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THE 1986 NATIONAL NUTRITION SURVEY
OF THE
KINGDOM OF TONGA

Technical Report prepared for
The National Food and Nutrition Committee

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National Nutrition
Survey

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Commission

(Produced with technical assistance from Melanaite Tangi in
Phases 1 & 2)

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Elizabeth Maclean.
Melanaite Tangi.
Survey Co-ordinators.

SUMMARY

1. The National Nutrition Survey for the Kingdom of Tonga was carried out from May - December 1986. This was on request from the National Food and Nutrition Committee who were planning for a National Nutrition Policy.
2. The project has been funded by the United Nations Children' Fund (UNICEF) and the Australian Government through the Australian High Commission in Tonga. The South Pacific Commission and ESCAP Pacific Operations Centre provided technical assistance throughout the project and provided some funding assistance.
3. Data was obtained on men 20-49 years, women 15-49 years and children 0-4 years on a randomly selected sample which covered 8 per cent of the total population. This information included dietary habits, infant feeding patterns, maternal and child health care practices, nutrition knowledge and anthropometric indicators including weight, height/lenght and haemoglobin readings (females). This information was collected by two teams of trained enumerators which included a nurse on each team. All results were compared to standards derived from internationally recognised sources.
4. The results indicated:
 - a) high incidences of overweight among adults, especially women.
 - b) good nutritional status among children.
 - c) good infant feeding practices including universal breastfeeding and early introduction of solids.
 - d) low incidence of anaemia amongst women except for women in Vava'u where the incidence of mild anaemia was high.
 - e) differences in dietary patterns in urban and rural areas attributable to availability of foods.
5. Interrelationships of diet and nutritional status in adults and children are discussed and proposals for future nutrition programmes in Tonga are made.

INTRODUCTION

INTRODUCTION

This report presents the results of the National Nutrition Survey conducted in the Kingdom of Tonga from May 1986 - December 1986. The planning for and implementation of this survey reflects the increased importance now being given by the Tongan Government to nutrition planning and policy making, as one means of achieving the Kingdom's development goals.

In the past emphasis on planning for nutrition in Tonga has been on an individual level by various ministries and non-government bodies. Due to initiatives by these groups the formation of the National Food and Nutrition Committee developed which has been to date perhaps the most important single development for food and nutrition activities in Tonga.

1. BACKGROUND TO THE SURVEY

1.1 Country Information

The Kingdom of Tonga, an archipelago situated in the central South Pacific, consists of a chain of 150 islands over an area of 360.000 sq km. Divided into four groups (the Niuas, Vava'u, Ha'apai and Tongatapu) most of these islands are low-lying and consist of raised coral limestone, although several, especially to the west, are volcanic cones. The volcanic soil is the most fertile, however because of its inaccessibility, it is the least cultivated. The limestone islands have sandier soils but suffer exhaustion under constant cropping.

Of the Tongan population of around 96.000 resident in the Kingdom (1984) about 68% live on the main island of Tongatapu, 16% on the northern group of Vava'u, and the remainder scattered on the Ha'apai and Niua's group.

Although the islands lie within the tropics, the climate, especially in the southern group, is moderately temperate. Tonga averages 23.6 degrees Celcius and 1.6 inches of rainfall per year. There is no surface water on several islands, and agriculture is rain fed and subject to occasional droughts. Tonga is predominantly an agricultural country with a large subsistence sector and is economically dependant on agricultural exports: coconut, coconut products, banana's and vanilla are the major sources of cash income. The fishing industry is underdeveloped-concentrating largely on reef fishing and is geared to meet subsistence needs.

1.2 The National Food and Nutrition Committee

The National Food and Nutrition Committee is under the auspices of the Central Planning Department, where the Nutrition Planning Coordinator provides NFNC Secretarial functions. The Chairman of the National Food and Nutrition Committee is the Director of Planning. Members of the NFNC are at Director level and include the following ministries and non government organisations:

Agriculture; Education; Health; Planning; Finance; Labour; Commerce and Industries; Institute of Rural Development (USP); Tonga National Council of Churches; Tonga Red Cross Society.

The purpose of the formation of the National Food and Nutrition Committee was basically to form a body which could:

- Formulate a National Food and Nutrition Policy and
- Coordinate activities of food and nutrition between relevant ministries and NGO's.

1.3 Studies of Nutritional Status and Dietary Studies in the Pacific and the Kingdom of Tonga

A review of several small surveys which have been conducted in the past and were aimed at specific areas of the Kingdom and target groups of the population was compiled in 1983 at the request of the National Food and Nutrition Committee (Engleberger 1983). These small surveys provide some subjective information on the kinds of and causes of nutritional problems in Tonga, but were by no means definitive enough to give an adequate base for evaluation of current and planned nutrition education campaigns and for the development of a National Food and Nutrition Policy (see Appendix II and Appendix III).

Many of these studies reported an excessive energy intake especially amongst adults including those in rural divisions (Adachi, 1976) and vitamin intake was frequently said to be marginal or low particularly for vitamins B, A and C (Langley, 1952; Whiteman, 1956; Adachi, 1976, 1977). Starchy root or fruit crops, coconut and fresh fish were generally reported as the most common foods particularly in rural areas and with time there was increased reporting of urban/rural differences in dietary patterns (Duttaroy, 1980; Borrelli and Malolo, 1982). A high consumption of sugar was noted by some authors (Adachi, 1977; Clark, 1978; Duttaroy, 1980).

Obesity was frequently identified as a problem among adults (Langley, 1952; Whiteman, 1956; Jansen, 1972; Yokono and Fukushima, 1976). Only one study (Weerasinghe, 1979) investigated haemoglobin status (among pregnant females) and a quite high prevalence (10.6%) of anaemia was found although the sample size was rather small. Weerasinghe (1979) also identified 21 cases (from 72 children 0-5 years age) as being malnourished, but all other studies showed very low incidences of malnutrition defined by low weight for age (2.2-5.9%) or low height for age (7.9 - 9.3%) (Jansen, 1972; Borrelli and Malolo, 1982;). Clinical signs of malnutrition among children were reported in 1982 in the Western Districts and Sopo areas of Tongatapu following the hurricane (Borrelli and Malolo, 1982). Clinical signs of Vitamin A deficiency were reported in children up to 12 years in 1972 (Jansen, 1972) and some signs of vitamin A deficiency were reported as early as 1956. Overall most studies, especially those of Jansen (1972) and Yokono and Fukushima (1976) reported the majority of adults to be well nourished and the health status of Tongans's to be excellent.

Nutritional and dietary studies have been conducted in many other countries within the Pacific over the past few decades. Food plays a very important role in the culture and traditions of most Pacific Islanders. When the first explorers came to this area they commented on the plentiful supplies of food available and the health and strength of the people. Today, in most Pacific island countries, the situation is very different. There are increasing problems of malnutrition (both over- and under-nutrition) where none or few seem to have existed before (Coyne, T.; Badcock, J.; and Taylor, R., 1984)

There is growing concern over the increase in malnutrition - both over-nutrition (especially in adults) and under-nutrition (especially in children and women) in the region. Town life is not traditional in the Pacific, and families transplanted to urban areas are cut off from traditional lands and may become totally reliant on the cash economy. This often means that families no longer grow their own food and do not eat their traditional foods even if they are available in their local markets - and often are not. Although easier to prepare, store foods are expensive and most are nutritionally inferior to local foods. Many mothers are unaware of the practicalities of budgeting and selecting good nutritious foods to feed their families. The migration of men or whole families to towns or overseas has led to the abandonment of agriculture in many rural areas. The status accorded imported foods and the lack of emphasis on subsistence agriculture in community education programmes have also contributed to the decrease in the production and use of local foods.

In many countries throughout the Pacific, mother's breast milk is being replaced by bottle milk, an expensive, inferior substitute for a perfect, natural food that costs nothing. The trend away from breast feeding to bottle feeding is listed by many investigators in Pacific Island communities as the major cause of the increase in malnutrition being found among infants.

Speculation on these studies with a view that similar patterns could be emerging in Tonga, as well as a recognition of inadequate sample sizes and disparities in methods used in surveys previously conducted within Tonga leaving an absence of any sound data bases and concrete evidence of specific health problems related to nutrition together with recommendations for a National Survey from local health personnel and visiting consultants and planning in the Fifth Development Plan for a National Nutrition Policy prompted the National Food and Nutrition Committee to develop a preliminary protocol for the Survey in 1985.

1.4 Objectives, Aims and Target Population for the Survey

The overall objective which emerged from this protocole was defined as:

- To determine the nutritional status and dietary patterns of the population of the Kingdom of Tonga.

The more specific aims of the survey were:

- a) to produce reliable estimates of the nutritional status of children nationwide;
- b) to produce reliable estimates of the nutritional status of adults nationwide;

- c) to identify groups which are most affected by malnutrition according to geographic location and agricultural environment;
- d) to begin to identify the nature of and causes of nutritional problems in Tonga.

METHODS

2. METHODS

The Survey was conducted in three phases:

Phase I	May - August 1986	Planning
Phase II	August - December 1986	Fieldwork
Phase III	February - August 1987	Analysis

2.1 Survey Design

In line with the specific aims of the survey it was decided that the target population should be:

- children 0-4 years
- females 15-49 years
- males 20-49 years

A sample of 10% of the above target groups were selected. This sample was directed at providing statistically valid information on groups living in different environmental and agricultural zones, particularly urban and rural groups.

2.2 Statistical Selection for Survey Sample

A two-stage stratified and effectively random sample was the design selected for the Survey. The first stage units (census blocks) were selected with probability proportional to size (PPS) which appeared to meet both field and estimation requirements.

In terms of field operations the sample provided convenient quotas of twenty households within each selected census block which, at the time of planning were deemed to be suitable daily work loads for a small survey team(1).

Consideration was also given to incorporating variables such as degree of urbanization and the type of soil in the locality which were considered relevant to nutrition and diet as stratification factors in the sample design. The urban/rural split was implicitly built into the sample design because of the way in which the census blocks were ordered geographically before the sample was selected. It was decided that if certain variables were considered to be relevant for the analysis, these could be incorporated in the coding/analysis stage.

(1) It was found however, during certain periods of the fieldwork that in fact more than one census block per day could be completed by a survey team. Factors affecting this were dependant upon time constraints, transport available, attendance of eligible people in census block, etc.

2.3 Questionnaire Design and Coding

During the design of the questionnaire forms it was agreed that whilst it might be interesting to try to obtain information on a wide variety of topics, it would be unrealistic to do so if good quality data was to be collected. Instead, it was preferred to keep the questionnaire as short and simple as possible, with no attempt, for example, to collect detailed information, particularly on food consumption via weighing the food at each meal. Information on income and expenditure may also have been useful, but it was agreed that again it would be unrealistic to try and collect this type of information as it required very detailed interviewing. It was noted early in the discussions that the design would benefit greatly from having a clear idea of why each question was being asked.

After outlining possible factors to be included in the questionnaire design, a set of specimen tables were prepared to clarify the objective of each question. This also gave an indication of the level of detail required as output from the survey. After examining these tables the survey forms were finalised. At this stage of designing the questionnaire it was considered necessary to have three separate forms - one for the selected age group of adult males, one for the selected age group of adult females and one for the selected age group of children. Examples of these forms are contained in Appendix I. The forms were translated and printed in Tongan and questions carefully phrased to ensure no bias was introduced by the interviewer.

The questionnaires were designed for easy completion by the enumerator. The enumerator completed the left hand side of the questionnaire only. The right hand side of the form consisted of coding boxes for efficient data entry. Coding was completed by one survey co-ordinator and checked by the other. A special coding manual was developed for transferring the information collected in the field to the coded format. Codes for each variable such as occupational group, food categories etc were preassigned with the exception of food taboo information which was coded at the end of the survey.

Each questionnaire was designed in three sections. Section 1 recorded background and birth and family history information, followed by a section on anthropometric data, which was followed by a section on dietary recall and other feeding and dietary information. Each section varied for men, women and the childrens' forms.

Each form had an individual serial number - incorporating geographic details as well as household and person number.

Section 1:

Following the identification number, information was collected on name, date of birth and age (in case date of birth information was not available and as a double check for those whose was) and in the case of childrens' sex. Additional information on pregnancy history was collected for women in order to evaluate haemoglobin data effectively. Questions on whether a woman was currently pregnant or breastfeeding were included for

adjustments to be made to weight data and selection of haemoglobin standards. For pregnant women, information on clinic attendance and iron tablet intake were also included. Additional information included at this stage for children was related to daily care (did the mother attend the survey?, did the mother work? etc.) and birth order to determine any possible relationship with any malnutrition.

Section 2: Anthropometric.

Weight and height or length (for children 0-23 months) was recorded on all questionnaires. Triceps skinfold thickness measurements were taken for adults only. Three consecutive readings were recorded. The mean reading was entered at the coding stage. Haemoglobin levels were recorded for women only. In the initial planning stages it was hoped to collect data on haemoglobin levels for infants but this was found to be logistically difficult in the field and so was abandoned.

Section 3:

Information on dietary patterns was collected using the twenty-four-hour recall method. Adults and the mother or caretaker for the children were asked to list all the foods eaten during the previous day. Rather than formalise eating patterns according to mealtimes, periods during the day were assigned and the respondents were asked to list foods eaten (either as meals or snacks) during the time frames. Coding was divided into 'yes' or 'no' a food type was eaten for fourteen variables according to the time frame in which the food was eaten. Classification of the foods to be included under each of the fourteen variables was discussed by the National food and Nutrition Committee. These are listed in Appendix IV.

Questions on current occupation were included for adult men and women with a view to determining daily levels of physical activity. Coding for this question was assigned by the National Food and Nutrition Committee based on International standard Classifications of Occupations.

Additional dietary information was included on the women's questionnaires with respect to any food taboo's (foods avoided and the reason for doing so) when pregnant or lactating with a view to determining any significant impact on nutritional status particularly haemoglobin status.

Additional information on current patterns of infant feeding (breast, bottle, solids or any combination) to obtain a cross-sectional picture of current infant feeding practices were included on the children's questionnaires. Questions on breastfeeding commencement and general use of bottles for feeding were also included for all children. There was a section for bottlefed children on type of milk and reasons for bottlefeeding and a section for children if they were on solids. The solid food section included the 24 hour dietary recall and questions on time and type of first solids given. Adults were also asked questions to try and test their nutrition knowledge. It was acknowledged that such questions are open to misinterpretation and may not be a true reflection of actual knowledge. However, it was

considered important to attempt to evaluate the nutrition committee's education programme which has been in action for the past five years. Carefully phrased questions designed to try and test knowledge on diseases caused by a bad diet, foods which make up a balanced meal and the best food for babies under four months were included on the men's and women's forms.

2.4 Selection of Survey Team Enumerators

The positions as enumerators for two survey teams were advertised and in due course the positions were filled by 13 local people. These young people all held the University Entrance qualification. An intensive ten day training programme was given in interview technique and accurate measurement technique prior to the commencement of fieldwork. A training manual was prepared as a guideline for all fieldwork.

In conducting the field work, two teams each of one household census collector, four enumerators, one recorder and one nurse were utilised (note 1). In each selected census block the teams conducted the interviews and performed the various measurements at a central location (often a local school, village hall or a large mango tree). The survey fieldwork and survey teams were supervised throughout by two survey co-ordinators.

2.5 Fieldwork Notes

2.5.1 Contact with Participating Villages

The town officer of each village is the channel by which the people can approach government officials, are informed of national and local events and tends to be the general authority and mediator for the village. This person is normally a senior man of the village who is elected every three years by the people. Dialogue was initiated between these officials and the survey coordinators via means of a formal letter from the Prime Ministers' Office informing them of the survey, the background to it and necessary participation from the town officers that was

Note 1. On Tongatapu one nurse was coopted from the MCH-Clinic at the Ministry of Health for the second team. One of the Survey Coordinators was a nursing sister permanently attached to the first team which was also the only team that travelled to outer islands. On 'Eua the nurse from the health centre (on 'Eua) was trained prior to fieldwork in the measurements and once familiar with the procedures was placed with the second team to cover selected census blocks. On several islands on Ha'apai this procedure was used with local nurses. In fact, this proved to be a conducive situation for the team to work in, as the local nurses knew the community and the people with whom they were working which often assisted participation.

required (note 1). Follow up visits by the Survey Co-ordinators were then made to all the participating villages in the Kingdom to meet with the town officer and answer any queries that may have been held in regard to the survey fieldwork. An estimation was given as to the approximate date the survey team would be approaching that village, and the town officer was given the list of households in the sample that would be approached for participation.

Corresponding with these meetings, news items on the radio station and articles in the weekly newspaper continued to inform the general population of the survey, and gave examples of the types of questions to be asked and measurements to be taken, thus giving people an idea of what to expect and the reasons for the survey being done.

Upon commencement of fieldwork each village was informed of the day and time of the teams arrival to their village via messages on the radio. This was in conjunction with the contact made by the household census collector, so in all events there seemed to be no non-response due to respondents not being aware of the date, time or place that the team would be visiting on.

2.5.2 Household Census Forms

Household census forms were used to record the outcome of contact made with each selected household. This survey was one of private households only so people living in institutions were not included in the survey, nor were wholly expatriate households. Although the sample was one representative of named households, it was really a sample of named dwellings. No attempt was made to follow households which had recently moved to another address, instead, the household which was found to be presently occupying the dwelling was taken. If the premises were found to be empty, this was recorded on the household census form and no attempt to find a replacement household was made.

An additional member of the interview team, the household census collector had masked a tour of the census block the day before the interviewing began (note 2). During this visit the household census form was completed, indicating the names of all household members, their sex and age in completed years and their

Note 1. Town Officers were necessary in assisting the household census collector to contact the selected households, selecting a suitable site for the team to work, and instrumental in motivating the eligible people to attend on the day the Survey teams visited their village.

Note 2. In theory this was workable, but it proved by far more efficient on Tongatapu and 'Eua to have the household census collector mask a tour of the census block two days prior to the teams' arrival.

eligibility status for the survey. The listing was recorded on a 'de facto' basis; all people staying in the visited household that night (including visitors) were recorded. Eligible household members were then informed of arrangements for conducting the survey and given an indication of the time when they were required to attend. The household census forms were critical for the success of the teams' work the following day as it enabled Enumerator 1 to identify and organise eligible persons to ensueing interviewers for questionning and measurements.

2.5.3 Procedures at Survey Site

The six member survey teams were assigned specific tasks for the duration of the survey. When survey participants arrived one team member registered them and found their individual form which would have been already assigned by the household census collector. This enumerator also completed all other background questions in Section 1 of the questionnaire. The survey participant then proceeded to the nurse member of the team who had a third team member working with her as recorder. All the measurements and calibration procedures were performed by the nurse in each team for the following: height; weight; length; skinfold thickness measurements; haemoglobin samples, according to requirements on the questionnaires. Details of all anthropometirc procedures are given in Appendix VI. The survey participant then proceeded to one of the remaining three enumerators who asked all the questions in Section 3 of the questionnaire ie. on feeding and dietary patterns. This section of the questionnaire took the longest and it was time efficient to have more than one enumerator working on this. By working on one section of the form only enumerators and measurers became familiar and skilled in their own area.

Interviews and measurements took on average 20 minutes per participant. It should be noted that children did not (in most cases) participate in anwsering the questions put forward by the enumerators. The respondent was usually the child's mother, a member of the family or in some cases a babysitter. Care was taken in interpreting some of the questions anwsered by the latter as they may have not been wholly familiar with the child's regular feeding regime.

2.6 Logistics

2.6.1 Tongatapu (August - mid September)

The main island group of Tongatapu was the first division in which fieldwork was initiated for the Survey. Tongatapu was selected as first division for commencement of fieldwork to serve as an example of any possible complications in organisation and logistics that may occur, thus providing the opportunity of redemption before teams moved to outer islands. Two teams functioned simutaneously in different districts on Tongatapu.

Early weeks of the fieldwork were complicated by an error in dispatch by manufacturers of accessories to the Haemoglobinemeter, meaning that blood samples could not be taken from the adult women. These women were gradually contacted throughout the remainder of the fieldwork, however response was

generally poor due to difficulty in actually finding the necessary women again; the women having moved or gone away, or simply disinterested in attending.

Generally, the fieldwork on Tongatapu was conducted efficiently and with minimal logistical problems once a pattern for the teams' work was established and the teams became familiar with the routine. The non-response rate in Nuku'alofa particularly was quite high and so in an effort to compensate for the eligible respondents missed, messages requesting attendance of these people were broadcast over the radio to a central meeting place in Nuku'alofa. This approach proved to be a moderate success. It was noted that the further the teams travelled on Tongatapu from Nuku'alofa, the higher the percentage of eligible respondents were received.

2.6.2 Vava'u (mid - September - mid - October)

Upon commencement of the Survey in the Northern Island groups, greater organisation was required for transporting the teams and equipment to a base from which they could work (note 1). Likely sites for working from, usually the hospital in the main district- had been contacted prior to the teams' arrival and arrangements made. The Senior Medical Officer of Prince Ngu Hospital in Vava'u provided office space and use of laboratory facilities.

Prior to the teams' arrival in Vava'u, radio messages announced when the team would be working in the selected villages for the Survey, and two days prior to the team attending each village, the household census collector would contact the necessary households informing them of the time and place in which the team would be working (i.e. the same procedure used for Tongatapu). Often two blocks were able to be covered in one day by the team; (see note 2) at times three were completed.

Four villages were on outer islands to which the teams travelled by boat. When visiting Otea Island, the adult weighing scales malfunctioned which required a return trip to the main island to obtain another pair of scales for adult weights. It was agreed by the team that working on outer islands was usually time effective owing to almost a complete percentage of respondents being available.

Note 1. One team only travelled to Vava'u, Ha'apai and the Niua's on account of uncertainty of transportation, accomodation, etc., and also the lesser number of respondents to cover.

Note 2. Two or more blocks were able to be covered in one day by the team, due to the close vicinity of respondents living, and the generally high interest of the respondents in the Survey. Mainly the reason for requiring a return visit was to follow up adult men who had been away in the bush at the time of the teams visit.

Invaluable assistance was received from the Senior Medical Officer and his Staff in Vava'u, which had a positive result on the team efficiency and work ability in this division.

2.6.3 Ha'apai (mid October - late October/mid - late November)

The Ha'apai group of Islands were covered in two visits. On completing the Vava'u group the team travelled back down to Ha'apai and covered the main Island groups: Lifuka and Foa, and travelled to nearby island groups which required only a day trip: Ha'ano and Mo'unga'one.

It was found within the main village of Pangai on Lifuka which consisted of seven census blocks to be covered, the response rates were extremely low, despite several attempts made by the household census collector through the town officer who was consistently helpful to contact the necessary respondents. The summise reached was that many people had migrated to other islands, had gone fishing or were not interested to attend. This resulted in a lengthy stay in Pangai, often with no real results. However on visiting the outer islands Ha'ano and Mo'unga'one, attendance and interest from the respondents was high and almost a full percent of attendance was achieved.

The southern group of the Ha'apai Islands that were included in the sample were covered later in November as difficulty was found in hiring a suitable vessel to transport the team and equipment from island to island. At the time of fieldwork on Lifuka, Foa, Ha'ano and Mo'unga'one a shared plane charter was available to the Niua group of islands. In view of the lack of transportation in Ha'apai and the uniqueness of the availability of a charter to the Niuas, it was decided to break from Ha'apai and return at a later date.

On completion of Niua'fo'a, Niuatoputapu and Tafahi, the team returned to Nuku'alofa and from there joined the HMAS 'Late', a Navy vessel, which transported the team to the remaining Islands in the Ha'apai group. Visiting these islands was the most successful of the survey as attendance and cooperation was almost 100 per cent from the respondents and in each island group the team was warmly welcomed.

Tofoa island was particularly difficult to approach and the village was reached after a lengthy walk up a steep cliff through thick bush. On arrival to the village it was discovered from the town officer that half of the selected sample was on the other side of the island and would best be reached by boat. The sample in the village where the team was then situated was interviewed and the team returned back to the boat to pursue the respondents on the far side of the island. The Captain of the 'Late' advised that it would not be wise to approach that side of the island, as the ocean was extremely rough and no landing was accessible except by swimming. As there was a lot of equipment required by the team for their work and many team members were not strong swimmers it was decided perhaps it was acceptable to have this half of the sample on Tofoa excluded from the Survey on a necessary basis. This problem was not encountered again and on all other islands almost full attendance was achieved.

2.6.4 Niuatoputapu, Niuafu'oe, Tafahi (early November)

The Niua group of islands were accessible only by plane.

Niuatoputapu island was visited first, with the Health Centre being used as base for the team to work from. The Health Officer in charge provided excellent support in terms of transportation and laboratory facilities and accompanied the team to assist in motivation of the respondents. Response was nearly 100% in most villages covered and it seemed the few non-attenders that did occur had actually migrated to other island groups.

Tafahi was visited in a day via boat transportation. Accessibility to the island and to the village itself was difficult, considering the equipment which was carried for the teams' working. Attendance was 100 per cent on Tafahi and the respondents were interested and cooperative of the teams work.

Niuafu'oe was more difficult for the teams to work in due to the rugged terrain of the island and limited transportation available. Three villages were included in the sample and although the team found difficulties in transportation of themselves and the equipment, respondents interest and attendance was high.

2.6.5 Eua (late September)

Eua Island was covered immediately after the Tongatapu fieldwork had been completed. Certain delays were experienced by the team on arriving (note 1).

The teams worked together with the nurses from 'Eua efficiently and covered the ten census blocks in a relatively short period of time, due to the high level of interest and assistance given by the Town Officer. The two teams were able to split up and visit different divisions within the same districts which enhanced the logistics of their work patterns.

As the two teams, and only one coordinator, were on Eua for a total of four days, the blood samples were taken, diluted in Drabkins solution and then stored in the insulated storage container which was brought back to Tongatapu to be read for Hb levels.

Note 1. The household census collectors had waited for the teams' arrival to contact the respondents. A method was devised for the team to work in conjunction with the household census collector, whereby the households selected for the said block were asked to come to a meeting place, and the enumerators selected the eligible respondents in these households. Once this selection had been made according to age categories, the first enumerator took preliminary information so the respondents then moved onto the interviewing and measurements. This method, although slightly more time consuming, proved to be an efficient and effective method in which to work.

Non response was highest amongst the men and it was found this was due to an island project near completion on which most men were working. However the teams were able to recall most of these men in the evenings.

The fieldwork on 'Eua was generally successful and an appropriate site for commencement of work off the main island and away from primary support services.

2.7 Classifications and Definitions Used

Adults

Classification of Nutritional Status

Adult nutritional status was determined by the prevalence of normal weight, overweight and obesity using international classifications for Body Mass Index (BMI).

Definitions of BMI

BMI was calculated as: $\text{weight (kg)}/\text{height}^2 (\text{m}^2)$. Relative 'desirable' weight of 120 per cent or moderate overweight approximately corresponds to a BMI of 25 in females and 27 in males; and 140 per cent 'desirable' weight or obesity approximately corresponds to a BMI of 30 in females and 32 in males (Bennet 1979). Relative 'desirable' weight is derived from Caucasian standards (Metropolitan Life Insurance Co. N.Y. 1960).

Definition of Anaemia

Anaemia was characterised by the level of blood haemoglobin using the WHO definition.

- (a) For non-pregnant and non-lactating and lactating females:
- | | | |
|-------------------|-------------|-------------------|
| Normal: | haemoglobin | = > 12.0g/dl |
| Mild anaemia: | haemoglobin | = 10.0 - 11.9g/dl |
| Moderate anaemia: | haemoglobin | = 8.0 - 9.9g/dl |
| Severe anaemia: | haemoglobin | = < 8.0g/dl |
- (b) For pregnant females:
- | | | |
|-------------------|-------------|----------------|
| Normal: | haemoglobin | = > 11g/dl |
| Moderate anaemia: | haemoglobin | = 9.0-10.9g/dl |
| Severe anaemia: | haemoglobin | = < 9g/dl |

Children

Classification of Nutritional Status.

Anthropometric data were analysed in 2 ways:

- mean, median and standard deviation of the various measurements compared by division or age groups.
- comparisons with commonly used international standards: i.e WHO/NCHS standards using a computerised data base.

* Jordan, M.D. Anthropometric software package.
Center for Disease Control, USA Provided by WHO, Geneva.

Various classifications have been used to express prevalence of malnutrition as percent of the median of the WHO/NCHS reference standards. The cut off points used are those generally used in international classifications of nutritional status of children 0-4 years.

Children whose weight for age is 80 per cent or more of the median of reference are usually considered of normal weight, i.e. they are well nourished. Children whose weights for age is greater than 120 per cent of the reference median are also of normal, but unusually high weight. Children whose weight for age falls between 60-79 per cent of the reference standard are said to be moderately underweight or malnourished and children whose weight for age falls below 60 per cent of the reference standard are said to be severely underweight or malnourished.

Children whose height or length** for age is 90 per cent or greater than the median of reference are considered normal height, whilst children whose height for age falls between 85-89 per cent of the standard are moderately stunted and those below 85 per cent standard are severely stunted.

Children whose weight for height or length is 90 per cent or greater than the standard median are considered normal and well nourished. Children whose weight for height is greater than 110 per cent of the reference median are also of normal but unusually high weight for their height. Children whose weight for height falls between 80-89 per cent of reference standard are considered to be mildly wasted (i.e. slightly underweight for their height/length), those whose weight for height falls between 70-79 per cent can be said to be moderately wasted and those whose weight for height falls below 70 per cent are severely wasted.

Waterlows Classification

There is a fourth classification of infant and child nutritional status called 'Waterlows' Classification', which is used to distinguish between acute and chronic malnutrition. Where malnutrition is particularly prevalent, it is necessary to make this distinction, since a child with acute malnutrition is in more urgent need of treatment. This classification combines two of the other anthropometric indicators - weight for height to indicate wasting, and height for age to indicate stunting. If a child's weight for height is above 80 per cent of the reference standard, and his height for age is above 90 per cent of the reference standard, he is then classed as normal and well nourished. If the child's weight for height is above 80 per cent of the reference standard, but his height for age is below 90 per cent of the reference standard, he is classed as 'stunted'. If a child's weight for height is below 80 per cent of the reference standard, but his height for age is above 90 per cent of the

** Height for children 0-23 months was measured as length and was compared to WHO/NCHS standards for length.

reference standard, he is classed as 'wasted'. If his weight for height is below 80 per cent of the reference standard, and his height for age is below 90 per cent of the reference standard, he is classed as 'stunted and wasted'. This can be summarised as follows:

		<u>Weight for Height (Wasting)</u>	
		80% of reference median or 2SD below median	
<u>Height for Age (Stunting)</u>		Above	Below
	Above	Normal	Acute or recent malnutrition
	Below	Nutritional dwarfism	Severe chronic malnutrition

Occupational Groups

Occupational groups were classified according to levels of energy expenditure. The Professional A group tended to be people engaged in professional technical positions (eg. doctors, teachers) which involved a moderate amount of physical activity. People in Professional B categories were also technical people, but they tended to have a minimum level of physical activity according to their occupation (eg secretaries, clerks). Categories for labourers was specifically for those engaged in heavy physical work (eg farming, construction workers) and the domestic duty categories, mostly for those occupied in household duties.

The fifth category for 'non-employed' was used mainly in urban areas where a higher proportion of people were actually non employed and assumed to have a low physical activity, whereas in rural areas non-employed people tended to be engaged in agricultural activities and said so to the enumerator. The 'other' category including students was mainly used for younger men and women who tended to be still at school.

Dietary Recall

Dietary recall patterns were categorised into foods eaten at given time periods throughout the day which were:

- from rising until mid-day; (morning)
- from mid-day until 5pm; (afternoon)
- from 5pm until retiring; (evening)

Data for the dietary recall was qualitative information, not quantitative information, and is expressed as the percentage of adults or children who were eating a particular type of food at one of the given time periods in the last 24 hours.

'Tongan' as a prefix refers to local produce. 'Imported' as a prefix refers to all imported foods including those processed locally from imported raw materials (eg. bread, and biscuits from flour)

2.8 Data processing

Data processing commenced once coding was completed at the cessation of fieldwork.

Data entry was carried out using one IBM AT3 with a 30 MB hard disk and one IBM XT (no hard disk) at the Central Planning Office. Software utilised included: dBASE III plus, and the SPSS-PC Statistical Package. Since no computer expertise was available the data entry procedures had to be as simple as possible and totally menu driven, which involved extensive program design written in dBase as well as training of 3 keypunchers and 1 supervisor.

The verification of the data was realised through a second entry of the data by a second keypuncher in order to minimize reading errors. When the record was entered for the second time, all values were checked against the initial entry. Mismatching values were flagged on the screen and the operator was allowed to correct them if required. In regards to the actual costs of the Survey the extra keypunching time required for the second entry was insignificant compared to the time needed for manual checks done after editing or printing the records.

Out of range values and inconsistencies (such as pregnant males) checks were performed at the entry stage or at the early analysis stage.

The supervisor performed daily checks to ensure that all records on the daily schedule were entered and verified. A pre-established report by census block was printed upon request.

RESULTS

3. RESULTS

3.1 Sample and analysis description

Response rate

The response rate expressed the percentage of achieved compared to the eligible population which was 77.2 per cent for the overall sample (Table 2). The response rate was particularly high amongst children in all divisions (82.8 per cent in Ha'apai to 97.6 per cent in Niuas). Females had lower rates in Ha'apai and 'Eua (74.1 per cent and 77.2 per cent respectively) while figures were very low for males ranging from 40.1 per cent 'Eua to 79.4 per cent in Niuas with an overall total of 56.7 per cent of males attending. Males included in the sample were often difficult to obtain mainly because of work reasons taking them away from the village on the day of interview.

Sample population

Identification with number codes grouped variables such as age, sex, census block, district, division and occupation.

Age groups were defined using 10 years grouping for adults and 6 to 12 months age groups for infants (Tables 2 and 3). These populations were compared to the 1976 census figures (Table 4) where the population was broken down by sex, age groups and divisions. Unfortunately the age group breakdown for children 0-5 years was limited by the census data to 2 groups: 0-11 months and 1-4 years.

The sample for males, females, and children had a very similar age distribution to the census. Within division there were some differences:

- For males the 20-29 age group was under-represented in the sample for 'Eua and Niuas and over-represented in Tongatapu. The 30-39 age group was low in Ha'apai compared to the 20-24 age group.

- For females more older women were interviewed in Ha'apai and more 20-24 years women were found in 'Eua.

- For children more new-borns were surveyed in Vava'a and less in Tongatapu compared to the 1976 census distribution.

Age adjustment - weighting factors

In order to compare results between divisions the data were adjusted for age using the 1976 total population for both sexes combined as the standard. Weighting factors were calculated and used when division comparisons were involved (Table 5).

One of the aims of the survey was to produce figures representative at the national level and so a second set of weighting factors was prepared to obtain a sample distribution similar to the census age distribution by division (Table 6). This was particularly important since the sample was drawn with proportions of 5-29 per cent in different divisions. The

population was also grouped by rural or urban districts, the latter including large areas of Tongatapu and of Vava'u.

Date of Interview

During fieldwork more interviews were performed in the week on Mondays (22.2%) with an activity decreasing to reach 15.2 per cent on Fridays. This should be noted when interpreting dietary recall results where people interviewed on Mondays recalled Sunday meals (Table 7). Since most of the fieldwork was conducted within three months, seasonal patterns were not felt to significantly affect dietary recall questions.

3.2 ADULTS - MALES 20-49 YEARS AND FEMALES 15-49 YEARS

3.2.1 Adults Nutritional Status

Adults nutritional status was determined by using the international classification for Body Mass Index for determining prevalences of normal weight, overweight and obese individuals in the population.

Problems were encountered in interpreting data from triceps skinfold measurements particularly in adult males and in determining appropriate cut-off points and characteristics for defining overweight and obesity. Observations in the field suggested some difficulty in taking this measurement despite the extensive training given to the measurers. This was especially so in men where good muscle development made it difficult to measure skinfold accurately. Data from skinfold measurements was therefore excluded from the analysis and nutritional status for adults was determined by the Body Mass Index.

The mean and median weight, height and body mass index for both males 20-49 years and females 15-49 years at the time of the survey, by division are shown in Tables 8-13. Anthropometric measurements with respect to prevalence of overweight by body mass index groupings, age group and occupation are shown in Tables 14, 15 and 16.

Mean weight for height and BMI Males 20-49 years

There were some differences in mean weights between divisions for each age group, and men in the Niuas tended to weight slightly less than men in other divisions and men in Ha'apai weighed slightly more. These differences were significant ($p < 0.05$). Mean and median weights for mean and median heights for adult men were high when compared with the mean and median weights for height of Caucasian populations (Metropolitan Life Insurance Tables, 1960).

All men in all age groups had weights ranging between 78.0 kg and 90.7 kg. Generally young men 20-29 years had the lowest weight in every division with the Niuas division having 20-29 year old men with the lowest mean weight of all divisions of 78.0 kg. Mean weights increased with age in all divisions. Urban men tend to weigh more than rural men but these differences were not significant.

Men in the Niuas and 'Eua tended to be smaller (173.6 cm) than men Tongatapu (176.0 cm) and Vavau (175.0cm) and these differences were significant ($p < 0.005$). There were no differences for mean height between age groups in all divisions. Urban men were taller than rural men ($p < 0.05$). Mean BMI levels increased with age in all divisions, but there were no significant differences between divisions. Urban men had slightly higher mean BMI values than rural men, but these differences were very small and not significant.

Mean weight height and BMI for Women 15-49 years

Mean weights of women increased markedly with age in all divisions. Mean weight values were highest in Ha'apai and lowest in the Niuas. There were no significant differences between urban and rural areas in mean weight values for women. By age groups 30-39 years and 40-49 years, women in most divisions weighed the same if not more than their male age counterparts, yet mean height data shows women to be shorter than men. There were no age group division or urban rural differences for mean height of women. Mean body mass index values showed a similar pattern of increasing with age in all divisions and in both urban and rural areas. There were no differences in mean BMI values between divisions, but rural and urban women had significantly higher mean BMI values than urban women ($p < 0.05$).

Obesity amongst Males 20-49 years

Tables 14 and 15 describe the prevalence of overweight by Body Mass Index for adult males by division by urban/rural groupings. There was a moderately high prevalence of overweight and obesity. National estimates give a prevalence rate of 37.6 per cent for men moderately overweight in all age groups and 10.0 per cent for men who are classed as obese. The incidence of both moderate overweight and obesity tended to increase with age with 34.8 per cent and 3.8 per cent of 20-29 year old males being moderately overweight and obese respectively, whilst 34.6 per cent and 14.5 per cent of 30-39 year old males and 46.4 per cent and 15.8 per cent of 40-49 year old males were moderately overweight and obese respectively.

Data for urban and rural groups on the prevalence of overweight by body mass index (Table 15) show a similar pattern in that a greater percentage of older males (40-49 years) in urban and rural areas respectively were more moderately overweight (55.9% and 43.0%) and obese (14.7% and 16.1%) than were their younger counterparts age 20-29 years (5.7% and 3.6% for obesity, 34.1% and 34.0% for moderate overweight).

Overall there was a higher incidence of obesity in rural areas but in urban areas there was a higher incidence of moderate overweight. These differences were not significant. There were some differences in the prevalence of moderate overweight and obesity between divisions which is shown in Table 14. In particular, there was more obesity in Ha'apai than in other divisions, especially in the older age groups, 30-49 years. There were 29.0 per cent of men who were obese in the 30-39 year age group, and 21.3 per cent of men who were obese in the 40-49 year age group compared to the national averages of 14.5 per cent

and 15.8 per cent. The Niuas` had the lowest prevalence rates of obesity in older men (12.5% and 10.0%), but the highest prevalence rate for younger men aged 20-29 years (10.0% compared to the National rate of 3.8% for this age group). Moderate overweight was more prevalent in 'Eua and Vava'u than in other divisions, but there was no consistent pattern of differences for overweight between divisions by age groups. Both overweight and obesity tended to increase with age in all divisions with a particularly high prevalence of moderate overweight in 40-49 year old men in 'Eua and the Niuas (61% and 50% respectively compared to the Nationally Estimated prevalence rate of 46.4%). Table 15 shows the prevalence of overweight by Body Mass Index for adult males by occupation. There were no significant differences in prevalence rates for moderate overweight or obesity between occupation groups. There were not sufficient numbers of men in the housework category, where there was no obesity found for statistical analysis. Labourers had slightly lower prevalence rates for both overweight and obesity, compared to the Professional occupation groups.

Obesity amongst Females 15-49 years

Data shown in Tables 14 and 15 indicate that females increase their weight with age and a high percentage are classed as obese by Body Mass Index especially in the 40-49 year age group in both urban and rural areas. A large percentage of younger women tend to be moderately overweight, with a national prevalence rate of 52.8% in women 15-20 years. As age increased, the percentage of women who were moderately overweight decreased. However the number of women who were obese increased so that the total prevalence of overweight and obesity was 61.7 per cent in women between the ages of 15-19 years, 75.4 per cent in the 20-29 year age group, 90.0 per cent in the 30-39 years age group and 91.0 per cent in the 40-49 year age group. Overall this indicated a decrease in the number of adult women with normal weights with age. In younger, rural women, total overweight and obesity prevalence tended to be higher than in urban women. However more women in the 40-49 year age group in urban areas tended to be overweight or obese than the same age group in rural areas. Similar trends of decreasing moderate overweight with age but increasing obesity were found in each division, with no major differences in prevalence rates between divisions. There were few differences between the prevalence rates of moderate overweight and obesity among women of all occupational groups, although prevalence rates for obesity were highest (45.4%) among housewives, especially when compared to Professional A group women, 31.3 per cent (Table 16).

3.2.2 Adult Dietary Recall

Dietary recall patterns for females 15-49 years, and males 20-49 years, at the time of the survey are presented in Tables 17-27.

Men 20-49 years

Table 17 indicates the foods men were eating at the time of the survey, according to urban/rural groupings. Most men ate some food throughout the day, with no urban/rural differences. Fewer men ate in the morning and afternoon, compared with women (86.1% of men, 94.6% of women ate in the morning, 85.6% of men, 90.5% of women ate in the afternoon).

Tongan staple consumption patterns for men were similar to those of the women, with consumption being higher in the morning in rural areas (43.9%), in comparison to urban areas (30.1%), and consumption rising in both areas in the afternoon (70.2%), and evening (68.1%). Imported staples were more commonly eaten in the morning (43.9%) than in the afternoon (14.4%) or the evening (31.7%). Fewer men than for women consumed imported staples at each time of the day. More men in urban areas ate imported staples than men in rural areas at each time of the day.

Tongan fat consumption was similar to women, with a low intake in the morning (31.5%), especially in the urban areas (25.0%), and a higher intake in the afternoon (50.1%) and evening (54.9%) in both areas. Imported fat intake was high in the morning for urban men (45.1%), but was low in the afternoon and evenings, and was low throughout the day for rural men. This was a similar pattern to that shown by women in both areas. Tongan protein was only moderately consumed by men in both areas in the afternoons (30.1%) and evening (37.6%), and consumption was low in the mornings (18.9%). Urban/rural differences were not as apparent as for the women, although rural men tended to consume slightly more than urban men. In contrast, fewer rural men consumed imported protein each time of the day, which was again similar to the consumption pattern for women. More men ate imported protein in the afternoon (38.9%) and evening (30.4%), than in the morning (15.0%).

Consumption of greens and other vegetables by men was just as low in both urban and rural areas at each time of the day as it had been for women. Fruit and fruit juice consumption for men was also similar to that of women, and was generally only low to moderate, with more men in urban areas consuming it than in rural areas.

Sugar and sugar snack consumption was high in the morning (39.1%) and evening (38.1%), and low in the afternoon, and was higher in urban areas than rural areas at each time of the day. Sugar and sugar snack consumption was lower for men than women at each time of day, and in both areas, but next to Tongan staples and Tongan fat, they were still one of the most commonly consumed foods by men. Consumption of other snacks was negligible throughout the day, and alcohol consumption was low with only 4.0 per cent of men consuming liquor in the evenings. Of these, 9.5 per cent of urban men consumed alcohol in the evening, compared to only 1.9 per cent of rural men.

Table 18 shows the percentage of men eating each kind of food by age group. There were no differences between age groups in the intake of some food at each time interval, but fewer young men (20-29 years) tended to eat Tongan staples than the older age

group (40-49 years), which was a similar trend for women. Imported staples were consumed by more younger men in the afternoon, and consumption decreased with age. A similar pattern emerged for fat consumption as that found in women, i.e. younger women ate less Tongan fat and more imported fat than older men. There were no major age group differences for consumption of Tongan protein and imported protein. Consumption of greens and other vegetables was consistently low in all age groups at each time period, and fruit and fruit juice consumption was moderate in all age groups, but did increase slightly with age at each time period. Consumption levels of greens, vegetable and fruit were very similar for men and women of all age groups. There were no age differences in the high consumption of sugar and sugar snacks.

Table 19 describes the percentage of males who ate each kind of food by division. Patterns of consumption of all foods were generally similar to those found in women. In the morning more men in Tongatapu and Vav'au consumed foods from imported sources, than men in other divisions, where more men consumed foods from Tongan sources. Only 32.5 per cent of men in Tongatapu, and 36.6 per cent of men in Vav'au consumed Tongan staples, compared to 55.1 per cent, 44.9 per cent and 41.4 per cent in Ha'apai, 'Eua and Niua respectively, but 51.3 per cent of men in Tongatapu were consuming imported staples, compared to only 21.5 per cent in the Niua. Morning consumption of Tongan fat was lowest in Tongatapu and Vav'au, but was also low in the Niua, but there was a moderate to high consumption of imported fat in Tongatapu. Tongan and imported protein consumption was low in all divisions. There were no differences between divisions for greens and other vegetable consumption.

There was a very high proportion of men eating fruit and fruit juice, as was found in the women, in the Niua (62.2%), but also in Ha'apai (50.1%), compared to only 24.3 per cent in Tongatapu and 19.0 per cent in 'Eua. Sugar and sugar snack consumption was high in all divisions, but especially in Tongatapu, where 45.5 per cent of men were consuming these foods.

In the afternoon, again in a similar pattern to that found for women, there were very few differences between divisions in consumption patterns. Tongan staple consumption was high in all divisions, and imported staple consumption was low. Tongan fat consumption was high in all divisions, and imported fat consumption was low with no men in the Niua, and only one man in 'Eua consuming imported fat in the afternoon. Consumption of greens was moderately higher in the Niua than other divisions, but consumption of other vegetables was low (8.5%). As found for the women, an exceptionally high percentage of men in the Niua (77.6%), were consuming fruits or fruit juice in this time period. Consumption of sugar and sugar snacks was low in 'Eua and low to moderate in all other divisions.

In the evening, there were again only a few differences between divisions in the percentage of men consuming each kind of food. There was a similar pattern to that found for women, with some of the highest consumption rates for imported items being found in Tongatapu. In addition, imported items were also eaten by a large percentage of men in 'Eua compared to other divisions,

except for imported protein, which was most commonly consumed in Tongatapu. Consumption of fruits was again highest in the Niuas (47.9%), and sugar and sugar consumption was low in the Niuas (18.6%).

Tables 20, 21 and 22 describe the frequency distribution of food types eaten by men in urban/rural areas, each division and each age group. Fewer men than women were eating in the three time intervals in the day (66.5%, compared to 80.4%), but 31.2 per cent were eating at two of the time intervals. Only 0.3 per cent of men did not eat at all during the day before the survey. There were no age group differences, but more men in the Niuas (83.3%) and Ha'apai (80.9%) were consuming food at each time interval, compared to other divisions. Most men ate some form of staple, three or more times during the day (68.3%), and only 0.3 per cent, i.e. those who didn't eat at all, ate no staple. There were no differences between urban/rural groups, age groups or divisions in this pattern. There were 71.7 per cent of the men consuming protein once or twice a day, but 10.0 per cent who were eating no protein at all. More urban men (25.6%) than rural men (15.6%) ate protein three or more times a day, and fewer urban men ate no protein at all (4.4%, compared to 12.1%). More older men (40-49 years) ate no protein in the day, than younger age groups, but there were no marked differences between the divisions. Most men ate fat from either source, two to three or more times daily, and there were no differences between urban and rural areas, age group or divisions. Very few men (9.2%) ate no fat in the day. There was a high percentage of men who ate no greens or any kind of vegetables in the day (35.2%), with 59.5 per cent of men eating them only 1-2 times a day. There were no urban/rural or age group differences, but consumption of greens and vegetables was particularly low in Ha'apai, where 59.7 per cent of men ate none all day. Fruit consumption was also low with 47.2 per cent of men eating no fruit, and only 5.0 per cent of men eating fruit three or more times in a day. There were marked differences with 66.9 per cent of urban men not eating any fruit, compared to 39.7 per cent of rural men. There were no age group differences, but fruit consumption was very low in Tongatapu, where 60.2 per cent of men ate no fruit at all; only 38.2 per cent ate fruit once or twice a day. This was in contrast to the Niuas, where only 3.8 per cent of men ate no fruit, and 23 per cent ate fruit more than 3 times a day, compared to a national average of 5.6 per cent of men eating fruit three or more times a day. Snack food consumption was more frequent in urban than rural areas, but nationally, 36.9 per cent of men ate no sugar or snacks in the day, which is a greater proportion than for women, where only 22.7 per cent of women ate no sugar or snacks all day. The age group differences in snack food consumption rates seen in women were not evident in men, nor were there differences between the divisions. Alcohol consumption was usually limited to once or twice a day, and was more common in urban areas (13.9%), than rural areas (1.8%), in the younger age group of 20-29 years (7.4%), and in Tongatapu (8.3%), and also the Niuas (28.1%). No men were recorded as having consumed alcohol in Ha'apai and 'Eua.

Tables 23 and 24 show the percentage of men who ate balanced meals at each time interval, by age group and by division. For the whole day 47 per cent of men were eating food

from the three food groups at each time interval, and there were no significant differences between age groups and divisions. It was not common to eat a balanced meal in the morning, with only 38.5 per cent of men eating a balanced meal at this time, whereas in the afternoon and evening 64.8 per cent and 65.7 per cent of men respectively, were consuming foods from the three food groups.

Females 15-49 years

Table 17A indicates the foods women were eating at the time of the survey, according to urban/rural groupings. Most women ate some food throughout the day with no differences between urban and rural groupings. Consumption of Tongan staples in the morning was higher (41.3%) in rural areas in comparison with consumption in urban areas (32.0%). However, Tongan staple consumption rises in both areas during the day with 73.6 per cent of women eating them in the afternoon, and 64.3 per cent of women eating them in the evening.

Imported staples were more commonly eaten in the morning (60.2%), than the evening (39.4%), and only eaten by a few women (16.8%) in the afternoon. Imported staples were more commonly eaten in urban than rural areas at each time interval in the day.

Tongan fat consumption was lowest in the morning, particularly for urban women (25.9%), compared to in the afternoon and evening, when both urban (54.6% and 58.10%), and rural women (57.6% and 55.5%) consumed high levels of Tongan fat. Imported fat intake was high in the mornings for urban women (55.3%), but was low in the afternoon and evening, and was low throughout the day for rural women.

Table 17A also indicates Tongan protein was only moderately consumed by urban and rural women, however, a significantly higher percentage of urban women consumed imported protein both in the afternoon (42.5%, compared to 33.0% in rural areas), and the evening (40.3%, compared to 25.2% in rural areas).

Consumption of greens and other vegetables was low in both urban and rural areas at each time of day, and there was only a moderate intake of fruit or fruit juice in the morning and afternoon, and a low intake in the evening. Consumption of fruit was higher in rural women than urban women. Sugar and sugar snack consumption was very high in the morning (55.3%), and the evening (46.6%), and moderate in the afternoon; with a higher consumption in urban areas at each time of the day. Next to Tongan staples and Tongan fats, sugar and sugar snacks were one of the most commonly consumed foods by women. Consumption of other snacks was low throughout the day, and alcohol was only consumed by one woman in the evening.

Table 18A shows the percentage of women eating each kind of food by age group. There were no differences between age groups in the intake of some food at each time interval, but fewer younger women (15-29 years) tended to eat Tongan staples than older women, except in the evening, and yet more younger women consumed imported staples, again except in the evening,

when there were no age group differences for both kinds of staple. A similar pattern emerged for fat consumption with younger women eating less Tongan fat and more imported fat than older women, in the mornings and afternoons. There were no age group differences for consumption of Tongan protein and imported protein, except for a lower intake of imported protein by the 40-49 year old women, at each meal. Consumption of greens and other vegetables was consistently low in all age groups at each time period, although older women (40-49 years) tended to eat slightly more greens and also consumed more fruit and fruit juice, especially in the mornings and afternoons. There were no age differences in the high consumption of sugar and sugar snacks.

Table 19A describes the percentage of females who ate each kind of food by division in the morning. There were differences between the divisions for most food types, with more women in Tongatapu and Vav'au consuming foods from imported sources than women in other divisions, where more women consumed foods from Tongan sources. Only 32.0 per cent of women in Tongatapu consumed Tongan staples, compared to 55.1 per cent and 51.1 per cent of women in Ha'apai and Niuas respectively, but 69.0 per cent of women in Tongatapu were consuming imported staples compared to 41.4 per cent and 33.5 per cent of women in Ha'apai and Niuas. Morning consumption of Tongan fat was lowest in Tongatapu and Vava'u, but highest for imported fat in these two divisions. Tongan and imported protein consumption was low in all divisions, except for a moderate intake of Tongan protein in the Niuas (37.6%). There were no differences between divisions for greens and other vegetable consumption. There was a particularly high intake of fruit and fruit juice in the Niuas in the morning (69.0% compared to a low 21.1% in Tongatapu). Sugar and sugar snack intake was high in all divisions, but especially in Tongatapu, where 63.2 per cent of women were consuming these foods.

In the afternoon, there were very few differences between divisions in consumption patterns. Tongan staple intake was high, and imported staple consumption was low in all divisions, including Tongatapu and Vav'au. Tongan fat consumption was high in all divisions, but especially in the Niuas (70.0%), where imported fat consumption was lowest (1.6%). Consumption of greens was moderately higher in 'Eua than other divisions, and there were an exceptionally high number of women consuming fruit and fruit juice in the Niua's (80.3%). Sugar snack consumption was low to moderate, the highest number of women consuming them being in Tongatapu.

In the evening there were again only a few differences between divisions in the percentage of women consuming each kind of food, with the highest consumption rate for imported staples, imported fat and imported protein being in Tongatapu, and lowest intakes of these items being in the Niuas. Consumption of greens and fruit and fruit juice, though only low to moderate for both foods was again highest in 'Eua for greens, and highest in the Niuas for fruit.

Tables 20A, 21A and 22A, describe the frequency distribution of food types eaten by women in urban/rural areas, each division and each age group. Most women were eating during

the three time intervals in the day (80.4%). Only 1.2 per cent were eating once, or not at all during the day. There were no marked differences between age groups, but more women in the Niua were consuming food at each of the three time intervals in the day, compared to other divisions. Most women ate some form of staple three or more times during the day (74.3%), and only 0.6 per cent did not eat any staple. There were no differences between urban/rural groups, age groups or divisions in this trend. There were 72.1 per cent of the women who ate some form of protein once or twice a day, but 9.6 per cent were not eating any protein at all. No consumption of protein was more common in the older age groups, especially 40-49 years, where 14.5 per cent of women ate no protein in the day. No consumption of protein was less common in Tongatapu than other divisions. Most women ate fat from either source, two to three or more times daily, and there were no differences between urban and rural areas, divisions or age groups. Very few women ate no fat in the day (5.1%). There was a high percentage of women who ate no greens or any other kind of vegetable in the day (32.8%), with 61.5 per cent of women eating them only 1-2 times a day. Women living in rural areas ate vegetables less often than urban women, and consumption was particularly low in Ha'apai, and the Niua where 54.2 per cent and 53.0 per cent (respectively) of women ate no greens or vegetables in the day. In contrast, in 'Eua, only 10.4 per cent of women ate no vegetables, and 79.3 per cent of women ate them 1 or 2 times in the day. There were no differences for vegetable consumption between age groups. Fruit consumption was also low, with 47.8 per cent of women eating no fruit in the day, and 31 per cent only eating fruit once a day. Urban women ate fruit less often than rural women, but there were no age group differences in frequency of consumption. Fruit consumption was low in Tongatapu, with 57.9 per cent of women eating no fruit, and 39.4 per cent eating fruit only once or twice a day. In the Niua, only 4.7 per cent of women ate no fruit, 61.7 per cent ate fruit once or twice a day, and 35 per cent ate fruit three or more times a day, compared to a national average of 5.2 per cent of women eating fruit three or more times a day.

Snack food consumption was more frequent in urban than rural areas, but nationally 22.8 per cent of women ate no sugar or snack foods during the day. Younger women ate sugar and snack foods more frequently than older women, and consumption was more frequent in Tongatapu than in other divisions, with 18.0 per cent of women eating no snacks, compared to 34.5 per cent of women in the Niua not eating sugar and snacks.

Tables 22.1 and 22.2, show the percentage of women who ate balanced meals at each time interval by age group and by division. For the whole day, 30.3 per cent of women were eating food from the three food groups at each time interval, and there were no significant differences between age groups and divisions, with the exception of 'Eua, where only 22.2 per cent of women ate a balanced mixture of foods throughout the day. It was not common to eat a balanced meal in the morning, with only 46.8 per cent of women eating a mixture of foods at this time, whereas in the afternoon and evening, 70.3 per cent and 63.1 per cent of women, respectively, were consuming foods from the three food groups. Women in 'Eua were more likely to consume a balanced variety of foods in the evening than other divisions (77.0%),

but in other divisions, the afternoon food intake was more likely to consist of food from each of the three food groups.

Dietary Patterns by Occupation for Males and Females

Food consumption in the afternoon and estimates of frequency of food types eaten in the afternoon by occupational groupings for both males and females are shown in Tables 25 and 26. Since the afternoon consisted primarily of lunch this information was reviewed to determine whether there were different lunch patterns between occupational groups. Overall there was a high percentage of people who were eating in the afternoon in all occupations (over 83%) with the exception of men the housework division there was a lower percentage eating in the afternoon (70.6).

There were very few differences in dietary patterns between occupational groupings for men and for women. Most men ate some food in the afternoon i.e. for lunch except men working in the house where only 70.6 per cent were eating at this time (n=5). In qualitative terms men and women in Professional A and B categories who tended to work in the towns were eating a similar lunch to labourers and houseworkers, etc, according to food types eaten at this time.

3.2.3 Relationships between Adults nutritional status and dietary patterns

Correlations between Body Mass Index and frequency of food types consumption by urban rural areas for men and for women are presented in Table 23. Overall for men, there were no significant correlations between food consumption patterns and body mass index. However, there was a slight correlation between a high frequency of consumption of imported staple, Tongan fat, imported fat and imported protein with a low Body Mass Index and a positive but not significant correlation between a high BMI and a high Tongan protein and Tongan staple frequency of consumption. Correlations for urban and rural men were similar except for Tongan staple, imported staple, and Tongan fat. There was a negative correlation between the frequency of consumption of Tongan staple and BMI in urban men and positive correlation between Tongan staple and BMI in rural men. A high imported staples and imported fat consumption was correlated with a high BMI for urban men and a low BMI for rural men. None of these differences were significant.

For women there was a significant positive correlation ($p < 0.05$) for a high frequency of consumption of Tongan staples and a high BMI and a negative correlation for a high consumption of imported staple and imported fat ($p < 0.05$). Frequency of Tongan fat and Tongan protein consumption was also positively correlated with elevated BMI and there was a negative correlation between imported protein intake and BMI. Urban/rural patterns were similar for most food types except for the consumption of any staple which was correlated with high BMI for urban women and negatively correlated with low BMI for rural women.

Care should be taken in interpreting these results, since the data on dietary consumption patterns was qualitative information only, and there could well be no relationship between frequency of consumption of a particular food type and Body Mass Index as is elaborated on further in the discussion.

3.2.4 Nutrition knowledge

Males 20-49 years and females 15-49 years

Correct responses and types of responses given at the time of the survey by males and females for the questions:

- a) Name one disease related to a poor diet.
- b) Name three foods to make up a balanced meal.
- c) Name the the best food for infants up to four months.

were compared by occupational groupings, divisions and urban/rural groupings in Tables 28 - 32.

Question 1

Results shown in Table 28 indicate that both urban (51.2%) and rural (58.1%) men were able to answer the first question correctly, and had a higher awareness of diseases related to a poor diet, than did women in both urban (48.0%) and rural (54.5%) areas.

In the Niuas 76.3% of men, and in Ha'apai 72.0 per cent answered the question correctly, compared to only 50.1 per cent and 56.4 per cent answering correctly in Tongatapu and Vava'au. Similiarly, in the Niuas' 59.7 per cent, and in Ha'apai 65.6 per cent of women answered the question correctly, with only 45.5 per cent of women in Tongatapu giving a correct response to this question.

There were no urban/rural differences, and no differences between occupational groups for men or women for this question (Tables 28 and 29) but more younger people were able to answer the question (Tables 30) 26.4 per cent of 15-19 year old females and 25.7 per cent of 20-24 year old males, compared to only 8.8 per cent of 45-49 year old females, and 15.5 per cent of 40-49 year old males). Only 10.0 per cent of 30-34 years females, and between 11.3 per cent and 15.9 per cent of 30-40 year old males were able to answer the question correctly. Most males and females in all divisions gave indigestion or other (which included diarrhoea and weak blood) as an answer to this question (Table 31). There were 19.9 per cent of females and 24.1 per cent of males who responded "Don't know" to the question.

Question 2

Only 27.4 per cent of men and 34.5 per cent of women named foods from the three food groups, and described a balanced meal. There were no differences between divisions, urban/rural areas, or occupational groupings (Tables 28 and 29). More younger women (Tables 30) in the 15-39 year old age group, answered the question correctly, than 40-49 year old women, but there were no age group differences for the men. Further analysis of the type

of response given, i.e. whether body building, energy or protective foods named, was not carried out because of the low correct response rates to this question.

Question 3

A high percentage of men (52.9 per cent) and of women (56.7%) could name the best food for an infant up to four months of age (Tables 28). More men and women in Tongatapu (56.8% and 58.9%) and Vav'au (58.6% and 66.2%) answered the question correctly compared to other divisions, and more urban men and women (62.3% and 60.7%) responded correctly than rural men and women (49.3% and 55.0%). Women who were in the Professional occupational categories, or were non-employed, i.e. students responded correctly more often than housewives (Table 29). Men who were at home also responded correctly less often than professional men (Table 29). Younger men and women could again answer this question better than older men or women (Table 30). There were 5.7 per cent of all women, but no men who said they didn't know the answer to this question (Tables 31), and 27.6 per cent of women and 34.5 per cent of men who gave an answer other than breast milk or some other form of milk as the correct answer.

3.2.5 Maternal Health and incidence of anaemia

The prevalence of anaemia and mean haemoglobin levels for women by age group, urban and rural groups, divisions and occupation are shown in Tables 33-46. Results are presented non-pregnant and non-lactating women, pregnant women and lactating women aged between 15 and 49 years.

a) Non-pregnant, non-lactating women.

Tables 33 and 34 show a slight increase in moderate and severe anaemia by age group for non-pregnant and non-lactating women, with a very high incidence of moderate anaemia occurring in women in Vava'u (13.0%). There was also a high incidence of mild anaemia among non-pregnant, non-lactating women 20-29 years (30.6%) and 30-39 years (33.0%), especially in Vava'u and the Niua - where 55.4 per cent and 32.8 per cent of all non-pregnant, non-lactating women at the time of the survey were classed as mildly anaemic. However, more than 60 per cent of all non-pregnant, non-lactating women in all divisions except Vava'u had normal haemoglobin in levels and were not anaemic. Only 31.2 per cent of non-pregnant, non-lactating females in Vava'u were not anaemic. There was very little severe anaemia in any division or age group and there were no urban/rural differences in the prevalence of anaemia in this group of women. The National Estimates for mean haemoglobin level for non-pregnant, non-lactating women shown in Tables 35 and 36 ranged between 12.2 g/dl and 12.4 g/dl, but mean and median values for Vava'u were lower than average in all age groups. There were no urban/rural differences in mean haemoglobin values for each age group.

b) Pregnant women

Tables 33 and 34 show that there was a high incidence of severe anaemia and moderate anaemia among pregnant women. In particular, older women had a high incidence of severe anaemia (11.1% in women 40-49 years) and of moderate anaemia (53.3% in women 30-39 years and 33.3% in women 40-49 years). Anaemia was particularly prevalent in Vava'u where 61.6 per cent of pregnant women were moderately anaemic and 11.7 per cent were severely anaemic. There was no severe anaemia in Ha'apai, 'Eua or the Niuas, and only 4.1 per cent of pregnant women in Tongatapu were severely anaemic. The Niuas also had a very low incidence of moderate anaemia (7.2%) compared to other divisions. The prevalence of severe anaemia was higher in urban pregnant women than rural pregnant women. National Estimates of mean haemoglobin levels for pregnant women ranged between 10.7g/dl to 11.6g/dl, which were the lowest mean haemoglobin levels for all women, whether non-pregnant and non-lactating, pregnant or lactating. Younger pregnant women had slightly higher mean and median haemoglobin levels than older pregnant women, and rural pregnant women had slightly higher mean haemoglobin levels than urban pregnant women.

Table 38 summarises the number of pregnant women attending antenatal clinic at the time of the survey. Over 50 per cent of women 15-29 years were attending clinic, but only 33.3 - 33.5% of older women 30-49 years were attending clinic. Only a small number of women actually were taking tablets during their pregnancy (11.1 - 23.4%). Of the women attending antenatal clinic, only 32.4 per cent were taking iron tablets, and more women who were having their first, second or third child (46.2%) were attending clinic in comparison to low attendances by women of high parity.

c) Lactating women

Tables 33 and 34 also summarise the prevalence of anaemia in lactating women by age group and by division. There was a high incidence of anaemia, particularly in the 20-29 years age group (42.4% of lactating women were mildly anaemic) and 15-19 year age group (11.5% with severe anaemia, 27.3% with mild anaemia). Mild anaemia was also prevalent in the older age groups, 30-39 years (34.0%) and 40-49 years (23.1%), but moderate and severe anaemia was not common in these older age groups of women. Vava'u had the highest incidences of mild and moderate anaemia (56.9% and 12.9%) and the Niuas' the lowest (11.0% and 0%), compared with National Estimates of 34.0 per cent and 3.7 per cent for mild and moderate anaemia.

The mean levels for haemoglobin for lactating women of all ages ranged between 11.9g/dl and 12g/dl. Lactating females in Vava'u had the lowest mean and median haemoglobin value compared to other divisions.

d) Prevalence of Anaemia by occupational grouping

National Estimates for mean and median haemoglobin levels are presented in Table 37 by occupational grouping. Housewives who were pregnant had the lowest mean haemoglobin values with 11.2g/dl. Mean and median haemoglobin levels were similar in all other occupational groups for non-pregnant and non-lactating women, pregnant women and lactating women (range of 11.7 - 12.5g/dl).

e) Overall findings on anaemia and haemoglobin status in all women 15-49 years

For all women aged 15-49 years, whether non-pregnant and non-lactating, pregnant or lactating, there was a much higher incidence of anaemia, especially mild or moderate anaemia in Vava'u; and mean and median haemoglobin levels for Vava'u were lower for all age groups, than other divisions. There was very little severe anaemia in all divisions, except among pregnant women in Vava'u, and in young (15-19 years) lactating women. Prevalence of anaemia in the Niuaus was particularly low for pregnant and lactating women, but there was a high incidence of mild anaemia among non-pregnant - non-lactating women in this division. Prevalence of anaemia tended to increase slightly with age, but there were no differences in mean haemoglobin levels between age groups in each division for all women. There were no urban/rural differences in mean and median haemoglobin levels (Tables 36) for all women, but there was a slightly higher prevalence of moderate and severe anaemia among urban women, especially in the pregnant and lactating groups. National Estimates of mean and median haemoglobin values were lowest for pregnant women of all age groups, compared to other women.

Table 35 shows the prevalence of anaemia by age group and by division. For non-pregnant and non-lactating women, there were no differences in the prevalence of anaemia between age groups in each division and numbers were too small for the pregnant and lactating groups for reasonable comparison.

Table 40 shows the prevalence of anaemia in each division for housewives and working women. The prevalence of anaemia tended to be similar for housewives or working women in all divisions in non-pregnant and non-lactating and lactating women, but pregnant women who were not working had a higher prevalence of anaemia than those who were working.

f) Relationships between the incidence of anaemia, dietary patterns and pregnancy history

The potential causal relationship of factors such as diet, antenatal clinic attendance, iron tablet intake and pregnancy history with anaemia were investigated. The prevalence of anaemia in pregnant women was the same whether or not the woman was attending antenatal clinic, and whether or not she was taking iron tablets (Table 41).

Anaemia prevalence was not apparently affected by the number of pregnancies (full-term, plus miscarriages) in all women, although numbers were too small for non-pregnant and non-lactating women who had more than five children and for women of high parity who were pregnant and lactating, for reasonable analysis to be carried out.

There was no significant correlation between types of food eaten and the incidence of anaemia for all groups of women.

Dietary data presented in Section 3.2.2, showed that women had a low rate of consumption of greens and vegetables, which would be among their best iron sources. There was probably a moderate intake of iron from the high rate of staples consumed. There was no difference in the rate of consumption of these iron sources between divisions to account for the high incidence of anaemia in Vava'u. There were no significant differences in the number of women consuming each kind of food between mildly anaemic, moderately or severely anaemic, and non-anaemic women, for all women, whether they were pregnant or lactating, or not.

g) Avoiding foods during pregnancy and lactation

Tables 43 and 44 show the percentage of women who said they would avoid certain foods during pregnancy or during lactation, by division, urban rural groupings and by age group. By National Estimates, 28.6 per cent of women avoided certain foods when pregnant and only 14.1 per cent avoided certain foods when lactating. There were no urban/rural differences for avoiding foods in pregnancy but women in Tongatapu tended to avoid foods to a lesser extent than other divisions. Fewer rural than urban women were avoiding foods in lactation. More older women avoided foods in pregnancy and lactation but the low figures for 15 - 19 year old women (3.8% for pregnancy, 1.3% for lactation) may be attributable to them having not been pregnant and not knowing any taboos or developing personal dislikes.

When asked which foods were avoided, there were many women who either misunderstood the question or listed foods and reasons associated with morning sickness or general malaise during pregnancy. The following foods and reasons were given (Table 45).

In Pregnancy:

48 per cent listed foods including mutton flaps, Tongan staples, fatty foods, sweet foods, breads, curry, fish and seafoods, tea, coffee, chicken, tinned meat and fish, cabbage, fizzy drinks, pork, green leaves, watermelon and lemon juice as causing sickness and morning sickness.

26 per cent listed fish, yam, capsicum, milk, tinned fish, mutton flaps, chicken, mangoes, tomatoes and pork as having a smell that was disliked.

3 per cent listed bread, tava (a local fruit similar to a lychee), eggs, cordial, cassava, taro, bananas, breadfruit, imported foods, Topai (a dumpling made from flour, water and sometimes coconut cream which is boiled in water and then drunk as soup) and also water as having a taste that was disliked.

7 per cent listed octopus and muli'one (a seahare) as causing a rash on the baby.

6 per cent listed fizzy drinks as causing indigestion.

1 per cent felt salty foods or alcohol and smoking were unhealthy during pregnancy.

5 per cent said tinned meat, green coconut and cold foods and drinks were not good for the baby and 4 per cent gave no reason at all for avoiding foods such as root crops, tinned meat, fresh fish, eggs, coconut juice and shell fish.

In Lactation: (Table 46)

10 per cent avoided canned food, seafood or octopus because of causing a rash in the baby.

83 per cent avoided octopus, fatty food, salty food, green coconut, tea, coffe, cabbage and mutton because they were unhealthy for the baby.

3 per cent avoided fresh fish, liver, chestnut, pork or shark because they were believed to contain poison and/or gave the baby diarrhoea.

4 per cent avoided cow's milk, cold foods and staple foods for no definite reason.

Very few women were avoiding foods in pregnancy related to any food taboos or beliefs (right or wrong) about a mother and child's health, in relation to foods eaten. Foods were generally avoided for practical reasons (e.g. morning sickness, dislike). There were no combinations of foods or lists of foods that would give rise to concern that certain nutrients would be lacking in the diet, although some women were avoiding fish and seafood, which may have been their major protein source. Similarly, no women was avoiding all sources of iron so that anaemia might be expected, and the prevalence of anaemia was shown to be the same for women who did and did not avoid foods in pregnancy. Most foods avoided in lactation were for reasons affecting the baby's health, such as causing rash or diarrhoea. So few foods were avoided by each person that none would be likely to affect the health of mother or child, although the prevalence of mild anaemia in women who were lactating at the time of the survey was higher among women who were avoiding foods of some kind (42.0%), compared to women who were not avoiding any foods (29.0%).

3.3 CHILDREN 0-4 YEARS (0-59 MONTHS)

3.3.1 Infant anthropometric

Tables 47, 48, 49 and 50 show the prevalence of malnutrition in children 0-4 years as percent of the median of the WHO/NCHS reference standards for weight for age, height for age, weight for height and Waterlow's classification, by age group and urban/rural groupings.

Tables 51, 52, 53 and 54 show the prevalence of malnutrition for each anthropometric indicator for all children 0-4 years, by division.

There were no cases of severe underweight (less than 60 per cent weight for age) severe stunting (less than 85% height for age) and little severe or moderate wasting (less than 70% and 70 - 79% weight for height respectively). Waterlows' Classification which combines two indicators - weight for height (for wasting) and height for age (for stunting), and gives a reference of the onset and duration of malnutrition again shows very little stunting or wasting i.e. little acute or chronic malnutrition.

Tables 47 and 51 refers to weight for age. There were 1.6 per cent of children whose weight for age was between 60-79 per cent (i.e. moderate malnutrition), of these there was a slightly higher prevalence in urban areas in 0-5 month old infants (9.5%) and in rural areas (6.8%) for 6-11 month old infants, but these differences were not significant. More children had weights for age between 60-79 per cent of standard median in Vava'u (4.5%) than in other divisions, this was not found to be statistically significant.

By National Estimates, a total of 98.3 per cent of children in the Kingdom had weights for age greater than 80 per cent of the standard. There were no significant differences between age group, division or urban/rural groups for normal weight for age.

In all age group divisions, and in both urban and rural areas, there was a high prevalence of children with a weight for age greater even than 120 per cent of the NCHS/WHO standard (23.4%). There was a higher prevalence of children in the 0-5 month age group with a weight for age greater than 120 per cent of standard, compared to all other age groups, i.e. above the normal range.

Tables 48 and 52 refer to height for age. By National Estimates 97.6 per cent of children in the Kingdom had heights greater than 90 per cent of the WHO/NCHS standard i.e. were of normal height for age. There was minimal moderate stunting with no differences between divisions, age group or urban/rural groupings.

Tables 49 and 53 refer to weight for height. By National Estimates 96.8 per cent of children in the Kingdom had weights for height greater than 90 per cent of the WHO/NCHS standard. i.e. were of normal weight/height. There was a small amount of

mild wasting (2.2%), i.e. children with weight for height between 80-89 per cent of standard, but this was of little or no importance, and there were no age group urban/rural or divisional differences. Only 12.2 per cent of children had a weight for height above what is considered the normal range, according to WHO/NCHS standards, compared to 23.4 per cent of children with a high weight for age; suggesting that in many cases, a high weight for age is related to Tongan children being tall.

A higher percentage of children in the Niua's division (18.2%) had a weight for height greater than 120 per cent of the standard, with 'Eua and Ha'apai also having a high prevalence (15.5% in each division) compared with 9.8 per cent and 9.7 per cent in Tongatapu and Vavau', but these differences were not significant.

Tables 50 and 54, refer to national estimates for Waterlow's Classification. There was minimal wasting and stunting (1.4%) by Waterlow's Classification, and there were no significant differences between divisions, urban/rural groups and age groups.

Mean and standard deviations for weight for age, height for age and weight for height by age group for division and urban/rural groups are presented in Tables 55, 56 and 57. For each age group there were no differences in mean weight for age, height for age or weight for height, between divisions and urban and rural groups. The national estimates for the mean of these anthropometric measures are shown in Figures 1-4 and are compared to the growth curve used in Tonga, (derived from Harvard standards) and by World Health Organization (using NCHS standards).

3.3.2 Infant feeding patterns

Infant feeding practices with respect to method of feeding, time of giving breastmilk, bottlefeeding practices and the introduction of solids, etc. are given in Tables 60-68.

Table 60 shows how infants were being fed at the time of the survey according to age. In the first three months of age, 100 per cent of infants were being breastfed. Small proportions of these infants were being given bottlefeeds (8.2%), solid foods (3.5%), or bottlefeeds and solids (4.9%), as well as being breastfed.

By 3-5 months, there was still a high percentage of women giving breastmilk (84.8%), but a large proportion of infants (65.4%) were receiving mixed feeds (i.e. breastmilk combined with bottle feeds and/or solids). Between 3-11 months the majority of infants were being fed either breast and solids, or a mixture of breastfeeding, bottlefeeding and solid foods.

Bottlefeeding became increasingly prevalent after 3 months of age, with 10.8 per cent of children 3-5 months of age, and 19.1 per cent of children between 6-8 months of age receiving bottle milk in combination with solid foods, i.e. no breast milk.

Introduction of solids appeared to be early, with some children receiving solids in combination with breast or bottle milk in the first three months, and by 3-5 months of age 78.9 per cent of infants were receiving some solids. This was confirmed by data shown in Table 64, where 81.8 per cent of children are shown by national estimates to have been given solids in the first five months. Surprisingly, 4.4 per cent of infants at 3-5 months of age were being fed solids only. In general there was a steady weaning off breast and/or bottlemilk, by 12-17 months (54.1%), and almost all children (97.3%) were receiving solids only by 24 months.

The time mothers first gave the breast after birth by division is presented in Table 61. By National estimates, 26.2 per cent of mothers were giving the breast immediately after birth, 41.1 per cent were giving the breast sometime in the first day, 14.4 per cent of infants were not receiving breastmilk until sometime in the second day, and 15.2 per cent were not receiving breastmilk until after the second day.

More women in Tongatapu gave the breast immediately after birth (33.7%) and by the end of the second day (84.8%), compared to other divisions, although 81.6 per cent of women in 'Eua also gave the breast in the first two days. Only 76 per cent of women in Vav'au gave breastmilk in the first two days, and of these only 12.3 per cent gave the breast immediately after birth. There was also a low percentage of mothers in Ha'apai who gave the breast at birth (13.2%).

Table 62 shows the prevalence of giving nourishment other than breastmilk to infants in the first two days of life, and the types of nourishment given. Overall 73.7 per cent of mothers were giving some other kind of nourishment. There were some differences between divisions with a high percentage (80.2%) of mothers in Tongatapu, and only 54.9 per cent and 63.5 per cent of mothers in 'Eua and the Niua's respectively giving something. Boiled water was the most commonly given item (88.5% of children), whilst 6.9 per cent of infants received some other kind of milk than breast milk. There were no differences between divisions in types of other nourishment given.

Water, cocoa and sugar water, were also commonly given in all age groups (31.8%; 11.7% and 10.8%, respectively). In the first 3 months, only water or fruit juice were ever given in a bottle other than milk, and there was a particularly high percentage of children given water (67.7%) in this age group.

Nationally, 32.1 per cent of infants had a bottle by which they received food or drink, other than milk (Table 64). Fruit juices were the most widely consumed food, other than milk, in a bottle (54.9%) (Table 63), especially from 3 months of age onwards.

The reasons for a mother choosing to bottle feed and the types of milk fed to bottlefed children 0-24 months of age are given in Tables 65 and 66. By National Estimates, 48.8% of mothers were bottlefeeding for reasons of working and of convenience; mothers working was a more common reason in Tongatapu (28.3%), and convenience was the most commonly given

reason for 'Eua (43.1%). Not enough breastmilk (5.9%) and breast problems (11.7%) were also common reasons given for bottlefeeding. Infant formula was the most commonly given milk (61.3%) and 11.4 per cent of children were given condensed milk. Condensed milk was particularly common in the 0-3 months of age group, compared with other age categories.

Introduction of solids tended to be early, with 8.8 per cent of children having been offered solids in the first two months rising to 34.3 per cent by the age of three months (Table 67) By four months of age 65.7 per cent of children had been introduced to solid foods. Early introduction of solids was more apparent in Vava'u than other divisions, and by six months of age, which is the latest age normally recommended for introduction of solids, over 90 per cent of infants had been offered solids, except in 'Eua and the Niua's where some mothers delayed introducing solid foods until 7-9 months (6.4%). By 12 months all children were introduced to solids in all divisions.

Data on infant feeding patterns presented in Table 67 which was obtained from a retrospective question of all children, and in Table 60 which was obtained from a question on current infant feeding pattern, show a similar pattern of introduction of solids peaking around the 3-5 months age group; but with earlier introduction in 8-9 per cent of children, and a delayed introduction after 6 months in some children.

Tongan staples were the most commonly given first food (Table 68), with 63.8 per cent of infants being offered them. Fruit was also a common first solid food, particularly in Ha'apai. Fewer imported staples were used as first foods (23.0%), and there was a high use of Tongan protein (47.6%) for a first food in the Niua's division in comparison to other divisions. Tongan staples were less commonly given in Tongatapu (59.6%), and more commonly given in the Niua's (89.4%). There was also a high proportion of children given greens and other vegetables in all divisions (40.3%), especially in Vava'u (56.6%), and 'Eua (50.9%), although only 28 per cent of children in the Niua's received green or vegetables. Moderate green and other vegetable consumptions in Tongatapu and Ha'apai were compensated for by good levels of fruit consumption. Nationally therefore, 80.3 per cent of children were being offered protective foods as first foods, 86.8 per cent were being offered energy foods (as staples), and only 15.4 per cent were offered body building foods. Fat was never offered as a first food, and the use of commercial snack foods and store baby foods was very low (1.4%). Store baby food use occurred mainly in Tongatapu and to a minor extent in Vava'u.

3.3.3 Maternal and Child Health Care

Table 69 gives the percentage of mothers attending antenatal clinic with each child, the percentage of children being seen by the public health nurse at least once, percentage of and mothers working outside the home on a regular basis. Ninety three percent of mothers attended antenatal clinic before the birth of a child, and there were no differences between divisions. Ninety five percent of children in all divisions had been taken to a public health nurse at least once, and on a

national basis, only 10.6 per cent of mothers worked outside the home, with a high proportion of these mothers being in Tongatapu (14.9%). The nutritional status of children of all age groups and in all divisions was not affected by whether mothers worked on a regular basis or by attendance by the mother at the antenatal clinic or by the child at public health clinic. All underweight or stunted children had seen the public health nurse once, and their mothers had attended antenatal clinic before birth.

3.3.4 Infant dietary patterns

Tables 70, 71 and 72 give data on the dietary patterns of children who are eating solid foods. Although there was a large proportion of children who ate solids before the age of six months, it could be expected that many of them would not be eating regular or balanced meals much before this time. Data for infants 6-59 months only will therefore be the main focus of discussion for this section. Data for 0-5month old infants has been included in the analysis by division and for urban/rural groupings, but as these children account for only 8.8 per cent of the total population of infants they do not influence the overall pattern of results presented.

Results are expressed as percentage of children who ate a particular food type, during the previous 24 hours. Most children ate some food some time in the mornings, afternoon and evening (Table 70: 94.5%; 92.7% and 89.7% respectively). Fewer children ate during each time in the rural area than in the urban area (morning 93.5% rural, 97.5% urban; afternoon, 91.6% rural, 95.7% urban; evening, 88.5% rural, 92.9% urban).

Imported staples, imported fat and sugar and sugar snacks were the most commonly consumed food items in the morning in the urban areas (80.9%, 53.9%, 57.2% respectively). Fruit/fruit juice, Tongan fat, Tongan protein were also commonly eaten (22.5%, 21.2%, 24.2% respectively). In the rural areas, a high percentage of children also ate imported staples in the morning (58.2%), although to a lesser extent than in the urban areas, but Tongan staples were consumed more in rural areas (32.6%) than in urban areas (22.0%). There was a high consumption of sugar and sugar snacks in both urban and rural areas (57.2% urban, 48.2% rural). Fruit/fruit juice and protein from Tongan sources was consumed moderately in both areas. Consumption of vegetables and greens and imported protein was very low in both areas.

There was a high consumption of Tongan staples, Tongan fat and protein foods from both imported and Tongan sources in the afternoon period in both areas (76.4%; 57.6%; 32.5%; 30.6% respectively). Consumption of imported staples and imported fat was lower in both areas than during the morning, but protein intake from both imported and Tongan sources was much higher. Consumption of Tongan staples was highest for the whole day during the afternoon period in both urban and rural areas. Vegetables and greens consumption was also much higher than in the morning, but were still only consumed moderately (27.0%, 21.9% respectively). Fruit/fruit juice intake also remained at a moderate level (consumed by 28.6% of children). Sugar snacks consumption was lower than for the morning, but intake was

significantly higher in the urban than the rural areas. In the evening there was a high rate of consumption of Tongan staples, 53.9 per cent, although not as high as during the afternoon period. Consumption of imported staple was much higher in the evening (43.4%), compared to the afternoon period (11.3%). Tongan fat consumption was also high, 42.9 per cent but imported fats were more commonly consumed than during the afternoon periods. Protein intakes from Tongan and imported proteins were moderate in urban areas (27.7% and 36.2% respectively), and moderate to low in rural areas (18.6% and 18.6% respectively). Greens, other vegetables, and fruit/fruit juice consumption were low in both urban and rural areas, but sugar and snack food consumption was high and was particularly high in rural areas, compared to the afternoon consumption.

Consumption of other snacks was low throughout the day in all areas, and consumption of store baby food was also very low throughout the day. Table 71 shows that it was predominantly the 0-5 month old age group, many of whom were just being introduced to solids who were consuming the store baby foods.

There were no differences in the percentage consumption of foods between age groups for either morning, afternoon or evening periods; except sugar/sugar snacks, which increased with age for morning and evening consumption.

Table 72 shows the percentage of children who ate each kind of food by division. There was a particularly high consumption of imported staples in the morning on Tongatapu (75.3%), with notably lesser amounts in other divisions, particularly in the Niua (27.4%). Consumption of Tongan staples in the morning was highest in the Niua's division (54.5%), and lowest in Tongatapu (22.9%). Imported fat consumption was high in Tongatapu (44.2%), moderately high in Vavau (32.4%), and low in the Niua's division (14.1%). Greens and other vegetables intake was low in all divisions. Fruit and fruit juice intake was also low in all divisions, especially Tongatapu (22.9%), with the exception of the Niua, where it was particularly high (75.3%). Sugar and sugar snacks intake was also very high in Tongatapu (58.0%), and quite low in the Niua's (24.7%). Tongan protein consumption was high in all divisions in the afternoon, with a high consumption of greens in 'Eua (45.0%), compared to other divisions. The patterns for consumption of fruits/fruit juice and sugars/sugar snacks was similar to that of the morning.

In the evening there were no differences between divisions for consumption of Tongan staples, but there was a higher rate of consumption of imported staples on Tongatapu and in Vava'u, compared to other divisions. Consumption of protein was low in all divisions, but there was a trend of higher consumption of imported protein on Tongatapu compared to other divisions, with very low intakes in Ha'apai and the Niua. There was a higher consumption of Tongan protein in the Niua, and slightly higher consumption in Ha'apai and 'Eua, compared to Tongatapu and Vava'u. Consumption of greens, other vegetables and fruit and fruit juice was again low in all divisions, except in the Niua, where there was a moderate consumption of fruit. There were no differences between divisions for consumption of sugar snacks.

Table 73, 74 and 75 show the frequency of food types eaten during the day by children 0-4 years in urban and rural groups by division and by age group. In Tables 76 and 77 foods have been grouped according to the 3 food groups and shows whether children consumed balanced meals by division and age group or not.

Most children ate some kind of staple (imported or Tongan) three times or more a day (Tables 73, 74 and 75). Only 5.8 per cent of children ate no staple. Most children ate some type of protein only once or twice a day, and 20.1 per cent of children ate no protein food in the day. Protein consumption did increase slightly with age. Over half the children over 6 months of age were eating fat 2 or 3 times a day in all areas, and with each age group fat consumption increased with age. For children 6-11 months, 45.2 per cent were eating no fat at all. There were 35 per cent of children eating either greens or vegetables once a day, and 18 per cent ate them two times a day. There was overall a low consumption of both fruits and vegetables in the day, and 40.4 per cent of children ate no vegetables (53.9% ate no fruit all day) in both urban and rural areas, in all divisions and in all age groups. Vegetable consumption - urban/rural, throughout the day was particularly low in Ha'pai and the Niuas, which was partly compensated for by a high fruit intake in the Niuas, only. Frequency of snack food consumption was highest in Tongatapu, and lowest in 'Eua and the Niuas, but overall 55.9 per cent of children were consuming snack foods once or twice a day; and 10.8 per cent were consuming snack foods 3 or more times a day.

In all divisions, a high percentage of children (65.4%) ate food from the three food groups during the afternoon. Only 39.5 per cent of children ate food from the three food groups in the morning and 48.6 per cent ate food from the three food groups in the evening (Table 77). Only 17.4 per cent of children throughout the day ate food from the 3 food groups at each of the three intervals in the day. Children age 6-11 months were less likely to eat mixtures of food, especially in the morning and evening.

Most children (85.5%) over 6 months of age ate at each meal (Table 78), particularly in the 12-17 months age group (93.6%). Children in Tongatapu and Vava'u were more likely to have eaten food at least three times in the day than in other divisions, but these differences were not significant, and there were no urban/rural differences. Few children ate only once during the day in all divisions and age groups (1.9%), and only 3.3 per cent of children ate no food which was mostly attributable to the 0-5 months age group, many of whom were not yet on solids. There were no differences in whether children skipped eating in the morning, afternoon or evening of the 8.4 per cent eating only twice a day.

3.3.5 Interrelationships between infants nutritional status, feeding and dietary patterns.

Tables 79 and 80 show the age of introduction of solid foods and patterns of infant feeding by nutritional status by weight for age. There were no significant differences between age of introduction of solids and nutritional status for children of all ages. Nutritional status was not related to infant

feeding pattern. The three 0-5 months children who were less than 80 per cent weight for age were being breast-fed, and children 6-23 months who were less than 80 per cent weight for age were receiving breast or bottle milk as well as solids. There were no major differences in feeding patterns between children whose weights for age were 80-119 per cent and 120 per cent or more for all age groups. Data on the few children who were on solid food only at an age less than 8 months, showed that all were well-nourished, except one whose weight for age was slightly less than 80 per cent of reference standard (78.0%). Early weaning off the breast or bottle is of concern, but does not appear to be causing malnutrition. There were no significant correlations between nutritional status and whether mothers worked or with the birth order of children.

DISCUSSION

4. Discussion

4.1 Adults nutritional status and dietary patterns

There was strong evidence from the body mass index data that overweight and obesity were major nutritional problems in the Kingdom of Tonga among both adult men and women. The problem was more critical amongst women than men and by middle age the majority of women were overweight or obese. Patterns of obesity were different between divisions for both sexes accountable by differences in food consumption patterns and energy expenditures.

Dietary pattern trends were as expected in that rural adults tended to consume more local produce and consumption of imported foods was highest amongst urban adults. A number of other Pacific studies have shown that these dietary pattern trends lead to more obesity among urban dwellers consuming imported foods (which are said to be more energy dense than local foods) and leading a sedentary lifestyle, than rural dwellers consuming predominantly local produce and leading a more active lifestyle (Coyne, Badcock, Taylor 1984). It was of interest to note therefore that in Tonga, rural men and women tended to be slightly more overweight than urban men and women and that within the rural area where adults were consuming mostly local food in some areas obesity was predominant, e.g. Ha'pai and yet in others, eg. the Niua's it was not. It could be that activity levels and therefore lifestyle may be having an important influence on body weight.

Although classified as being rural, Ha'pai tends to have more obesity in both men and women than was evident in any other division. The islands in the Ha'pai group are small and widely scattered, travel is mostly by sea and lifestyles tends to be subsistent and agriculturally orientated. Smaller amounts of land per head are available in Ha'pai than elsewhere in Tonga (Potter 1986). Many of the islands are low lying sandy soil islands or atolls and soil quality tends to be poor with a deficiency of organic matter and phosphorus.

For many of the Ha'pai islands food crop resources tended therefore to be repetitive and lacked variety. It consisted predominantly of local starchy root or fruit crop (mostly cooking banana or cassava), coconut cream at most meals and fish, which was mostly eaten only once a day. Fruit and vegetable consumption was very low. Without quantitative dietary information however it is difficult to conclude whether or not diet patterns can account for the high incidence of obesity. General observations suggest that the lifestyle was not very active - islands were small and flat with minimal walking; access between islands was by motor boats and there was little cash cropping or other agricultural activity other than subsistence, which may account for weight gain but again would require further study.

In comparision, in the Niua's, where obesity was least prevalent the islands are of a rugged terrain and tend to have a hotter climate throughout the year due to their position far north from the other divisions within the Kingdom. Inhabitants from these islands are known for their fitness and physical

strength attributed to the farming practices in these conditions. This seems to indicate that a consistently high level of physical expenditure whilst consuming foods from local sources rather than from imported sources is advantageous in terms of body weight measurements.

Activity levels may also account for the lower incidence of obesity in urban areas where extracurricular energy consuming activities such as jogging, exercise class and sports and associated training were increasingly common place and awareness of the need for a healthier lifestyle was greater and appeared to be helping compensate for the change in diet. It was also of interest to note urban dwellers were consuming local produce whenever they could so there was not a total switch in diet away from the traditional foods.

The pattern of increasing obesity with age was the same in both urban and rural areas and for men and women in most occupations excepting women classified as housewives, who tended to be slightly more obese than women in other occupations and men in labour type occupations who tended to be slightly less obese than men in other occupations. For women possibly this could be a result of a more consistent access to food and for men this could be exercise related as men in this type of occupation would have a higher level of physical activity.

The fact that there are major problems especially amongst women is further evident from data presented by age group. It is of concern that adults even at a younger age tend to be overweight particularly women. Prevalence of obesity tends to increase with age worldwide and because Tongan women go into adulthood with a high weight there is already an increased risk of becoming obese. It must be borne in mind that Caucasian standards have been applied to the Tongan data and that it is possible to speculate Tongan adults are in fact naturally heavier and Caucasian interpretations of moderately overweight might be normal weights for Tongans. However in the absence of scientific appraisal of the appropriateness of these standards we cannot be conclusive. Given that culturally, health, well being and social standing are associated with body 'bigness' it might be appropriate to accept a certain amount of overweight but more work is required to determine what might be acceptable from a health as well as a cultural point of view. However in the absence of this data the moderately overweight category in this study could be considered as the ideal weight ranges for Tongan adults and need not be a priority target group for weight reduction at this time. This does not discount that the people who are obese are definitely unhealthy and it is recommended that these people should at least aim to lose weight to the moderately overweight level.

It was of interest to note that more younger people were eating more imported food than older people. We have already speculated that diet may not be a major contributory factor in obesity since in some instances rural people consuming Tongan foods are more obese than urban people consuming imported foods. However, in light of evidence from other studies in the Pacific and elsewhere, an increase in imported food consumption often leads to an increase in obesity. Therefore, if young people

continue to consume more imported foods they may carry an increased risk of becoming obese as they grow older. Urban leanness may be being maintained by lifestyle factors as discussed previously, however, these need to be maintained and extended to rural areas to prevent further obesity. There will be a danger of a further increase in obesity for rural people if these lifestyle factors are not practised and the consumption of imported foods increases.

It might be concluded from this study that provided high activity levels are maintained a switch from traditional diet to a more convenient diet based on imported foods need not have an adverse affect on body weight. However it should be stressed that a diet based on local foods tends to be more nutritious with respect to a higher fibre, vitamin and mineral content and should therefore be encouraged in preference to imported foods. It cannot be overstated that this study looked only qualitatively not quantitatively at dietary patterns and energy intake from whatever source may equally be the key to account for the different trends in obesity incidence. Also while the differences in incidence between urban and rural areas are of interest it is still of major concern that national levels of obesity amongst adults are very high, especially amongst women.

While questions related to dietary recall asked only qualitative information and no quantitative data was taken, results do indicate patterns evolving for particular foods in each time period throughout the day. Staples, either Tongan or imported were commonly consumed, in the morning in both areas and imported staples were particularly common because of convenience and lack of required preparation, in comparison to Tongan staples which require preparation and cooking time. More imported staples were consumed by urban dwellers than by rural dwellers throughout the day, also for reasons of convenience.

Another reason why Tongan staples were more frequently consumed in urban areas may be availability and cost. People were not totally abandoning consumption of local staples and subjective discussion indicated people do still prefer to eat local foods from a taste and satiety point of view. This indicates that if local staples were more available at a lower cost the convenience of imported foods may be outweighed. In each meal during each time period of the day, staples from either sources were always consumed by both men and women and quite frequently more than one staple was eaten in a meal which could be another contributing factor toward obesity.

During the afternoon and evening periods more Tongan fat and Tongan proteins were consumed than in the morning, particularly in rural areas, because of a greater availability. This was especially so for Tongan protein, which often would be some variety of fish or shellfish that had been caught on the day it was consumed. If no fish was caught on the day no protein was eaten in rural areas. Mostly imported protein was eaten in urban areas and this was mainly mutton flaps, tinned corned beef or tinned fish which for protein content are as adequate as fresh local protein sources. However, in nutrition terms the large proportion of fat to meat on the mutton flaps and in tinned meat often far outweighs the value of the protein content and should

be on the whole discouraged particularly if fresh protein sources are available. Protein consumption seemed not to be regarded as an important part of most people's diet at any time throughout the day, and whilst no particular health problems occurred as a result of this, education on the importance of protein as part of a balanced meal would be of value.

Imported foods other than staples, proteins and fats generally were more often consumed in urban areas than they were in rural areas. Consumption of sugar and sugar snack foods were particularly high in Tongatapu for both men and women, and although a lot of this represented sugar in coffee and tea, it also included sugary snack foods, such as soft drinks, ice cream and sweets. High sugar consumption was noted in previous causal studies (Adachi, 1977 and Duttaroy, 1980) and in the light of high obesity prevalence and the relationship with dental caries education on the importance of reducing sugar intake is required.

Fruits and other vegetables were rarely consumed in any meal in both urban and rural divisions despite an apparent ready availability of fruits. The exception to this was in the Niua's division, where at the time of the survey fruit consumption was exceptionally high for both men and women. It seems this was a result of mango season occurring at that time but the definite impression was given that large quantities being consumed were because of this abundance rather than for any nutritional value.

Education aimed at an increase in consumption of fresh fruit and vegetables needs to be emphasised. This could be from a twofold aspect in that fruits and vegetables are low in energy value and are good for weight control and also that fruit and vegetables should comprise part of a normal healthy balanced diet in order to provide essential vitamins and minerals and prevent infections.

Morning meals in both urban and rural divisions tended to be the least balanced of all meals throughout the day, in contrast to other meals eaten in the afternoon and evenings. Overall meals were not well balanced and appropriate education on the importance of acting a variety of foods throughout the day. This could be coupled with education on weight control.

Actual prevalence rates for obesity have not been previously reported for comparison with this survey. It is of interest that obesity has been reported as far back as 1956 in Whiteman's study which suggests the problem is not a new one. However, it is likely that from actual weights recorded many people are very obese and heavier than has previously been noted. That obesity has perhaps always been a problem can also be linked with the fact that this study shows a high incidence even in rural areas where lifestyle and food consumption patterns are more 'traditional'.

The increasing incidence of non-communicable disease in the Kingdom also suggests the problem of obesity is more serious and widespread than previously reported. Non-communicable diseases are closely linked with dietary changes such as increased sugar, salt and animal fat consumption and with lack of exercise as well as obesity itself. The current trend in

dietary patterns in the Kingdom, in particular in the urban areas to a high animal fat, high sugar and salt and low fibre diet gives cause for concern. Linked with obesity and comparing with health trends elsewhere in the Pacific there are compelling health reasons for obese Tongan people to reduce their weight.

4.2 Maternal health and incidence of anaemia

Maternal Health: Anaemia

Haemoglobin status and prevalence of anaemia for women appears to vary within divisions although generally the occurrence of anaemia was minimal and subject to specific groups of the population surveyed. Vava'u presented significantly higher proportions of women having severe anaemia particularly amongst pregnant women and young lactating women. Attendance at antenatal clinic was high in all divisions including Vava'u, and so all women would be expected to be exposed to the same amount of health education. It was surprising that there was not more anaemia as women were not eating many greens. These tend to be a good source of iron and also provide vitamin C which assists in iron absorption. Similarly fruit and other vegetable consumption was low and not providing the necessary vitamin C. Protein intakes were low, which also suggests a relatively low intake of iron.

Dietary patterns as such are not indicative why there is so much anaemia in Vava'u, however it has been suggested for Vava'u that because of the steeper slopes and heavier rainfall (in comparison to Tongatapu for example) that this would cause both leaching and erosion to occur in the soils, thus creating a less fertile soil containing lower levels of all the major nutrients, excepting potassium (Potter 1986). This leaching effect of nutrients could indirectly be affecting the haemoglobin status of women in Vava'u as the iron content of crops is probably lower. Chemical analysis of crops grown in different parts of the Kingdom is required to provide further information and help explain these findings.

The potential causal relationship with anaemia of factors such as antenatal clinic attendance, iron tablet intake, pregnancy history and food taboo's were investigated. Although antenatal clinic attendance was high for all women this did not influence anaemia status, as is evident with women in Vava'u, neither did the consumption of iron tablets or the number of pregnancies significantly affect the anaemia status of women. It was interesting to note that food taboos were not particularly prevalent and those that were occurring were very individual and would not be expected to have any major impact on the nutritional status of pregnant women. Although there were no urban/rural differences encountered it seemed that women who were living a more traditional lifestyle close within the family unit were the ones who were avoiding certain foods, possibly as a result of teaching passed from older women in the family. Women who were consumers of alcohol and tobacco were indicating the avoidance of these during pregnancy and lactation, which probably reflects the positive input of health education directed at these women during antenatal clinic.

Maternal and child health care

Throughout the Kingdom maternal and child health care has an encouraging record of attendance. The majority of women surveyed were shown to have contact with a public health clinic through attendance at least once during pregnancy and at least once after their infants were first born. Maternal health education from public health nurses and health officers has probably contributed to this attendance record. Clinic attendance rates are also perhaps a reflection of the importance of the associated social activity, especially in rural areas, which in turn produced a positive effect on women attending, since public health nurses were able to promote and assist in facilitating breastfeeding. Attendance at antenatal clinic was the same for urban and rural areas and whether or not the mother was working outside the home. The nutritional status of both mothers and children was not affected by the mother working. This is probably due to the fact that breastfeeding is the usual practice which is facilitated by most work places being within close proximity of the child and babysitter which allowed breastfeeding still to be practiced. This high level of attendance by mothers to clinic also reinforced positive feeding patterns for infants, results of which are clearly evident by the low incidence of malnutrition amongst infants and children.

4.3 Infants Nutritional Status and Dietary Patterns

Nutritional status

Nutritional status of children assessed at the time of the survey indicated no major problems. Comparisons were made to the WHO reference standards and it can be seen that Tongan children are noticeably above the standards used. Children tended to be marginally longer/taller for their weight for age according to the classifications used and their weights were also greater for their age and greater still for the already high figures for their length or height.

Maternal and child health data contained in public health records suggests that average infant birth weights in Tonga are greater than mean recorded birth weights in other developing countries. This may account for the high weights of Tongan infants especially in the first six months because by starting off at a weight greater than the 'norm' a high weight is maintained. This is from a similiar point of view that is often argued for low birth weight babies who can be expected to remain below the normal level for weight for age even when growing steadily. According to the WHO standards used Tongan infants will tend to be termed as being overweight which is not necessarily a correct classification to use. On the one hand it might be appropriate to suggest carefully investigating the development of standard anthropometric reference charts for Tongan children by analysing the current data further and carrying out further studies. On the other hand any concerns raised over the apparent high incidence of overweight should be carefully balanced by the current lack of underweight. Raising the standards would increase the number of children classified as underweight. It is therefore the authors' view that since Tongan infants appear to be very healthy and well nourished clinically,

current standards and reference weight charts should continue to be used. Meanwhile it would be of considerable value to investigate further average Tongan birth weights.

The incidence of malnutrition and underweight has always been reported to be low over the past three decades of study and this still seems to be the case. This is very encouraging. In other areas of the Pacific, undernutrition among children is a serious problem especially in Melanesian areas such as Vanuatu (28% of under-fives) and in Papua New Guinea (38% of under-fives) (Man Ming Hung, 1983; Lambert, 1982). Undernutrition has also been reported in some Polynesian communities such as Western Samoa (Sio, 1984). In contrast however, Tuvalu has reported high birth weights and high weights throughout infancy, much the same as have been described in this study (Tuvalu Primary Health Care Plan, 1984). This trend was also thought to be related to almost universal breast feeding and early introduction of solids and also the good health status of mothers. Vitamin A deficiency was reported in previous studies (Whiteman, 1956 and Jansen, 1972) but was not investigated during this current survey. In the light of the low intake of fruit and vegetables among children (and adults) this should be closely monitored. Vitamin A deficiency has been reported in the past few years by medical services in Kiribati and Truk (Federated States of Micronesia), which was attributed to a low consumption of fresh fruit, vegetables and local staples and a high consumption of imported staples and sugar and sugar snacks - a pattern similar to the one observed in Tonga today. Low fruit and vegetable consumption in relation to increasing skin and eye problems among school children was also reported in Tuvalu (Primary Health Care Plan 1984).

Infant Feeding Patterns

Breastfeeding was universal in the first three months of life, and results show no child to have been solely bottlefed during that period of time. These results should be an encouragement for continued public health education on the positive advantages of breastfeeding. Although the breast was given to all infants in the first three months of age and the majority of mothers started feeding immediately after birth or in the first few days there was a small proportion of some mothers who indicated that the breast was not given until the second day and sometimes not until after the second day of birth, and the practice of giving hot water as a supplement was used. Reasons behind this practice were not clear. There are two possible interpretations. On the one hand it may appear these infants would be missing the advantages of receiving colostrum. Colostrum is advantageous for an infant to receive, as it contains a high concentration of a certain immunoglobulin, of whose antimicrobial action helps to protect breast fed infants against infection. The output of this substance falls rapidly once lactation has been established, and so it is preferable for the infant to receive the first milk, rather than this to be discarded (Davidson et al. 1979). Another explanation might be that it takes two days or more to firmly establish breastfeeding and for the milk to 'let-down' for some women and so the mothers are giving hot water in the meantime. This means babies are receiving colostrum once milk comes in. Either way this means

there are some babies who may go without nourishment for up to two days, since water contains no nutrients. The survey did not provide data to adequately explain this apparent problem amongst some women which may need further investigation as a basis for reinforcing breastfeeding education. The percentage of mothers not giving breast immediately although notable, were far outweighed by the percent of mothers who did breastfeed straight after birth. Health education should continue to stress the importance of early breastfeeding. Hospital practices currently include putting the baby to breast immediately after birth and this practice should be extended to women giving birth at home. More women in Tongatapu give birth in a hospital which may account for the higher rate of giving breast after birth in this division.

Although after three months of age bottlefeeding did occur and solids were introduced, still a high proportion of mothers breastfed up until twelve months as well as giving solids or the bottle. The absence of malnutrition is reinforced by these patterns of infant feeding, which indicate children are well fed from birth.

In Tonga solids are introduced early by conventional infant feeding practices, although this does not negatively affect their health status. Similarly where late introduction of solids occurred for infants in 'Eua and the Niua's this did not appear to affect their health status. The solids mothers were giving were usually of sound nutritional value and rarely were store baby foods given, despite their availability.

Despite the high breastfeeding rate it was of concern that a large proportion of mothers were using bottles to give fruit juice, other fluids or solids. The use of a bottle should be discouraged. A totally breast fed infant does not require additional fluids or solids in the first 4-6 months of life and after this age additional fluids and solids should be given with a cup and spoon, not a bottle which is difficult to keep clean.

Convenience because mothers are working seems to be the main reason for bottlefeeding, which is an argueably valid reason for choosing to bottlefeed. However it would be useful to investigate ways to facilitate continued breastfeeding by working mothers by changing work regulations to include such measures as providing adequate maternity leave, allowing time off during the day for breastfeeding etc. More health education on appropriate breastfeeding practices for mothers such as establishing a night time feeding routine, expressing breastmilk and feeding with a cup and spoon etc. should also be encouraged. Health education is also required for mothers who choose bottlefeeding because of breast problems. Nurses may require more education in how to help mothers who have difficulty breastfeeding for whatever reasons.

Dietary Patterns

Dietary patterns for most infants and children are encouraging in that they reflect meals are eaten at least three times a day and almost all children ate at least twice a day. However, foods from the protective group and protein foods are often missing from these meals and the afternoon was generally

the only time a balance of foods from the three food groups was given. There was a similar trend in adult dietary patterns and children were probably receiving foods based on the adult diet.

All children were consuming energy foods several times in the day mainly as staple foods. On Tongatapu there was a high consumption of imported staples whereas in rural areas Tongan staples were more frequently consumed which was also a reflection of adult dietary patterns. Protein consumption although quite low in all divisions, was probably compensated for in the first year to eighteen months by the large proportion of children still being breastfed. However education on protein requirements and the importance of protein for growing children should be an education programme for consideration.

Morning food consumption revolved around an early morning meal or breakfast in both areas. In the urban areas, this and mid-morning snacks consisted mostly of bread (imported staple), topai (Tongan cake) - imported staple and sugar snack), margarine (imported fat) and a hot drink containing milk (Tongan protein), and sugar (sugar/sugar snacks). In the urban areas some children had a cold sugar drink (sugar snacks). Sweet biscuits and savoury biscuits were also consumed. Food left over from the previous evenings' meal was consumed by some children first thing in the morning (i.e. staple, plus coconut cream (Tongan fat), some protein, e.g. fish, and sometimes a vegetable or some greens). Fruit and fruit juices were not a major part of the mornings' diet.

Afternoon and evening patterns were also similar for urban and rural areas. A typical pattern for the afternoon was a meal consisting of Tongan staples and Tongan fat, and protein foods from both imported and tongan sources. Consumption of Tongan staples was at its highest for the whole day in both areas in the afternoon. Fruit/fruit juice and vegetable consumption remained moderate in the afternoon, and sugar/sugar snacks intake was lower than morning, yet significantly higher in urban areas than rural areas. A typical pattern for the evening was Tongan staples, imported staples, imported fats and Tongan fats, with foods from the imported groups having a higher consumption rate than in the afternoon. Foods from protein groups, both Tongan and imported were moderate in urban areas and low in rural areas and in both areas low in the evening. Vegetables and fruit/fruit juice consumption was also low for both areas in the evening. Sugar/sugar snack consumption was high, particularly in rural areas, compared to the afternoon consumption.

It was encouraging to see a low consumption of store baby foods occurring throughout the Kingdom. Economic means were probably the main contributing factor for this and also availability would be limited in most divisions. The highest consumers of store baby foods were infants in the 0-5 month age group, which is when solids were being introduced. Store baby foods should be discouraged as first solid foods for infants on a nutritional basis, since they tend to have a high content of salt and sugar. They are also expensive compared to readily available local foods suitable as first foods. An increase in economic means could possibly increase store baby food use and so public health education should continue actively discouraging their use.

Fruits, fruit juice, vegetables and greens were not being consumed by many infants, with the exception of infants in the Niuas', where a high percentage of children were eating fruits due to the over abundance during the season for mangos. No assessment of health status with respect to vitamin or mineral intake was made and it is possible that nutritional status could be affected in the long term as a result of low intakes of water soluble vitamins and minerals normally obtained from fruit and vegetables. Children with a low vitamin and mineral status are usually more susceptible to diarrhoea and skin infections. Diarrhoea and skin disorders which do occur to children are known to be related to nutritional status and there may be a relationship with the low vegetable and fruit consumption and the incidence of these diseases within the Kingdom. Education programmes should be directed at encouraging increased fruit and vegetable consumption, particularly for children.

Sugar and sugar snack foods form a significant part of the diet in both urban and rural areas. These items are nutritionally poor and are expensive and should be discouraged. The incidence of dental caries among school children is observed to be high and sugar and sugar snack food consumption would be contributing to this. Sugar and sugar snack consumption has also been shown in this study to be high among adults and also in the FAO School Children survey report (Hugo 1987). Sugar is high in energy and can contribute to obesity as well as dental caries. By limiting an infant's intake and discouraging a "sweet tooth" this may help reduce sugar and sweet food intake as these children enter school and grow into adults.

4.4 Nutrition knowledge.

Discussion

In designing the questionnaire it was well recognised that there are considerable difficulties in asking questions relating to a person's 'knowledge'. However it was felt that some means of assessing the effectiveness of current nutrition education programmes was required. Every effort was made to phrase the questions appropriately and to train the interviewers to phrase the question without bias. From observation during the interviews it was felt that the interviewers were posing the question appropriately. However it is still not possible to conclude if people who responded 'they didn't know' or answered incorrectly, did not understand the question fully or they really did not know the answer.

For those people who answered correctly it was felt the questions were on the whole phrased such that it would be hard to give a correct answer accidentally or by guess work. If this assumption is accepted it would appear that education in the subject areas tested was equally effective in all divisions and urban/rural areas. More younger people were able to answer questions more correctly than older people which is perhaps a reflection of recent nutrition education in schools. Surprisingly, fewer housewives who would be expected to be exposed to the most radio education could answer the question on infant feeding compared to women who were out of the home all day working.

Many people also showed a lack of correct understanding of diet related diseases which perhaps should be given more attention in nutrition education areas because of the high prevalence of obesity and consequent concern about the incidence of diet related diseases found in this study.

The concept of a balanced meal was not well understood. It has long been debated whether this is relevant for nutrition education in the Pacific because food supply and patterns of eating do not follow conventional structured meal patterns found in western societies. Nutrition education needs to be restructured to either reinforce the current message more effectively, or more appropriately change the message to suit the situation. This study has shown a number of problems in current eating patterns to be one of the key factors e.g. fruit and vegetables are missing from Tongan diets and too many energy foods are consumed. A more effective message may be to eat more fruit and vegetables or less energy foods rather than just eat a balanced meal. Now that more information is available on eating problems, nutrition education can be more justifiably structured this way.

CONCLUSIONS

- 1). The nutritional status of infants and young children in the Kingdom was basically good. There is no evidence of protein-energy malnutrition, either clinical or sub-clinical although dietary patterns indicate low intakes of protein. No assessment was made of vitamin or mineral status but dietary intakes were low suggesting the potential for nutritional problems in this area which should be closely monitored.
- 2). Breastfeeding was universal for young infants for the first three months of life. While bottlefeeding did occur it was always in association with breastfeeding or solid feeding and never substituted totally for breastfeeding. The main reason for bottlefeeding were for mothers working which suggests that infant formula promotion has not had a major affect but that maternal leave and work regulations need reviewing to better accomodate a continuation of breastfeeding and more education on how working mothers can successfully maintain a breastfeeding regime.
- 3). No assessment was made of dental health but consumption of sugar and sugar snacks was high particularly for children, which could be detrimental to dental health.
- 4). Prevalence of obesity in adults is very high especially in older age groups (over 35 years of age) and in women. Obesity is a primary causal factor in other diseases such as diabetes, hypertension and heart disease and its treatment and prevention should be accorded priority for future public health action programmes.
- 5). There was no evidence that prevalence of obesity was related to the type of food consumed. Causes of obesity were postulated as being related to quantities of food consumed, lack of exercise and related lifestyle changes and requires further study in order to successfully address the problem.
- 6). People in urban areas were consuming more imported foods more often than rural people. This is probably due to a combination of factors such as more availability, an inconsistent supply of local foods, convenience with respect to preparation and cooking time and lower costs of imported goods with respect to staples.
- 7). Vegetable consumption was very low and fruit consumption was seasonal suggesting the potential for vitamin and mineral deficiencies to occur.
- 8). Prevalence of anaemia was low amongst women except for women in Vava'u which may be related to low iron content soils.

- 9). Maternal and child clinic attendance was good and probably contributes highly to the good maternal and nutritional status. Maternal and child health care clinics were potentially a good mode for education on obesity prevention amongst women and their families. Food taboo's were not significant and not affecting the health and nutritional status of pregnant and lactating women.
- 10). Data relating to nutrition knowledge was inconclusive yet suggests it may need a change of direction and emphasis towards accomodating people's eating habits and to suit lifestyle changes people are experiencing so that obesity levels are controlled. From a pratical rather than scientific viewpoint Caucasian standards for normal weight for height for adults need reviewing in a Tongan context so that cultural attitudes to overweight and obesity are balanced with health considerations and attitudes.

RECOMMENDATIONS

1. To reformulate a National Food and Nutrition Policy to be submitted to Cabinet. The policy should aim to improve nutritional status.

Targets will need to be set such as:

- a) Maintaining the current good nutritional status and infant feeding practices.
- b) Improving adult nutritional status by minimising the number of adults in the obese classification.
- c) Increase consumption of local foods, particularly protein foods and fruits and vegetables and ensure there is at least no further increase in consumption of imported foods such as sugar, soft drinks, store baby foods, snack foods and mutton flaps.

To achieve these targets:

- a) Programmes should be aimed at increasing production and marketing of fresh produce with particular emphasis on improving availability in urban areas.

- b) Nutrition education programmes should give priority to improving adult nutritional status through nutrition education programmes. Guidelines for nutrition education programmes need to be developed based on information provided from this survey and be directed at specific target groups. This may be readily achievable by developing a series of dietary guidelines:

- . control weight
- . use less sugar
- . use less fat particularly animal fat
- . eat a variety of fresh foods
- . limit alcohol intake
- . increase exercise
- . promote breastfeeding

Key target groups for education include:

- a) adults (general population on weight control)
- b) school children (with a view to preventing obesity and dental caries in adults of the next generation)
- c) women of child bearing years with particular emphasis in the first instance on women in Vava'u in the prevention of anaemia, and also all women on the importance of protein foods for growing children. Further investigations are required for discovering the causes of anaemia in Vava'u.

d) Particular attention should be paid to establishing an appropriate data base and monitoring nutritional status in the future. This includes ongoing monitoring of adult nutritional status and children and availability of food in urban and rural areas. (fresh and imported). Food imports should be monitored particularly imports of poor nutritional value and step taken to ensure that at least there is no increase in current levels of these import items.

2. Maintain current efforts to co-ordinate nutrition education programmes through an interdepartmental committee and practice implementation of policy through this committee.
3. Carry out a quantitative diet survey to further describe causes of obesity which were found to be prevalent in the Kingdom.
4. There should be further discussion and investigation on establishing the ideal weights and heights for Tongan adults.
5. Birth weight data currently available in Maternal and Child Health records should be reviewed and an average Tongan birth weight established. This should be followed by discussion and appraisal of the appropriateness of current weight for age charts used within the Kingdom. Meanwhile current WHO weight for age charts are considered adequate in the absence of conclusive data.

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APPENDICES

English translation of questionnaireChildren 0-59 months

1. Are you the mother of the child?
Did you (the mother) go to antenatal clinic before the birth of this child?
Has this child been taken to the public health nurse?
Are you (the mother) working on a regular basis outside the home?
2. How is the child fed? (tick one box only).
a) Breastfed only e) Breast, bottle and solid
b) Bottlefed only f) Solid only
c) Breast and bottlefed g) Don't know (do not fill in
d) Breastfed and solid rest of form)
3. After birth when did mother give breast? (Tick one box only)
a) Immediately d) After second day
b) Later in first day e) Did not breastfeed
c) In second day f) Don't know
4. Did mother give anything other than breast in first two days? Yes/No/Don't know
If yes:
a) Green coconut juice f) Fruit juice
b) Young coconut flesh g) Fruit juice
c) Hot water h) Other milk
d) Sugar water i) Other
e) Prechewed food
5. Is anything other than milk ever given in a bottle?
Yes/No/Don't know
If yes 'what'
a) Water e) Milo/cocoa
b) Sugar water f) Soft food
c) Juices g) Other
d) Cordial/soft drink

Bottlefed children

6. If child is bottlefed with milk why?
a) Mother's working g) Mother sick
b) Mother pregnant h) Mother went away
c) Insufficient milk i) Convenience
d) Breast problem j) Other
e) Belief own milk bad k) Don't know
f) Baby refused breast
7. What milk is generally given in bottlefeeds at present?
a) Infant formula
b) Full cream powder milk
c) Evaporated milk
d) Condensed milk
e) Other
f) Don't know

Children on solids

8. At what age were solid foods introduced to the child?
What foods were first offered?
9. What did the child eat and drink yesterday from:
 - a) rising to midday
 - b) midday to 5pm
 - c) 5pm to retiring

APPENDIX II: Summary of Past Surveys conducted in Tonga
pertaining to Dietary Habits.

- 1) Researcher Langley (South Pacific Health Services)
 Year of Study 1952
 Location of Study Kolovai, TONGATAPU
 Type of Study Quantitative Food Record for 24-hour intake (No Data for Sundays)
 Diet of 3 Infants observed and recorded for 3 consecutive meals
 No./Group Studied 6 Households chosen from total of 90 in Kolovai including 22 adults (over 16 yrs) 27 children (1-15 yrs)
 Basic Findings Calorie Intake: (Average per Head) 3290 cal. Daily grouping by sex or age. Thus the figure does not refer to only adult food intake. Requirements vary as to sex age. Adult calorie intake more than adequate.
 Protein Intake: (Average per Head) 69 Grams daily great percentage of protein from vegetables sources. Some lack of riboflavin, other nutrients adequate Cassava most commonly consumed staple, bread also common.

- 2) Researcher Whiteman (South Pacific Health Services)
 Year of Study 1956
 Location of Study Ha'afeva, HA'APAI
 Type of Study Quantitative Food Record of 5 days (Sunday included)
 No./Group Studied 8 Households
 Basic Findings Diet Adequate with some lack of Vitamin A. Depended on whether Lesi and Lu were eaten. Breadfruit most important staple and supplied much of iron, Vitamin C and Calcium. Kape second most important staple.

- 3) Researcher Jansen (WHO)
 Year of Study 1972
 Location of Study Nuku'alofa, Ha'apai and Vava'u
 Type of Study Quality Survey 24-hours Recall
 No./Group Studies 636 School Children
 129 Mothers
 51 Boarders and 2 Colleges
 Basic Findings Carbohydrate: Supplied mainly by tubers in Ha'apai and Vava'u. In Nuku'alofa a great emphasis on cereals. Fresh fish readily available in Ha'apai/Vava'u less total protein vegetables fruits especially at boarding schools

4. Researcher Adachi
 Year of Study 1976
 Location of Study 'Uiha Is, HA'APAI
 Type of Study Quantitative Food Record for a Thursday and Sunday
 No./Group Studied 16 females
 6 males
 Basic Findings Calorie Intake: Very high. 6 Females with over 3.000 cal. daily and 4 males over 4.500

over 3.000 cal. daily and 4 males over 4.500

APPENDIX II cont'd

daily

Protein Intake: High. 9 Females and all males with over 45 grams daily; 60 % of protein was of animal origin

Daily Vitamins/Minerals: Some lack of Vitamin A. Other nutrients adequate

Daily Foods: Cassava, coconut and fish most important foods in diet

New Foods included: sugar, salt, soft drinks.

Almost all satisfied with their diets

- 5) Researcher Adachi
 Year of Study 1977
 Location of Study 'Uiha Is. HA'APAI
 Type of Study Quantitative Food Record for a Thursday and Sunday
 No./Group Studied 60 Females and males
 Basic Findings Diet adequate with exception of Vitamin A. Energy intake high. No Protein deficiency. Sugar one of the most frequently consumed foods as to imported foods. Very few new foods

- 6) Researcher Tonga National Council of Church
 Year of Study 1978
 Location of Study All six Island Groups of the Kingdom, Tongatapu, 'Eua, Vava'u, Niuatoputapu, Niuafu'ou and Ha'apai
 Type of Study Household Dietary recall for Particular Questions
 No./Group Studies 724 Households mostly Rural Poor (representing 5.3 % of Kingdom's total no. Households)
 Basic Findings Meal Patterns:
 54.2 % of Households had two meals daily,
 41.7 % had three meals daily.
 57.5 % of households had one meal daily with animal protein.
 39.1 % had none,
 83.5 % of households had pork/beef or chicken 1-3 times weekly
 79 % of households had fish/shellfish 1-3 times weekly.
 45.1 % of households had jellyfish or sea slug 1-3 times weekly

- 7) Researcher Duttaroy (MINISTRY OF AGRICULTURE FORESTRY AND FISHERIES)
 Year of Study 1980
 Location of Study 3 Strata
 1. Urban Tongatapu
 2. Rural Tongatapu
 3. Outer Islands (including 'Eua, Vava'u and Ha'apai)
 Type of Study Household Dietary Record for one week
 No./Group Studied 208 Households (representing 1.5 % of

Kingdom's total no. households)
 APPENDIX II (cont'd)

Basic Findings

Reliance on foods produces by own household:
 30 % in urban Tongatapu, 63 % in rural
 Tongatapu and 80 % in outer Islands
 Of Locally produced foods:
 rootcrops provided 65 % of energy, next came
 coconut and hopa
 Of Imported foods:
 flour and sugar most important followed by
 mutton flaps
 Of root crops:
 Taro futuna most popular in outer Islands.
 55% of rootcrops consumed in urban Tongatapu
 was purchased in outer Islands such purchase
 negligible. 40% of expenditure on local
 foods was on rootcrops
 Daily Per Capita Calorie: (2,700 cal.) with
 1,850 cal. local food, rest from import
 Annual per capital Household Intakes:
 For fish: 25.6 kg in outer Islands, 19.2 kg
 in rural Tongatapu and 13.5 kg in urban
 Tongatapu. Less important local animal food
 included pork, beef and chicken in that
 order.
 For rootcrops:
 highest intake in outer Islands

- 8) Researcher Borrelli & Malolo (MINISTRY OF HEALTH)
 Year of Study 1982
 Location of Study Group H: Ha'apai areas
 Group T: Tongatapu (West plus Sopa) areas
 Contro: Tongatapu (Fua'amotu areas)
 Type of Study 24-Hours Dietary. Recall of foods eaten
 before and after the Hurricane
 No./Group Studied 631 Children of 0-5 years old
 Basic Findings Great lack of fruits and vegetables in the
 diet both before and after the Hurricane.
 Drop in consumption of fruits/vegetables and
 starchy fruits after Hurricane. Tendency
 toward flour and imported energy food
 sources, particularly in Tongatapu
- 9) Researcher Clark (independant)
 Year of Study 1978
 Location of Study Urban Nuku'alofa, rural areas in major
 Island groups
 Type of Study 24-Hours Dietary. Recall for children
 subjects. Household food consumption on
 frequency per week of particular foods
 No./Group Studied 265 Children, 2-5 years old.
 Households of those children
 Basic Findings Diets of children in Urban areas inferior, to
 diets rural areas.
 Households for consumption of sugar: average
 1.18 pound/week in urban. Average .57
 pound/week rural area.

APPENDIX III: Summary of Past Surveys in Tonga Pertaining to Nutritional Status.

- 1) Researcher Langley
 Year of Study 1952
 Location of Study Tongatapu
 Type of Study Age; Weights; Heights.
 No./Group Studied 42 infants in Kolovai
 622 children 2-16years
 224 adults 17 and over
 Basic Findings Infants did well up to 7 months (as compared to SPC reference standards). School children seemed adequate. Adults - suggested to be tall and heavy.

- 2) Researcher Whiteman
 Year of Study 1956
 Location of Study Ha'afeva, Ha'apai
 Type of Study Age; Weight; Clinical exam.
 No./Group Studied 8 families
 Basic Findings All women overweight except 2. Some clinical signs of Vitamin A deficiency found.

- 3) Researcher Jansen
 Year of Study 1972
 Location of Study MCH centre in Tongatapu, Ha'aapi and Vava'u. Government primary schools. Adult out-patient clinic at Vaiola hospital (Nuku'alofa)
 Type of Study Age; Weights; Heights; Arm circumferences; Triceps and subscapula skinfolds; Clinical exam.
 No./Group studied 25 newborns; 285 children 0-5years age.
 1254 school children
 31 male adults
 220 female adults
 Basic Findings Birth weights adequate.
 Vast majority of children and adults well nourished.
 No cases of malnutrition for infants below 9 months of age. 3.5% malnutrition weight for age in 0-5 year age group. No malnutrition in school children as by weight for age. Obesity a problem in adults. Clinical signs related to Vitamin A deficiency seen frequently in children up to 12 years age.

- 4) Researcher Yokono and Fukushima
 Year of Study 1976
 Location of Study 'Uiha, Ha'apai
 Type of Study Age; Weight; Height; Skinfolds; Clinical exam.
 No./Group studied 119 adults chosen randomly from entire adult population of island (being 238)
 Basic Findings Health state of people excellent.
 Blood pressure constant.
 Some tendency for obesity in middle age

APPENDIX III (cont'd)

through correlation of skinfolds and body density.

- 5) Researcher Weerasinghe
 Year of Study 1979
 Location of Study Tongatapu
 Type of Study 1. Analysis of paediatric admissions 1978;
 2. Records for birth weights from Vaiola maternity ward 1979;
 3. Antenatal clinic records 1979 for haemoglobin values.
 4. Age and weight of MCH clinic children.
 No./Group Studied 114 male infants
 540 pregnant females
 72 children 0-5years age.
 Basic Findings 1) 21 cases of diagnosed malnutrition.
 2) Birth weights adequate.
 3) Anaemia quite prevalent. 10.6% of 8 mothers with Hb less than 10gms.
 4) Sample size small and difficult to interpret.
- 6) Researcher Borrelli and Malolo
 Year of Study 1982
 Location of Study 1. Ha'apai: areas hard hit by Hurricane Isaac
 2. Tongatapu: areas hard hit by Hurricane Isaac.
 3. Tongatapu: Fua'amotu area.
 Type of Study Age; Weight; Height: Clinical exam.
 No./Group Studied 887 children: 0-5years old.
 Basic Findings Weight for age: from 2.2 to 5.9% of children in all three groups had low values (lower than two S.D. of WHO median.
 Height for age: 7.9 to 9.3% low values (less than 2 S.D. of WHO median.
 Weight for Height: from 4 to 5.4% low and 4.3% to 7.6% excess. No analysis reported for percentage of malnutrition as by age group. Clinical signs of malnutrition more common in Western District and Sopa areas on Tongatapu.

APPENDIX IV: Classification of Foods for Dietary Recall

Tongan Staples

Cassava, Yam, Taro, giant Potato, sweet Potato, Potato, Plaintain, green Banana, Chestnut, ma Tonga (scraped cassava mixed with coconut cream), Breadfruit.

Imported Staples

Bread, Tongan Donut, Buns, Small Cakes, Vermicelli, Noodles etc., Spagetti and other Pasta, Rice, cabin Crackers, other Biscuits, breakfast Cereals - e.g. Oatmeal, Weet Bix.

Tongan Fat

Coconut cream, fat from Pork meat

Imported Fat

Butter, Margarine, cooking Oils, Dripping

Tongan Protein

Fish - reef and deep sea, all Shellfish, Crustaceans and Seafood, Pork, Beef
Goat, chicken, Horse, Egg, fresh Milk, fresh Cream, roasted Peanuts.

Imported Protein

Muttonflaps, tinned Fish, tinned Corned Beef, Sausages, Cheeses, salted Beef, longlife Milk and powdered Milk.

Greens

Taro, Pele (edible hibicus), sweet Potato, Pumpkin, Dendelion leaves, Chinese Cabbage, English Spinach.

Other Vegetables

Corn, Pumpkin, Tomatoes, Carrots, Lettuce, Cucumber, Beans, Zucchini, Capsicum, Onions.

Fruits/Fruit juice

all fruits - both local and imported

all fruit juices - both locally made and imported

Sugar snacks

all Sweets, Sugar added to bevarages (included additions to both tea/coffee etc. and fruit drinks, milk etc.), Sugar added to all baked products, Sugar included in frozen ice, confections, e.g. iceblocks, icecream etc., Jellies, jams, marmelades etc., Milo and cocoa.

APPENDIX IV (cont'd)

Other Snacks

All packaged snack type foods - e.g. 'twisties', 'bongo's, etc.
raw peanuts

Other

Additives such as soy sauce, tomato sauce, curry etc. Any other food items that did not fit into an above category

Alcohol

All alcoholic beverages consumed

* N.B. the addition to salt at all meals was assumed to be a national habit and so specific coding was considered unnecessary.

APPENDIX V: Classification of Occupations according to
level of Physical Activity

1. Professional A - Doctors, Nurses, Health Officers, Senior Staff, Ministers, Directors and Managers (of shops, farms, offices), Teachers, Lawyers, Church officials, Army officials, Police and Parliamentarians
2. Professional B - Typists, Secretaries, Clerks, Sales people (market, shops), Church lay ministers, Drivers, Handicraft makers, Office workers
3. Farming, Fishing, Roadwork, Construction, Carpenters, Boat builders, Army personnel (non officers), cargo workers
4. Domestic duties - housecleaning, washing, housestaffs, cleaners
5. Non-employed
6. Students; other

APPENDIX VI.

Anthropometric equipment and used
procedures in fieldworkHeight:

The procedure used for measuring the height of both males and females was the same. Height measurements was also taken for children 24-59 months old.

Equipment used: measuring stick (locally made; wooden)

Procedure

- * The measuring stick was placed on a level piece of ground, with the headboard at the top of the measuring stick.
- * The man or the woman stepped onto the footboard with no shoes on and placed his/her back against the measuring stick, with the back of his/her head resting flatly against the measuring stick. His/her heels, back and head were placed flatly up against the measuring stick
- * The headboard was brought down lightly but firmly to the top of the person's head. The recorder recorded the height in centimetres, where the headboard came to.

Length:

This procedure was used for measuring the children from 0-23 months only.

Equipment used: Length measuring board

Procedure:

- * The lengthboard was laid horizontally on the ground or a low bench
- * With the help of the recorder, the infant was placed undresses and barefoot on the board with its head right against the fixed end of the board
- * The mother was asked to gently hold the infants head at the fixed end of the board with infants eyes looking straight up. The infants knees were held together and the legs extended out straight, with the feet flexed at right angles placed flatly up against the footboard. Both heels were brought into contact with the footboard
- * The measurer removed the childs' feet from contact with the footboard with one hand to prevent the child from kicking and moving the footboard, while holding the foot-board securely in place with the other hand.
- * The length was then read to the nearest 0.1cm. The measurement was repeated until 2 readings agreed to within 0.5cm. The second measurement was the one taken.

APPENDIX VI (cont'd)

Weight:

All children 0-4 years were weighed using the hanging scales.
All adults were weighed using the flat bathroom scales.

Children 0-4 years (0-59 months)

Equipment used: Hanging infant weighing scales (salter type) with trousers.

Procedure:

- * The scale was usually suspended from a firm point e.g. beam of a roof, branch of a tree. When no such point was available, the recorder stood on a raised object and held the scale up whilst measurement was taken. The scale was suspended so that it hung with the dial at eye level for the nurse to read easily and accurately.
- * The scales were zeroed before every child was weighed. This was done by zeroing the scale with the weighing trousers on it.
- * Infants were completely undressed and nappies removed. Older children were normally undressed as well. The nurse held the trousers open while the mother placed the child in the weighing bag.
- * The child was allowed to hang freely so that his feet did not touch the ground. When the child was hanging freely the weight was read to the nearest 0.1kg, reading up to the next higher 0.1 kg when the pointer tip was at or beyond the midway point of a 0.1 kg graduation.

Adults: Men and Women

Equipment used: 'Seca' portable weighing spring scales.

Procedure:

- * The scales were placed on firm, level ground and zeroed. The scales were zeroed before each adult stood on the scales, and after each fieldtrip to main divisions the scales were calibrated with a standard weights.
- * Adults wore only light clothing.
- * The adults stood with their feet completely on the black pad of the scales facing towards the dial. They stood upright and did not lean over or look at the dial while the measurement was taken. The nurse told them their weight after recording was complete.
- * To take the measurement, the nurse leant down so that she was looking directly over the dial from the side or front of the scales and read the measurement to the nearest half kilogram. The dial was divided into one kilogram markings.