; 1987. unpub.

75. Burton ML, Nero KL, Pollock NJ. Food consumption patterns in the Marshall Islands: a preliminary report. Ministry of Health Services; 1999. unpub.

76. Ministry of Health Services. The Republic of the Marshall Islands National Nutrition survey 1991: technical report. Ministry of Health Services, Republic of the Marshall Islands; 1991.

77. Kirk N. Nutrition in native peoples: some observations on the food habits of Nauruans. Journal of Health 1958;8(3):79–82.

78. Ringrose H, Zimmet P. Nutrient intake in an urbanized Micronesian population with a high diabetes prevalence. Am J Clin Nutr 1979;32:1334–41.

79. WHO. The health aspects of food and nutrition. WHO Regional Office for the Western Pacific, Manila, Philippines; 1979.

80. Hankin J, Dickinson LE. Urbanization, diet, and potential health effects in Palau. Am J Clin Nutr 1972;25:348–53.

81. Abraham M. Report on food conditions in Rarotonga, Cook Islands. SPC, Noumea, New Caledonia; 1947.

82. Fry PC. Dietary survey on Rarotonga, Cook Islands, parts 1-3. Am J Clin Nutr 1957; 5(3):42–50; 5(3):268–273; 5(6): 634–643.

83. Hunter JD. Diet, body build, blood pressure and serum cholesterol levels in coconut-eating Polynesians. Fed Am Socs Exp Biol 1962;21(2):36–43.

84. Prior IA, Harvey HP, Neave M, et al. The health of two groups of Cook Islands Maoris. NZ Department of Health Special Report Series 26. Government Printer, Wellington, New Zealand; 1966.

85. Swinburn B, Matenga-Smith T, Daniel R, et al. Tutakimoa life-wise project. University of Auckland, New Zealand; 1995.

86. Dumbrell S, Koteka G, Taylor R, et al. Prevention and control of non-communicable disease: present activities in the Cook Islands – Report No. 2. Technical Paper No. 52. SPC, Noumea, New Caledonia; 1984.

87. National Health and Medical Research Council. Dietary Guidelines for Australians. Australian Government Printing Service, Canberra; 1992.

88. Langley D. Nutrition survey, Niue Island, 1953. South Pacific Health Services, Suva, Fiji; 1953.

89. Mitikulena M, Mitikulena A, Talagi S, et al. The 1987 national nutrition and dietary survey of Niue. Technical Paper No. 202. SPC, Noumea, New Caledonia; 1993.

90. WHO. Energy and protein requirements. Report of a meeting of experts. WHO Report No. 724. FAO, WHO, UNU. Geneva; 1986.

91. Malcolm S. Diet and nutrition in American Samoa. Technical Paper No. 63. SPC, Noumea, New Caledonia; 1954.

92. Bindon JR. Breadfruit, banana, beef, and beer: modernization of the Samoan diet. Ecology of food and nutrition 1982;12:49–60.

93. Brown VJ, Hanna J, Severson G. A quantitative study of native and migrant Samoans. Am J Phys Anthropol 1984;63(142).

94. Pollock NJ. Food and identity: Food preferences and diet of Samoans in Wellington, New Zealand. Publications de l'Université Française du Pacifique 1989;1(2):45–9.

95. Holmes S. Report on a qualitative nutrition study in Western Samoa. South Pacific Health Services, Suva, Fiji; 1951.

96. Pelletier DL. Diet, activity and cardiovascular disease risk factors in Western Samoan men. In: Baker PT, Hanna JM, Baker TS, eds. The Changing Samoans, Oxford University Press, New York; 1986.

97. Quested C, Lui O, Lamb J. Samoa country paper for the International Conference on Nutrition in Rome, 1992. NFNC, Health Department, Samoa; 1992.

98. Sparling M. The influence of a modern diet on body mass index in a transitional village in Western Samoa. University of Hawaii; 1997. thesis.

99. Davidson F. The Tokelau island migrant study: Atoll diet. In: Stanhope JM, ed. Migration and health in New Zealand and the Pacific: Proceedings of a Seminar 1975, Epidemiology Unit, Wellington Hospital, Wellington; 1977:109–12.

100. Harding W. The diet of Tokelau island migrants in New Zealand. In: Stanhope JM, ed. Migration and health in New Zealand and the Pacific: proceedings of a seminar 1975, Wellington. Epidemiology Unit, Wellington Hospital; 1977:113–6.

101. Jardin C. Food and dietary habits in the Cook Islands, Niue and Tokelau. SPC, Noumea, New Caledonia. n.d. unpub. original French.

102. Mckenzie JM, Guthrie BE. Zinc in Tokelau Islands diet. NZ Med J 1979;118–9. letter.

103. Naylor R. A review of health services of Tokelau. SPC, Noumea, New Caledonia; 1990.

104. Langley D. Nutrition survey: the Kingdom of Tonga 1952. South Pacific Health Services, Suva, Fiji; 1952.

105. Jansen AA. Malnutrition and child feeding practices in the Kingdom of Tonga. J Trop Pediatr 1982;28:202–8.

106. Englberger L. Review of past food and nutrition surveys in Tonga. NFNC No. 17. Government Printer, Tonga; 1983.

107. Finau SA, Prior IAM, Maddill J. Food consumption patterns among urban and rural Tongans. Review, USP, 1987;8:35–41.

108. Maclean E, Bach F, Badcock J. The 1986 National nutrition survey of the Kingdom of Tonga: summary report. Technical Paper No. 200. SPC, Noumea, New Caledonia; 1992.

109. Englberger L. Policy paper for importing lean meat into Tonga. NFNC, Central Planning Department, Tonga. unpub.

110. Englberger L. First Tonga healthy weight loss competition 1995–1996. Central Planning Department, Government of Tonga; 1996.

111. Englberger L, Halavatau V. Second Tonga healthy weight loss competition. Central Planning Department, Government of Tonga; 1996.

112. Englberger L, Yasuda H, Yamazaki R. Third Tonga healthy weight loss competition. Central Planning Department, Government of Tonga; 1998.

113. Englberger L, Halavatau V. Tonga national weight loss programme 1995–1997. Central Planning Department, Government of Tonga; 1997.

114. Wicking J, Ringrose H, Whitehouse S, Zimmet P. Nutrient intake in a partly westernized isolated Polynesian population: The Funafuti survey. Diabetes Care 1981;4(1):92–4.

115. Walker JO. Nutrition report in relation to a study of diet, blood cholesterol levels and coronary disease in Polynesians of the Cook Islands. South Pacific Health Services, Suva, Fiji; 1960.

116. Johnson B, Dignan C, Kofe S, eds. The food and nutrition situation in Tuvalu: the need for a national food and nutrition policy in Tuvalu. SPC, Noumea, New Caledonia; 1994.

117. Doumenge JP, Villenave D, Chapuis O. Agriculture, foods and nutrition in four South Pacific archipelagoes. Centre D'Études de Géographie Tropicale, France; 1995.

118. Loison G, Jardin C, Crosnier J. Alimentation et nutrition dans les territoires français du Pacifique. Med Trop 1999;33(4):363–8.

119. Pollock NJ. The relationship of energy intake and expenditure to body fatness in Wallis. Department of Anthropology, Victoria University of Wellington, New Zealand. unpub.

120. WHO. Obesity: preventing and managing the global epidemic. Report of a WHO consultation on obesity. WHO, Geneva; 1997.

121. McNamara DJ, Shils ME, Olson JA, Shike M, eds. Modern nutrition in health and disease, 8th edn. Lea & Febiger, Philadelphia; 1994.

122. Hursting SD, Thornquist M, Henderson MM. Types of dietary fat and the incidence of cancer at five sites. Prev Med 1990;19:242–53.

123. Goodman MT, Hankin J, Wilkens LR, Kolonel LN. High-fat foods and the risk of lung cancer. Epidemiology 1992;3(4):288–99.

124. Le Marchand L, Kolonel LN, Wilkens LR, Myers BC, Hirohata T. Animal fat consumption and prostate cancer: a prospective study in Hawaii. Epidemiology 1994;5:276–82.

125. Cummings JH, Bingham SA. Diet and the prevention of cancer. BMJ 1998;317:1636–40.

126. Le Marchand L, Wilkens LR, Mi MP. Early-age body size, adult weight gain and endometrial cancer risk. Int J Cancer 1991;48(6):807–11.

127. Anderson JW, Gustafson NJ, Bryant CA, Tietyen-Clark RD. Dietary fiber and diabetes: a comprehensive review and practical application. J Am Diet Assoc 1987;87(9):1189–97.

128. Dignan C, Burlingame B, Arthur J, Quigley R, Milligan G. The Pacific Islands food composition tables. SPC & New Zealand Institute for Crop and Food Research Ltd & International Network of Food Data Systems. SPC, Noumea, New Caledonia; 1994.

129. Bjelke E. Dietary vitamin A and human lung cancer. Int J Cancer 1975;15:561–5.

130. Willett WC, MacMahon B. Diet and cancer – an overview (part 2). New Eng J Med 1984;310:697–701.

131. Le Marchand L, Hankin JH, Kolonel LN, Beecher DM, Wilkens LR, Zhao LP. Intake of specific carotenoids and lung cancer risk. Cancer Epidemiol Biomarkers Prev 1993;2(3):183–7.

132. Willett WC, Hunter PH. Vitamin A and cancers of the breast, large bowel and prostate: epidemiologic evidence. Nutr Rev 1994;52(2 suppl):S53–S59.

133. Kolonel LN, Hinds MW, Nomura AM, Hankin JH, Lee J. Relationship of dietary vitamin A and ascorbic acid intake to the risk for cancers of the lung, bladder, and prostate in Hawaii. Natl Cancer Inst Monogr 1985;69:137–42.

134. Bao DQ, Mori TA, Burke V, Puddey IB, Beilin LJ. Effects of dietary fish and weight reduction on ambulatory blood pressure in overweight hypertensives. Hypertension 1998;32:710–7.

135. Berry EM. Dietary fatty acids in the management of diabetes mellitus. Am J Clin Nutr 1997;66(suppl):991S–7S.

136. Law MR. Epidemiological evidence on salt and blood pressure. Am J Hypertens 1997;10:42s–5s.

137. World Cancer Research Fund; American Institute for Cancer Research. Food, nutrition and the prevention of cancer: a global perspective. American Institute for Cancer Research, Washington DC; 1997.

138. Smith-Warner SA, Spiegelman D, Yaun SS, van den Brandt PA, Folsom AR, Goldbohm RA. Alcohol and breast cancer in women. JAMA 1998;279:535–40.

139. Guam Department of Public Health and Social Services. Health risk behaviour. Government of Guam; 1991.

140. Chalmers J, WHO-ISH Hypertension Guidelines Committee. Technical Report Series 628. 1999 Guidelines for the management of hypertension. J Hypertens 1999;17:151–85.

141. WHO. Arterial hypertension: Report of a WHO expert committee. Technical Report Series 628. WHO, Geneva; 1978.

142. Burt VL, Culter JA, Higgins M, et al. Trends in the prevalence, awareness, treatment, and control of hypertension in the adult US population. Data from the health examination surveys 1960 to 1991. Hypertension 1995;26(1):60–9.

143. Australian Institute of Health and Welfare. Australia's Health 1998: the sixth biennial health report of the Australian Institute of Health and Welfare. AIHW, Canberra; 1999.

144. Maddocks I. Possible absence of essential hypertension in two complete Pacific Island populations. Lancet 1961;396–9.

145. Taylor R, Zimmet P, Tuomilehto J, Ram P, Hunt D, Sloman G. Blood pressure changes with age in two ethnic groups in Fiji. J Am Coll Nutr 1989;8(4):335–46.

146. Ram BP, Ram P. Hypertension and diabetes in Gau Islands. Fiji Med J 1983;35–8.

147. Ram BP, Ram P. Hypertension in Kadavu. Fiji Med J 1986;14(5&6):134–40.

148. Munif H, Ram P. Hypertension in Lakeba. Fiji Med J 1986;14(5&6):142–4.

149. Hoskins P, Turtle JR, Handelsman D, Hannelly T. Diabetes mellitus, hypertension, and obesity in Fiji. Diabetes 1984;33(suppl):1.

150. Nye ER, Bakani I, Coverdale HA, Sutherland WHF, Spears GFS. Anthropometric characteristics, blood pressure and lipoprotein lipids in Fiji: comparison of an urban and rural population. Community Health Studies 1986;10(1):19–30.

151. Russell-Jones DL, Hoskins P, Kearney E, et al. Rural/urban differences of diabetes-impaired glucose tolerance, hypertension, obesity, glycosolated haemoglobin, nutritional proteins, fasting cholesterol and apolipoproteins in Fijian Melanesians over 40. Quarterly J Med 1990;74(273):75–81.

152. Nignpense BE. Prevalence of hypertension in Rakiraki, Fiji Islands. School of Tropical Medicine, University of Liverpool; 1991.

153. Sabbah P, Duriez P, Blanc M, Goldberg M. L'hypertension artérielle à Thio (Nouvelle-Calédonie). Med Trop 1990;50(3):298–300.

154. Wallon P. Stroke in New Caledonia: a prospective study over two years. University of Bordeaux, France; 1999.

155. Maddocks I. Blood pressures in Melanesians. Med J Aust 1967;1123–6.

156. Sinnett P, Whyte HM. Epidemiological studies in a total highland population, Tukisenta, New Guinea: cardiovascular disease and relevant clinical, electrocardiographic, radiological and biochemical findings. J Chron Dis 1973;26(5):265–90.

157. Boyce AJ, Attenborough RD, Harrison GA, Hornabrook RW, Sinnett P. Variation in blood pressure in a New Guinea population. Ann Hum Biol 1978;5(4):313–9.

158. Sinnett P, Whyte HM. Epidemiological studies in a highland population of New Guinea: environment, culture and health status. Hum Ecol 1973;1(3):245–77.

159. Masironi R, Koirtyohann SR, Pierce JO, Schamschula RG. Calcium content of river water, trace element concentrations in toenails, and blood pressure in village populations in Papua New Guinea. Sci Total Environ 1976;6:41–56.

160. Martin FIR, Wyatt GB, Griew AR, Mathews JD, Campbell DG. Diabetic surveys in Papua New Guinea – results and implications. PNG Med J 1981;24(3):188–94.

161. King H, Heywood P, Zimmet P, et al. Glucose tolerance in a highland population in Papua New Guinea. Diabetes Research 1984;1:45–51.

162. King H, Collins A, King LF, et al. Blood pressure in Papua New Guinea: a survey of two highland villages in the Asaro Valley. J Epid Comm Health 1985;39:215–9.

163. Scrimgeour EM, McCall MG, Smith DE, Masarei JRL. Levels of serum cholesterol, triglyceride, HDL-cholesterol, apoproteins A-I and B, and plasma glucose, and prevalence of diastolic hypertension and cigarette smoking in Papua New Guinea highlanders. Pathology 1989;21:46–50.

164. King H, Collins VR, King LF, Finch CF, Alpers M. Blood pressure, hypertension and other cardiovascular risk factors in six communities in Papua New Guinea, 1985-1986. PNG Med J 1994;37(2):100–9.

165. Lindeberg S, Berntorp E, Nilsson-Ehle P, Terent A, Vessby B. Age relations of cardiovascular risk factors in a traditional Melanesian society: the Kitava study. Am J Clin Nutr 1997;66:845–52.

166. Lindeberg S, Lundh B. Apparent absence of stroke and ischaemic heart disease in a traditional Melanesian island: a clinical study in Kitava. J Int Med 1993;233:269–75.

167. Dowse GK, Spark RA, Mavo B, et al. Extraordinary prevalence of non-insulin-dependent diabetes mellitus and bimodal plasma glucose distribution in the Wanigela people of Papua New Guinea. Med J Aust 1994;160:767–74.

168. Heriot WJ, Borger JP, Zimmet P, King H, Taylor R, Raper LR. Diabetic retinopathy in a natural population. Aust J Ophthalmol 1983;11:175–9.

169. Zerba KE, Friedlaender JS, Sing CF. Heterogeneity of the blood pressure distribution among Solomon Islands societies with increasing acculturation. Am J Phys Anthropol 1988;81:493–511.

170. Kottke BA, Friedlaender JS, Zerba KE, Sing CF. Lipid and apolipoprotein levels in six Solomon Island societies differ from those in a US white population. Am J Phys Anthropol 1990; 81(4):483–91.

171. Friedlaender JS, Page LB. Blood pressure changes in the survey populations. In: Friedlaender JS, ed. The Solomon Islands project: a long-term study of health, human biology, and culture change. Clarendon Press, Oxford; 1987.

172. Norman-Taylor W, Rees WH. A health survey in the New Hebrides. Technical Paper No. 143. SPC, Noumea, New Caledonia; 1964.

173. Finlayson PJ, Caterson I, Rhodes KM, Plehwe WE, Hannelly T, Silink M. Diabetes, obesity and hypertension in Vanuatu. PNG Med J 1988;31:9–18.

174. Taylor R, Jalaludin SL, Levy S, Montaville B, Gee K, Sladden T. Prevalence of diabetes, hypertension and obesity at different levels of urbanisation in Vanuatu. Med J Aust 1991;155(2):86–90.

175. Montaville B, Lund M, Malisa P, et al. Vanuatu/WHO/SPC non-communicable disease survey 1985. Technical Paper No. 192. SPC, Noumea, New Caledonia; 1987.

176. Bruss M. Overview of the problem of non-communicable diseases in CMNI. Country report presented at the SPC Regional Nutritionists Workshop. Noumea, New Caledonia, 28 Sept – 2 Oct 1998. unpub.

177. CNMI and Division of Public Health. Health/nutrition assessment Tanapag elementary school summary report. Department of Public Health, Saipan, Commonwealth of the Northern Mariana Islands; 1996.

178. Murrill RI. A blood pressure study of the natives of Ponape Island, Eastern Carolines. Hum Biol 1949;21:49–59.

179. Patrick RC, Prior IA, Smith JC, Smith AH. Relationship between blood pressure and modernity among Ponapeans. Int J Epidemiol 1983;12(1):36–44.

180. Auerbach SB, Engelgau M, Pretrick E, et al. Obesity, hypertension, Type II diabetes mellitus dyslipidemias and the non-communicable diseases program in the Federated States of Micronesia. Pohnpei; 1999. unpub.

181. Reed D, Labarthe D, Stallones R. Health effects of westernisation and migration among Chamorros. Am J Epidemiol 1995;142(7):673–91.

182. Zimmet P. The impact of modernization on the health of a Pacific nation: The Kiribati Diabetes and Cardiovascular Disease Survey. SPC, Noumea, New Caledonia; 1981.

183. Hetzel AM. Health survey of the trust territory of the Pacific Islands. US Armed Forces Med J 1959;10(10):1199–223.

184. Levy S, Taylor R, Higgins I, et al. Marshall Islands women's health survey, 1985. Technical Paper No. 196. SPC, Noumea, New Caledonia; 1989.

185. Greenop P, Dignan C. The National Nutrition Survey of the Republic of the Marshall Islands 1991. Ministry of Health Services, Republic of the Marshall Islands; 1994.

186. Gittelsohn J. Overnutrition and undernutrition in the Republic of the Marshall Islands: report of a pilot study and future directions. Ministry of Health and Environment, Republic of the Marshall Islands; 1998. unpub.

187. Zimmet P, Taft P. The high prevalence of diabetes mellitus in Nauru, a Central Pacific Island. Advances Metabolic Disorders 1978;9:225–40.

188. Collins VR, Dowse GK, Finch F, Zimmet P. An inconsistent relationship between insulin and blood pressure in three Pacific island populations. J Clin Epidemiol 1990;43(12):1369–78.

189. Taylor R and Thoma K. Nauruan mortality 1976–1981 and a review of previous mortality data. SPC, Noumea, New Caledonia; 1983.

190. Collins VR, Dowse GK, Finch F, Zimmet P, Linnane AW. Prevalence and risk factors for micro- and macro-albuminuria in diabetic subjects and entire population of Nauru. Diabetes 1989; 38:1602–10.

191. Labarthe D, Reed D, Brody J, Stallones R. Health effects of modernization in Palau. Am J Epidemiol 1973;98(3):161–74.

192. Jensen GD, Polloi AH. Health and life-style of longevous Palauans: implications for developmental theory. Int J Aging Hum Devel 1984;19(4):271–85.

193. Bishop B. Epidemiological analysis of diabetes mellitus in the Republic of Palau. Country report presented at the SPC Regional Nutritionists Workshop. Noumea, New Caledonia, 28 Sept – 2 Oct 1998.

194. McGarvey ST, Baker PT. The effects of modernization and migration on Samoan blood pressures. Hum Biol 1979;51(4):461–79.

195. McGarvey ST, Schendel DE. Blood pressure of Samoans. In: Baker PT, Hanna JM, Baker TS, eds. The changing Samoans, behavior and health in transition. Oxford University Press, New York; 1986.

196. Hanna JM, Baker WA. Biocultural correlates to the blood pressure of Samoan migrants in Hawaii. Hum Biol 1979;51(4):481–97.

197. Murphy W. Some observations on blood pressure in the humid tropics. NZ Med J 1955;54(299):64–73.

198. Bennett P, Taylor R, Uili R, Zimmet P. Epidemiological studies of cardiovascular disease and diabetes in Polynesians from Rarotonga (Cook Islands) and Niue. Technical Paper No. 185. SPC, Noumea, New Caledonia; 1984.

199. Taylor R, Bach F, DeRoeck D, et al. The 1987 non-communicable disease survey of Rarotonga, Cook Islands. SPC, Noumea, New Caledonia; 1989.

200. Taylor R, Bach F, Teariki T, et al. Non-communicable disease evaluation survey: preliminary report. SPC, Noumea, New Caledonia; 1987.

201. Katoh K, Yamauchi T, Hiraiwa K. Blood pressure, obesity and urine cation excretion in two populations of the Cook Islands. Tohoku J Exp Med 1990;160(2):117–28.

202. Losacker W. Report of a medical survey on Aitutaki Island. Ministry of Health, Rarotonga, Cook Islands; 1992.

203. Munokoa N, Boaza M, Iorangi T. 1995 Annual bulletin. Ministry of Health Medical Records Unit, Rarotonga, Cook Islands; 1996.

204. Harburg E, Gleibermann L, Harburg J. Blood pressure and skin color: Maupiti, French Polynesia. Hum Biol 1982;54(2):283–98.

205. Delebecque KH, Delebecque P. L'excès pondéal chez les salariés à Tahiti. Rapport no. 375. Service d'Hygiène et de Salubrité Publique, Tahiti; 1987.

206. Gras C, Papouin G, Prigent D, et al. Les accidents vasculaires cérébraux en Polynésie Française. Med Trop 1992;52(1):43–8.

207. Taylor R, Whitmore J, Shirley R, et al. Niue women's health survey, 1983. Technical Paper No. 187. SPC, Noumea, New Caledonia; 1985.

208. Wessen AF, Hooper A, Huntsman J, et al. Migration and health in a small society: the case of Tokelau. Oxford University Press, New York; 1992.

209. Beaglehole R, Eyles EF, Salmond CE, Prior IA. Blood pressure in Tokelauan children in two contrasting environments. Am J Epidemiol 1978;108(4):283–8.

210. Beaglehole R, Eyles EF, Prior IA. Blood pressure and migration in children. Int J Epidemiol 1979;8(1):5–10.

211. Finau SA, Prior IAM, Salmond C. Hypertension among urban and rural Tongans. Med J Aust 1986;144:16–20.

212. Koike G, Yokono O, Iino S, et al. Medical and nutritional surveys in the Kingdom of Tonga: comparison of physiological and nutritional status of adult Tongans in urbanized (Kolofo'ou) and rural (Uiha) areas. J Nutr Sci Vitaminol 1984;30(4):341–56.

213. Sawata S, Hidaka H, Yasuda H, Tomomatsu K, Sato R, Oka H. Prevalence of cardiovascular diseases in the Kingdom of Tonga. Jpn Heart J 1988;29(1):11–8.

214. Foley W, Kelly-Hope L, Halavatau V, et al. Tonga, non-communicable diseases and nutrition survey 1992: description of findings. Technical Report Series 98-01. Nutrition Program, University of Queensland, Brisbane; 1998.

215. Zimmet PZ, Jackson L, Whitehouse S. Blood pressure studies in two Pacific populations with varying degrees of modernisation. NZ Med J 1980;91(657):249–52.

216. Taylor R, Bennet P, Zimmet P. Epidemiological studies of diabetes and cardiovascular disease in Wallis Polynesians: a comparison of residents of Wallis Island and first generation migrants to Noumea, New Caledonia. Technical Paper No. 181. SPC, Noumea, New Caledonia; 1984.

217. Bezannier G. Report on a health survey carried out in Mua, Wallis. DTASS, Noumea, New Caledonia; 1996. transl.

218. Crews DE. Multivariate prediction of total and cardiovascular mortality in an obese Polynesian population. Am J Public Health 1989;79(8):982–6.

219. Baker PT. Rationale and research design. In: Baker PT, Hanna JM, Baker TS, eds. The changing Samoans, behavior and health in transition. Oxford University Press, New York; 1986.

220. Crews DE. Body weight, blood pressure and the risk of total and cardiovascular mortality in an obese population. Hum Biol 1988;60(3):417–33.

221. Kannel WB, Gordon T, Schwartz MJ. Systolic versus diastolic pressure and risk of coronary heart disease. Am J Cardio 1971;27:335–46.

222. Pawson IG, Janes C. Massive obesity in a migrant Samoan population. Am J Public Health 1981;71(5):508–13.

223. Taylor R, Zimmet P, Tuomilehto J, Ram P, Hunt D, Sloman G. Blood pressure and its correlations in the biracial (Melanesian and Indian) populations of Fiji. Fiji Ministry of Health, Suva; 1980. unpub.

224. Page LB, Damon A, Moellering RC. Antecedents of cardiovascular disease in six Solomon Island societies. Circulation 1974;49:1132–46.

225. Prior IA, Evans JG. Sodium intake and blood pressure in Pacific populations. Israel J Med Sci 1979;5:608–11.

226. Taylor R, Zimmet P, Levy S, Collins VR. Group comparisons of blood pressure and indices of obesity and salt intake in Pacific populations. Med J Aust 1985;142:499–501.

227. Morris RC, Sebastian A, Forman A, Tanaka M, Schmidlin O. Normotensive salt sensitivity: effect of race and dietary potassium. Hypertension 1999;33(1):18–23.

228. Suter PM. The effects of potassium, magnesium, calcium and fiber on risk of stroke. Nutr Rev 1999;57(3):84–8.

229. Appel LJ, Moore TJ, Obarzanek E, et al. A clinical trial of the effects of dietary patterns on blood pressure. New Eng J Med 1997;336(16):1117–24.

230. Dyerberg J, Bang HO, Hjorne N. Fatty acid composition of plasma fatty acids in Greenland Eskimos. Am J Clin Nutr 1975;28:958.

231. Endres S, DeCaterina R, Schmidt EB, Kristensen SD. n-3 polyunsaturated fatty acids: update 1995. Eur J Clin Invest 1995;25:629.

232. Leon AS, Myers MJ, Connett J, for the MRFIT Research Group. Leisure time physical activity and the 16-year risks of mortality from coronary heart disease and all-causes in the Multiple Risk Factor Intervention Trial (MRFIT). Int J Sports Med 1997;18(suppl 3):S208–S215.

233. Pereira MA, Folsom AR, McGovern PG, et al. Physical activity and incident hypertension in black and white adults: the Atherosclerosis Risk in Communities Study. Prev Med 1999; 28(3):304–12.

234. Lindquist TL, Beilin LJ, Knuiman MW. Influence of lifestyle, coping and job stress on blood pressure in men and women. Hypertension 1997;29:1–7.

235. Campbell NRC, Burgess E, Taylor G, et al. Lifestyle changes to prevent and control hypertension: do they work? Can Med Assoc J 1999;160(9):1341–3.

236. Expert panel on detection, evaluation, and treatment of high blood cholesterol in adults. Report of the National Cholesterol Education Program. Arch Intern Med 1988;148:36–69.

237. Li N, Tuomilehto J, Dowse GK, Virtala E, Zimmet P. Prevalence of coronary heart disease indicated by electrocardiogram abnormalities and risk factors in developing countries. J Clin Epidemiol 1994;47(6):599-611.

238. Ram P, Cornelius M. Ischaemic heart disease in Fiji. Fiji General Practitioner 1995;1(1):6–10.

239. Coventry J, King H, Zimmet P, Raper LR, Sicree RA. Impaired glucose tolerance in the biethnic (Melanesian and Indian) populations of Fiji. Diabetes Research 1986;3:427–32.

240. Ram P, Collins VR, Zimmet P, et al. Cardiovascular disease risk factors in Fiji: the results of the 1980 survey. Fiji Med J 1983;88–94.

241. Nestel P, Ringrose H, Taylor R, Zimmet P, Sloman G. High density lipoprotein apoprotein variability in a biracial population. Arteriosclerosis 1983;3(2):132–7.

242. Comité de Prévention de Nouvelle-Calédonie. Situation nutritionnelle en Nouvelle-Calédonie: bilan et propositions d'actions. Comité de Prévention de Nouvelle-Calédonie, Nouméa; 1998.

243. Temu PI. Adult medicine and the "new killer diseases" in Papua New Guinea. PNG Med J 1991;34:1–5.

244. Hornabrook RW, Serjeantson SW, Stanhope JM. Normal serum biochemistry in Papua New Guinean adults. PNG Med J 1975;18(4):232–8.

245. Iser DJ. Has westernization influenced serum cholesterol levels in Bougainvillian males? PNG Med J 1993;36(4):311–5.

246. Lindeberg S, Berntorp E, Carlsson R, Eliasson M, Marckmann P. Haemostatic variables in Pacific Islanders apparently free from stroke and ischaemic heart disease – the Kitava study. Thromb and Haemostas 1997;77(1):94–8.

247. Hodge AM, Dowse GK, Collins VR, Zimmet PZ. Mortality in Micronesian Nauruans and Melanesian and Indian Fijians is not associated with obesity. Am J Epidemiol 1996;143(5):442–55.

248. Erasmus RT, Sinha AK, Nathaniel K. Serum lipid concentrations in the Koki community: a preliminary report. PNG Med J 1993;36:306–10.

249. Hodge AM, Dowse GK, Erasmus RT, et al. Serum lipids and modernization in coastal and highland Papua New Guinea. Am J Epidemiol 1996;144(12):1129–42.

250. Federation of American Societies for Experimental Biology and Life Sciences Research Office. Third report on nutrition monitoring in the United States: Volume I. US Government Printing Office, Washington DC; 1995.

251. Harris M. Prevention and control of non-communicable diseases in Chuuk, Kosrae and Pohnpei, Federated States of Micronesia. WHO Mission Report. WHO, WPRO, Manila; 1999.

252. Anonymous. Special tabulations: cause of death by ethnicity, Guam, 1993-97. Office of Planning and Evaluation, Department of Public Health and Social Services, Agana, Guam; 1998.

253. Hodge AM, Dowse GK, Zimmet P. Micro-albuminuria, cardiovascular risk factors, and insulin resistance in two populations with a high risk of type 2 diabetes mellitus. Diabet Med 1996;13(5):441–9.

254. Hodge AM, Dowse GK, Zimmet PZ. Association of body mass index and waist-hip circumference ratio with cardiovascular disease risk factors in Micronesian Nauruans. Int J Obes Relat Metab Disord 1993;17(7):399–407.

255. Reed D, Labarthe D, Stallones R, Brody J. Epidemiologic studies of serum glucose levels among Micronesians. Diabetes 1973;22:129–36.

256. McGarvey ST. Samoa cardiovascular disease risk factor study 1990-95: preliminary data. Noumea; 1999. pers. comm.

257. Galanis DJ, McGarvey ST, Sobal J, Bausserman L, Levinson PD. Relations of body fat and fat distribution to the serum lipid, apolipoprotein and insulin concentrations of Samoan men and women. Int J Obes 1995;19:731–8.

258. Galanis DJ, Sobal J, McGarvey ST, Pelletier DL, Bausserman L. Ten-year changes in the obesity, abdominal adiposity, and serum lipoprotein cholesterol measures of Western Samoan men. J Clin Epidemiol 1995;48(12):1485–93.

259. Jackson, R.T. The Auckland Risk Factor Study. M Med Sci Thesis. University of Auckland, New Zealand; 1984.

260. Lindeberg S, Nilsson-Ehle P, Vessby B. Lipoprotein composition and serum cholesterol ester fatty acids in non-westernized Melanesians. Lipids 1996;31(2):153–8.

261. Leaf A, Kang JX. Omega-3 fatty acids and cardiovascular disease. World Rev Nutr Diet 1998;83:24–37.

262. Renaud S, Gueguen R. The French paradox and wine drinking. Novartis Found Symp 1998;216:208–17.

263. Lee IM, Manson JE, Hennekens CH, Paffenbarger RS Jr. Body weight and mortality. A 27-year follow-up of middle-aged men. JAMA 1993;270(23):2823–8.

264. Berns MA, de Vries JH, Katan MB. Increase in body fatness as a major determinant of changes in serum total cholesterol and high density lipoprotein cholesterol in young men over a 10-year period. Am J Epidemiol 1989;130(6):1109–22.

265. Okosun IS, Cooper RS, Prewitt TE, Rotimi CN. The relation of central adiposity to components of the insulin resistance syndrome in a biracial US population. Ethn Dis 1999;9(2):218–29.

266. Verges DL. Dyslipidaemia in diabetes mellitus. Review of the main lipoprotein abnormalities and their consequences on the development of atherogenesis. Diabetes Metab 1999;25(suppl 3): 32–40.

267. Read RSD, Kouris-Blazos A. Overweight and obesity. In: Walqvist M, ed. Food and nutrition: Australasia, Asia and the Pacific. Allen & Unwin, St Leonards, NSW; 1997.

268. Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. Diabet Med 1997;14:S7–S85.

269. Coughlan A, McCarty DJ, Jorgensen LN, Zimmet P. The epidemic of NIDDM in Asian and Pacific Island populations: prevalence and risk factors. Horm Metab Res 1997;29:323–31.

270. Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care 1997; 20(7):1183–97.

271. Alberti KG, Zimmet P. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Provisional report of a WHO consultation. Diabet Med 1998;15:539–53.

272. WHO. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus. Report of a WHO consultation. Report No. WHO/NCD/NCM99.1. WHO, Geneva; 1999.

273. Zimmet P, Alberti G, De Courten M. New classification and criteria for diabetes: moving the goalposts closer. Med J Aust 1998;168:593–4.

274. WHO. Diabetes mellitus: report of a WHO study group. Technical Report Series 727. WHO, Geneva; 1985.

275. De Courten M, Bennet P, Tuomilehto J, Zimmet P. Epidemiology of NIDDM in non-europids. In: Alberti K, Zimmet P, DeFronzo RA, Keen H, eds. International textbook of diabetes mellitus, 2nd edn. John Wiley & Sons, Sydney; 1997.

276. Fiji Department of Health. Return of diseases and deaths for the year 1950 at the Colonial War Memorial Hospital; Labasa, Lautoka, Levuka and Tamavua hospitals. Suva, Fiji; 1950.

277. Tuomilehto J, Ram P, Eseroma R, Taylor R, Zimmet P. Cardiovascular diseases and diabetes mellitus in Fiji: analysis of mortality, morbidity and risk factors. Bulletin of the WHO 1984;62(1):133–43.

278. Ravono J. Morbidity and mortality report 1993-1996. Fiji Ministry of Health, Suva, Fiji; 1998.

279. Cassidy JT. Diabetes in Fiji. NZ Med J 1967;66:167–72.

280. Zimmet P, Taylor R, Ram P, et al. Prevalence of diabetes and impaired glucose tolerance in the biracial (Melanesian and Indian) population of Fiji: a rural-urban comparison. Am J Epidemiol 1983;118(5):673–88.

281. Sicree RA, Ram P, Zimmet P, Cabealawa S, King H. Mortality and health service utilization amongst Melanesian and Indian diabetics in Fiji. Diabetes Res Clin Pract 1985;1:227–34.

282. Collins VR, Dowse GK, Ram P, Cabealawa S, Zimmet P. Non-insulin-dependent diabetes and 11-year mortality in Asian Indian and Melanesian Fijians. Diabet Med 1996;13:125–32.

283. Hoskins P, Handelsman D, Hannelly T, Silink M, Yue DK, Turtle JR. Glycosylated hemoglobin as an index of the prevalence and severity of diabetes in biethenic Fiji. Diabetes Res Clin Pract 1987;3:257–67.

284. Bolton T, McGill M, Cornelius M, et al. Diabetes-related amputation: a devastating problem in Fiji. Proceedings of the International Diabetes Federation. Suva, Fiji; 1999. abstract.

285. Zimmet P, Canteloube D, Genelle B, et al. The prevalence of diabetes mellitus and impaired glucose tolerance in Melanesians and part-Polynesians in rural New Caledonia and Ouvea (Loyalty Islands). Diabetologia 1982;23:393–8.

286. Papoz L, Barny S, Simon D, The CALDIA Study Group. Prevalence of diabetes mellitus in New Caledonia: ethnic and urban–rural differences. Am J Epidemiol 1996;143(10):1018–24.

287. Taylor R, Bennet P, Uili R, et al. Diabetes in Wallis Polynesians: a comparison of residents of Wallis Island and first generation migrants to Noumea, New Caledonia. Diabetes Res Clin Pract 1985;1:169–78.

288. Scaglion R. Chiefly models in Papua New Guinea. The Contemporary Pacific 1996;8(1):1–31.

289. Campbell CH. Diabetes mellitus in the Territory of Papua New Guinea. Med J Aust 1963;2:607–10.

290. Hingston RG, Price AU. Diabetic surveys in Papua. PNG Med J 1964;7(1):33–5.

291. Price AV, Tulloch JA. Diabetes mellitus in Papua New Guinea. Med J Aust 1966;2:645–8.

292. King H, Finch F, Collins A, et al. Glucose tolerance in Papua New Guinea: ethnic differences, association with environmental and behavioural factors and the possible emergence of glucose intolerance in a highland community. Med J Aust 1989;151:204–10.

293. Thompson DJ. Preliminary investigation into the relationship between diet and diabetes on Tarawa, Gilbert Islands. SPC, Noumea, New Caledonia; 1978. unpub.

294. Martin FIR, Simeanova L. Insulin secretion in non-obese (J-type) diabetics in Papua New Guinea. Aust NZ J Med 1979;9(3):260–2.

295. WHO Expert Committee on Diabetes Mellitus. Second report. Technical Report Series 646. WHO, Geneva; 1980.

296. National Diabetes Data Group. Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 1979;28:1039–57.

297. Knowler WC, Bennett PH. Serum insulin concentrations predict changes in oral glucose tolerance. Diabetes 1983;32(suppl 1):46A.

298. Zimmet P, Whitehouse S. The effect of age on glucose tolerance: studies in a Micronesian population with a high prevalence of diabetes. Diabetes 1979;28(7):617–23.

299. O'Dea K. Westernisation, insulin resistance and diabetes in Australian Aborigines. Med J Aust 1991;155:258–64.

300. Friedlaender JS, Rhodes JG. Longitudinal anthropometric changes in adolescents and adults. In: Friedlaender JS, ed. The Solomon Islands project. a long-term study of health, human biology, and culture change. Clarendon Press, Oxford; 1987.

301. Beizer RA. Prevalence of abnormal glucose tolerance in six Solomon Islands populations. Am J Phys Anthropol 1990;81(4):471–82.

302. Ministry of Health and Medical Services. National diabetes control program: plan of action. Ministry of Health and Medical Services, Honiara, Solomon Islands; 1998.

303. Bastien P. Public-health epidemiology in Vanuatu. Med J Aust 1990;152:13–7.

304. Finch CF, Dowse GK, Collins VR, Zimmet P. Quantifying the extent to which random plasma glucose underestimates diabetes prevalence in the Nauruan population. Diabetes Res Clin Pract 1990;10:177–82.

305. Yen SC. Abnormal carbohydrate metabolism and pregnancy. Am J Obstet Gynecol 1964; 90(4):468–73.

306. Kuberski T, Bennet P. The status of diabetes mellitus in the Territory of Guam. Technical Paper No. 47. SPC, Noumea, New Caledonia; 1979.

307. Kuberski T, Bennet P. Diabetes mellitus as an emerging public health problem on Guam. Diabetes Care 1980;3(2):235–41.

308. Koerner DR. Abnormal carbohydrate metabolism in amyotrophic lateral sclerosis and Parkinsonism–dementia on Guam. Diabetes 1976;25:1055–65.

309. Pinhey TK, Heathcote GM, Craig UK. Health status of diabetic persons in an Asian-Pacific population: evidence from Guam. Ethn Dis 1997;7:65–71.

310. Rodriguez, DG. The health needs of Chamorros. Department of Public Health and Social Services, Government of Guam; 1995.

311. Collins VR, Taylor R, Zimmet P, et al. Impaired glucose tolerance in Kiribati. NZ Med J 1984;97(768):809–12.

312. Zimmet P. Prevalence rates of diabetes in Kiribati 1999. SPC Aug 13; 1999. pers. comm.

313. Conard RA, Sutow WW, Lowrey A, et al. Medical survey of the people of Rongelap and Utirik Islands: thirteen, fourteen, and fifteen years after exposure to fallout radiation. National Laboratory Associated Universities Inc. Brookhaven, Upton, New York; 1970.

314. Wessels IF, Markoff DD, Miller G. Project Canvas-Back in the Marshall Islands. Ophthalmic Surg 1989;20(10):745–51.

315. Grant AM. A medical survey of the Island of Nauru. Med J Aust 1933;1:113–8.

316. Tulloch JA. Diabetes mellitus in the tropics. Churchill Livingston, London; 1962.

317. Zimmet P, Taft P, Guinea A, Guthrie W, Thoma K. The high prevalence of diabetes mellitus on a Central Pacific Island. Diabetologia 1977;13:111–5.

318. Zimmet P, Arblaster M, Thoma K. The effect of westernisation on native populations: studies on a Micronesian community with a high diabetes prevalence. Aust NZ J Med 1978;8:141–6.

319. Zimmet P, King H, Taylor R, et al. The high prevalence of diabetes mellitus, impaired glucose tolerance and diabetic retinopathy in Nauru: the 1982 survey. Diabetes Res 1984;1:13–8.

320. Dowse GK, Zimmet P, Finch F, Collins VR. Decline in incidence of epidemic glucose intolerance in Nauruans: implications for the "Thrifty Genotype". Am J Epidemiol 1991;133(11):1093–104.

321. McCready J. Epidemiological analysis of diabetes mellitus in the Republic of Palau. SPC, Noumea, New Caledonia; 1998. unpub.

322. Crews DE, McKeen P. Mortality related to cardiovascular disease and diabetes mellitus in a modernizing population. Soc Sci Med 1982;16:175–81.

323. Welborn TA, Curnow DH, Wearne JT, McCall MG, Stenhouse NS. Diabetes detected by blood sugar measurement after a glucose load. Report from the Busselton Survey, 1966. Med J Aust 1968;2:778–83.

324. Prior IA, Rose BS, Harvey HP, Davidson F. Hyperuricaemia, gout and diabetic abnormality in Polynesian people. Lancet 1966;1:333–8.

325. Weinstein S, Sedlak-Weinstein E, Taylor R, Zimmet P. The high prevalence of impaired glucose tolerance and diabetes mellitus in an isolated Polynesian population, Manihiki, Cook Islands. NZ Med J 1981;94(697):411–3.

326. King H, Taylor R, Koteka G, et al. Glucose tolerance in Polynesia. Med J Aust 1986;145:505–10.

327. Boisson JL, Laudon F. L'épidemiologie du diabète en Polynésie française. 2èmes Journées Médicales de Polynésie française. Institut Mathilde Frebault, Papeete, Tahiti; 1991.

328. Zimmet P, Faaiuso S, Ainuu J, Whitehouse S, Milne B, DeBoer W. The prevalence of diabetes in the rural and urban Polynesian population of Western Samoa. Diabetes 1981;30(1):45–51.

329. Collins VR, Dowse GK, Toelupe P, et al. Increasing prevalence of NIDDM in the Pacific island population of Western Samoa over a 13-year period. Diabetes Care 1994;17(4):288–96.

330. Ostbye T, Welby TJ, Prior IAM, Salmond C, Stokes YM. Type 2 (non-insulin-dependent) diabetes mellitus, migration and westernization: the Tokelau Island migrant study. Diabetologia 1989;32:585-90.

331. Prior IA, Beaglehole R, Davidson F, Salmond CE. The relationships of diabetes, blood lipids, and uric acid levels in Polynesians. Advances Metabolic Disorders 1978;9:2412–61.

332. Palu T, Colagiuri R, Layton M, et al. Assessing diabetes complications in Tonga. Annual scientific meeting of Australian Diabetes Association and Australian Diabetes Educators Association. Sydney, Australia; 1996.

333. Zimmet P, Seluka A, Collins J, Currie P, Wicking J, DeBoer W. Diabetes mellitus in an urbanised, isolated Polynesian population: the Funafuti survey. Diabetes 1977;26(12):1101–8.

334. Taylor R, Zimmet P. The influence of variation in obesity in the sex difference in the prevalence of abnormal glucose tolerance in Tuvalu. NZ Med J 1981;94(691):176–8.

335. Bezannier G, Tauvale S. Health survey on the district of Mua: final report. Health Department, Territory of the Islands of Wallis and Futuna; 1997. transl.

336. Savige J. Diabetes mellitus in the Tolais of the Gazelle Peninsula, New Britain. PNG Med J 1982;25(2):89–92.

337. Aubry P, Rignaud JL. Some consideration on diabetes mellitus in Polynesia. Apropos of 75 cases. Med Trop 1966;26(3):260–7.

338. Price AU. Diabetes mellitus. The diseases and health services in Papua New Guinea. Department of Public Health, Port Moresby; 1973.

339. Martin FIR. The clinical characteristics of diabetes mellitus in Papua New Guinea. PNG Med J 1978;21(4):317–24.

340. Zimmet P, Taylor R, Bennet P. Diabetic microangiopathy in Pacific populations. In: Abe H, Hoshi M, eds. Japan Medical Research Foundation, 20th edn. University of Tokyo Press, Tokyo; 1983.

341. King H, Balkau B, Zimmet P, et al. Diabetic retinopathy in Nauruans. Am J Epidemiol 1983;117(6):659–67.

342. King H, Zimmet P, Taylor R, et al. Characteristics associated with diabetic retinopathy in Nauruans. Tohoku J Exp Med 1983;141(suppl):343–53.

343. Jarrett RJ, Viberti GC, Argyropoulos A, Hill RD, Mahmud U, Murrells TJ. Micro-albuminuria predicts mortality in non-insulin-dependent diabetes. Diabetic Med 1984;1:17–9.

344. Humphrey ARG, Dowse GK, Thoma K, Zimmet P. Diabetes and non-traumatic lower extremity amputations. Diabetes Care 1996;19(7):710–4.

345. Lees JS, Lu M, Russell D, Bahr C, Lee ET. Lower extremity amputation: incidence, risk factors and mortality in the Oklahoma Indian Diabetes Study. Diabetes 1993;42:876–2.

346. Division of Public Health. Diabetes in the CNMI. Department of Public Health, Saipan, CNMI; 1995.

347. Gras C, Lecordier N, Spiegel A, Prigent D, Brodin S, Gendron Y. Le diabète non-insulino-dépendant (type II) à Tahiti. Med Trop 1992;52(1):35–42.

348. Cordonnier DJ, Zmirou D, Benhamou PY, Halimi S, Ledoux F, Guiserix J. Epidemiology, development and treatment of end-stage renal failure in type 2 (non-insulin-dependent) diabetes mellitus. The case of mainland France and of overseas French territories. Diabetologia 1993;36:1109–12.

349. Mera J, Hanerg K, James A, et al. Marshall Islands vital and health statistics abstract 1992-1996. Bureau of Health Planning and Statistics, Ministry of Health and Environment, Majuro, Marshall Islands; 1997.

350. Newland HS, Woodward AJ, Taumoepeau LA, Karunaratne NS, Duguid IGM. Epidemiology of blindness and visual impairment in the Kingdom of Tonga. Br J Ophthalmol 1994;78:344–8.

351. WHO. Guidelines for programmes for the prevention of blindness. WHO, Geneva; 1979.

352. Hoskins P, Handelsman D, Hannelly T, Silink M, Yue DK, Turtle JR. Diabetes in the Melanesian and Indian peoples of Fiji: a study of risk factors. Diabetes Res Clin Pract 1987;3:269–76.

353. King H, Zimmet P, Pargeter K, Raper LR, Collins VR. Ethnic differences in susceptibility to non-insulin-dependent diabetes: a comparative study of two urbanized Micronesian populations. Diabetes 1984;33(10):1002–7.

354. Neel JV. Diabetes mellitus: a thrifty genotype rendered detrimental by "progress"? Am J Hum Genet 1962;14:353–62.

355. Hales C. Fetal and infant growth and impaired glucose tolerance in adulthood: the "thrifty phenotype" hypothesis revisited. Acta Paediatr (suppl) 1997;422:73–7.

356. Hales C, Barker D, Clark PMS, et al. Fetal and infant growth and impaired glucose tolerance at age 64. BMJ 1991;303:1019–22.

357. Barker D. Early growth and cardiovascular disease. Arch Dis Child 1999;80(4):305.

358. Nelson RG, Morgenstern H, Bennett PH. Birth weight and renal disease in Pima Indians with Type 2 diabetes mellitus. Am J Epidemiol 1998;148(7):650–6.

359. Lithell H, McKeigue PM, Berglund L, Mohsen R, Lithell U-B, Leon DA. Relation of size at birth to non-insulin dependent diabetes and insulin concentrations in men aged 50-60 years. BMJ 1996;312:406–10.

360. Leon D, Lithell H, Vagero D. Reduced fetal growth rate and increased risk of death from ischaemic heart disease: cohort study of 15000 Swedish men and women born 1915-29. BMJ 1998;317:241–5.

361. Rich-Edwards J, Stampfer MJ, Manson JE. Birth weight and risk of cardiovascular disease in a cohort of women followed up since 1976. BMJ 1999;315:396–400.

362. Law C, Shiell A. Is blood pressure inversely related to birth weight? The strength of evidence from a systematic review of the literature. J Hypertens 1996;14(8):935–41.

363. Harding J. Intrauterine nutrition and adult disease. Asia Pac J Clin Nutr 1995;4:349.

364. O'Dea K. Overview of the thrifty genotype hypothesis. Asia Pac J Clin Nutr 1995;4:339–40.

365. Hattersley AT, Tooke JE. The fetal insulin hypothesis: an alternative explanation of the association of low birthweight with diabetes and vascular disease. Lancet 1999;353:1789–92.

366. Zimmet P, Collins VR, Dowse GK, Knight LT. Hyperinsulinaemia in youth is a predictor of type 2 (non-insulin-dependent) diabetes mellitus. Diabetologia 1992;35:534–41.

367. King H, Zimmet P, Raper LR, Balkau B. Risk factors for diabetes in three Pacific populations. Am J Epidemiol 1984;119(3):396–409.

368. Ringrose H, Mollard C, Taylor R, et al. Energy intakes and diabetes prevalence of rural and urban Melanesian and Indian populations in Fiji. Proceedings of the Twelfth International Congress of Nutrition, San Diego Calif. USA; 1981.

369. Hodge AM, Dowse GK, Zimmet P. Diet does not predict incidence or prevalence of non-insulin-dependent diabetes in Nauruans. Asia Pac J Clin Nutr 1993;2:35–41.

370. Tassie JM, Papoz L, Barny S, Simon D, The CALDIA Study Group. Nutritional status in adults in the pluri-ethnic population of New Caledonia. Int J Obes Relat Metab Disord 1997;21(1):61–6.

371. Ford ES, Will JC, Bowman BA, Narayan KM. Diabetes mellitus and serum caretenoids: findings from the third national health and nutrition examination survey. Am J Epidemiol 1999; 149(2):168–76.

372. Hellerstein MD. Is chromium supplementation effective in managing type 2 diabetes? Nutr Rev 1998;56(10):302–6.

373. Brand Miller J, Foster-Powell K, Colagiuri S. The G.I. factor: the glycaemic index solution. Hodder Headline Australia, Rydalmere, NSW; 1997.

374. Sorokin M. Hospital morbidity in the Fiji Islands with special reference to the Saccharine Disease. S Afr Med J 1975;49(36):1481–5.

375. FAO. Food balance sheets 1992-94 average. Statistics Division, FAO of the United Nations, Rome; 1996.

376. Hodge AM, Dowse GK, Collins VR, Zimmet P. Abnormal glucose tolerance and alcohol consumption in three populations at high risk of non-insulin-dependent diabetes mellitus. Am J Epidemiol 1993;137(2):178–89.

377. Taylor R, Ram P, Zimmet P, Raper LR, Ringrose H. Physical activity and prevalence of diabetes in Melanesian and Indian men in Fiji. Diabetologia 1984;27(6):578–82.

378. Ringrose H, Ram P, Mollard C, Taylor R, Zimmet P. Energy intakes and diabetes prevalence of rural and urban Melanesian and Indian populations in Fiji. Fiji Med J 1985;13(11&12):250–2.

379. Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS Jr. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. New Eng J Med 1991;325(3):147–52.

380. Eriksson J, Lingärde F. Prevention of type 2 (non insulin dependent) diabetes mellitus by diet and physical exercise: the 6-year Malmö feasibility study. Diabetologia 1991;34:891–8.

381. Pan X, Li G, Hu Y, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. Diabetes Care 1997;20(4):537–44.

382. Olefsky JM, Koltermann OG, Scarlett JA. Insulin action and resistance in obesity and non-insulin-dependent type 2 diabetes mellitus. Am J Physiol 1982;243:E15–E30.

383. Modan M, Halkin H, Almong S, Lusky A, Eshkol A, Shefi M. Hyperinsulinaemia: a link between hypertension, obesity and glucose intolerance. J Clin Invest 1985;75:809–17.

384. Nguyen CLK, Khomko N, Ling MMM, et al. Diabetes prevention — practical experience and the future. Proceedings of the Nutrition Society of Australia, Adelaide, South Australia, 29 Nov – 2 Dec 1998;22:183.

385. Harris MI. Gestational diabetes may represent discovery of pre-existing glucose intolerance. Diabetes Care 1988;11:402–11.

386. O'Sullivan J. Diabetes mellitus after GDM. Diabetes 1991;40:131–5.

387. Pettitt DJ, Narayan KM, Hanson RL, Knowler WC. Incidence of diabetes mellitus in women following impaired glucose tolerance in pregnancy is lower than following impaired glucose tolerance in the non-pregnant state. Diabetologia 1996;39(11):1334–7.

388. Collins VR, Dowse GK, Zimmet P. Evidence against association between parity and NIDDM from five population groups. Diabetes Care 1991;14(11):975–81.

389. Sicree RA, Hoet J, Zimmet P, King H, Coventry J. The association of non-insulin-dependent diabetes with parity and still-birth occurrence amongst five Pacific populations. Diabetes Res Clin Pract 1986;2:113–22.

390. Eckel RH, Krauss RM. American Heart Association call to action: obesity as a major risk factor for coronary heart disease. Circulation 1998;97:2099–100.

391. Popkin BM, Doak CM. The obesity epidemic is a worldwide phenomenon. Nutr Rev 1998; 56(4):106–14.

392. NHMRC Working Party on the Prevention of Overweight and Obesity. Acting on Australia's weight: a strategic plan for the prevention of overweight and obesity. Australian Government Publishing Service, Canberra; 1997.

393. Flegal KM, Carroll MD, Johnson CL. Overweight and obesity in the United States: prevalence and trends, 1960-1994. Int J Obes 1998;22:39–47.

394. Colditz GA, Willett W, Rotnitzky A, Mansop JE. Weight gain as a risk factor for clinical diabetes mellitus in women. Ann Intern Med 1995;122(7):481–6.

395. Society of Actuaries. Build and blood pressure study, 1959. Society of Actuaries, Chicago; 1960.

396. Bennett PH. Standardisation of methods and reporting of tests in epidemiological studies. Diabetes Care 1979;2:98–104.

397. Burton BT, Foster WR, Hirsch J, Van Italie TB. Health implications of obesity: an NIH Consensus Development Conference. Int J Obes Relat Metab Disord 1985;9:155–70.

398. WHO. Physical status: the use and interpretation of anthropometry. WHO Technical Report Series 854. WHO, Geneva; 1995.

399/400. Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: executive summary. Am J Clin Nutr 1998;68(4):899–917.

401. Taylor RW, Keil D, Gold EJ, Williams SM, Goulding A. Body mass index, waist girth, and waist-to-hip ratio as indexes of total and regional adiposity in women: evaluation using receiver operating characteristic curves. Am J Clin Nutr 1998;67:44–9.

402. Han TS, Bijnen FCH, Lean MEJ, Seidell JC. Separate associations of waist and hip circumference with lifestyle factors. Int J Epidemiol 1998;27(3):422–30.

403. Lean MEJ, Han TS, Seidell JC. Impairment of health and quality of life in people with large waist circumference. Lancet 1998;351:853–6.

404. Hawley TG, Jansen AA. Weights and heights of Fijians from coastal and inland villages. NZ Med J 1978;87(605):86–90.

405. Hawley TG, Jansen AA. Weight, height, body surface and overweight of Fijian adults from coastal areas. NZ Med J 1971;74(470):18–21.

406. Friedlaender JS. Patterns of adult weight and fat change in six Solomon Islands societies: A semi-longitudinal study. Soc Sci Med 1982;16(2):205–15.

407. Paterson J, Laura A, Harris R, et al. Solomon Islands National Nutrition Survey 1989: Technical report. Ministry of Health and Medical Services, Solomon Islands; 1990.

408. Jabre B, Raoult A, Richard C, et al. Study of the suburban district of Tagabe, Vila, New Hebrides. SPC, Noumea, New Caledonia; 1976.

409. Elymore J, Elymore A, Badcock J, et al. The 1987/88 national nutrition survey of the Federated States of Micronesia. Summary Report. SPC, Noumea, New Caledonia; 1989.

410. Malcolm S. The diet of mothers and children on the Island of Guam. Technical Paper No. 113. SPC, Noumea, New Caledonia; 1958.

411. King H, Taylor R, Zimmet P, et al. Non-insulin-dependent diabetes (NIDDM) in a newly independent Pacific nation: the Republic of Kiribati. Diabetes Care 1984;7(5):409–15.

412. Dignan C, Calf J, Webb K, Mackerras D, Franke B. Dietary survey of Rongelapese living on Mejatto Island. SPC, Noumea, New Caledonia; 1994. unpub.

413. Sicree RA, Zimmet P, King H, Coventry J. Weight change amongst Nauruans over 6.5 years: extent, and association with glucose intolerance. Diabetes Res Clin Pract 1987;3:327–36.

414. CNMI National Food and Nutrition Advisory Council and WHO. CNMI National Food and Nutrition policy and ten year plan of action. National Food and Nutrition Advisory Council, Saipan, CNMI; 1996.

415. Baker PT. Migration and human adaptation. In: Fleming C, Prior I, eds. Migration, adaption and health in the Pacific: papers presented at a conference, 1979. Epidemiological Unit, Wellington Hospital, Wellington; 1981.

416. McGarvey ST. Obesity in Samoans and a perspective on its etiology in Polynesians. Am J Clin Nutr 1991;53(suppl):1586S–94S.

417. McGarvey ST, Levinson PD, Bausserman L, Galanis DJ, Hornick CA. Population change in adult obesity and blood lipids in American Samoa from 1976–1978 to 1990. Am J Hum Biol 1993;5:17–30.

418. Hodge AM, Dowse GK, Toelupe P, Collins VR, Imo T, Zimmet PZ. Dramatic increase in the prevalence of obesity in Western Samoa over the 13 year period 1978-1991. Int J Obes Relat Metab Disord 1994;18(6):419–28.

419. Greksa LP. Evaluation of work capability: an example from American Samoa. J Human Ergol 1985;14:23–32.

420. Faine S, Hercus E. The nutritional status of Cook Islanders. BMJ 1951;5(3-4):327–43.

421. Tairea K, Hughes R, Hughes MCB, et al. Report of the 1998 Rarotonga infant growth monitoring project. Technical Paper No. 212. SPC, Noumea, New Caledonia; 1999.

422. Institut Territorial de la Statistique. Résultats du recensement général de la population de la Polynésie Française. ITSTAT, Tahiti, French Polynesia; 1983.

423. Burrows W. Some notes and legends of a South Sea island. J Poly Soc 1923;32:143–51.

424. Ramirez ME. Biological variability in a migrating isolate: Tokelau effects of migration of fat patterning in adults. Hum Biol 1987;59(6):901–9.

425. Ramirez ME, Mueller WH. The development of obesity and fat patterning in Tokelau children. Hum Biol 1980;52(4):675–87.

426. Maclean E, Badcock J, Bach F. The 1986 National nutrition survey of the Kingdom of Tonga. Government Printers, Nuku'alofa, Tonga; 1987.

427. Craig PL, Halavatau V. Different body perceptions between weight loss participants and the community in Tonga. Australasian Society for the Study of Obesity Abstracts; 1997.

428. Craig PL. A report on the study of body perception and percent body fat in Tongans. NFNC, Central Planning Department, Tonga; 1998.

429. Zimmet P, Whitehouse S. The effect of age on glucose tolerance: studies in the Polynesian population of Funafuti. Acta Diabetologica Latina 1982;19(1):65–74.

430. The Government of Tuvalu & UNICEF. A situation analysis of children and women in Tuvalu 1996. National Children Coordinating Committee in Tuvalu. UNICEF, Suva, Fiji; 1996.

431. Gunnell DJ, Frankel SJ, Nanchahal K, Peters TJ, Smith GD. Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort. Am J Cli Nutr 1998;67:1111–8.

432. Han TS, Feskens EJM, Lean MEJ, Seidell JC. Associations of body composition with type 2 diabetes mellitus. Diabet Med 1998;15(2):129–35.

433. Metropolitan Life Insurance Company. New weight standards for men and women. Journal of the Metropolitan Life Insurance Company 1959;40:1–4.

434. Rush EC, Plank L, Laulu M, Robinson SM. Prediction of percentage body fat from anthropometric measurements: comparison of New Zealand European and Polynesian young women. Am J Clin Nutr 1997;66:2–7.

435. Rush EC, Plank L, Robinson SM. Resting metabolic rate in young Polynesian and Caucasian women. Int J Obes 1997;21:1071–5.

436. Swinburn BA, Craig PL, Daniel R, Dent DPD, Strauss BJG. Body composition differences between Polynesians and Caucasians assessed by bioelectrical impedance. Int J Obes Relat Metab Disord 1996;20(10):889–94.

437. Heitmann BL, Swinburn BA, Carmichael H, et al. Are there ethnic differences in the association between body weight and resistance, measured by bioelectrical impedance? Int J Obes Relat Metab Disord 1997;21(12):1085–92.

438. Swinburn BA. Using the body mass index: weigh then weigh up. NZ Med J 1998;111(1075):377–9.

439. Craig PL, Swinburn BA, Matenga-Smith T, Matangi H, Vaughan G. Do Polynesians still believe that big is beautiful? Comparison of body size perceptions and preferences of Cook Islands, Maori and Australians. NZ Med J 1996;109:200–3.

440. Brewis AA, McGarvey ST, Jones J, Swinburn BA. Perceptions of body size in Pacific Islanders. Int J Obes Relat Metab Disord 1998;22(2):185–9.

441. Taylor R, Henderson BE, Levy S, et al. Cancer in Pacific Island countries. Information Document No. 53. SPC, Noumea, New Caledonia; 1985.

442. Reed D. Current status of cancer studies in the South Pacific. Nat Cancer Inst Monogr 1977; 47:61–6.

443. Boyd JT. Cancer incidence in Fiji. Int J Epidemiol 1973;2(2):177–87.

444. Institut Pasteur de Nouvelle-Calédonie. Rapport technique 1997 — Activités de Surveillance Épidémiologique. Institut Pasteur de Nouvelle-Calédonie, Nouméa, Nouvelle-Calédonie; 1997.

445. Ballivet S, Salmi LR, Dubourdieu D, Bach F. Incidence of thyroid cancer in New Caledonia, South Pacific, during 1985–1992. Am J Epidemiol 1995;141(8):741–6.

446. Dubourdieu D, Huerre M, Noellat P, Nomoredjo A, Videault A. Le cancer du col de l'utérus en Nouvelle-Calédonie de 1977 à 1988. Données épidémiologiques et histocytopathologiques. Facteurs de risques. Arch Anat Cytol Path 1992;39(1–2):15–21.

447. Martin WMC, Sengupta SK, Murthy DP, Barua DL. The spectrum of cancer in Papua New Guinea. Cancer 1992;70(12):2942–50.

448. Atkinson L, Clezy JK, Reay-Young PS, et al. The epidemiology of cancer in Papua New Guinea. Department of Public Health, Papua New Guinea; 1974.

449. Misch K, Atkinson L, Reay-Young PS, Parkin PM, eds. Cancer occurrence in developing countries. Cancer registry of Papua New Guinea; 1971–1978. Oxford University Press, Oxford; 1986.

450. Wilson A, Taylor R, Nugumi G, et al. Solomon Islands oral cancer study. Technical Paper No. 183. SPC, Noumea, New Caledonia; 1983.

451. Taylor R, Parker M, Ansford A, Davison A. Cancer in Solomon Islands 1970-82. PNG Med J 1983;26(2):102–13.

452. Thomas SJ, Maclennan R. Slaked lime and betel nut cancer in Papua New Guinea. Lancet 1992;340(8819):577–8.

453. Paksoy N, Montaville B, McCarthy SW. Cancer occurrence in Vanuatu in the South Pacific, 1980-86. Trop Geogr Med 1990;42:157–61.

454. Paksoy N, Montaville B, McCarthy SW. Cancer occurrence in Vanuatu in the South Pacific, 1980-86. Asia Pac J Public Health 1989;3(3):231–6.

455. Bach F. Vanuatu cancer registry. SPC, Noumea, New Caledonia; 1993.

456. Cancer in Vanuatu. In: Galea G, Hughes R, eds. Enhancing cancer information in the Pacific. SPC, Noumea, New Caledonia; 1998.

457. Central Statistics Division. 1996 Commonwealth of the Northern Mariana Islands statistical yearbook. Department of Commerce, Saipan, CNMI; 1997.

458. Haddock RL, Naval CL. Cancer in Guam: a review of death certificates from 1971–1995. Pacific Health Dialog 1997;4(1):66–77.

459. Bach F. Cancer registration in Guam. SPC, Noumea, New Caledonia; 1992.

460. Thomas P. Feasibility and design study of non-communicable disease program in the Pacific. AusAID country report, Kiribati, 24 February 1999. Canberra, Australia; 1999.

461. Goodman MT, Yoshizawa CN, Kolonel LN. Descriptive epidemiology of thyroid cancer in Hawaii. Cancer 1988;61:1272–81.

462. Crews DE. Multiple causes of death and the epidemiolgical transition in American Samoa. Soc Biol 1988;35(3-4):198–213.

463. Mishra SI, Luce-Aoelua PH, Wilkens LR, Bernstein L. Cancer among American-Samoans: site-specific incidence in California and Hawaii. Int J Epidemiol 1996;25(4):713–21.

464. Mishra SI, Luce-Aoelua PH, Wilkens LR. Cancer among indigenous populations: the experience of American Samoans. Cancer 1996;78(7 suppl):1553–7.

465. Medical Records Unit. Cook Islands Ministry of Health medical records unit 1996 annual bulletin. Ministry of Health, Cook Islands; 1996.

466. de Vathaire F, Le Vu B. Cancer mortality in French Polynesia between 1984 and 1992. Br J Cancer 1996;74(10):1680–1.

467. Mou Y. Overview of the situation of non-communicable diseases in French Polynesia. Proceedings of the SPC Regional Nutritionists Workshop. Noumea, New Caledonia, 28 Sep – 2 Oct; 1998.

468. Boutin JP, Botterman F, Cartel JL. Epidemiology of hepatocellular carcinoma in French Polynesia. Med J Aust 1989;151(5):302–3. letter.

469. Boutin JP, Botterman F, Alandry G, Cartel JL, Spiegel A, Roux J. Épidémiologie du cancer primitif du foie en Polynésie française. Bull Soc Pathol Exot 1990;83:596–602.

470. Laure YKS. French Polynesia cancer registry. In: Galea G, Hughes R, eds. Enhancing cancer information in the Pacific. SPC, Noumea, New Caledonia; 1998.

471. Paksoy N, Bouchardy C, Parkin DM. Cancer incidence in Western Samoa. Int J Epidemiol 1991;20(3):634–41.

472. Tuomilehto J, Zimmet P, Taylor R, Bennet P, Wolf E, Kankaanpaa J. Smoking rates in Pacific Islands. Bulletin of the WHO 1986;64(3):447–56.

473. WHO. Tobacco or health: a global status report. WHO, Geneva; 1997.

474. Collins VR, Dowse GK, Zimmet P. Smoking prevalence and trends in the Pacific. Pacific Health Dialog 1996;3(1):87–95.

475. Meo L, Phillips D, Brough R. Smoking in Viti Levu, Fiji. Pacific Health Dialog 1996;3(1):41–2.

476. Division of Public Health. 1997 Youth risk behavior survey results - grade 6-8 tobacco use. Department of Public Health, Saipan, CNMI; 1998.

477. Division of Public Health. 1997 Youth risk behavior survey results – grade 9-12 tobacco use. Department of Public Health, Saipan, CNMI; 1998.

478. Department of Public Health. Smoking report. Ministry of Health, Rarotonga, Cook Islands; 1998.

479. Le Marchand L, Wilkens LR, Mi MP. Obesity in youth and middle age and risk of colorectal cancer in men. Cancer Causes Control 1992;3:349–54.

480. Le Marchand L, Kolonel LN, Earle ME, Mi MP. Body size at different periods of life and breast cancer risk. Am J Epidemiol 1988;128(1):137–52.

481. Goodman MT, Hankin J, Wilkens LR, et al. Diet, body size, physical activity, and the risk of endometrial cancer. Cancer Res 1997;57(22):5077–85.

482. Goodman MT, Nomura AM, Wilkens LR, Hankin J. The association of diet, obesity and breast cancer in Hawaii. Cancer Epidemiol Biomarkers Prev 1992;1(4):269–75.

483. Willett WC. Diet, nutrition and avoidable cancer. Environ Health Perspect 1995;103(suppl 8): 165–70.

484. Truswell AS. Whether meat is a risk factor for cancer remains uncertain. BMJ 1999; 319(7203):186.

485. Gurr MI. No evidence has linked ovarian cancer with high intakes of fat and meat. BMJ 1999; 319(7203):186.

486. Mobarhan S. Micronutrient supplementation trials and the reduction of cancer and cerebrovascular incidence and mortality. Nutr Rev 1994;52(3):102–5.

487. Gann PH, Ma J, Giovannucci E, et al. Lower prostate cancer risk in men with elevated plasma-lycopene levels: results of a prospective analysis. Cancer Res 1999;59(6):1225–30.

488. Singh PN, Fraser GE. Dietary risk factors for colon cancer in a low-risk population. Am J Epidemiol 1998;148(8):761–74.

489. DeCosse JJ, Miller HH, Lesser ML. Effect of wheat fiber and vitamins C and E on rectal polyps in patients with familial adenomatous polyposis. J Natl Cancer Inst 1989;81:1290–7.

490. Le Marchand L, Hankin J, Wilkens LR, Kolonel LN, Englyst HN, Lyu LC. Dietary fiber and colorectal cancer risk. Epidemiology 1997;8(6):658–65.

491. Fuchs CS, Giovannucci EL, Colditz GA, et al. Dietary fiber and the risk of colorectal cancer and adenoma in women. New Eng J Med 1999;340(3):169–76.

492. Stoll BA. Western nutrition and the insulin resistance syndrome: a link to breast cancer. Eur J Clin Nut 1999;53:83–7.

493. Kim YI. Diet, lifestyle, and colorectal cancer: is hyperinsulinemia the missing link? Nutr Rev 1998;56(9):275–9.

494. Levine W, Dyer AR, Shekelle RB. Post load plasma glucose and cancer mortality in middle aged men and women: 12 year follow-up findings of the Chicago Heart Association Detection Project in Industry. Am J Epidemiol 1990;131:254–62.

495. Will JC, Galuska DA, Vinicor F, Calle EE. Colorectal cancer: another complication of diabetes mellitus? Am J Epidemiol 1998;147:816–25.

496. Schoen RE, Kuller LH, Burke GL, et al. Increased blood glucose and insulin, body size, and incident colorectal cancer. J Natl Cancer Inst 1999;91(13):1147–54.

497. Le Marchand L, Kolonel LN, Yoshizawa CN. Lifetime occupational physical activity and prostate cancer risk. Am J Epidemiol 1991;133(2):103–11.

498. Neel JV. The "thrifty genotype" in 1998. Nutr Rev 1999;57(5 Part II):S2–S9.

499. Galea G, Hughes R. Enhancing cancer information in the Pacific. Report on a Regional Course for Cancer Registrars in Pacific Island Countries and Territories. SPC, Noumea, New Caledonia; 1998.

500. Swinburn B, Ashton T, Gillespie J, et al. Health care costs of obesity in New Zealand. Int J Obes 1997;21:891–6.

501. Cassel JC. Ponape–Palau blood pressure comparison. In: Stanhope JM, ed. Migration health in New Zealand and the Pacific: proceedings of a seminar 1975. Epidemiology Unit, Wellington Hospital, Wellington; 1977.

502. Prior IA. Cardiovascular epidemiology in New Zealand and the Pacific. NZ Med J 1974; 80(524):245–52.

503. Smith L. Healthy and sustainable oceans. PACNEWS (March 22); 1999.

504. WHO. Report of the joint FAO-WHO technical meeting on planning and evaluation of applied nutrition programmes. WHO Technical Report 1966;340 Rome, 11–16 Jan; 1965.

505. Sinnett P, Whyte M. Lifestyle, health and disease: a comparison between Papua New Guinea and Australia. Med J Aust 1978;1(1):1–5.

506. Reed D, Labarthe D, Stallones R. Epidemiologic studies of serum uric acid and levels among Micronesians. Arthritis Rheumat 1972;15(4):381–90.

507. Bindon JR, Knight A, Dressler WW, Crews DE. Social context and psychosocial influences on blood pressure among American Samoans. Am J Phys Anthropol 1997;103:7–18.

508. Colagiuri R, Borger R, Samiu O, Taufa L, Colagiuri S. Situational survey of diabetes in Sydney and Tonga. Ministry of Health, Tonga; 1999.

509. Bezannier G. Report of a health survey carried out in the village of Gahi, Wallis, 1997. translated from Enquête sanitaire sur le district de Mua: rapport final. Wallis et Futuna Service de Santé, 1997.

510. Bezannier, G. Report of a health survey carried out in Utufua village, Wallis, 1997. translated from Enquête sanitaire sur le district de Mua: rapport final. Wallis et Futuna Service de Santé, 1997.

511. Bezannier, G. Report of a health survey carried out in Lavegahau village, Wallis, 1997. translated from Enquête sanitaire sur le district de Mua: rapport final. Wallis et Futuna Service de Santé, 1997.

512. Bezannier, G. Report of a health survey carried out in the Teesi village, Wallis, 1997. translated from Enquête sanitaire sur le district de Mua: rapport final. Wallis et Futuna Service de Santé, 1997.

513. Bezannier, G. Report of a health survey carried out in Tepa village, Wallis, 1997. translated from Enquête sanitaire sur le district de Mua: rapport final. Wallis et Futuna Service de Santé, 1997.

514. WHO. Arterial hypertension and ischaemic heart disease: preventive aspects. Technical Report Series 231. WHO, Geneva; 1962.

515. Sinnett P. Cardiovascular epidemiology – a study in New Guinea. Singapore Med J 1973;14(3):241.

516. Dowse GK. Lack of antibodies to glutamic acid decarboxylase in young adults of the high diabetes prevalence Wanigela people of Papua New Guinea. Diabetes Res Clin Pract 1994; 24(3):195–8.

517. Hodge AM, Dowse GK, Zimmet P, Collins VR. Prevalence and secular trends in obesity in Pacific and Indian Ocean Island populations. Obes Res 1995;3(suppl):77s–87s.

518. Hodge AM, Dowse GK, Koki G, Mavo B, Alpers M, Zimmet P. Modernity and obesity in coastal and Highland Papua New Guinea. Int J Obes Relat Metab Disord 1995;19(3):154–61.

519. Dowse GK, Zimmet P, King H. Relationship between prevalence of impaired glucose tolerance and NIDDM in a population. Diabetes Care 1991;14(11):968–74.

520. Zimmet P, Whitehouse S. Pacific Islands of Nauru, Tuvalu and Western Samoa. In: Trowell HC, Burkitt DP, eds. Western diseases: their emergence and prevention. Edward Arnold Press, UK; 1981.

521. Prior IA. Diabetes and cardiovascular disease survey carried out in the Kingdom of Tonga. Ministry of Health, Nuku'alofa, Tonga: 1973.

522. Taylor R, Bennet P, Le Gonidec G, et al. The prevalence of diabetes mellitus in a traditional-living Polynesian population: the Wallis Island survey. Diabetes Care 1983;6(4):334–40.

523. Ministry of Health & Medical Service. Solomon Islands Epidemiological Report (SIER). Government of Solomon Islands, Honiara; 1990.

524. Pinhey TK, Heathcote GM, Rarick J. The influence of obesity on the self-reported health status of Chamorros and other residents of Guam. Asian American and Pacific Islander Journal of Health 1994;2(3):196–211.

525. Prior IA, Stanhope JM, Evens JG, Salmond CE. The Tokelau Islands migrant study. Int J Epidemiol 1974;3(3): 225–32.

526. Craig PL. Study on body perception and percent body fat: interim summary report. Ministry of Health, Government of Tonga, Nuku'alofa: 1996.

527. Craig PL, Comino E, Caterson I. Tongans have lower body fat than Australians with the same body mass index. Australasian Society for the Study of Obesity Abstract; 1997.

528. Colagiuri S, Colagiuri R. Case study: development of diabetes care in Tonga. Report to a WHO meeting on the integration of NCD prevention and control into the Healthy Cities and Healthy Islands Programme. Melbourne, 8–12 November 1999.

529. FSM-UNICEF Program of Cooperation. A situation analysis of children in the Federated States of Micronesia. Department of Human Resources, Palikir, Pohnpei; 1991.

APPENDICES

The following appendices consist of a series of tables that contain information from studies and surveys carried out over many years in Pacific Island countries and territories. They are intended to supplement information contained in the chapters of this publication. As much detail as possible has been put in the tables and, where necessary, explanations and notes are added.

The reader will notice a wide variation in the methodology, definitions and classifications used in the studies. This is partly due to the changes in reference values and diagnoseis of disease over the last 40 years and partly due to differences in terminology and classification of disease between countries.

Appendix 1: Hypertension

Table 1: Hypertension: males

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
MELANESIA										
Fiji Islands										
Gau	(144)		345	1958	20+				127.7	82.4
Fijian - rural	(145)*	a	242	1980	20+	11	3.5	14.5	121.4 (16.4)	70.4 (11.1)
Fijian - urban			401			11.2	8.6	19.7	124.1 (17.8)	74.5 (12.9)
Indo-Fijian - rural			214			7.8	7.2	15.1	120.7 (21.4)	70.9 (14.2)
Indo-Fijian - urban			384			10.2	9.9	20.1	122.5 (20.1	74.4 (14.3)
Gau **	(146)	a	305	1981	30+	2.3	12	14.3		
Kadavu **	(147)	a	582	1983–84	20+	27.3	9.8	37.1		
Lakeba **	(148)	a	296	1985	20+	14.2	12.8	27		
Fijian - rural-Qamea	(150)		142	1983	16+				120.5 (1.6)	72.1 (1.0)
Fijian - urban-Nabua			114						116.2 (1.4)	70.1 (1.3)
Fiji-rural - Viti Levu	(151)		87		40+				122 (11.5)	79 (8.7)
Suva			35						132 (16.6)	83 (12.9)
Fijian - rural	(152)		22	1991	30–64	18	14	32	128.4 (28.8)	82 (15.8)
Indo-Fijian - rural			53			8	6	14	124.4 (17.2)	80.4 (12.7)
Fijian	(36)**	a		1993	20+					
Fijian - rural			352			4.5	9.7	14.2	128.1	80.2
Fijian - urban			163			2.5	8	10.5	129.7	83.0
Indo-Fijian - rural			368			2.2	11.1	13.3	120.5	75.8
Indo-Fijian urban			199			1.5	7.5	9	125.9	79.0
New Caledonia										
Ounjo - rural	(39)	b	61	1980	20+		18			
Melanesian - urban			89				13			
Polynesians - urban			261				6.9			
Melanesians	(153)	c	293	1985–88	30+		14.3		141.0	87.0
Wallisians			44				20.5		147.0	91.0
Europeans			129				9.3		137.0	83.0
Papua New Guinea										
Western Highlands -	(505)	a	391	1966–68	15+		6.6			
rural									124.0	82.0
Wogupmeri River			50						112.0	71.0
Karkar Island			128						120.7	71.1
Kalo - rural	(160)		40	1977	18+		-		112.8 (2.1)	74.8 (1.6)
urban - Civil Servants			80		18–34		-		113.1 (2.9)	78.5 (3.4)
Koki - urban			130		18+				121.4 (12.0)	81.1 (1.0)
Gamusi - rural	(161)	a	36	1983	20+				114.3 (13.1)	67.9 (12.8)
Gimisave - rural			11						107.6 (14.5)	60.8) (7.6)
			12						106.8 (13.2)	64.1 (13.2)
			24						107.2 (15.2)	61.1 (11.3)
Gamog - rural		a	92	1985–86	20+				109.0	65.4
Marup - semi-rural	(164)		129						106.0	56.1
Kaul - semi-rural			78				1.1		115.0	68.6
Napapar - rural			126				1.4		115.0	71.4
Matupit - peri-urban			126				0		120.0	75.0
Highlands - peri-urban			136				4.3		125.0	81.1
Kitiva - rural	(246)		142	1990	20+		3.4			
							4.0		116 (15.0)	70 (6.0)
Wanigela - rural	(167)		163	1991	25+				130.4	
Kalo - rural			92						115.2	
Koki - urban			401	1991						

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Eastern Highlands	(163)	d	52		17+	18			134.6	
Solomon Islands										
Bougainville	(169)		292	1966–72	15+				114.0	73.3
Malaita			379						120.1	78.4
Ontong Java			859						116.3	75.9
Bougainville			304	1985–86					119.8	75.8
Malaita			158						117.7	72.8
Ontong Java			620						119.0	75.3
Munda - urban Melanesian	(57)	a	433	1985	18+	7				
Paradise – rural Melanesian			173			5.3				
Solstar - Micronesian			140			3.6				
Vanuatu										
Efate	(172)		143	1962	10+				124.1	78.3
Malekula Island			218						120.9	79.1
Vila and Norsup	(173)	a	161	1984	38.2		7.8***			
									122 (1.0)	79 (1.0)
Vila - urban	(175)	a	438	1985	20+	14	6.3	20.3	124.1 (14.6)	78.2 (10.5)
Ngu - intermediate			153			6.3	3.5	9.8	116.2 (18.4)	67.6 (11.6)
Tan - rural			165			9.1	2.2	11.3		
urban	(62)	a	388	1998	20+	17.7	16.1	33.8	123.2 (13.7)	74.6 (10.8)
intermediate			233			11.4	14.2	25.6		
rural			194			13.1	6.7	19.8		
MICRONESIA										
Federated States of Micronesia										
Pohnpei	(178)	f	127	1947			1.6			
Pohnpei	(179)			1983					111.9	76.4
Kolonia			242						119.9 (0.8)	70.3 (0.7)
intermediate			173						117.5 (0.9)	67.5 (0.8)
remote			138						121.8 (1.4)	68.4 (1.0)
Chuuk	(180)	g		1993–94	35–44			39.6		
					45–54			42.1		
					55–64			54.8		
					65–74			55.8		
Kosrae					35–44			12.8		
					45–54			26.9		
					55–64			40.8		
					65–74			66.2		
Pohnpei					35–44			25		
					45–54			51		
					55–64			46		
					65–74			61		
Guam										
Rota	(181,506)	a	122	1967–68			31			
Guam			273				34			
California			164				34			

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Kiribati										
Abaiang - rural	(144)		120	1960	20–29				128.3 (16.5)	78.6 (10.1)
			117		30–39				125.9 (14.5)	79.2 (10.3)
			68		40–49				126.8 (15.0)	80.4 (9.4)
			89		50–59				123.2 (15.9)	77.9 (9.4)
			41		60–69				132.8 (18.3)	81.7 (11.9)
			16		65+				135.9 (30.3)	79.1 (11.3)
North Tabiteuea - rural	(71)	a	79	1981	20–24		4.1			
			97		25–34		16.3			
			98		35–44		19.4			
			93		45–54		16			
			50		55–64		10.5			
			57		65+		6.9			
Betio - urban			173		20–24		11.3			
			318		25–34		16.6			
			223		35–44		22.8			
			145		45–54		23.8			
			42		55–64		16.7			
			18		65+					
Marshall Islands										
Eastern islands	(183)		6572	1948–50	15–24				116.0	76.0
					25–44				118.0	77.0
					45+		35.8		125.0	78.0
Nauru										
Nauru	(215)		299	1975			35.8		154.6	101.5
Nauru***	(188)		1184	1987			16.96		131.2 (0.7)	78.7 (0.4)
Palau										
Palau	(183)		10575	1948–50**	15–24				118.0	70.0
					25–44				122.0	74.0
					45+				125.0	75.0
Koror - urban	(191)		109	1968–70*					136.0	88.0
Peleliu - rural			41						135.0	83.0
Ngerchelong - rural			69				11		121.0	81.0
POLYNESIA										
Samoa	(195)**	a		1979	20–29				119.4 (10.3)	75.7 (8.1)
					30–39				118.0 (10.8)	77.8 (9.4)
					40–49				122.3 (12.1)	80.6 (7.9)
					50–59				125.2 (13.5)	82.1 (9.9)
					60–69				124.6 (18.4)	82 (10.7)
					70+					
			140		18+		5			
American Samoa										
Samoa	(195)	a		1982	20–29				134.1 (12.3)	74.7 (11.5)
					30–39				126 (9.5)	78.8 (9.4)
					40–49				128.4 (13.7)	84.9 (9.8)
					50–59				135.4 (21.0)	83 (12.8)
					60–69				124.2 (19.7)	69.8 (32.0)
					70+					
			96		18+		11.8			

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Manu'a - rural Am.	(195)	a		1976	20–29				123.8 (8.3)	81.9 (4.6)
					30–39				124 (12.8)	82.8 (9.7)
					40–49				124.6 (12.1	82.5 (8.1)
					50–59				120.2 (17.4)	79.2 (12.2)
					60–69				131.1 (18.6)	84.3 (11.1)
					70+				140.1(9.1)	75.5 (4.4)
			105		18+		9.2			
Tutuila - rural Am.	(195)	a		1976	20–29				124.4 (11.5)	80.4 (8.6)
					30–39				127.8 (18.4)	85.8 (11.9)
					40–49				132.7 (22.4)	86.1 (12.5)
					50–59				137.7 (25.3)	89.6 (16.7)
					60–69				139.6 (23.9)	85.7 (12.6)
					70+				132.8 (20.2)	86.6 (6.7)
			331		18+		19.6		137.3 (14.5)	85.1 (12.9)
Tutuila	(507)		69	1992	37–81				143.1 (21.7)	87.0 (13.8)
Pago Pago - urban Am.	(195)	a		1976	20–29				125.6 (11.2)	80.9 (8.3)
					30–39				133.7 (16.1)	89.6 (11.5)
					40–49				132.3 (17.8)	88.9 (11.8)
					50–59				145.3 (21.8)	93.5 (11.6)
					60–69				135.8 (16.1)	85 (9.6)
					70+				154.9 (32.5)	94.1 (18.1)
			262		18+		24.1			
Hawaii	(195)	a		1975	20–29				129.9 (15.9)	84.4 (11.08
					30–39				132.4 (17.0)	89.1 (12.5)
					40–49				129.6 (17.9)	87.6 (11.7)
					50–59				129.6 (14.7)	86.2 (11.3)
					60–69				135.3 (24.1)	90.7 (17.3)
					70+				129.1 (15.5)	83.1 (4.2)
			249		18+		22.7			
California	(195)	a		1979	20–29				129.5 (12.9)	83.7 (9.2)
					30–39				131.6 (14.7)	86.9 (8.8)
					40–49				140.5 (18.6)	94.4 (12.8)
					50–59				142.5 (29.8)	90.6 (11.9)
					60–69					
		b			70+					
			166		18+		32.8			
Cook Islands										
Pukapuka	(197)		54	1951	25–44				107.9 (8.8)	67.8 (7.6)
			32		45–64				109.4 (12.0)	68.0 (6.9)
			10		65+				108.0 (9.3)	65.0 (6.3)
Rarotonga	(83)	a		1960	20–29				122.3 (8.1)	78.4 (7.4)
					30–39				136.6 (15.1)	91.5 (11.5)
					40–49				141.5 (19.8)	94.3 (12.9)
					50–59				139.9 (25.9)	91.6 (12.8)
					60–69				148.2 (27.6)	91.6 (13.2)
					70+				147.0 (42.9)	89.0 (20.2)
					40+		25			

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%) Borderline	Definite	Total	Mean blood pressure mmHg (sd) Systolic	Diastolic
Atiu–Mitiaro	(83)	a		1960	20–29				127.1 (11.6)	79.5 (5.9)
					30–39				122.1 (10.6)	77.6 (7.7)
					40–49				128.0 (13.5)	82.1 (7.2)
					50–59				139.8 (18.1)	88.5 (11.8)
					60–69				135.0 (24.1)	85.5 (10.3)
					70+				153.7 (21.3)	89.0 (8.2)
					40+		10			
Rarotonga	(198)		72	1980	20–24	8.3			127.7 (16.2)	73.3 (10.8)
			129		25–34	15.5			128.8 (16.0)	82.6 (11.7)
			109		35–44	26.6			134.6 (18.4)	88.6 (14.1)
			112		45–54	32.1			136.6 (23.5)	89.4 (16.0)
			71		55–64	42.3			146 (25.1)	88.0 (17.0)
			50		65+	32			143.4 (24.5)	83 (15.6)
			542*		20+	24.6			134.8	84.9
Rarotonga	(199)	a	64	1987	20–24		1.6		121.8 (13.8)	73.4 (9.6)
			109		25–34		7.3		121.2 (12.3)	79.4 (10.3)
			111		35–44		20.7		129.4 (15.9)	84.5 (11.4)
			103		45–54		21.4		134.4 (18.3)	87.1 (11.5)
			60		55–64		20		135.5 (20.1)	82.2 (13.6)
			44		65+		20.5		139.3 (22.9)	77.9 (14.8)
			491		20+		15.2		129.3 (17.9)	81.6 (12.4)
Rarotonga	(201)		4	1986	16–29				115.5 (5.7)	73.5 (6.6)
			12		30–49				129.5 (14.7)	82.8 (10.9)
			8		50+				155.8 (27.3)	90.3 (21.1)
Mangaia			31	1986	16–29				120.3 (12.3)	70.9 (11.4)
			28		30–49				128.7 (12.2)	82.5 (9.4)
			15		50+				137.3 (14.5)	85.1 (12.9)
Aitutaki	(202)		224	1992	40+	26.8				
Penrhyn,Rakahanga,			280			10.0				
Tauhu		g	154			21.4				
Pukapuka	(85)		48	1993	20	31			130.6	87.9
Tutakimoa										
French Polynesia		b	46	1973	1–19				111.2 (11.7)	70.5 (9.8)
Maupiti	(204)		31		20–39				120.8 (17.3)	76.2 (11.3)
			20		40–59				126.7 (12.8)	85.4 (10.6)
			15		60 +				136.1 (20.4)	85.3 (13.0)
			112		10+	10.7	9.8	20.5	120.0 (17.1)	76.7 (12.4)
		a	2903	1986	18–59		15.7			
Tahiti - salaried workers and civil servants	(205)									
			49	1995	16–19	18.4	4.1	22.5		
French Polynesia	(19)		126		20–29	27	12.7	39.7		
			122		30–39	37.7	10.7	48.4		
			91		40–49	35.2	28.6	63.8		
			90		50–59	30	41.1	71.1		
			67		60+	25.4	43.3	68.7		
		a	545	1995	16+	30.3	19.8*	50.1	133.7 (21.4)	86.2 (14.6)

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Niue										
Niue	(198)	a	104	1980	20–24				122.5 (12.7)	74.1 (1.9)
			122		25–34		9		124 (13.8)	77.6 (11.8)
			108		35–44		17.6		127.1 (16.5)	81.1 (12.2)
			95		45–54		10.5		127.9) (17.9)	81.0 (12.0)
			59		55–64		10.2		128.1 (25.6)	78.5 (13.2)
			60		65+		11.7		132.2 (18.8)	75.2 (13.1)
			548 *		20+		10.0 *		126.4 *	78.2 *
Tokelau										
Tokelau - non migrants	(208)		367	1971	15+	9.3	4	13.3	124.2	70.0
			339	1976		6.7	3.3	10	120.9	68.5
			350	1982		7.4	3	10.4	120.9	69.6
			559	1972–74	15+	11.7	12	23.7	132.4	79.8
Migrants to NZ			617	1975–77		15.4	11.2	26.6	130.2	78.2
			679	1980–81		11	11.7	22.7	129.4	79.2
Tonga			181	1973	20–69	19.8	8.6	28.4		
Nuku'alofa	(211)	a	199			9.9	4.3	14.2		
Foa			151	1992	15–64	17.2	14.6	31.8		
urban - diastolic only	(214)	a	327			26.6	16.3	42.9		
rural - diastolic only			151			13.9	3.3	17.2		
urban – systolic only			327			24.5	1.5	26		
rural – systolic only			608	1999	15+			41.0	131.0 (20.7)	81.0 (11.8)
urban & rural	(508)									
Tuvalu			269	1976	10+		18.3		133.4	83.5
Funafuti	(215)	a								
Wallis and Futuna			38	1980	20–24	7.9		7.9	119 (14.0)	68.3 (10.2)
Wallis Island	(216)	a	80		25–34	6.3	2.5	8.8	118.8 (13.1)	71.6 (11.8)
			56		35–44	7.1		7.1	115.6 (13.9)	72.4 (8.8)
			41		45–54	4.9	7.3	12.2	117.3 (14.5)	75.6 (11.8)
			36		55–64	11.1	8.3	19.4	119.5 (17.7)	75.1 (14.0)
			23		65+	21.7		21.7	115.2 (20.4)	71.7 (12.7)
			274		20+	8.4	2.9	11.3		
			213		25–64	6.7 (1.7)#	3.5 (1.3)#	10.2		
			0	1980	20–24			(2.1)#		
Wallisians in Noumea		a	50		25–34	8	2		120.3 (12.5)	76.7 (9.3)
			100		35–44	10	4		122.8 (12.5)	77.0 (10.3)
			90		45–54	8.9	11.1		126.4 (15.7)	79.4 (11.2)
			13		55–64	7.7	23.1		138.4 (16.9)	81.3 (11.4)
					65+					
					20+					
			253		25–64	8.8 (1.9)#	7.2 (1.7)#			
			143	1996	20–29		4.9	16.0		
Wallis Island	(335,509-513)	e	98		30–39		6.1	(2.4)#		
			147		40–49		9.5			
			102		50–59		7.8			
			59		60–69		23.7			
			62		70+		24.2			
			611		20+		10.5			

* Age-adjusted by direct method to local census data
** Not age-adjusted
*** For both males and females
\# Age-standardised, 25–64

Criteria for Diagnosis

a WHO Expert Committee on arterial hypertension. Technical report 628, 1978. Normal Blood Pressure, diastolic >=90 mmHg and systolic >=140 mmHg. Borderline hypertension, diastolic 91 to 94 mmHg and/or Systolic 141 to 159 mmHg. Definite hypertension, diastolic >=95 and/or Systolic >=160 mmHg.

b WHO Expert Committee on arterial hypertension and ischaemic heart disease. Tech Report 231, 1962. Normal blood pressure, diastolic <90 and Systolic <140 mmHg. Definite hypertension, diastolic >=95 and Systolic >=160 mmHg (514).

c Hypertension = Systolic >= 170 and/or Diastolic >= 100 mmHg.

d Definite hypertension = Systolic >= 160 and/or diastolic >= 95 mmHg

e Systolic >160 and/or diastolic >100 mmHg – then confirmed 'a few days later'.

f Systolic >=160 and/or Diastolic >=100 mmHg

g Systolic >=140 and/or Diastolic >=90 mmHg.

h Diastolic >=95 or on BP medication.

Table 2: Hypertension: females

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
MELANESIA										
Fiji Islands										
Fijian - rural	(145)*	a	235	1980	20+	14.9	7.1	21.3	124.0 (20.2)	74.5 (12.3)
Fijian - urban			462			12	9.2	21.3	122.5 (22.3)	7401 (13.3)
Indo-Fijians - rural			238			5.7	3.9	9.6	115.0 (20.5)	68.7 (11.9)
Indo-Fijians - urban			462			8.2	9.2	17.5	116.2 (24.9)	69.5 (14.3)
Gau	(144)		393	1958	20+		0		124.9	83.1
Gau **	(146)	a	398	1981	30+	6	23	29.0		
Kadavu **	(147)	a	649	1983–84	20+	30.2	16.9	47.1		
Lakeba **	(148)	a	444	1985	20+	14.2	11.1	12.4		
Fijian - rural - Qamea	(150)		174	1983	16+				118.6 (1.6)	67.3 (1.3)
Fijian - urban - Nabua			201						113.1 (1.5)	67.7 (1.1)
Fijian - rural - Viti Levu	(151)		109		40+				123.0 (15.7)	78.0 (10.9)
Fijian - urban - Suva			71						128.0 (19.4)	80.0 (14.4)
Fijian - rural	(152)		58	1991	30–64	10	10	20.0	127.6 (18.5)	80.0 (12.2)
Indo-Fijian - rural			106			7	14	21.0	125.4 (18.0)	76.7 (11.9)
Fijian	(36)**	a		1993	20+					
rural			220			2.9	9.2	12.1	124.3	78.1
urban			382			3.2	10	13.2	124.8	79.7
Indo-Fijians			218			2	12.7	14.7	121.0	73.8
rural			355			1.8	7.8	9.6	119.7	74.7
New Caledonia										
Ounjo - rural	(39)	b	50	1980	20+		28			
Melanesian - urban			77				10.4			
Polynesian - urban			215				10.2			
Melanesians	(153)	c	288	1985–88	30+		28.5		153	93
Wallisians			44				13.6		140.0	86.0
Europeans			100				12		136.0	84.0
Papua New Guinea										
Western Highlands	(505)	a	386	1966–68	15+		5.4		124.0	80.0
Karbar Island	(157)		150	197?					115.4	68.4
Kalo - rural	(160)		65	1977	18+				110.6 (1.5)	75.8 (1.1)
Civil Servants - urban			38		18–34				104.5 (1.5)	74.6 (1.4)
Koki - urban	(161)	a	46		18+				121.5 (2.2)	80.0 (1.6)
Gamusi - rural			29	1983	20–29				109.8 (11.1)	65.3 (8.6)
			29		20–44				107.0 (8.8)	63.5 (10.0)
			32		45+				108.1 (19.3)	59.3 (10.6)
Gimisave - rural			17	1983	20–29				97.0 (12.6)	56.7 (11.2)
			32		20–44				95.1 (14.0)	51.1 (10.8)
		a	24		45+				103.9 (21.3)	58.9 (15.0)
Gamog - rural	(164)		88	1985–86	20+		0		102.0	63.1
Semi-rural - Marup			143				0.8		100.0	55.1
Semi-rural - Kaul			107				1.3		110	68
Coastal - rural			143				4.8		114.0	69.8
Coastal - peri-urban			147				6.3		117	72.6
Highlands - peri-urban			143				11.8		116.0	74.4
Kitiva - rural	(246)		61	1990	20+				121.0 (17.0)	70.0 (8.0)
Wanigela - rural	(167)		378	1991	25+				126.5	
Kalo - rural			106						116.1	

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Koki - urban	(249)		349						129.1	
Eastern Highlands	(163)	d	69		17+		5			
Solomon Islands										
Bougainville	(169)		312	1966–72	15+				110.1	71.1
Malaita			400						120.2	77.3
Ontong Java			963						114.3	74.5
Bougainville			375	1985–86	15+				114.9	73.8
Malaita			189						120.6	71.7
Ontong Java			807						118.9	74.9
Munda - urban	(57)	a	440	1985	18+		7.7			
Paradise - rural			157				5.7			
Solstar Micronesians			161				5.8			
Vanuatu										
Efate	(172)		147	1962					123.4	76.9
Malekula Island			205						123.1	78.2
Port Vila and Norsup	(173)	a	159	1984			7.8 ***		120.0 (1.0)	78.0 (1.0)
Port Vila	(175)	a	190	1985 *		3.9	12.4		120.6 (22.8)	76.0 (12.4)
Ngu - intermediate			195			9.4	6.7		121.8 (22.1)	69.6 (12.3)
Tan - rural			231			6.6	2.2		117.9 (12.7)	75.5 (11.1)
urban	(62)	a	382	1998 *		13.5	14.5	28.0		
intermediate			209			9	17.1	26.1		
rural			214			10.2	6.2	16.4		
MICRONESIA										
Federated States of Micronesia										
Pohnpei	(178)	a	124	1947		12.9			111	76.6
Pohnpei	(179)			1983					114.2 (1.2)	66.4 (0.8)
Kolonia			220						111.6 (1.0)	65.7 (0.7)
Intermediate			143						121.3 (1.5)	69.2 (0.9)
Remote			123							
Chuuk	(180)	f		1993–94	35–44			30.1		
					45–54			52.1		
					55–64			55.9		
					65–74			73.2		
Kosrae					35–44			12.8		
					45–54			26.9		
					55–64			40.8		
					65–74			66.2		
Pohnpei					35–44			23.0		
					45–54			41.0		
					55–64			61.0		
Guam										
Rota	(181,255)	a	149	1967–68	20+		30			
Guam			355				35			
California			151				32			
Guam	(139)	h	402	1991	18+		6			

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%) Borderline	Definite	Total	Mean blood pressure mmHg (sd) Systolic	Diastolic
Kiribati										
Abaiang - rural	(144)		171	1960	20–29				116.4 (13.6)	73.4 (8.8)
			123		30–39				118.2 (17.5)	73.9 (11.0)
			83		40–49				122.8 (19.5)	78.4 (11.9)
			67		50–59				125.7 (16.0)	76 (10.8)
			27		60–69				124.1 (19.0)	75.9 (10.0)
North Tabiteuea - rural	(71)	a	10		65+				126 (20.0)	77 (12.3)
			114	1981	20–24		2.6			
			124		25–34		7.3			
			114		35–44		9.6			
			98		45–54		12.2			
			58		55–64		15.5			
			56		65+		17.9			
Betio - urban			219		20–24		3.2			
			330		25–34		7.3			
			210		35–44		11			
			139		45–54		17.3			
			49		55–64		16.3			
			34		65+		26.5			
Marshall Islands										
Majuro	(184)	a	611	1985	15–59	5.9	4 *	5.9	110.5 (19.6)	65.3 (13.7)
Ebeye			612			2.2	2.2 *	2.0	101.9 (15.2)	65.6 (12.4)
Watje			177			0.6	2.8 *	0.6	102.9 (14.7)	64.3 (12.2)
Nauru										
Nauru	(215)	a	338	1975			19.5		140.1	87.4
Nauru ***	(188)		1184	1987			16.9			
Palau										
Palau	(183)		10,575	1948–50**	15–24				117	69
					25–44				119	70
					45+				122	73
Koror - urban	(191)		145	1968–70*	20+				133	84
Peleliu			57						137	82
Ngerchelong			89				19		124	77
POLYNESIA										
Am. Samoa & Samoa	(195)	a		1979	20–29				114.2 (10.2)	73.3 (8.3)
					30–39				112.7 (10.1)	75.4 (8.7)
					40–49				123.2 (10.9)	81.4 (10.9)
					50–59				131.5 (23.4)	84.6 (13.3)
					60–69				132.1 (21.1)	82.3 (13.7)
					70+				131.9 (12.3)	83.4 (7.8)
			184		18+		6.5			
		a		1982	20–29				119.9 (10.7)	75.1 (8.1)
					30–39				117.6 (12.7)	73.2 (8.5)
					40–49				130.6 (15.9)	82.2 (12.0)
					50–59				134.8 (29.4)	82.5 (15.0)
					60–69				139.3 (32.6)	83.0 (19.0)
					70+				141.8 (9.3)	70.6 (6.8)
			95		18+		6.3			
Manu'a rural – Am.		a		1976	20–29				114.7 (12.4)	73.8 (9.2)
					30–39				120.7 (15.1)	80.3 (10.6)
					40–49				127.8 (20.8)	84.4 (12.6)
					50–59				135.0 (25.3)	84.4 (14.3)
					60–69				148.6 (32.2)	90.1 (13.7)
					70+				137.6 (22.7)	78.2 (12.4)
			191		18+		17.9			

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Tutuila rural - Am.		a		1976	20–29				114.3 (11.4)	73.1 (9.7)
					30–39				125.0 (18.5)	81.5 (11.7)
					40–49				137.1 (20.1)	87.0 (12.1)
					50–59				140.3 (26.8)	87.8 (17.9)
					60–69				142.5 (28.9)	84.9 (14.9)
					70+				135.3 (16.7)	78.6 (9.3)
			413		18+		15.5			
Pago Pago urban - Am.		a		1976	20–29				116.5 (11.0)	76.0 (9.4)
					30–39				124.4 (16.5)	82.6 (12.2)
					40–49				140.0 (26.0)	90.6 (15.2)
					50–59				140.1 (23.6)	89.2 (12.7)
					60–69				158.6 (28.9)	96.7 (16.6)
					70+				148.0 (15.8)	89.5 (11.3)
			381		18+		21			
Hawaii		a		1975	20–29				116.9 (11.2)	79.5 (10.3)
					30–39				122.6 (15.4)	80.9 (10.0)
					40–49				121.1 (18.6)	89.3 (13.5)
					50–59				125.6 (17.9)	84.0 (12.3)
					60–69				143.0 (16.9)	89.3 (11.9)
					70+				139.6 (30.9)	87.7 (18.9)
			332		18+		13.4			
California		a		1979	20–29				117.4 (10.7)	76.7 (7.8)
					30–39				132.1 (15.5)	86.0 (11.0)
					40–49				137.1 (14.2)	88.6 (10.1)
		b			50–59				145.2 (21.5)	90.0 (11.4)
					60–69					
					70+					
			158		18+		18.2			
Tutuila	(507)		65	1992	37-81				148.6 (25.6)	85.1 (14.9)
Cook Islands										
Pukapuka	(197)		66	1951	25–44		3		107.4 (12.6)	68.3 (10.0)
			36		45–64				111.4 (11.4)	68.6 (7.1)
			6		65+				112.5 (10.7)	75.8 (11.6)
Rarotonga	(83)	c	14	1960	20–29				115.6 (12.8)	74.3 (9.1)
			6		30–39				113.7 (16.1)	78.3 (11.0)
			5		40–49				171.2 (35.2)	108.0 (30.1)
			9		50–59				145.4 (28.5)	90.9 (12.9)
			4		60–69				154.0 (28.9)	94.5 (18.2)
			1		70				172	94
			71		40+		26			
Atiu-Mitiaro		c	21	1960	20–29				117.9 (17.1)	74.4) (6.4)
			15		30–39				122.7 (10.3)	80.5 (7.6)
			14		40–49				141.1 (29.8)	89.0 (12.8)
			13		50–59				151.7 (20.1)	96.3 (14.0)
			3		60–69				141.3 (13.0)	86.7 (7.0)
			3		70+				138.7 (12.1)	78.0 (7.2)
			151		40+		21			
Rarotonga	(84)	a	83	1966	20–29				121.1 (12.1)	78.5 (10.4)
			37		30–39				131.5 (16.5)	84.0 (11.9)
			41		40–49				152.2 (26.7)	97.6 (16.4)
			33		50–59				170.2 (38.2)	102.9 (17.6)
			21		60–69				174.8 (35.1)	105.6 (18.7)
			13		70+				172.9 (36.8)	98.5 (17.4)
					40+		47			

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%) Borderline	Definite	Total	Mean blood pressure mmHg (sd) Systolic	Diastolic
Pukapuka		a	54	1966	20–29				112.2 (12.3)	70.9 (7.9)
			47		30–39				118.3 (14.1)	75.4 (8.7)
			28		40–49				122.6 (17.6)	76.5 (11.6)
			31		50–59				134.2 (20.5)	80.5 (11.2)
			21		60–69				127.7 (15.8)	78.2 (10.2)
			10		70 +				125.4 (33.0)	67.8 (15.0)
					40+		7			
Rarotonga	(198)	a	75	1980	20–24		1.3		118.8 (13.0)	70.0 (10.4)
			150		25–34		8.7		116.3 (19.7)	74.8 (13.6)
			155		35–44		18.1		127.8 (20.2)	82.5 (14.6)
			111		45–54		30.6		134.4 (24.0)	85.6 (14.6)
			51		55–64		56.9		163.1 (29.1)	98.2 (19.6)
			42		65+		59.5		162.3 (23.6)	88.6 (16.7)
			581*		20+				130.5	81.8
Rarotonga	(199)	a	102	1987	20–24		1		109.6 (10.4)	69.2 (9.6)
			137		25–34		1.5		112.8 (13.6)	71.7 (10.1)
			131		35–44		12.2		121.6 (16.9)	80.1 (12.2)
			120		45–54		24.2		136.4 (22.0)	85.4 (12.1)
			75		55–64		21.3		138.0 (21.3)	85.8 (11.4)
			52		65+		34.6		150.6 (31.3)	83.3 (14.8)
			617		20+		13.3		125.0 (22.9)	78.1 (13.1)
Rarotonga	(201)		6	1986	16-29				111.0 (6.5)	64.7 (9.6)
			10		30–49				137.4 (23.2)	87.4 (16.7)
			12		50+				154.7 (24.8)	88.5 (9.8)
Mangaia			32	1986	16-29				112.5 (11.2)	71.8 (8.4)
			31		30–49				127.1 (15.9)	81.6 (10.4)
			22		50+				145.9 (16.9)	89.6 (13.8)
Aitutaki	(202)		313	1992	40+		20.8			
Penrhyn, Rakahanga, Tauhu			289				18.3			
Pukapuka	(85)		157				19.1			
Tutakimoa		g	85	1993	20+		27		124.9	84.1
French Polynesia										
Maupiti	(204)	b	43	1973	1–19				108.0 (13.1)	69.2 (10.8)
			37		20–39				109.7 (9.4)	74.2 (11.1)
			27		40–59				128.5 (21.9)	87.1 (17.9)
			11		60 +				136.4 (20.3)	87.1 (18.1)
			118		10+	6.8	11.9	18.7	115.9 (18.5)	76.5 (15.4)
Tahiti - salaried workers and civil servants	(205)	a	1670	1986	18–59		6.7			
French Polynesia	(19)	a		1995	16–19	8.8	4.4	13.2		
					20–29	16.6	3.5	20.1		
					30–39	21	11.5	32.5		
					40–49	27.3	23.6	50.9		
					50–59	33.7	30.5	64.2		
					60+	29.3	44.4	73.7		
French Polynesia		a	728	1995	16+	22.4	15.7*	22.4	126.3 (23.9)	83.1 (16.3)
Niue										
Niue	(198)	a	80	1980	20–24		2.5		113.7 (13.2)	69.8 (9.9)
			123		25–34		4.1		115.6 (12.3)	74.3 (10.0)
			146		35–44		8.2		120.2 (15.0)	75.8 (11.2)
			101		45–54		13.9		130.9 (21.2)	80.4 (14.0)
			68		55–64		16.2		139.1 (25.5)	79.9 (12.4)
			83		65+		18.1		138.6 (21.2)	75.1 (13.1)
			601 *		20+		9.4*		123.9 *	75.6 *

	Reference (Source)		N	Year of survey	Age range	Prevalence of hypertension (%)			Mean blood pressure mmHg (sd)	
						Borderline	Definite	Total	Systolic	Diastolic
Niue	(207)	a	12	1983	15–19				108.2 (8.6)	67.5 (9.2)
			75		20–24				115.2 (10.4)	71.3 (10.2)
			119		25–34		2.5		119.7 (11.4)	74.9 (10.5)
			111		35–44		4.5		122.5 (14.1)	77.0 (11.3)
			114		45–54		15.8		133.2 (18.0)	83.0 (11.7)
			62		55–64		41.9		146.4 (20.5)	88.0 (14.3)
			47		65+		21.3		143.4 (21.5)	87.7 (13.1)
			540		15+		11.5*			
Tokelau										
Tokelau - non migrants	(208)	a	467	1971		13.0	8.1	21.1	122.5	73.5
			445	1976		5.6	8.3	13.9	123.9	70.9
			378	1982		10.7	5.8	16.5	121.4	71.7
Migrants in NZ										
		a	442	1972–74		12.4	15.2	27.6	129.7	78.2
			502	1975–77		10.2	12.9	23.1	128.4	75.1
			578	1980–81		12.3	12.1	24.4	125.7	75.1
Tonga										
Nuku'alofa	(211)	a	218	1973	20–69	14.0	12.2	26.2		
Foa			193			8.0	8.2	16.2		
urban - diastolic	(214)	a	157	1992	15–64	17.2	14.6	31.8		
rural - diastolic			320			26.6	16.3	42.9		
urban - systolic			157			15.3	3.2	18.5		
rural - systolic			320			25.0	1.6	26.6		
urban & rural	(508)		608	1999	15+			41.0	131.0 (20.7)	81.0 (11.8)
Tuvalu										
Funafuti	(215)	a	308	1976	10+		13.6		139.2	85.6
Wallis and Futuna										
Wallis Island	(216)	a	57	1980	20–24	3.5	1.8	5.3	112.9 (12.5)	70.4 (10.2)
			81		25–34	4.9	2.5	7.4	110.2 (13.5)	71.6 (10.2)
			61		35–44	9.8	6.6	16.4	114.2 (17.7)	74.7 (13.0)
			52		45–54	3.8	7.7	11.5	120.7 (16.7)	76.3 (10.3)
			34		55–64	11.8	8.8	20.6	127.7 (20.0)	75.6 (11.8)
			20		65+	15	15	30.0	126.9 (22.2)	74.3 (11.3)
			305		20+	6.9	5.6	12.5		
		#	228		25–64	6.9 (1.7)	5.8 (1.6)		12.8 (2.2)	
Wallisians in Noumea		a	23	1980	20–24	8.7	0		111.3 (14.7)	70.0 (10.3)
			96		25–34	5.2	11.5		117.8 (20.8)	76.3 (16.0)
			102		35–44	13.7	13.7		127.3 (24.1)	81.6 (16.5)
			72		45–54	20.8	19.4		129.2 (20.7)	82.2 (13.5)
			18		55–64	27.7	11.1		133.8 (20.1)	78.7 (12.4)
		#			25–64	14.4(2.1)	14.2 (2.1)			
Wallis Island	(335,509-513)	e	197	1996	20–29		2.5			
			158		30–39		15.8			
			147		40–49		23.1			
			121		50–59		31.4			
			77		60–69		29.9			
			58		70+		29.3			
			758		20+		18.7**			

* Age-adjusted by direct method to local census data

** Not age-adjusted

*** For both males and females

Criteria for Diagnosis

a WHO Expert Committee on arterial hypertension. Technical report 628, 1978. Normal Blood Pressure, diastolic <=90 mmHg and systolic <=140 mmHg. Borderline hypertension, diastolic 91 to 94 mmHg and/or Systolic 141 to 159 mmHg. Definite hypertension, diastolic >=95 and/or Systolic >=160 mmHg.

b WHO Expert Committee on arterial hypertension and ischaemic heart disease. Tech Report 231, 1962. Normal blood pressure, diastolic <90 and Systolic <140 mmHg. Definite hypertension, diastolic >=95 and Systolic >=160 mmHg (514).

c WHO technical report 168, 1959. Hypertension = Systolic >= 160 and/or Diastolic >= 95 mmHg

d Diastolic >= 95 mmHg

e Systolic >160 and/or diastolic >100 mmHg – then confirmed 'a few days later'

f Systolic >=140 and/or diastolic >=90 mmHg

g Diastolic >=95 mmHg or on BP medication

h Self-reported

Appendix 2: Blood lipids

Table 1: Mean blood lipids — Males

	Reference (Source)	N	Year of survey	Age range	Tot. Chol mmol/l (sd)	Apo A-1 mg/dl (sd)	Apo B mg/dl (sd)	LDL mmol/l (sd)	HDL mmol/l (sd)	TGs mmol/l (sd)
MELANESIA										
Fiji Islands										
Fijian	(241)		1980							
urban		55		20-44		96 (18)				
urban		24		45+		89 (11)				
rural		34		20-44		87 (15)				
rural		20		45+		93 (13)				
Indo-Fijian										
urban		29		20-44		106 (19)				
urban		16		45+		95 (19)				
rural		44		20-44		96 (12)				
rural		13		45+		99 (11)				
Fijian	(237)			35-59	4.53					
Lakeba Melan/Polyn				35-59	4.63					
Indo-Fijians				35-59	4.85					
urban	(151)	35	1980s		5.6 (1.6)	107 (21)	119 (38)			
rural		87			3.8 (1.0)	101 (20)	80 (22)			
New Caledonia										
Loyalty Islands	(237)			35-59	4.36					
Noumea, Wallis										
Touho, Oundjo					3.99					
Papua New Guinea										
Highlands - Tukisenta	(515)	391	1966-68	15	3.83					1.5
Lowlands - Coastal	(244)	69	1968-69	17-48	2.1–3.2					
Highlands - Lufa		41	1968-69	17-48	1.9–3.9					
urban - Koki	(160)	130	1977	18+	3.71 (0.09)					0.65 (0.02)
Civil servants		80	1979	18-34	4.2 (0.12)					0.78 (0.07)
rural - Kalo		40	1977	18+	3.7 (0.28)					0.61 (0.04)
Highlands-Gamusi/Gimisave	(249)	90	1983	25+	4.3 (0.09)					1.18 (0.10)
rural - Gamog	(164)	92	1985-86	20+	4.02					
semi-rural - Marup		129			3.97					
Semi-rural - Kaul		78			3.5					
Coastal-rural - Napapar		126			3.69					
Coastal - peri-urban - Matupit		126			4.08					
Highlands - peri-urban - Masilakaiufa	(249)	87	1985-86	25+	4.9 (0.11)					1.24 (0.13)
rural - Bougainville	(245)	50	1988-89	18+	3.7 (1.0)					
urban - Bougainville		50	1988-89	18+	4.8 (0.8)					
Mine workers - Bougainville		50	1988-89	18+	5.3 (0.9)					
Kitava	(246)	119	1990	20-86	4.7 (1.0)					1.14 (0.4)
rural - Kalo	(516)	106	1991	25+	4.9					1.1
rural - Wanigela		378			4.9					1.0
urban - Koki		349			5.5					1.2
urban - Koki	(248)	84	na	19+	4.9 (1.0)					1.3

	Reference (Source)	N	Year of survey	Age range	Tot. Chol mmol/l (sd)	Apo A-1 mg/dl (sd)	Apo B mg/dl (sd)	LDL mmol/l (sd)	HDL mmol/l (sd)	TGs mmol/l (sd)
Solomon Islands										
Bougainville	(170)	280	1966-80	15+	3.62 (0.7)	103.4 (21.2)				1.00 (0.5)
Malaita		125			3.54 (0.9)	109.4 (25.4)				1.25 (0.4)
Ontong - Java		155			4.08 (0.7)	130.2 (24.5)				0.78 (0.3)
Vanuatu										
rural	(34)	161	1985	20+	4.93 (1.19)					1.29 (0.63)
intermediate		155			5.44 (1.2)					1.13 (0.49)
urban		435			5.26 (1.38)					1.43 (0.99)
MICRONESIA										
Federated States of Micronesia										
Kosrae	(180)	2051	1993-94	20+	4.3 (0.9)	117.2 (24.7)	87.3 (21.7)			1.15 (1.6)
Sokehs, Pohnpei		579			4.5 (0.9)	104.2 (23.7)	100.3 (24.4)			1.2 (0.7)
Guam										
rural - Rota		122	1968	20+	4.8					
urban in Guam	(63)	273			5.1					
urban in California		164			5.5					
Kiribati										
rural	(34)	474	1981	20+	4.3 (1.1)					
urban		919			4.5 (0.9)					
Nauru										
adults	(517)	1041	1987	20+	5.2 (0.03)				0.95 (0.01)	1.10 (0.04)
Palau										
rural - Ngarchelong	(191)	69	1967-70	20+	3.83					
intermediate - Peliliu		41			4.22					
urban - Koror		109			4.43					
POLYNESIA										
Am. Samoa & Samoa	(257)	178	1990-91	25-55	5.22 (0.95)	131.6 (20.5)	128.8 (33.0)	3.57 (0.95)	1.01 (0.26)	1.39 (1.06)
Cook Islands										
Rarotonga	(198)	542	1980	20+	4.93					1.3
French Polynesia	(19)	545	1995	16+	4.97 (1.12)			3.15 +0.94	1.07 (0.32)	1.65 (1.42)
Niue	(198)	548	1980	20+	3.71					1.1
Tokelau										
in Tokelau	(208)	5	1982	15+						1.1
in New Zealand		4.9	1980-81							1.4
Tonga										
Males & females	(213)	102	1983		5.24 (1.1)					
Males & females	(508)	608	1999	15+	5.2 (1.1)				1.13 (0.26)	
Tuvalu	(114)	269	1975-76		4.1 (0.08)					0.9 (0.06)
Wallis and Futuna										
on Wallis	(216)	269	1980	25+	3.77 (0.83)					0.77 (0.41)
in Noumea		252			3.95 (1.03)					1.06 (0.99)

Table 2: Mean blood lipids — Females

	Reference (Source)	N	Year of survey	Age range	Tot. Chol mmol/l (sd)	Apo A-1 mg/dl (sd)	Apo B mg/dl (sd)	LDL mmol/l (sd)	HDL mmol/l (sd)	TGs mmol/l (sd)
MELANESIA										
Fiji Islands										
Fijian	(241)		1980							
urban		59		20-44		87 (11)				
urban		21		45+		90 (21)				
rural		38		20-44		90 (13)				
rural		21		45+		84 (21)				
Indo-Fijian										
urban		52		20-44		96 (13)				
urban		11		45+		106 (16)				
rural		44		20-44		96 (16)				
rural		12		45+		102 (19)				
Fijian	(237)			35-59	4.58					
Lakeba Melan/Polyn				35-59	4.46					
Indo-Fijians				35-59	4.47					
urban	(151)	47	1980s		5.2 (1.3)	110 (19)	109 (38)			
rural		96			4.0 (1.0)	93 (19)	89 (23)			
New Caledonia										
Loyalty Islands	(237)			35-59	4.27					
Noumea, Wallis										
Touho, Oundjo					4.16					
Papua New Guinea										
Highlands - Tukisenta	(515)	386	1966-68	15+	4.07					1.5
Coastal Lowlands										
Highlands - Lufa	(244)	69	1968-69	17-48	2.3–3.9					
urban - Koki		41	1968-69	17-48	2.4–4.7					
Civil servants	(160)	46	1977	18+	3.87 (0.16)					0.61 (0.05)
rural - Kalo		38	1979	18-34	4.10 (0.16)					0.68 (0.08)
Highlands - Gamusi		65	1977	18+	3.72 (0.28)					0.58 (0.05)
Gimisave	(249)	94	1983	25+	4.5 (0.10)					1.18 (0.10)
rural - Gamog	(164)	88	1985-86	20+	4.06					
semi-rural - Marup		143			4.27					
semi-rural - Kaul		107			3.87					
Coastal - rural - Napapar		143			4.06					
Coastal - peri-urban - Matupit		147			4.21					
Highlands - peri-urban - Masilakaiufa	(249)	113	1985-86	25+	5.1 (0.11)					1.10 (0.11)
Kitava	(246)	43	1990	20-86	5.7 (1.2)					1.2 (0.5)
rural - Kalo	(516)	106	1991	25+	5					1.0
rural - Wanigela		378			4.8					0.9
urban - Koki		349			5.1					0.9
urban - Koki	(248)	58		19+	4.5 (0.9)					1.0

	Reference (Source)	N	Year of survey	Age range	Tot. Chol mmol/l (sd)	Apo A-1 mg/dl (sd)	Apo B mg/dl (sd)	LDL mmol/l (sd)	HDL mmol/l (sd)	TGs mmol/l (sd)
Solomon Islands										
Bougainville	(170)	347	1966-80	15+	3.95 (0.8)	111.1 (25.0)				1.02 (0.5)
Malaita		166			4.01 (0.9)	124.5 (30.3)				1.37 (0.8)
Ontong Java		231			4.5 (0.9)	136.9 (27.5)				0.93 (0.5)
Vanuatu										
rural	(34)	229	1985	20+	4.58 (0.93)					1.23 (0.56)
intermediate		194			5.3 (1.27)					1.16 (0.60)
urban		192			4.95 (1.32)					1.14 (0.54)
MICRONESIA										
Federated States of Micronesia										
Kosrae	(180)	2051	1993-94	20+	4.3 (0.9)	117.2 (24.7)	87.3 (21.7)			
Sokehs, Pohnpei		579			4.5 (0.9)	104.2 (23.7)	100.3 (24.4)			
Guam										
rural - Rota	(63)	149	1968	20+	5.2					
urban in Guam		355			5.3					
urban in California		151			5.4					
Kiribati										
rural	(34)	562	1981	20+	4.8 (1.2)					
urban		981			4.6 (0.9)					
Nauru										
Adults	(517)	1041	1987	20+	5.2 (0.03)				0.95 (0.01)	1.10 (0.04)
Palau										
rural - Ngerchelong	(191)	89	1967-70	20+	4.43					
intermediate - Peliliu		57			4.51					
urban - Koror		145			4.59					
POLYNESIA										
American Samoa & Samoa	(257)	147	1990-91	25-55	5.18 (0.91)	132.4 (24.3)	119.2 (24.8)	3.65 (0.83)	1.07 (0.26)	1.02 (0.49)
Cook Islands										
Rarotonga	(198)	581	1980	20+	4.9					1.0
French Polynesia	(19)	728	1995	16+	4.79 (1.14)			3.23 (1.04)	1.12 (0.30)	1.46 (0.90)
Niue	(198)	601	1980	20+	3.81					0.9
Tokelau										
in Tokelau	(208)		1982	15+	5.34					
in New Zealand			1980-81		4.9					
Tonga										
Males & females	(213)	102	1983		5.24 (1.1)					
Males & females	(508)	608	1999	15+	5.2 (1.1)				1.13 (0.26)	
Tuvalu	(114)	308	1975-76		4.3 (0.08)					0.9 (0.04)
Wallis and Futuna										
on Wallis	(216)	278	1980	25+	4.15 (0.96)					0.85 (0.42)
in Noumea		301			3.97 (10.3)					0.92 (0.55)

Appendix 3: Diabetes

Table 1: Males and Females

	Reference (Source)		N	Year of survey	Age range	Prevalence of diabetes (%)		
						IGT	% new diabetics	diabetes
MELANESIA								
Fiji Islands								
Fijian	(279)	aa	1000	1964–65	>=21		0.2	0.6
Indo-Fijian			1000				1.9	5.7
Fijian - rural	(280)	b	477	1980	>=20	8.2	62.5	1.7
Fijian - urban			863			11.1	64.9	6.6
Indo-Fijian - rural			452			10.6		12.8
Indo-Fijian - urban			846			10.4		13.1
Fijian female	(352)	f	337	1983	>=20			15.8
Fijian male			199					8.2
Indo-Fijian female			714					24.3
Indo-Fijian male			558					17.0
Fijian female		g	948			9.43	62.5	24.2
Fijian male			545			9.43	62.5	15.1
Indo-Fijian female			2080			10.6	32.3	34.1
Indo-Fijian male			1572			10.6	32.3	25.4
Fijian female - rural		c,e	109		>40	2.8		0.9
Fijian female - urban	(151)		71			12.6		11.3
Fijian male - rural			87			2.3		1.2
Fijian male - urban			35			8.6		2.8
New Caledonia								
Melanesian - rural	(285)	a	172	1979	>=20	5.8	66.7	1.7
Ouvea - Melanesian			535			5.0	91.7	2.2
Ouvea - Polynesian			401			8.0		7.0
Melanesian female			3951				62.2	9.3
Melanesian male			3252				55.4	7.4
Polynesian female			338				58.3	14.8
Polynesian male			223				38.7	16.1
European female			623				37.0	9.2
European male			562				41.7	7.6
Papua New Guinea								
Rural # (m & f)	(48)	a	105	1977	>=18	4.5		1.0
Urban # (m & f)			185			6.2		15.6
Civil servants # (m & f)	(160)	a	118	1979	>=18	2.5		0.0
Highlands - NAN (m & f)	(161)	b	308	1983	>=20	2.3	-	0.0
Highlands - NAN (m & f)	(292)	c	257	1985	>=20	1.9	-	0.0
Rural AN - (m & f)			269				100.0	0.7
Peri-urban - AN (m & f)			273			0.7	72.7	4.0
PNG - AN	(167)	c		1991	>=25			
Kalo - rural AN (m & f)			541			4.1	-	2.0
Wanigela - rural AN (m & f)			197			18.5	26.9	12.4

	Reference (Source)		N	Year of survey	Age range	Prevalence of diabetes (%) IGT	% new diabetics	diabetes
Solomon Islands*								
NAN	(301)	c		1985–86	>=18			
Aita						6.52		
Nagovisi						1.31		
Nasioi						0.51		
Baegu - AN						4.49		2.4
Lau - AN						1.11		4.3
Ontong Java - AN						0.69		1.8
Paradise - rural female	(57)	l	157	1985	>=18	1.5		1.5
Munda - urban female			440			2.1		14.0
Solstar - rural female			161			12.4		7.9
Paradise - rural male			173					
Munda - urban male			443			0.2		
Solstar - rural male			140			6.5		4.3
Vanuatu								
Port Vila #	(173)	j		1984	25–68	3.2		0.7
Norsup #			77			3.9		2.6
Tanna - rural	(174)	b	393	1985	>=20	2.3		0.5
Nguna - intermediate			335			2.4		0.0
Port Vial			626			2.4		2.6
Male	(62)	t	815	1998	>=20	2.1		1.0
Female			805			2.3		1.7
MICRONESIA								
Federated States of Micronesia								
Chuuk	(180)	m	1520	1992–94	>=35			
					35–44			9.0
					45–54			22.0
					55–64			18.0
					65–74			9.0
Kosrae		m	690	1992–94	>=20			
					20–34			1.0
					35–44			7.0
					45–54			21.0
					55–64			33.0
					65–74			9.0
Pohnpei		m	300	1992–94	>=30			
					35–44			14.0
					45–54			19.0
					55–64			21.0
					65–74			21.0
Guam								
Chamorro male - rural	(255)	n	122	1967–68				3.0
Chamorro female - rural			149					8.0
Chamorro male - urban			273					10.0
Chamorro female - urban			355					13.0
Male	(309)	m	232	1991	>=30			9.5
Female			295					10.2
Chamorro (m & f)								10.7

	Reference (Source)		N	Year of survey	Age range	Prevalence of diabetes (%) IGT	% new diabetics	diabetes
Kiribati								
Tabiteuea North - rural	(411)	b	1031	1981	>=20	13.5	83.8	3.6
Betio - urban			1880			16.0	80.0	7.7
Marshall Islands								
Wotjo	(314)	p	169	1987	>=25			13.0
Nauru								
	(317)	d	221	1975	>=20	11.3	69.7	34.4
	(187)		421	1976	>=10	7.0	66.1	29.0
	(319)	b	1583	1982	>=20	18.4	40.9	24.2
	(320,519)	c	1213	1987	>=20	11.4	26.9	27.9
	(269)	c	1404	1994	25–74	16.2		28.1
CNMI								
Carolinian	(176)	o		1996				5.4
Chamorro								5.3
Palau								
Palau	(255)	n	510	1967–70	>=20			5.0
Palau	(321)	o		1997	>=20			3.3
POLYNESIA								
Cook Islands								
Pukapuka - rural # (m & f)	(84)	q	379	1962–63	>=20		89.0	2.4
Rarotonga - urban (m & f)			471				77.0	5.5
Male			243				73.0	4.5
Female			228				80.0	3.9
Rarotonga (m & f)	(326, 198)	b	1102	1980	>=20	9.6	50.0	6.7
Male			534			9.7		5.3
Female			568			10.8		8.3
Manihiki (m & f)	(325)	a	133	1980	>=20			
Male			75			8.0		4.8
Female			58			31.0		8.2
Rarotonga (m & f)	(199)	b	1396	1987	>=20			
Male			489			12.3		10.6
Female			607			19.2		10.7
French Polynesia								
Male	(19)	b	545	1995	>=16	25.3		16.5
Female			728			42.2		23.6
Total (m & f)			1273			34.9		20.6
Niue								
Niue	(326)		1128	1980	>=20	6.9	49.4	7.4
Samoa								
Male and female	(328,520)	e		1978	>=20			
rural			745			3.9	44.0	3.4
urban			744			8.3	60.0	8.7
Male and female	(269)	c		1991	>=20			
Poutasi - rural			463			8.2	60.0	6.5
Tuasivi - rural			524			5.3	46.8	9.0
Apia			785			9.6	49.2	16.0

	Reference (Source)		N	Year of survey	Age range	Prevalence of diabetes (%) IGT	% new diabetics	diabetes
Tokelau								
Males - Tokelau Round I	(330)	r	197	1968–71	35–74			3.0
Males - Tokelau Round II			157	1976				5.1
Males - Tokelau Round III			158	1982				7.0
Males - NZ Round I			208	1972–74				7.5
Males - NZ Round II			223	1975–77				7.1
Males - NZ Round III			276	1980–81				10.8
Females - Tokelau Round I			230	1968–71				8.7
Females - Tokelau Round II			212	1976				11.5
Females - Tokelau Round III			188	1982				14.3
Females - NZ Round I			154	1972–74				11.7
Females - NZ Round II			176	1975–77				18.3
Females - NZ Round III			235	1980–81				19.9
Tonga								
Male - rural	(521)	s	200	1973				4.7
Nuku'alofa male			184					5.5
Foa female			190					10.0
Nuku'alofa female			215					9.7
Male	(508)		271	1999	15+	10.4		11.7
Female			337		15+	8.6		14.0
Male and female			608		15+	9.3		13.0
Tuvalu								
Funafuti	(333)	d	397	1976	>=20	13.6	70.6	4.3
Wallis Island								
Rural male	(522)	b	262	1980	25–64	4.0		1.4
Rural female			288		25–64	9.3		3.5
Rural (m & f)			549		>=20	5.5	73.3	2.6
Noumea - Wallisian male	(287)	b	253	1980	25–64	9.9		10.3
Noumea - Wallisian female			288		25–64	8.5		13.2
Noumea - Wallisian (m & f)		b	564	1980	20–64	8.7		11.9

*	Age-standardised to local population
#	not age-standardised
NAN	Non-Austronesian (Highland) ancestry
AN	Austronesian (coastal) ancestry
***	Database review

Diabetes Classification

aa Urine test with Clinistix, positives followed-up next day with fasting blood test, if >= 120 mg/l then considered diabetic. If fasting between 100 and 120 mg/l then 2-hour OGTT, 50 gram glucose: diabetes = OGTT >= 120 mg/l (6.7 mmol/l)

a WHO, Expert Committee on Diabetes Mellitus, Second Report, Tech Series 646, 1980

b WHO Expert Committee, 1980 and National Diabetes Data Group:Classification and Diagnosis of Diabetes Mellitus and other categories of glucose intolerance. Diabetes 28: 1039-1057, 1979 (Diabetes = 2-h >=200mg/100ml [11.1mmol/l] IGT140-199/100ml] 7.8-11.0 mmol/l)

c WHO, Diabetes Mellitus, Report of WHO Study Group. Technical Report Series 727. 1985; Diabetes = 2h >= 10.0 mmol/l; IGT >= 6.7 < 10.0 mmol/l

d 75 g OGTT; DM - 2hPG >= 160 mg/ml

e National Diabetes Data Group:Classification and Diagnosis of Diabetes Mellitus and other categories of glucose intolerance. Diabetes 28: 1039-1057, 1979

f Glycosylated haemoglobin (HBA1). Diabetes >= 1200 pmol HMF/mg Hb

g Capillary blood glucose >= 7.0 mmol/l (the equivalent of fasting venous plasma glucose >= 8.0 mmol/l [140mg/dl]) (capillary blood samples used)

h Capillary blood glucose measure with glucose strips. Known diabetics and those with capillary blood glucose >= 110 mg/l (>=6.1 mmol/l) returned for 2-hour oral glucose tolerance test of 75 g, WHO 1985

i Capillary blood glucose >= 6.0 mmol/l, then 2-hour oral glucose tolerance (75g) WHO 1980 criteria

j Fasting or random plasma glucose; random = 8.0mmol/l, IGT+ 8–10.9 mmol/l; fasting, WHO 1980 criteria

k Fasting or random capillary glucose

l Fasting capillary blood glucose if >= 90 mg/l (5.0 mmol/l), then 75 g 2-hour oral glucose load; diabetes = OGTT >= 200 mg/l (11.1 mmol/l)

m Self-reported diabetes

n One-hour oral glucose load of 50 g glucose. Diabetes > 205 mg/l 1-hour serum glucose level after 50 g glucose load, "hyperglycemia" = 205 mg/100ml

o Database review

p Random capillary blood glucose; diabetes => 200 mg/dl (11.1 mmol/l)

q Casual urine Testape for glucose. Those with glycosuria, received 2-hour 100g glucose load. Abnormal if >= 130 mg/l (7.2 mmol/l)

r Plasma glucose level >= 13.9 mmol/l (250 mg/dl) following a 1-hour glucose load of 100 g

s 2-hour plasma glucose level following 75g glucose load. Probable diabetes = 145-179 mg/dl (8.0 - 9.8 mmol/l). Definite diabetes >= 180 mg/dl (>=9.9 mmol/l)

t Random and fasting capillary blood glucose; if random diabetes >= 200 mg/dl (11.1 mmol/l) IGT + 145-200 (8 -11.0 mmol.l) if fasting diabetes = 145 mg/dl (8.0 mmol/l), IGT = 109-144 (6.0 to 7.9 mmol/l)

Appendix 4: Obesity

Table 1: Males

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
MELANESIA								
Fiji Islands								
Fijian males	(404)	184	1958–72	20–24	22.9	3.3	0.0	3.3
		168		20–29	24.1	9.5	4.8	14.3
		289		30–39	24.0	19.0	4.2	23.2
		246		40–49	24.2	13.8	4.5	18.3
		185		50–59	23.6	8.6	0.5	9.1
		157		60+	22.9	6.4	0.0	6.4
Total males		1229	1958–72	>20	23.7	11.1	2.6	13.7
Fijian males	(33)	241	1980–81	20–29	24.3	5.1		5.1
		174		30–39	25.4	18.4		18.4
		155		40–49	26.0	24.8		24.8
		123		50–59	26.5	30.1		30.1
		113		60+	24.3	16.2		16.2
Urban males		104			27.3			
Rural males		702			24.9			
Total males		806		>20	25.2	17.0		17.0
Fijian males - urban	(280)	401	1980	>20	25.8 (3.8)			
Fijian males - rural		242			25.5 (3.7)			
Indo-Fijian males	(33)	62	1980–81	20–29	21.1			1.6
		62		30–39	23.5			6.5
		36		40–49	24.0			11.1
		29		50–59	22.3			3.4
		23		60+	24.0			8.7
Total		212		>20	22.8			5.7
Indo-Fijian males - urban	(280)	384	1980	>20	22.8 (3.9)			
Indo-Fijian males - rural		214			21.5 (3.8)			
Males - Melanesian	(352)	497	1983	>=20	25.5			
Males - Melanesian		38			26.1			
Males - Indo-Fijian		1272	1983	>=20	23.9			
Males - Indo-Fijian		267			24.5			
Males - Melanesian - rural	(151)	87	1980s	25–40				
Males - Melanesian - urban		35			30.1			
Males - Fijian	(36)	117	1993	19–24	23.2	3.4	0.9	4.3
		145		20–34	25.3	17.9	6.2	24.1
		104		30–44	26.0	21.2	13.5	34.7
		91		40–54	26.6	46.2	3.3	49.5
		60		50–64	25.7	28.3	6.7	35.0
		36		65+	23.8	16.7	0.0	16.7
Total		553		>19	25.1	21.1	5.6	26.7
Males - Indo-Fijian		118	1993	19–24	19.7	4.2	1.7	5.9
		191		20–34	21.4	12.0	2.1	14.1
		130		30–44	22.3	14.6	4.6	19.2
		94		40–54	23.5	28.7	2.1	30.8
		42		50–64	23.1	28.7	2.4	31.1
		29		65+	22.2	24.1	3.4	27.5
Total		604		>19	21.7	15.4	2.6	18.0
Females - Fijian	(404)	250	1958–72	20–24	23.6	18.0	1.6	19.6
		195		20–29	23.8	20.5	4.1	24.6
		348		30–39	25.3	21.8	18.7	40.5
		257		40–49	25.8	34.2	21.0	55.2
		166		50–59	24.9	24.0	9.0	33.0
		134		60+	22.5	19.8	6.1	25.9
Total		1350		>20	24.6	23.3	11.4	34.7

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese*		
						25–29	≥30	≥25
Females - Fijian	(33)	302	1980–81	20–29	24.4			23.0
		218		30–39	26.6			49.1
		178		40–49	27.6			56.5
		117		50–59	27.1			48.7
		92		60+	25.0			38.0
Females - Fijian - urban	(33)	144			27.6			
Females - Fijian - rural		765			25.5			
Total		907		>20	26.0			40.6
Females - Fijian - urban	(280)	462	1980	>20	27.9 (5.8)			
Females - Fijian - Rural		235			26.3 (4.7)			
Females - Indo-Fijian	(33)	135	1980–81	20–29	20.8			8.9
		91		30–39	24.3			28.9
		38		40–49	24.3			31.6
		29		50–59	25.1			34.5
		8		60+	22.5			25.0
Total		301		>20	22.8			20.6
Females - Indo-Fijian - urban	(280)	452	1980	>20	23.9 (5.9)			
Females - Indo-Fijian - rural		238			23.5 (5.8)			
Females - Fijian - rural	(149)	881	1983	>=20	27.1			
Females - Fijian - urban		53			27.7			
Females - Indo-Fijian		1919			25.0			
Females - Indo-Fijian		141			25.4			
Females - Fijian - rural	(151)	109	1980s	>=20	25.8			
Females - Fijian - urban		71			30.9			
Females - Fijian	(36)	138	1993	19–24	24.6	15.9	2.9	18.8
		165		20–34	26.8	27.9	15.8	43.7
		135		30–44	29.0	32.6	28.9	61.5
		85		40–54	29.3	35.3	29.4	64.7
		71		50–64	29.6	36.6	33.8	70.4
		42		65+	25.1	26.2	11.9	38.1
Total		636		>19	27.3	28.1	19.3	47.4
Females - Indo-Fijian		139	1993	19–24	19.9	9.4	1.4	10.8
		178		20–34	22.8	23.6	5.6	29.2
		146		30–44	25.1	28.8	17.1	45.9
		82		40–54	25.3	32.9	15.9	48.8
		51		50–64	25.6	35.3	17.6	52.9
		25		65+	22.6	20.0	12.0	32.0
Total		621		>19	23.2	23.7	10.0	33.7

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese*		
						25–29	≥30	≥25
New Caledonia								
Males - Melanesian - rural	(285)	90	1979	> 20	24.1	14.2	2.2	16.4
Males - Melanesian - island		208			24.6	24.1	3.9	28.0
Males		164			24.0	22.0	1.2	23.2
Females - Melanesian - rural		82			24.5	39.0	11.0	50.0
Females - Melanesian - island		307			26.4	56.0	24.1	80.1
Females		237			26.8	57.3	26.1	83.4
Males - Melanesian - rural	(41,370)	213	1992–94	30–59	28.5 (4.6)			59.1
Males - Melanesian - urban		3010			26.8 (4.4)			44.6
Males - Polynesian		222			29.9 (5.4)			72.1
Males - European - urban		224			26.6 (4.8)			39.7
Males - European - rural		336			27.2 (5.2)			45.4
Females - Melanesian - urban		428			29.7 (5.7)			79.6
Females - Melanesian - rural		3493			28.5 (5.5)			71.4
Females - Polynesian		333			32.0 (6.8)			82.9
Females - European - urban		299			26.1 (6.3)			46.5
Females - European - rural		317			27.3 (6.7)			56.9
Papua New Guinea								
Males - Kaul	(51)	19	1974	18–29	21.9			10.0
Males - Kaul		51		>18	21.9			10.0
Males - Lufa		28		18–29	22.5			10.0
Males - Lufa		43		>18	22.7			10.0
Females - Kaul		29		18–29	21.2			24.0
Females - Kaul		69		>18	20.7			22.0
Females - Lufa		28		18–29	22.2			23.0
Females - Lufa		41		>18	22.0			22.0
Males - Koki	(160)	130	1977	>18	27.1 (0.3)			
Males - civil servants		80	1979	18–34	23.8 (0.3)			
Males - rural		40	1977	>18	22.4 (0.4)			
Females - Koki		46	1977	>18	29.4 (0.7)			
Females - civil servants		38	1979	18–34	24.2 (0.6)			
Females - rural		65	1977	>18	22.4 (0.4)			
Males - Gamog	(164)	92	1980–86	>20	21.0			
Males - Marup		129			21.8			
Males - Kaul		78			22.5			
Males - coastal-rural		126			24.4			
Males - coastal-peri-urban		126			24.3			
Males - highland-peri-urban		136			23.5			
Females - Gamog		88	1980–86	>20	20.1			
Females - Marup		143			20.8			
Females - Kaul		107			21.9			
Females - coastal-rural		143			23.9			
Females - coastal-peri-urban		147			25.4			
Females - highland-peri-urban		143			22.4			
Males - Kalo	(167)	92	1991	>25	25.8			11.8
Males - Wanigela		163			27.1			33.0
Males - Koki		401			29.2			37.7
Females - Kalo		106	1991		26.1			19.4
Females - Wanigela		378			25.3			18.6
Females - Koki		349			30.9			56.3

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese*		
						25–29	≥30	≥25
Solomon Islands								
Males - Kwaio	(406)	6	1966–70	10–19	19.1			
		23		20–29	22.2			
		20		30–39	22.0			
		18		40–49	22.1			
		20		50+	20.8			
Males - Aita		13		10–19	23.2			
		15		20–29	23.7			
		22		30–39	24.0			
		10		40–49	22.0			
		4		50+	21.9			
Males - Baegu		9		10–19	21.1			
		16		20–29	22.4			
		10		30–39	22.6			
		18		40–49	21.8			
		10		50+	21.8			
Males - Lau		5		10–19	21.3			
		6		20–29	25.5			
		5		30–39	25.0			
		10		40–49	24.6			
		11		50+	26.0			
Males - Nagovisi		6		10–19	18.5			
		5		20–29	21.6			
		12		30–39	21.7			
		19		40–49	22.5			
		21		50+	22.2			
Males - Nasioi		5		10–19	21.1			
		9		20–29	21.3			
		12		30–39	22.9			
		9		40–49	20.8			
		3		50+	23.9			
Females - Kwaio		17		10–19	21.1			
		31		20–29	22.1			
		19		30–39	21.0			
		19		40–49	20.1			
		14		50+	19.8			
Females - Aita		17		10–19	22.1			
		17		20–29	24.2			
		16		30–39	23.1			
		7		40–49	22.7			
		2		50+	18.8			
Females - Baegu		4		10–19	20.9			
		17		20–29	21.8			
		18		30–39	21.3			
		12		40–49	20.5			
		11		50+	19.2			
Females - Lau		11		10–19	24.7			
		14		20–29	24.8			
		7		30–39	23.0			
		17		40–49	25.5			
		7		50+	23.0			
Females - Nagovisi		13		10–19	20.9			
		11		20–29	21.4			
		24		30–39	21.4			
		15		40–49	20.3			
		12		50+	20.0			
Females - Nasioi		5		10–19	20.0			

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
		12		20–29	20.7			
		12		30–39	21.8			
		7		40–49	19.8			
		8		50+	20.8			
Males - Melanesian - urban	(57)	433	1985					12.0
Males - Melanesian - rural		173						10.0
Males - Micronesian - rural		140						41.0
Females - Melanesian - urban		440						37.0
Females - Melanesian - rural		157						45.0
Females - Micronesian - rural		161						71.0
Females - Melanesian	(523)	1929	1989–90	20–29	24.3			
Females - Polynesian		190		20–29	26.7			
Females - Micronesian		33		20–29	29.4			
Females - Melanesian		1300		30–39	24.9			
Females - Polynesian		119		30–39	28.7			
Females - Micronesian		20		30–39	28.6			
Females - Melanesian		750		40–49	24.4			
Females - Polynesian		65		40–49	27.9			
Females - Micronesian		8		40–49	30.4			
Females - Melanesian		3979		20–49	24.5			
Females - Polynesian		374		20–49	27.5			
Females - Micronesian		61		20–49	29.3			
Vanuatu								
Males	(173)	161	1984		25.0 (0.3)		14.9	
Females		159			25.8 (0.4)		26.4	
urban (m & f)		243			25.8			
rural (m & f)		77			24.2			
Males - urban	(175)	75	1985	<25	24.0 (2.1)	22.7	1.3	24.0
Males - intermediate		19		<25	23.1 (1.7)	15.8		15.8
Males - rural		30		<25	22.5 (2.3)	13.3		13.3
Males - urban		181		20–34	25.8 (3.4)	43.1	12.2	55.3
Males - intermediate		42		20–34	23.8 (2.1)	34.1		34.1
Males - rural		43		20–34	22.8 (1.8)	11.6		11.6
Males - urban		123		30–44	27.3 (3.5)	56.6	18.0	74.6
Males - intermediate		34		30–44	25.1 (4.7)	23.5	11.8	35.3
Males - rural		25		30–44	22.7 (3.0)	12.0		12.0
Males - urban		38		40–54	26.4 (4.5)	36.8	18.4	55.2
Males - intermediate		19		40–54	24.9 (2.6)	42.1	5.3	47.4
Males - rural		34		40–54	22.9 (3.0)	26.5		26.5
Males - urban		14		50–64	27.4 (3.4)	35.7	28.6	64.3
Males - intermediate		26		50–64	24.1 (4.5)	38.5	7.7	46.2
Males - rural		21		50–64	22.4 (1.9)	9.5		9.5
Total males - urban		438		>25	25.9 (3.5)	42.5	12.8	55.3
Total males - intermediate		155		>25	24.1 (3.3)	29.9	5.8	35.7
Total males - rural		165		>25	22.6 (2.4)	13.9		13.9
Females - urban		44	1985	<25	24.3 (3.7)	27.3	11.4	38.7
Females - intermediate		29		<25	22.8 (3.6)	20.7	3.4	24.1
Females - rural		41		<25	24.2 (2.7)	41.5		41.5
Females - urban		93		20–34	27.3 (4.5)	46.2	22.6	68.8
Females - intermediate		44		20–34	25.2 (4.6)	31.1	11.1	42.2
Females - rural		73		20–34	23.3 (2.3)	16.4	1.4	17.8
Females - urban		34		30–44	30.7 (5.9)	20.6	52.9	73.5
Females - intermediate		43		30–44	27.3 (4.6)	34.9	27.9	62.8
Females - rural		39		30–44	22.3(3.0)	15.4		15.4
Females - urban		8		40–54	30.0 (7.6)	12.5	37.5	50.0
Females - intermediate		26		40–54	25.6 (3.8)	34.6	15.4	50.0
Females - rural		28		40–54	22.1 (2.5)	7.1	3.6	10.7
Females - urban				50–64				
Females - intermediate		34		50–64	25.9 (4.9)	26.5	23.5	50.0
Females - rural		20		50–64	21.9 (4.3)	33.3	33.3	66.6
Total females - urban		179		>25	27.9 (5.7)	35.2	26.3	61.5

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese*		
						25–29	≥30	≥25
Total females - intermediate		188		>25	25.4 (4.4)	30.2	18.0	48.2
Total females - rural		208		>25	22.9 (3.0)	18.8	1.4	20.2
Females	(62)	273	1998	20–29	24.6 (3.8)	29.7	11.0	40.7
		221		30–39	26.6 (5.1)	35.3	22.6	57.9
		158		40–49	27.7 (5.5)	35.4	29.7	65.1
		78		50–59	26.8 (5.8)	26.9	26.9	53.8
		70		>=60	24.9 (5.6)	31.4	12.9	44.3
Males		248		20–29	24.2 (3.2)	24.6	6.5	31.1
		222		30–39	25.3 (3.7)	35.1	12.6	47.7
		168		40–49	26.9 (4.6)	41.1	22.0	63.1
		95		50–59	25.7 (4.5)	40.0	13.7	53.7
		81		>=60	24.1 (3.7)	34.6	6.2	40.8
MICRONESIA								
Federated States of Micronesia								
Females - rural	(183)		1948–50		22.1			
Females	(409)	810	1987–88	10–19	24.8 (3.8)	33.5	7.8	41.3
		1228		20–29	27.2 (5.0)	36.8	24.9	61.7
		1037		30–39	30.3 (6.1)	30.9	49.3	80.2
		513		40–49	30.6 (6.4)	28.7	61.9	80.6
Total females		3588		10–49	28.0 (5.8)	33.2	31.9	65.1
Males - Chuuk	(180)		1993–94	20–34				
Males - Pohnpei								
Males - Kosrae								55.0
Males - Chuuk				30–44				75.0
Males - Pohnpei								77.0
Males - Kosrae								74.0
Males - Chuuk				40–54				75.0
Males - Pohnpei								72.0
Males - Kosrae								81.0
Males - Chuuk				50–64				67.0
Males - Pohnpei								66.0
Males - Kosrae								74.0
Males - Chuuk				60–74				40.0
Males - Pohnpei								76.0
Males - Kosrae								71.0
Females - Chuuk			1993–94	20–34				
Females - Pohnpei								
Females - Kosrae								0.8
Females - Chuuk				30–44				83.0
Females - Pohnpei								88.0
Females - Kosrae								81.0
Females - Chuuk				40–54				82.0
Females - Pohnpei								92.0
Females - Kosrae								88.0
Females - Chuuk				50–64				69.0
Females - Pohnpei								76.0
Females - Kosrae								83.0
Females - Chuuk				60–74				65.0
Females - Pohnpei								76.0
Females - Kosrae								71.0

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
Guam								
Females	(410)	47	1956	16–24	23.5			
		39		20–34	24.6			
		38		30–44	35.6			
		17		40–60	29.5			
Total females		148		16–60	27.2			
Males (self-reported)	(524)	86	1991	40–60	38.6			
Females (self-reported)		126			38.6			
Kiribati								
Males - rural	(411,34)	176	1981	20–34	25.0			
Males - rural		191		30–54	26.0			
Males - rural		107		55+	23.5			
Males - urban		491		20–34	26.9			
Males - urban		368		30–54	28.3			
Males - urban		60		55+	26.8			
Total males - rural		474		20–55+	25.1 (4.3)			
Total males - urban		919			27.7 (3.0)			
Females - rural		238	1981	20–34	25.1			
		212		30–54	25.0			
		114		55+	21.6			
Females - urban		549	1981	20–34	28.1			
		349		30–54	28.6			
		83		55+	26.3			
Total females - rural		564	1981	20+	24.4 (4.7)			
Total females - urban		981			28.3 (6.3)			
Marshall Islands								
Males	(183)		1948–50		22.9			
Females					23.2			
Females - Majuro	(184)	110	1985	10–19	23.3	16.4	8.2	24.6
		101		20–24	25.3	22.8	18.8	41.6
		164		20–34	27.2	36.2	24.7	60.9
		121		30–49	30.5	40.4	48.3	88.7
		55		50–59	30.0	40.0	43.5	83.5
Total females - Majuro		551		>= 15	27.1	31.8	27.4	59.2
Females - Ebeye		75	1985	10–19	23.0	21.1	1.3	22.4
		108		20–24	24.5	25.5	10.9	36.4
		180		20–34	27.4	32.7	29.4	62.1
		147		30–49	30.8	35.3	52.1	87.4
		47		50–59	29.1	40.4	38.3	78.7
Total females - Ebeye		557		> = 15	27.1	31.3	28.2	59.5
Females - Wotje		9	1985	10–19	22.0	11.0	0.0	11.0
		16		20–24	24.5	50.0	0.0	50.0
		9		20–34	26.7	58.4	0.0	58.4
		17		30–49	28.6	26.2	33.7	59.9
		5		50–55	26.8	40.0	20.0	60.0
Total females - Wotje		56		> = 15	26.0	37.5	12.5	50.0
Females - urban	(76)	146	1991	10–18	24.3			
		209		19–24	27.3			
		288		20–34	29.7			
		196		30–49	29.1			
Total females - urban		839		>15	27.6			
Females - rural		29	1991	10–18	22.1			
		84		19–24	25.3			
		103		20–34	27.5			
		89		30–49	30.6			
Total females - rural		305		>15	26.4			
Total females		175	1991	10–18		14.0	8.0	22.0
Total females		293		19–24		30.0	19.0	49.0
Total females		391		20–34		35.0	35.0	70.0
Total females		285		30–49		31.0	51.0	82.0
Total females		1144		>= 15		30.0	31.0	61.0

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese*		
						25–29	≥30	≥25
Nauru								
Males	(413)	28	1975	0–19	25.5 (0.9)			
		28	1982	0–19	33.1 (1.0)			
		47	1975	20–29	32.3 (0.7)			
		667	1982	20 +		19.0	73.8	92.0
		47		20–29	37.1 (0.9)			
		29	1975	30–39	33.1 (0.9)			
		29	1982	30–39	34.1 (1.0)			
		35	1975	40–49	31.6 (1.1)			
		35	1982	40–49	33.1 (1.3)			
		17	1975	50–59				
		17	1982	50–59	30.5 (1.6)			
		6	1975	60+	31.3 (1.4)			
		6	1982	60+	30.1 (1.8)			
Total males		162	1975		30.8 (0.5)			
Total males		162	1982		34.1 (0.5)			
Total males		537	1987		34.2 (0.3)			
Females		45	1975	0–19	27.2 (0.9)			
		45	1982	0–19	34.1 (1.3)			
		66	1975	20–29	34.4 (1.0)			
		680	1982	20 +		24.0	68.2	92.6
		66		20–29	38.3 (1.0)			
		31	1975	30–39	35.6 (1.0)			
		31	1982	30–39	38.2 (1.3)			
		35	1975	40–49	35.7 (1.0)			
		35	1982	40–49	36.7 (1.0)			
		23	1975	50–59	33.8 (1.3)			
		23	1982	50–59	35.2 (1.5)			
		4	1975	60+	29.7 (2.3)			
		4	1982	60+	29.0 (2.2)			
		204	1975	0–60+	33.0(0.5)			
		204	1982	0–60+	36.6 (0.3)			
Total females		619	1987		34.9 (0.3)			
CNMI								
no data available								
Palau								
Males and females	(183)	10575	1948–50	>15	23.6			
Males - Koror	(191)	109	1970	>20	26.6			
Males - Peleliu		41	1970	>20	25.2			
Males - Ngerchelong		69	1968	>20	24.8			
Females - Koror		145	1970	>20	26.5			
Females - Peleliu		57	1970	>20	27.0			
Females - Ngerch		80	1968	>20	27.2			
POLYNESIA								
American Samoa								
Males - Samoan	(416)	78	1976–78	>20	26.2 (4.2)	21.8	11.5	33.3
Males - Manu'a		137			28.6 (5.0)	30.7	25.5	56.2
Males - Tutuila		624			29.8 (5.7)	25.8	36.1	61.9
Males - Hawaii		222			31.6 (5.7)	30.6	44.6	75.2
Females - Samoan		89			27.7 (4.8)	27.0	19.1	46.1
Females - Manu'a		238			32.7 (6.9)	26.9	50.0	76.9
Females - Tutuila		848			33.0 (6.9)	27.9	51.5	79.4
Females - Hawaii		290			33.6 (7.2)	25.5	54.5	80.0
Males - Am. Samoan	(417)	97	1990	20–34	33.0 (5.9)	23.7	55.9	79.6
		120		30–44	34.0 (6.7)	18.8	65.8	84.6
		96		40–54	34.5 (6.6)	15.6	71.1	86.7
		26		50–64	33.3 (4.1)	17.4	73.9	91.3
		12		64–74	28.5 (3.5)	30.0	30.0	60.0
Females - Am. Samoan		147	1990	20–34	33.6 (6.1)	23.2	59.2	82.4
		155		30–44	36.6 (7.3)	16.6	74.7	91.3
		90		40–54	35.5 (6.7)	21.8	69.0	90.8
		50		50–64	35.9 (5.7)	24.0	71.7	95.7
		37		60–74	31.6 (7.5)	21.2	51.5	72.7

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
Cook Islands								
Males	(420)	17	1950	21–30	25.3			
		29		31–40	27.5			
		9		41–50	27.5			
		15		51–60	26.3			
Females		18		21–30	28.4			
		24		31–40	29.0			
		10		41–50	31.4			
		14		51–60	30.0			
Males - rural	(83)	109	1962	>20	26.1			
Males - urban		89			28.1			
Female - rural		53			31.5			
Female - urban		27			32.2			
Males - rural	(84)	188	1966	>20	25.8			
Males - urban		243			26.5			
Female - rural		191			27.0			
Female - urban		227			30.7			
Males	(198)	542	1980			36.8	19.9	56.7
Females		581	1980			32.3	46.3	78.6
Manihiki Island	(325)		1980					
Males		75		>=20	28.3 (8.3)	30.6	20.0	50.6
Females		58			30.5 (8.3)	22.4	50.0	72.4
Males	(198)	72	1980	20–24	26.3 (0.5)		12.5	
		129		20–34	28.5 (0.4)		20.9	
		109		30–44	30.3 (0.5)		32.1	
		112		40–54	28.5 (0.4)		18.8	
		71		50–64	28.5 (0.5)		22.5	
		50		>=65	25.5 (0.6)		4.0	
Total males		543		>20	28.2	36.8	19.9	56.7
Females		75	1980	20–24	26.2 (0.5)		18.7	
		150		20–34	28.7 (0.5)		36.7	
		155		30–44	31 (0.5)		54.8	
		111		40–54	30.6 (0.7)		46.9	
		51		50–64	32.6 (0.9)		70.6	
		42		>=65	29.6 (1.2)		57.1	
Total females		584		>20	29.8	32.3	45.8	78.6
Males - Rarotonga	(201)	4	1986	16–29	25.7 (4.0)			
		12		30–49	29.5 (3.6)			
		8		>50	30.9 (6.1)			
Males - Mangaia		31		16–29	26 (2.2)			
		28		30–49	29.8 (4.2)			
		15		>50	29.3 (5.7)			
Females - Rarotonga		6		16–29	26.5 (3.8)			
		10		30–49	29.7 (7.8)			
		12		>50	31.7 (5.2)			
Females - Mangaia		32		16–29	27.0 (4.1)			
		31		30–49	30.8 (4.8)			
		22		>50	32.2 (7.4)			
Males	(199)	64	1987	20–24	26.7		3.1	
		119		20–34	29.4		23.9	
		111		30–44	30.1		31.5	
		103		40–54	30.9		36.9	
		60		50–64	28.4		18.3	
		44		>=65	25.0		11.4	
Total males		491		>20	29.0		23.8	
Females		102	1987	20–24	27.1		21.0	

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
		137		20–34	29.6		41.2	
		131		30–44	33.4		65.6	
		120		40–54	32.1		61.3	
		75		50–64	32.6		61.3	
		52		>=65	31.0		59.6	
Total females		608		>20	31.0		51.2	
Males	(85)	20	1993	20–24	26.8			
		10		20–34	33.1			
		8		30–44	29.2			
		3		40–54	30.0			
		6		50–64	24.7			
		1		>=65	29.6			
Total males		48		>20	29.5	41.9	39.6	81.3
Females		26	1993	20–24	26.5			
		19		20–34	28.7			
		18		30–44	29.3			
		6		40–54	34.4			
		12		50–64	30.3			
		4		>=65	30.2			
Total females		85		>20	30.1	40.0	38.8	78.8
French Polynesia								
Males	(19)	49	1995	16–19	24.9			
		126		20–29	27.4			
		122		30–39	29.4			
		91		40–49	30.7			
		90		50–59	31.0			
		67		60+	27.7			
Total males		545		>16	28.8	38.9	36.4	75.3
Females		68	1995	16–19	24.9			
		199		20–29	28.8			
		157		30–39	30.1			
		110		40–49	32.3			
		95		50–59	31.4			
		99		60+	30.7			
Total females		728		>16	29.8	28.2	44.3	72.5
Niue								
Males	(198)	104	1980	20–24	25.5 (0.3)	19.2	3.9	23.1
		122		20–34	27.4 (0.4)	38.5	11.5	50.0
		108		30–44	27.4 (0.4)	41.7	11.1	52.8
		95		40–54	26.4 (0.4)	28.4	11.6	40.0
		59		50–64	24.4 (0.5)	28.8	0.0	28.8
		60		>=65	23.0 (0.4)	15.0	0.0	15.0
Total males		548		>=20	26.1	30.6	7.7	38.3
Females		80		20–24	26.6 (0.6)	27.5	27.5	55.0
		123		20–34	28.6 (0.4)	39.1	39.0	78.1
		146		30–44	28.6 (0.4)	40.4	34.9	75.3
		101		40–54	29.1 (0.7)	35.6	42.6	78.2
		68		50–64	27.5 (0.7)	38.2	26.5	64.7
		83		>=65	23.8 (0.5)	22.8	12.1	34.9
Total females		601		>=20	27.2	35.5	33.0	68.5
Males	(89)	94	1987	20–29	26.6			
		83		30–39	28.3			
		77		40–49	28.9			
		55		50–59	27.4			
		23		60–65	26.3			
Total males		332		>20		34.0	15.0	49.0
Females		105		20–29	29.2			
		100		30–39	30.5			
		101		40–49	31.8			
		75		50–59	31.5			
		27		60–65	29.1			
Total females		408		>20		38.0	46.0	84.0

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
Samoa								
Males - Samoan	(258)	78	1970–77	> 20		33.3	11.5	44.8
Females - Samoan		89				46.1	19.1	65.2
Males		178	1990–91	20–55	31.5 (6.2)			
Females		147			33.4 (6.6)			
Males - Apia	(418)	71	1991	20–34			45.1	
		77		30–44			70.1	
		64		40–54			67.2	
		78		50–64			51.3	
		40		65 +			60.0	
		330		20–74	31.8		56.9	
Males - Poutasi		58	1991	20–34			36.2	
		58		30–44			43.1	
		48		40–54			52.1	
		40		50–64			57.5	
		28		65 +			32.1	
		232		20–74	29.8		43.5	
Males - Tuasivi		51	1991	20–34			21.6	
		58		30–44			46.6	
		51		40–54			45.1	
		44		50–64			40.9	
		30		65 +			43.3	
		234		20–74	29.5		35.9	
Females - Apia		97	1991	20–34			57.7	
		83		30–44			89.2	
		120		40–54			84.2	
		96		50–64			86.5	
		43		65 +			62.8	
		458		20–74	34.8		74.3	
Females - Poutasi		74	1991	20–34			52.7	
		48		30–44			66.7	
		40		40–54			70.0	
		34		50–64			64.7	
		27		65 +			63.0	
		223		20–74	32.3		61.5	
Females - Tuasivi		61	1991	20–34			52.5	
		77		30–44			57.9	
		63		40–54			66.7	
		40		50–64			52.5	
		30		65 +			46.7	
		271		20–74	31.6		56.5	
Tokelau								
Males	(525)	72	1968	10–19	22.2			
		27		20–24	25.0			
		61		20–34	26.1			
		80		30–44	27.2			
		67		40–54	27.8			
		41		50–64	26.7			
Females		86	1968	10–19	25.7			
		42		20–24	27.2			
		76		20–34	28.2			
		87		30–44	30.4			
		66		40–54	31.3			
		55		50–64	29.2			

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
Tonga								
Males & females	(213)	102	1983	21–91	28.9			
Males	(426)	309	1986	20–29	26.6 (2.9)	34.8	3.8	38.6
		182		30–39	28.0 (4.3)	34.6	14.5	49.1
		185		40–49	28.7 (4.4)	45.4	15.8	61.2
		681		>20	27.6 (3.8)	37.6	10.0	47.6
Females		393	1986	10–19	26.2 (4.0)	52.8	8.9	61.7
		468		20–29	28.3 (4.6)	43.4	32.0	75.4
		316		30–39	32.3 (4.1)	27.2	62.8	90.0
		295		40–49	32.8 (6.4)	25.3	65.7	91.0
		1471		>15	29.5 (5.9)	38.8	39.1	77.9
Males	(214)	60	1992	10–19		21.7	16.7	38.4
		135		20–29		39.3	19.3	58.6
		100		30–39		42.0	32.0	74.0
		72		40–49		34.7	43.1	77.8
		74		50–59		31.1	40.5	71.6
		29		60–64		41.4	37.9	79.3
		470		15 +		35.7	29.8	65.5
Females		26	1992	10–19		15.4	30.7	46.1
		97		20–29		32.0	38.1	70.1
		124		30–39		30.6	60.5	91.1
		100		40–49		23.0	67.0	90.0
		88		50–59		31.8	59.1	90.9
		32		60–64		31.3	53.1	84.4
		467		15 +		29.3	54.8	84.1
Males	(526,527)	80	1992	20–29	28.1			
		52		30–39	31.7			
		46		40–49	32.2			
		30		50–59	31.0			
		34		60+	28.8			
		242		>20	30.1			
Females		77	1992	20–29	29.0			
		70		30–39	32.6			
		71		40–49	35.6			
		51		50–59	34.2			
		30		60+	30.6			
		299		>20	32.5			
Males	(508,528)	271	1999	15+				
Females		337		15+				
Males and females		608		15+	31.6 (5.9)		56.0	

	Reference (Source)	N	Year of survey	Age range	Mean BMI (sd)	% overweight or obese* 25–29	≥30	≥25
Tuvalu								
Females	(529)		1983			25.0	50.0	75.0
Males	(114)	269	1976	> 20	26.6 (3.0)			
Females		308			29.0 (3.9)			
Wallis and Futuna								
Males - Wallis	(216)	38	1980	20–24	25.0 (2.3)			
		80		20–34	26.6 (3.3)			
		56		30–44	27.8 (5.1)			
		41		40–54	28.1 (5.7)			
		36		50–64	27.3 (5.4)			
		23		65+	26.7 (4.7)			
Males - Noumea		50	1980	20–34	30.1 (3.1)			4.2
		100		30–44	29.2 (4.1)			4.5
		90		40–54	29.5 (4.0)			5.7
		13		50–64	28.6 (3.3)			9.0
Females - Wallis		57	1980	20–24	26.9 (3.3)			21.1
		81		20–34	29.1 (4.7)			25.3
		61		30–44	30.9 (5.4)			27.7
		52		40–54	29.6 (5.4)			27.1
		34		50–64	29.9 (5.4)			23.6
		20		65+	26 (5.8)			18.6
Females - Noumea		23	1980	20–24	29.4 (5.8)			23.2
		96		20–34	32.6 (5.7)			29.4
		102		30–44	33.8 (5.6)			31.6
		72		40–54	32.5 (5.8)			29.9
		18		50–64	32.4 (5.0)			28.2

* overweight BMI 25–29
obese BMI ≥30

ABBREVIATIONS

ALS	– Amyotrophic lateral sclerosis
AN	– Austronesian
BMI	– Body Mass Index
CHD	– Coronary Heart Disease
CNMI	– Commonwealth of the Northern Mariana Islands
CI	– Confidence interval
CRGA	– Committee of Representatives of Governments and Administrations
CVD	– Cardiovascular disease
DEXA	– Dual energy X-ray absorptiometry
ECG	– Electrocardiogram
FAO	– Food and Agriculture Organization
FSM	– Federated States of Micronesia
HbsAg	– Hepatitis B surface Antigen
HBV	– Hepatitis B virus
HDL	– High-density lipoprotein
IFG	– Impaired fasting glycaemia
IGF-1	– Insulin-like growth factor 1
IGFBP	– Insulin-like growth factor–binding protein
IGT	– Impaired glucose tolerance
ISH	– International Society of Hypertension
LDL	– Low-density lipoprotein
NAN	– Non-Austronesian
NCD	– Non-communicable disease
NCHS	– National Center for Health Statistics
NIDDM	– Non-insulin-dependent diabetes mellitus
PICTs	– Pacific Island countries and territories
PIR	– Proportional incidence ratio
PL	– Parkinsonism–dementia
PNG	– Papua New Guinea
RDI	– Recommended Dietary Intake
RMI	– Republic of the Marshall Islands
RMR	– Resting metabolic rate
RR	– Relative risk
SPC	– Secretariat of the Pacific Community, formerly South Pacific Commission
STD	– Sexually transmitted disease
TBW	– Total body water
VLDL	– Very low density lipoprotein
VO2	– Maximal energy-producing capacity of an individual
WHO	– World Health Organization
WRC	– Work ratio capacity

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to urban lifestyles occurring in Pacific Island peoples,
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