SOUTH PACIFIC COMMISSION



# NUTRITIONAL PROBLEMS IN THE PILOT AREA OF AITUTAKI (COOK ISLANDS)
(13-22 January 1975)

by

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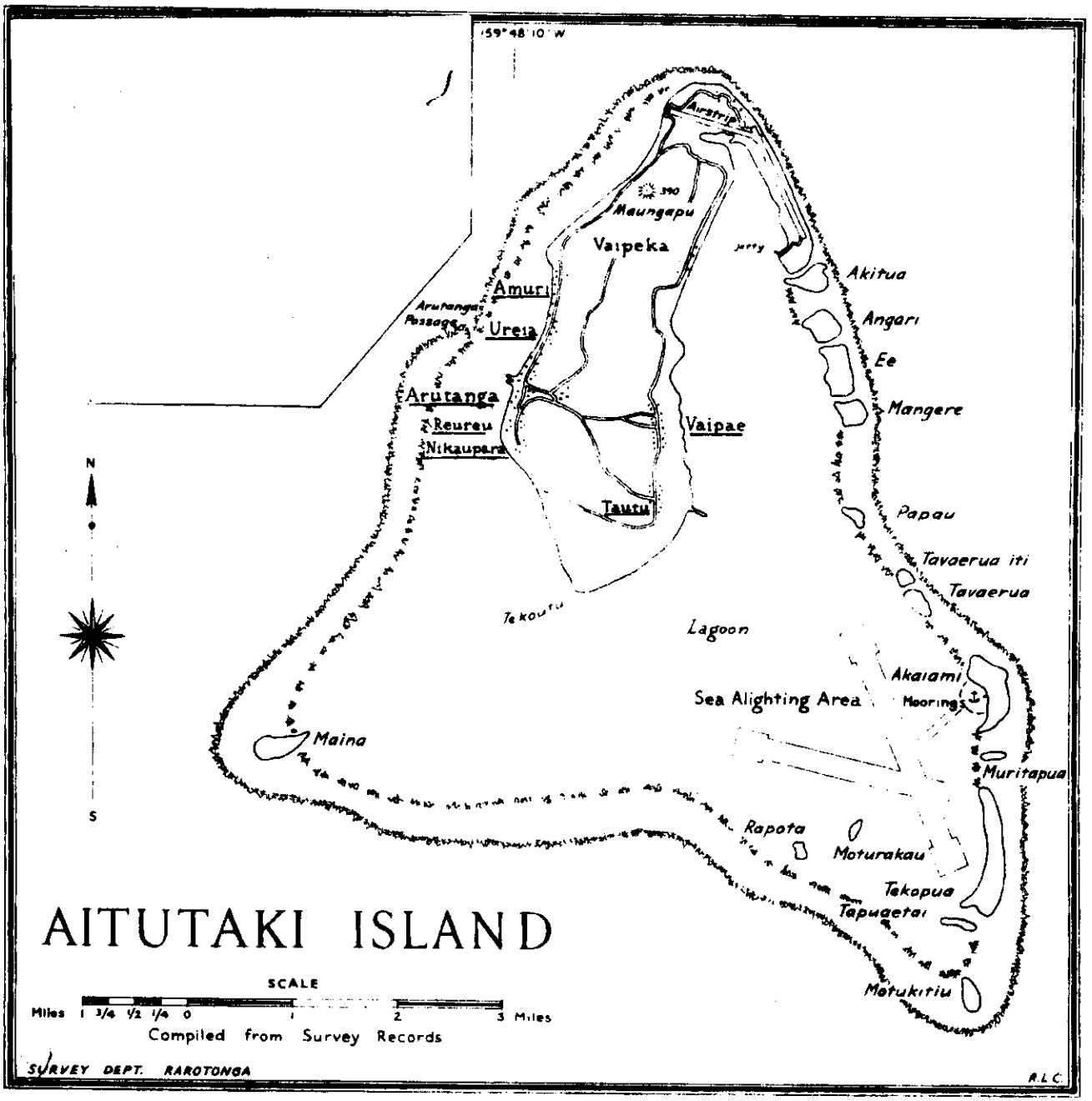
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Compiled from Survey Records
SURVEY DEPT. RAROTONGA
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# CHAPTER I

## GENERAL INTRODUCTION

### 1. The SPC Pilot Areas

In accordance with the recommendations of the Twelfth South Pacific Conference (1972) and of the Fourth Conference of Directors of Territorial Health Services (1973), it was decided that the objectives of the long-term Special Project on Nutrition should include surveys, progress reports and specific action programmes in pilot areas.

These pilot areas were of necessity limited in number :

- firstly, by the limited staff and funds available for the multidisciplinary special project on nutrition;
- secondly, by the time factor. Merely identifying problems is not enough; and field studies, the sorting and utilisation of the resulting data, courtesy and technical visits, and the initiating of action programmes are a very time-consuming business.

The final choice of pilot areas was made on the basis of Government agreements in accordance with the wishes of Public Health Directors.

However, the South Pacific is enormous, and its tiny country and island communities, as well as its urban and semi-urban areas, are extremely diverse. As a result, the pilot areas cannot be claimed to be representative. Our method should rather be considered as a random sampling, a piecemeal completion of information previously acquired by organisations such as the SPC in the fields of nutrition (aspects of public health), and food consumption, production and hygiene. In other words, pilot areas were chosen not in such a way as to provide material of statistical interest, but to facilitate comparison between areas which differ geographically, ethnically, and in terms of their specific problems, whether identified or merely suspected. The study covers and compares a Melanesian group in the New Hebrides and a Polynesian group in the Cook Islands.

In the Condominium of the New Hebrides, the areas selected were the little village of Tautu, near Lakatoro (British influence, Presbyterian), and the Wala-Rano group of villages (predominantly under Catholic influence), on Malekula Island.

A further survey was made in Tagabe, an area of immigration in the suburbs of Vila.

### 2. The choice of Aitutaki

This was made by decision of the Ministry for Health of the Cook Islands, following a proposal by Professor Racult based on the following considerations:

- Until then, information on local nutrition and diet, developments in nutritional education, specific sanitation projects, and the development and channelling of food production had been limited to Rarotonga. This was an opportunity to go further afield.

- The local Public Health Centre offered organisational facilities; demographic and statistical information was already available; the geographical ground work had been done by W.H.O. during the anti-filariasis campaign, as well as the coding of houses and families; the island was already covered by a Maternal and Child Health (MCH) system.

- A hybrid economy, in the intermediary stage between the traditional subsistence economy and a market economy.

- Problems arising from the emigration of a substantial part of the working population.

- Large population and high density, conducive to sampling for purposes of deduction.

- Possibility of concrete action programmes in the fields of:

- Nutritional education (in liaison with the Departments of Education and Public Health).

- Improved sanitation.

- Food production, in particular fisheries.

Such programmes require co-ordination with the appropriate Government Departments and SPC Projects (Social - Economic - Agriculture - Fisheries), and in addition cannot not be seriously considered until initial feasibility studies have been drawn up. The risk of error or confusion of objectives would otherwise be too great.

3. Documentation and References

- SPC Medical Documentation Centre.

- Library and Health Statistics Centre, Cook Islands Ministry for Health.

- Conversation with the public health authorities and staff at Avarua, Cook Islands.

- Visits and conversations with the medical staff at the general hospital, the out-patient clinic, and MCH unit.

- Visit to the dental department.

- Conversation with Aitutaki medical and para-medical staff.

## 4. Training of Survey Staff

A survey on the state of nutrition in Rarotonga, organised by the Director of Public Health, was carried out from 16 to 20 December, 1974 with the help of Mrs Poko Nicholas, Chief Nurse, Health Inspector T. Ringiao and his wife Mrs T. Ringiao (Staff Nurse), and three District Nurses. Ten families - 250 persons in all - from different parts of Rarotonga underwent measuring and clinical examinations. First, the staff were familiarised with survey methods, clinical examination procedures and the use of forms with a view to the coming survey in Aitutaki. Findings will be presented in a separate report.

## 5. Geographical Information

Aitutaki is a small volcanic island in the Southern Cooks, 140 miles north of Rarotonga. It is surrounded by a coral reef and has a large lagoon. The island is fertile and has more abundant resources in fish than any other in the group. Its coconut palms are highly productive, in particular the dwarf variety. Under the Government Agricultural Plan, there is extensive orange and banana production, most of which goes to the export market. The population is Polynesian, and has remained homogeneous. According to the 1973 Census, total population is about 3,000. However, workers emigrating to New Zealand are to an increasing extent being followed by their families, with the result that the permanent population is only about 2,000, and even this figure varies. It comprises a majority of elderly people, under 15's, and wives who have not yet followed their husbands abroad. The island has an aerodrome and there are daily flights to Rarotonga. In addition, a boat from Rarotonga calls every two weeks. However, weather conditions tend to make the schedule a haphazard one, as the small boats used for loading and unloading are sometimes unable to pass the reef.

Aitutaki comprises eight civil districts which differ slightly in terms of the activities of their inhabitants.

Arutanga on the west coast is the administrative and commercial centre. It has the island's only wharf, but the latter is accessible only by a narrow pass through the reef.

The residential quarters Ureia and Amuri, in view of their standard of living and dietary patterns, may be considered as part of Arutanga.

Vaipae, sited on the east coast and the lagoon, is the agricultural district. Tautu, in the south-east, is also a rural village.

Reureu and Nikaupara, on the western shores of the lagoon, are essentially fishing villages. The airport staff and their families live in the district of Vaitupa, near the aerodrome.

## 6. Foods and Diets in Aitutaki

### (a) Foods available

#### (i) From home gardens

**Starchy roots :** Kumara
Arrowroot (main food made into flour for export)
Taro
Taro tarua
Yams
Banana
Breadfruit

**Fruits :** Pawpaws
Oranges
Mangoes
Avocadoes
Custard apples
Passionfruit
Mandarines
Pineapples

**Vegetables :** Lettuce
Tomatoes
Green beans
Cucumbers
Egg plants
Carrots
Cabbage (Chinese or European)
Pumpkin

**Nuts :** Coconuts
Tahitian chestnuts

#### (ii) Fish and shellfish

Parrot fish, Mullet, Flying fish
Shellfish
Octopus
Lobsters

#### (iii) Meat and eggs

Pork
Chicken
Fresh meat (from freezer)
Eggs (from freezer or store)
Canned beef
Canned fish

(c) General food patterns

In general, the Aitutakians have no definite meal hours in the European sense. Hunger and food availability govern the time of eating. On the whole, the first meal is the early morning one, although many school children go to school without having had any food. The meal content varies greatly from one household to another, the underlying factor being the availability of money.

Early morning meal

Basically : Coffee, tea, cocoa
Sugar
Bread

Occasionally milk or coconut milk, butter and jam are added. Sometimes leftovers from previous meal (root vegetables, fish, green vegetables) are eaten.

Mid-day meal : Root vegetable (arrowroot, kumara, taro, taro tarua, breadfruit - mainly boiled)
or Rice
Tinned meat or fish
or Fresh fish (whenever available)
Sometimes : green vegetables (mainly rukau) and coconut cream.

Evening meal : Tea, coffee, cocoa
Sugar
Bread
Leftovers from mid-day meal.

Sometimes, canned food is used (Irish stew, spaghetti, etc.). Bread is consumed in very large amounts. Children in schools bring a piece of bread for lunch. Much snacking takes place at all ages. Fruits are practically never eaten with meals but whenever available as a snack; so are Tahitian chestnuts, bread, coconuts, sweets, soft drinks, boiled root vegetables.

The principal source of protein in Aitutaki is still fresh fish, although this has been declining as a result of :

(a) The immigration of able-bodied men to New Zealand.
(b) The availability of frozen fish and tinned meat and fish in the stores, coupled with the increase in cash holdings sent by relatives from New Zealand.

The Aitutaki lagoon is very rich in fish. However, there are families having no men or adolescents to do the fishing who do not eat fresh fish, although the women collect shellfish. When great amounts of fish are caught, many are thrown back into the sea as there is not enough freezing space. No fish preservation by salting or drying is practised.

(iv) From the stores

Milk and milk products :

Powdered whole milk
Evaporated whole milk
Condensed sweetened milk
Cheese (Cheddar)
Butter (tinned)

Fats

Butter
Dripping
Oil

Cereals

Bread
Flour
Rice (white polished)
Cabin bread
Biscuits

Sugars

White sugar
Sweets
Jam

Beverages

Coffee
Tea
Cocoa
Soft drinks
Beer
Distilled alcohol

Vegetables

Potatoes
Onions
Tomatoes

(b) Factors governing availability of food in household

(i) Income from employment or sent by relatives from New Zealand.

(ii) Presence of men in family to go out fishing.

(iii) Presence of young people able and willing to do gardening.

(iv) Family preference (a substantial part of income is spent on alcohol).

Method of cooking

Although cooking facilities have become more developed in Aitutaki, the methods of cooking have changed very little. Cooking is mainly done on an open fire or wood stove, although most families own a primus or a gas stove. The earth oven (umu) is used once or twice a week (especially over weekends for working women).

Boiling is the most common way of preparing food. Ingredients are boiled separately (taro, fish, leaves) and the water is thrown away.

Frying is not very common, and baking is usually limited to the traditional foods (pudding of breadfruit, pawpaw, banana with coconut milk, wrapped in leaves).

Storage

Small quantities of foods are stored at home. One would find coffee, tea, sugar, flour, salt, dripping. Other ingredients are bought as the need arises. Vegetables and fruits are collected from the gardens for immediate consumption. Food safes are found in most of the homes; foodstuffs are kept in them for fear of cockroaches and rats but utensils are not necessarily covered or kept in the safe.

Order of eating

On the whole, all the family eats the main meal (lunch) together. Fingers are used although cutlery is available.

The majority of people are not aware of nutritional concepts; they believe that any food given is good for the child. The toddler is left on its own to eat.

Food habits and beliefs

There is a very marked tendency towards the quick adoption of imported food (this began during the presence of American forces in Aitutaki).

Imported foodstuffs unquestionably do have prestige value. Although the island cannot be considered as having a subsistence economy, the income spent is not locally earned (it comes mainly from New Zealand). This trend is undermining the cultivation of adequate food crops for local consumption which, together with the increased production of cash crops (such as bananas, oranges, pineapples, etc), leads to a greater rate of importation of processed food with further financial stringency.

As the importance of cash increases, people move to Rarotonga and to New Zealand in search of higher pay. The result is that Aitutaki is losing its labour force and gardening is being abandoned, while people left behind are buying more and more imported foods for their subsistence.

According to the Agriculture Department, transportation and marketing are the obstacles to the development of vegetable production in Aitutaki. The seeds (of European vegetables) are costly, so unless people are convinced of the need to use them and the profit it would entail they will not make the necessary effort.

Occasionally, people do eat chicken and pork, although this mainly happens during celebrations and special occasions (umukai). If a pig is killed, it is immediately consumed.

Eggs are bought at the store. They are imported from New Zealand - if available, everyone would eat them. Hens can be seen everywhere; they are not penned because this would involve providing feed for them. No eggs are collected.

The people like corned beef best and although the price rises with the arrival of each boat, people still prefer it to canned fish.

Eating raw vegetables or cooked dark green leaves (apart from rukau), is not common. Perhaps the reason is the indigestible calcium oxalate content of the frequently used staple food. However an educational programme should be set up to encourage the use of existing dark green leafy vegetables and to demonstrate the different ways of preparing them (arrowroot and kumara tops are rich in calcium riboflavin, carotene and ascorbic acid).

Arrowroot is the main food on the island. It is easy to grow and its yield is always abundant. It is prepared in powdered form for export (mainly to be used by islanders in New Zealand).

Land owners (16-60 years) used to be fined if they did not cultivate their land; an amount of kumara was specified for family consumption (300 every two to three months, or 10 bananas, 10 taros, 10 arrowroots, 10 kumara per month for each member above 16 years) and inspections were carried out to verify this; however, it seems that this law is no longer put into practice since emigration started.

Bread is consumed in very large amounts with meals, in between meals, with coffee and tea as a snack. In its absence, cabin bread is used.

Saturday is fishing day for all salaried people. On the average a family would get fish three times a week. Men fish inside the lagoon; it is believed that any fish caught outside the lagoon may be poisonous. Both men and women collect shellfish.

There are remarkably few variations from day to day in individual diet, although some changes are taking place due to the availability of a wider variety of foodstuffs: people can buy frozen meat at the government freezer, eggs in the shops etc. Many women are good cooks and have learnt the preparation of curries, chop suey, stews, fried dishes, desserts, cakes, etc. However, these are only prepared for special occasions and umukai, when they are added to the traditional foods. But the daily menu remains very much the same:

- Boiled root vegetables
- Rukau (boiled taro leaves and coconut cream)
- Boiled fish (or canned meat)

Fish and meat are not given to babies before one year of age. This may be due to one or more of the following reasons:

- fear of poisoning (although it is not very common in Aitutaki);
- fear of bones;
- ignorance of its importance in baby diet;
- laziness of the mother where preparation of special food for the infant is involved (this was the reason most frequently given).

(d) Infant feeding practices

Whereas the Cook Island women were known to breastfeed their babies up to the age of nine to ten months (Fry, P.C.: Dietary Survey on Rarotonga, Cook Islands III, Feeding practices and growth of Rarotongan children from birth through six years, American Journal of Clinical Nutrition 5:6, November-December 1957), this trend is witnessing a drastic change; there is strong psychological pressure on women to bottle feed, the reasons for this being:

(i) Working mothers claim they do not have the time to breastfeed.
(ii) Prestige of bottle feeding.
(iii) Commercial advertisement.
(iv) Health workers unconsciously promote bottle feeding through their advice.

Often babies are left in the care of their grandmother. The reason given for this practice is that the mother is too young, she does not know how to look after the baby, she is too lazy, etc.

Whereas traditionally supplementary feeding began at about nine months with the flesh of immature coconuts, cooked mashed taro and baked fish, today the children are weaned earlier (average duration six months), and many young mothers are not breastfeeding at all (contrary to what Fry found in 1957, where "the vast majority of children under one year of age are partly or entirely breastfed"). District nurses give many directions while they are weighing babies at weekly district clinics. Instructions about food are often not followed. Almost every mother can recite exactly what foods are good for children, but many do not understand why the foods are so important. There is reluctance on the part of mothers to spend time and trouble to prepare special food for infants.

Pawpaw is the first solid food introduced (at about four to five months). Fish is introduced around the age of nine months.

Refrigeration is another obstacle. Crops are left for days and weeks waiting for the ship to come. Many are lost.

Freezers are needed for preserving the huge amount of fish that is caught with one net. With the increased number of flights to and from Rarotonga, the marketing of Aitutaki fish in Rarotonga should be developed.

(i) Foods and non-foods

Green leaves are not consumed regularly (with the exception of rukau, taro leaves). Mothers claim that children do not like to eat them, although it has been observed that it is not the habit to include them in a meal.

(ii) Prestige foods

These include any food bought at the store, all refined foods specially sweets, biscuits, cakes, soft drinks, beer, alcohol, eggs and bread.

(iii) Celebration foods

These are pig, chicken, goat (Seventh Day Adventists), fish, cakes, beef curry, chop suey (with corned beef), banana and pawpaw pudding, taro, kumara and breadfruit.

(iv) Food tabus

A pregnant woman should not eat:

octopus
coconut crab
lobster
shrimps
sea crabs.

If she does, baby will have birth marks or he will get sores.

Babies should not eat mangoes or pawpaw; they will get diarrhoea (a possible explanation for this belief is that fruits are usually eaten when they are still green).

Eggs are rarely given to babies and children. The reason might be the cost (1 doz for $1) or it might be that the habit of consuming eggs is recent.

Milk is not given to children after one year of age. It can be added to coffee or tea but it is not believed to be a food.

Taro, kumara, bread, tinned meat, taro leaves and tea are the main baby foods. It is very rare to find a mother preparing special food for infants, and babies' diet is very monotonous. If a baby refuses any new food, the mother stops offering it to him since "he hates it". There is a very big need for an educational campaign to explain:

(i) The necessity of supplementary feeding and how it affects the development of the baby.
(ii) How new food should be introduced.
(iii) Food hygiene; (water from tanks is not pure in dry season - gastro enteritis).
(iv) Importance of continued breast feeding or giving milk to babies (since the moment the baby starts eating, milk is suppressed and tea is substituted).
(v) Value of dark green leafy vegetables and fruits for infants and children.
(vi) Early and adequate feeding of fish (since it is the source of protein most likely to be available).
(vii) Importance of checking on food eaten by a child once he is over a year old. At this age he is usually treated as an adult and left to manage for himself, he has to compete with adults and siblings for a share of the food at meal time; as a result, he does not get enough of the nutritious parts of the meal. At any rate, children learn quickly to find food for themselves and eat heartily whenever the opportunity arises. (Fry, Ibid).

Contrary to what Fry found out, that "eggs are almost never consumed by Maoris", if they are available, anyone, at any age, would eat them. Judging from observations and discussions, there appear to be very few rigid cultural rules as to child care and feeding. The time of introduction of supplementary foods seems largely an individual matter, and there is great variation in the amount of time and trouble a mother is willing to spend on the preparation of baby food.

(e) Recommendations

In the Cook Islands there is no shortage of nutrients in the traditional diet. The impact of urbanisation is creating a great dependence on imported foodstuffs and, together with economic limitation, this gives rise to nutritional problems, mainly malnutrition in children, obesity and its complications in adults.

If we analyse the situation, we find the following problems:

(i) Ignorance of the importance of proper diet and of the nutrient concept (mothers think any food a child eats is good for it. The result is malnourished children. Although the number of cases manifesting severe clinical syndromes is not large, it is likely to increase. The mild cases run the risk of being unnoticed, this leading to physical and mental retardation and lowered resistance to infection).

(ii) Heavy dependence on refined foods, resulting in rapid increase of dental caries.

(iii) Occurrence of specific deficiencies in certain dietary requirements, resulting from the restricted range of local foodstuffs and aggravated by dependence on imported foods: iron deficiency, vitamin A, riboflavin).

It can be assumed that sufficient foodstuffs can be produced locally to meet population requirements for some time to come. The major problems to be overcome are those of production, transporting, and marketing local foodstuffs, and education of the population in adequate dietary habits, particularly in children.

* * *

# CHAPTER II

## STUDY OF THE NUTRITIONAL STATUS OF THE INHABITANTS OF AITUTAKI

### 1. Organisation and Methods

The Aitutaki survey team comprised:

- Professor André Raoult (clinical examination)
- Dr Anja Niiranen, Pediatrician (measurements and clinical examination of children aged 0 to 5 years)
- Dr T. Raea (assisted Professor Raoult with measurements and clinical examination)
- Health Inspector T. Ringiao (collection of information and questioning)
- Staff nurse T. Ringiao
- District nurses K. Mataiti and T. Ratu
- Miss Bushra Jabre took part in all operations, gathering information for her own study.

### 2. Procedure

Notices were prepared, as was the 1973 Census, on the basis of indexed family cards which were originally used for the anti-filariasis campaign, and have been kept up to date for the last five years.

Where dates of birth were found to be false, they were corrected for all persons of up to 18 years of age.

Testing and examination took place in an appropriate building, generally the Community Centre or Well Baby Clinic.

The survey took place in an orderly and cheerful manner. In so far as prior commitments allowed, the inhabitants did their best to be present. There was very little absenteeism in terms of the population generally to be found on the island at this time of the year. The Field Survey lasted a total of eight working days from 13-22 January 1975.

### 3. Chronology

10 January : arrival of Professor Raoult and Dr Niiranen; meeting with Dr Terepoi Macate to discuss arrangements.

11 January : arrival of Miss Bushra Jabre.

13 - 22 January : examination of the inhabitants of Vaipae-Tautu-Nikaupara-Reureu-Arutanga-Ureia-Amuri in the respective village meeting rooms. Departure had been planned for 25 January, but bad weather delayed the boat. The team remained on Aitutaki until 31 January, visiting the island and continuing technical discussions. During his four-day trip by sea to Aitutaki, Professor Raoult visited Atiu, Mamae and Mitiaro.

4. Analysis of survey group compared with 1973 census findings

Replies were received from 1,456 people. This may be considered as equivalent to the total number of persons on the island at the time.

Age Distribution

- 0-5 years: 20 per cent
- 5-12 years inclusive, i.e. normal school age: 33.9 per cent
- 13-17 years, i.e. puberty and adolescence: 13 per cent
- 18-50 years - working population: 22.4 per cent
- Over 50 years - elderly: 10.2 per cent

Sex

Distribution by sex was even up till age 12 (386 M/399 F). In the working age group, however, there is a substantial female majority (224/102); this results from predominantly male emigration to New Zealand. Beyond age 50, distribution was 67 M/82 F. Women of child bearing age (18/50) made up 15.4 per cent of the population (224). During the year covered by the Survey (February 1974 - February 1975) there were 61 births. There were 164 infants at the vulnerable stage (6 months - 3 years), and 174 in the pre-school group (3-6 years inclusive).

Comparative analysis of survey group and 1973 Census Data:

| Census | | Survey Group | |
|---|---|---|---|
| 0 - 1 year : | 100 | 0 - 1 year : | 61 |
| 1 - 3 years : | 200 | 1 - 3 years : | 131 |
| 3 - 5 years : | 214 | 3 - 4 years : | 105 |
| Total 0 - 5 years : | 514 | Total 0 - 5 years : | 297 = 57.8 per cent of 1973 population |
| 5 - 9 years : | 567 | 5 - 8 years : | 187 |
| 10 - 14 years : | 458 | 9 - 12 years : | 307 |
| 15 - 19 years : | 204 | 13 - 17 years : | 189 |
| | | 18 - 20 years : | 47 |
| Total 5 - 19 years : | 1,229 | Total 5 - 20 years : | 730 = 59.4 per cent of 1973 population. |

| Census Adults | | | Survey Group | | |
|---|---|---|---|---|---|
| 20 - 30 years | : | 416 | 20 - 30 years | : | 104 |
| 30 - 40 years | : | 250 | 30 - 40 years | : | 96 |
| 40 - 50 years | : | 179 | 40 - 50 years | : | 79 |
| 50 - 60 years | : | 145 | > 50 years | : | 149 |
| 60 - 70 years | : | 166 | | | |
| 70 - 80 years | : | 29 | | | |
| > 80 years | : | 7 | | | |
| Total adults | : | 1,192 | | | 428 = 35.9 per cent of 1973 population. |
| TOTAL | : | 2,935 | TOTAL | : | 1,455 = 49.6 per cent of 1973 population. |

5. Clinical Information

Data was gathered directly on SPC information slips for processing by machine, and was interpreted by Professor Raculi. Symptoms are divided into primary and secondary sections.

There is a certain element of subjectivity on the part of the operator; this is inevitable with a method of this type. In addition, the nature of the system precludes description of all variations. However it simplifies classification and assessment.

The so-called key symptoms are intended only as a guideline. These symptoms are not totally specific, but by classifying them into syndromes a better demonstrative effect is achieved.

We complied with the recommendations of The Assessment of the Nutritional Status of the Community (WHO, Geneva, 1966) as published by D.B. Jelliffe in WHO Monograph No. 53.

Nutritional deficiencies are in many cases arranged in associated groups.

No biochemical information was available at this stage at Aitutaki. This type of field survey, using local personnel, should therefore be considered as an exercise in sorting and selection; as such, it was useful for field training of nursing staff. In addition, it led to the identification of the main nutritional problems in the field of public health and to the formation of practical conclusions.

6. Measurements

Interpretation of graphs : The graphs are collective, and refer to overall situations. Individuals are shown by points in relation to two parameters. For example : weight according to age; age as horizontal axis; weight as vertical axis.

A coding system is used to highlight noteworthy facts. For example : X Parotidosis. The key to such symbols is given under each graph. Reference curves are given so as to facilitate classification in relation to distributions and averages recommended by WHO, following large-scale surveys in the United States (Iowa). These references may not be automatically applied to local distributions and averages, since the latter cover all individuals, including many deficient cases. Each individual is represented by a point, and may thus be related to his local average. This simplifies comparison with information from other regions or countries.

Findings should not be construed as value judgments; their purpose is to facilitate comparison within the South Pacific, and classification by degrees. Body measurements are expressed in the metric system, in accordance with recognised international practice.

The following references are used :

Height - Weight : 0-5 years : research by Howard V. Meredith (Iowa Child Welfare Research Station) described in Waldo E. Nelson - Textbook of Pediatrics.

Thickness of skinfold - Arm circumference. In : D.B. Jelliffe, The Assessment of the Nutritional Status of the Community (WHO Monograph No. 53, 1966).

Head circumference. In : Growth and Development of Children (E.H. Watson, G.H. Lowrey from recent sources including Stuart and Simmons).

Obesity. In : Obesity, Nancy L. Wilson quoting Behnke.

In Each overall graph, a comparison is made between the group mean and the WHO standard (P 50).

Extreme cases are defined in terms of percentile P 3 (low) or percentile P 90 (high) of a normal distribution. Alternatively, they are classed as - for example - 120 per cent of P 50 (high) or 80 per cent of P 50 (low).

Measuring techniques

Weight from 0-5 years; weight calculated in hectograms with a suspended scale. Above 5 years: bathroom scale with 0.5 kg precision.

Height (length) from 0-3 years, length was measured in a prone position, with a measuring device of 1 cm precision. Above 3 years: standing height, barefoot.

Skinfold calculated to within one mm, using a Harpenden Dial Caliper - British Indicator.

Head circumference: tape measure, to within one mm.

Blood pressure: auscultation with a Vaquez Laubry gauge.

Age groups

In accordance with the manual of the WHO Western Regional Office (Manila), the following age groups were adopted :

| | | |
|---|---|---|
| 0 - 5 months | : | infants |
| 6 - 11 months | : | infants |
| 1 - 3 years | : | toddlers |
| 4 - 6 years | : | pre-school |
| 7 - 12 years | : | school age |
| 13 - 17 years | : | adolescents |

* * *

FIGURE A

COOK ISLANDS : AITUTAKI : POPULATION EXAMINED — FEBRUARY 1975

ILES COOK : AITUTAKI : POPULATION EXAMINEE — FEVRIER 1975

| | ARUTANGA - UREIA - ANURI Urban Quartiers urbains | | | NIKAUPARU - REUREU Fishermen Pêcheurs | | | TAUTU Mixed Cultivateurs - Pêcheurs | | | VAIPAE Cultivators Cultivateurs | | | T O T A L | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age group Groupe d'âge | M | F | T | M | F | T | M | F | T | M | F | T | M | F | Total | % |
| [illegible] - 6 m | 5 | 4 | 9 | 3 | 5 | 8 | 3 | 2 | 5 | 1 | 5 | 6 | 12 | 16 | 28 | |
| [illegible] m - 1 y | 6 | 7 | 13 | 6 | 2 | 8 | 2 | - | 2 | 3 | - | 10 | 17 | 16 | 33 | |
| 0 : 0 - 1 y | 11 | 11 | 22 | 9 | 7 | 16 | 5 | 2 | 7 | 4 | 12 | 16 | 29 | 32 | 61 | 20 % |
| 1 - 3 y | 21 | 28 | 49 | 12 | 10 | 22 | 11 | 9 | 20 | 22 | 18 | 40 | 66 | 65 | 131 | |
| 3 - 4 y | 16 | 15 | 31 | 13 | 12 | 25 | 9 | 7 | 16 | 20 | 13 | 33 | 58 | 47 | 105 | |
| 5 - 6 y | 16 | 21 | 37 | 8 | 2 | 10 | 5 | 4 | 9 | 2 | 11 | 13 | 31 | 38 | 69 | |
| 7 - 8 y | 23 | 23 | 46 | 9 | 13 | 22 | 2 | 7 | 9 | 21 | 21 | 42 | 54 | 64 | 118 | 29,2 % |
| 9 - 12 y | 66 | 59 | 125 | 25 | 30 | 55 | 30 | 25 | 55 | 33 | 39 | 72 | 154 | 153 | 307 | 33,9 % |
| 7 : 7 - 12 y | 89 | 82 | 171 | 34 | 43 | 77 | 32 | 32 | 64 | 54 | 60 | 114 | 209 | 217 | 426 | |
| 13 - 17 y | 38 | 33 | 71 | 16 | 34 | 50 | 16 | 10 | 26 | 8 | 34 | 42 | 78 | 111 | 189 | 13 % |
| Total young Total jeunes | 191 | 190 | 381 | 92 | 108 | 200 | 78 | 64 | 142 | 110 | 148 | 258 | 471 | 510 | 981 | 67 % |
| 18 - 20 y | 9 | 21 | 30 | 4 | 2 | 6 | 5 | 1 | 6 | 4 | 1 | 5 | 22 | 25 | 47 | |
| 20 - 30 y | 12 | 37 | 49 | 6 | 11 | 17 | 5 | 11 | 16 | 5 | 17 | 22 | 28 | 76 | 104 | |
| 30 - 40 y | 7 | 26 | 33 | 6 | 15 | 21 | 5 | 14 | 19 | 6 | 17 | 23 | 24 | 72 | 96 | 22,4 % |
| 40 - 50 y | 13 | 25 | 38 | 6 | 12 | 18 | 3 | 7 | 10 | 6 | 7 | 13 | 28 | 51 | 79 | |
| > 50 | 29 | 37 | 66 | 12 | 20 | 31 | 15 | 10 | 25 | 12 | 15 | 27 | 67 | 82 | 149 | 10,2 % |
| Total adults Total adultes | 70 | 146 | 216 | 33 | 60 | 93 | 32 | 43 | 76 | 33 | 57 | 90 | 169 | 306 | 475 | |
| Total general Total général | 261 | 336 | 597 | 125 | 168 | 293 | 111 | 107 | 218 | 143 | 205 | 348 | 640 | 816 | 1456 | |

# CHAPTER III

## STUDY OF NUTRITIONAL STATUS DURING GROWTH

In order to give a clearer presentation of the conclusions for each main age group, this study is divided into the following sub-chapters:

- 0 - 3 years : Infants in this group are vulnerable, and growth and state of nutrition must be carefully watched. This age bracket corresponds to a nutritional (weaning) crisis, which influences subsequent development.

- 3 - 5 years : (pre-school) : here the incipient consequences of the nutritional crisis may be observed. This is the post-critical recovery phase.

- 6 - 12 years (primary school) : this is a period of slow growth, during which the child is under the control and the responsibility of the educational authorities, and in which his dietary habits and his environment undergo a change.

- 13 - 18 years (puberty and adolescence) : this period is marked by a further (and critical) gain in height and weight, and development of secondary sexual characteristics. It is a period of learning and preparation for adult life.

N.B. : Each group comprises a study of both body measurements and clinical data.

### 1. Infants from 0 to 3 years inclusive

| | | | |
|---|---|---|---|
| Infants examined : | 0 to 6 months | : | 28 (12 M - 16 F) |
| | 6 to 12 months | : | 33 (17 M - 16 F) |
| total | (0 to 12 months) | : | 61 (29 M - 32 F) |
| | 1 to 3 years | : | 131 (66 M - 65 F) |
| total | (0 to 3 years) | : | 192 (95 M - 97 F) |

N.B. : A theoretical distinction is made between infants above and below 12 months.

#### (a) Body measurements

These were the work of Dr Anja Niiranen, SPC Consultant Pediatrician, and were gathered during a growth study of South Pacific children aged 0 to 5 years. Here we shall quote only information which is essential for evaluating the state of nutrition.

(i) Weight - Although subject to accidental and temporary variations, this is the parameter most frequently used in health assessment by the mobile MCH units in Aitutaki and Rarotonga. During the survey period, there was practically no sign of seasonal diarrhoea, nor was there a measles epidemic; however, a small outbreak of whooping-cough was noted at Vaipae.

Weight of boys (Graph No. 1)

Until the age of one year, the median weight was well above the Iowa standard (P 50), reaching approximately P 90. Up to one year, 73 per cent of those weighed were equal to or above P 50. One abnormal (mongolian) child was below P 3. Subsequently, increased differences were noted, together with a general downward trend.

From one to two years, after remaining stationary from 12 to 18 months, the median dropped below P 50.

$\geqslant$ P 50 : 37 per cent
$<$ P 50 : 63 per cent
$<$ P 3 : 20 per cent (8/40)

Thus, 20 per cent of boys were well below the normal lower limit, and may therefore be considered as under-nourished.

The overall retardation in weight, at 2 years, was slight (0.5 kg); however, a light or very light group could already be distinguished.

From 2 to 3 years the situation worsens, with a drop in the median. Average retardation is now 1 kg, and the gap continues to widen.

$\geqslant$ P 50 : 37 per cent
$<$ P 50 : 63 per cent
$<$ P 3 : 20.8 per cent

Weight of girls (Graph No. 1 bis)

Here the situation is slightly different; excellent until 6 months, at which age 64 per cent exceed P 50, and 35 per cent exceed P 90. Thereafter, the median drops below P 50.

6 months to 1 year
P 50 : 20 per cent
very light (between P 10 and P 3) : 36 per cent
below P 3 : 8 per cent

Average retardation at age 1 year was 1 kg. At 1 to 3 years, the gap continues to widen, the median now being well below P 50.

$>$ P 50 : 43.3 per cent
$\leqslant$ P 3 : 24.5 per cent

Thus, there is very slightly more malnutrition in girls than in boys. Average weight retardation at age 2 is 0.4 kg, and at age 3, 1 kg.

Overall weight figures for both sexes in the age range 1 to 3 years (nutritional crisis) indicate 22.6 per cent malnutrition.

(ii) Height (length, until age 3).

Boys

The median height was well above the Iowa standard (P 50) actually reaching P 90 (Graph No. 2), but dropped slightly after age 1. Thus, boys at Aitutaki are tall during their initial years; 37 per cent are over P 90.

Age 1 to 3, the median dropped slightly, while remaining above P 50.

There remained, however, a short group (11 per cent between P 10 and P 3), and a very short group (8.5 per cent $\leq$ P 3). Generally speaking, and compared with the American standard, height retardation during this period is lesser, and occurs later, than weight retardation. Using the Wetzel projection, it may be calculated that if the children of Aitutaki remained in the upper (P 90 to P 97) bracket corresponding to the first year, retardation in terms of the theoretical prediction would be 7.5 cm at age 3 years.

Girls

The pattern noted was very similar to that of the boys. However, the downtrend occurs somewhat earlier - towards age 6 months; it is not pronounced, and reaches its maximum at age 2 years. As with the boys, a small group was seen to be very retarded; 13.3 per cent were below P 10. (Graph No. 2 bis).

(iii) Head circumference

Boys

Generally speaking, characteristics were seen to be as for height (Graph No. 3).

The brain is known to increase in volume extremely rapidly until age 2, the increase progressively slowing thereafter until 3 to 3½ years.

At Aitutaki, the median head circumference was seen to exceed P 50 up till age 15 months.

In the 0 to 15 months bracket, 53 per cent were above P 50. 23 per cent were above P 90.

From 15 months to 3 years, there was a very marked levelling-off of the median, with practially no further increase in head circumference. Only 15.4 per cent remained $\geq$ P 50. Twenty-seven per cent showed marked retardation, as if brain development had stabilised at 9 months. As we shall see later, this was related to a number of cases of malnutrition, which although sub-clinical at this stage, subsequently develops into a group of symptoms.

Girls

Generally speaking, and in terms of the standard, head circumference was below that noted for boys, and was on the average below P 50 (Graph No. 3 bis). The decrease in development occurred earlier than for boys (about 6 months), but was more progressive.

Here also, there was a heavily retarded group : 21 per cent.

Taking the results of boys and girls together, it may be seen that:

- Development of head circumference is extremely rapid, and above the P 50 standard, during the first months. Subsequently, however, growth is very slow, and falls behind.

- This retardation is comparable to that noted in height measurements, but relatively more pronounced.

- In the age group 1 to 3, a high proportion of children (about 25 per cent) show retardation of some 3 cm compared to P 50.
  In the same way as for height, real retardation should be calculated on the basis of P 90, which corresponds to the local median up to age 1 year. For the handicapped group, retardation in terms of potential development is 5 cm, or about 10 per cent of standard head circumference.

Conclusion : All body measurements made between ages 1 and 3 - weight, height, head circumference - show insufficiency and retardation, in contrast to promising results noted for the first few months.

Retardation occurs somewhat earlier and is slightly more marked in girls. There are very substantial differences between individuals: an upper group shows normal growth patterns, while a lower group falls further and further behind. This latter group represents about 25 per cent of the total, on the basis of all criteria applied. This clearly indicates the existence of a growth crisis; it is generally speaking moderate, and corresponds to the so-called weaning crisis. This was further confirmed by clinical findings.

(b) Clinical information

(i) Under-nutrition : This appears in the form of thinness. Subnormal weight, as indicated by measurement, is the result of impaired development affecting either fatty tissues (caloric deficiency), or the muscular structure (protein deficiency). Either, or both (this is generally the case) structures may suffer.

We noted no true marasmus.

(ii) Protein malnutrition : We applied this term only to cases involving an oedema, even when very moderate. It is generally accompanied by muscular wasting, and degeneration of the hair (loss of colour - sparse - easily pulled out). Under-nutrition and malnutrition are generally grouped together under the term, used by WHO, of PCM (Protein - Calorie Malnutrition). We noted (both sexes) :

| | | |
|---|---|---|
| 0 - 6 months | : | 0 cases |
| 6 months to 1 year | : | 2 cases |
| 1 to 3 years | : | 1 case |

Total : 3 cases of PCM out of 164 children in the age range 6 months to 3 years. This represents 1.8 per cent, a very low rate. In addition, it was moderate PCM; on the other hand, the proportion is doubtless far higher for the population as a whole. In fact, all three cases were noted in the farming village of Vaipae; this village having 50 children in the 6 months to 3 year age bracket, there was in fact 6 per cent PCM. The prevailing tendency in this age group appears to be a somewhat greater incidence of under-nutrition (approximately 25 per cent) than malnutrition; the two are, however, practically always associated.

(iii) Symptoms indicating chronic malnutrition or sequels of sub-clinical malnutrition.

In the 1 to 3 years age group (both sexes) we noted:

6 cases out of 131 (4.6 per cent) of abnormal hair growth, 3 of which were at Vaipae (3 out of 40 = 7.5 per cent), 1 at Tautu, 2 in the urban centre, and none in the fishing villages.

These percentages are very low when compared with the New Hebridean Melanesians.

- Parotid enlargement : 1/131 (0.8 per cent)
- Liver enlargement : 4/131 (3.1 per cent)

Generally speaking, the incidence of these two affections is low at this age.

Melanodontia begins to appear at 18 months, the number of cases increasing progressively thereafter until loss of the first teeth.

Total : 25 cases out of 131 (19.1 per cent)

Vaipae had the highest incidence : 10/40 (25 per cent), followed by the urban centre 8/49 (16.3 per cent).

N.B. : In villages where fish consumption is high (Nikaupara, Reureu, Tautu), there was far less melanodontia in this age group.

(iv) Other indications of malnutrition

Anaemia: (0 to 3 years) - in 2 cases out of 164 (1.2 per cent) moderate anaemia with enlargement of the spleen (origin unknown) was noted.

The problem of infant anaemia appears practically negligible.

Avitaminosis : indications of vitamin A deficiency - none
indications of vitamin C deficiency - none

Ariboflavinosis : (Vitamin $B_2$ deficiency) - one case of glossitis.

Rickets : one case of rickets (at one year) with skull and thorax deformities.

Thus, conventional avitaminosis seems very rare.

(v) Skin hygiene

Pyoderma (with associated scabies) : 24/174 (0 to 3 years) = 14 per cent.

Dermatomycosis (pityriasis) : 1.

On the whole, the children were clean in terms of both body hygiene and clothing.

(vi) Miscellaneous : We noted 2 cases of mongolism involving substantial weight and height retardation, one of which also suffered from congenital malformation of the upper limbs; i.e. three cases of congenital affection.

(c) General conclusions for this age group

Compared with the other two pilot areas - Malekula (Wala Rano) and Tagabe - infant nutrition is fairly satisfactory.

Measurements during the first months of life show excellent potential (weight - height - head circumference) for the first year.

Following this, however, comes a critical period which generally sets in between six and twelve months of age. It first produces weight retardation and a few cases of PCM, and subsequently a slow-down in growth and skull development.

Our cross-section was not homogeneous. Substantial differences between individuals were noted; one group had continued above-average growth rates whereas the lower group, with abnormal hair growth, melanodontia, and liver enlargement, steadily increased. The latter group represents approximately 25 per cent of the 1 to 3 years age group.

This is a substantial figure and justifies preventive measures which we shall examine later.

In a rough classification of

(1) alert,

(2) alarm,

(3) danger, we would estimate this group as being at alarm level.

In contrast, excessive body weight is frequent in the upper group, especially in girls. Even taking their above-average height into account, this is a danger signal, indicating potential obesity at adolescent and adult stage.

The observations made during the first years of life, and their consequences, will be further examined in relation to subsequent age brackets. They tend to indicate that sub-clinical malnutrition between ages 1 and 3, while it does not always involve spectacular symptoms, does have after-effects: enlarged parotids, enlarged liver, melanodontia, height and weight retardation, and retarded skull development. The combined effect of these is to extend the impact of multiple deficiencies (protein, calories, minerals, vitamins) well beyond the age of 3 years.

## 2. Pre-school children (age 3 to 6 years)

174 children (89 M - 85 F) were examined.

### (a) Body measurements

The parameters used were :

weight - triceps skinfold - arm circumference -
height - head circumference.

#### (i) Boys (89)

Weight :

Mean weight was slightly below P 50, hence satisfactory. However, there was a widening of the gap noted in the 1-3 year age bracket (Graph No. 5). Classification by weight was as follows:

Overweight ( > P 90) : 9 = 10.1 per cent

Average to overweight (< P 90 ⩾ P 50) : 19 = 21.3 per cent

Total > P 50 : 28 = 31.4 per cent

Light to average ( < P 50 >P 3) : 42 = 47.2 per cent

Underweight ( < P 3) : 19 = 21.3 per cent

Total < P 50: 61 = 68.6 per cent

The underweight group (21.3 per cent) was larger than in the 1-3 year age group, where it was 15.2 per cent.

Skinfold (thickness of the sub-cutaneous fatty tissues)

Mean skinfold at age 3 years was in line with P 50 (9 mm). It dropped between ages 5 and 6, then stabilized at 8 mm. (Graph No. 8)

40/89 (44 per cent) were above P 50
49/89 (56 per cent) were below P 50
8/89 (9 per cent) were below the WHO malnutrition line (80 per cent of P 50)
14/89 (15 per cent) exceeded 120 per cent of P 50; these cases showed excessive fatty tissue.

Arm circumference (Graph No. 9)

Mean circumference followed P 50 (16 cm) until age 5, remained stationary until age 6, then showed a tendency to drop off.

36/89 (40 per cent) were above P 50
53/89 (60 per cent) were below P 50

None of the children examined were in the WHO severe malnutrion zone.

Height (Graph No. 5)

Height is considered as being a more reliable long-term nutritional indication than weight, once the heredity factor has been discounted. Also, recovery after a temporary insufficiency is slower and often incomplete. We have drawn a distinction (Graph No. 4) between :

- Mean height in the group as a whole.
- Mean height of apparently normal children.
- Mean height of children with one or more symptoms of chronic malnutrition: enlarged parotids, enlarged liver, melanodontia and abnormal hair growth.

In the 3- to 6- year group, mean height exactly followed the standard up to age 3½, then progressively dropped off. At age 6 years, average retardation was 7.5 cm.

The mean height of apparently normal cases remained more or less equal to P 50.

In the group showing symptoms of malnutrition, the median fell very sharply to below P 3.

At age 6 years, this group was 10 cm below the standard, and the apparently normal group.

Distribution for the group as a whole was as follows:

I. Very tall : $\geqslant$ P 90 : 4/89 (4.5 per cent)

II. Average to tall : $<$ P 90 $\geqslant$ P 50 : 28/89 (31.5 per cent)

III. Average to short : $<$ P 50 $\geqslant$ P 3 : 33/89 (37.1 per cent)

IV. Very short : $<$ P 3 : 24/89 (27 per cent)

Total $>$ P 50 : 36 per cent

Total $<$ P 50 : 57/85 (67.1 per cent).

This retardation can be attributed to the inclusion of a number of children showing the above-mentioned signs of malnutrition; distribution of these cases was as follows (for the group as a whole):

Group I ($>$ P 90) : 0/4 (0 per cent)

Group II ($<$ P 90 $\geqslant$ P 50) : 11/28 (39.4 per cent)

Group III ($<$ P 50 $\geqslant$ P 3) : 17/33 (51.5 per cent)

Group IV ($<$ P 3) : 19/24 (79.2 per cent)

Consequently, height/retardation does appear to be associated with malnutrition and its sequels. There is, for example, a clear connection with infantile melanodontia. This is the only age group in which melanodontia can effectively be studied, as the affection concerns only the first (milk) teeth.

Distribution was as follows:

Group I ($>$ P 90) : 0/4 (0 per cent)

Group II ($<$ P 90 $\geqslant$ P 50) : 6/28 (21.4 per cent)

Group III ($<$ P 50 $\geqslant$ P 3) : 15/33 (45.5 per cent)

Group IV ($<$ P 3) : 14/24 (58.3 per cent)

Distribution of the other symptoms was as follows:

Parotidosis

| | | | |
|---|---|---|---|
| Group I : 0/4<br>Group II : 1/28 (3.6 per cent) | } Total > P50 : | 1/32 (3.2 per cent) | |
| Group III : 2/33 (6.1 per cent)<br>Group IV : 3/24 (12.5 per cent) | } Total < P50 : | 5/57 (10.5 per cent) | |
| TOTAL 6/89 (6.7 per cent) | | | |

Enlargement of the liver

| | | |
|---|---|---|
| Group I : | 0/4 | |
| Group II : | 3/28 (10 per cent) | 3/32 (9.1 per cent) |
| Group III : | 1/33 ( 3 per cent) | |
| Group IV : | 4/24 (16.7 per cent) | 5/54 (9.3 per cent) |

The differences recorded are significant only in Group 4. For all three symptoms, the highest rates were noted in the height-retarded group. This phenomenon will be fully analysed in Chapter IV, Section 2.

Head circumference

The median for apparently normal cases is consistently half-way between the reference mean and one standard deviation.
For those with symptoms of malnutrition, the median is irregular at the beginning, then drops considerably at age 6 years (Graph No. 4 bis).

This group has an average retardation of 3.5 cm at 6 years.

Overall distribution for the age group 3 - 6 years was as follows:

Group I $\gg$ P 50: 24/89 = 26.9 per cent

Group II $<$ P 50 $\gg$ P 3 : 33/89 = 37 per cent

Group III $<$ P 3 : 32/89 = 35.9 per cent

As was noted with height measurements, this retardation is due to the inclusion of a substantial percentage of children with symptoms of chronic malnutrition.

(ii) Girls (85)

Weight (Graph No. 5 bis)

As was the case for boys, mean weight was equivalent to P 50 at age 3, then dropped and levelled off at P 25. Distribution was as follows:

$\geq$ P 50 : 21/85 (24.7 per cent)

$<$ P 50 : 64/85 (75 per cent)

$\leq$ P 3 : 4/85 (4.7 per cent)

In comparison with the preceding age bracket, weight recovery is considerable.

Skinfold

Skinfold thickness is generally greater in girls than in boys. The situation was the same as for weight; the median closely followed P 50 from 3 to 4 years (10 mm), then dropped until age 5 years, levelling off at 8 mm at age 5 to 6 years. (Graph No. 8 bis)

Distribution was as follows:

$\geq$ P 50 : 21/85 (24.7 per cent)

$<$ P 50 : 64/85 (75 per cent)

The pattern was thus identical to that noted for weight.

Extreme groups : 20 per cent above normal skinfold : 2/85 (2.4 per cent)

20 per cent below normal skinfold : 5/85 (5.9 per cent)

Two of the latter were below the WHO malnutrition line; however the extreme groups are very small.

Circumference of left arm

The mean circumference followed the same pattern as previously; commencing above P 50 (17 cm at age 3 years), it then dropped to 16 cm between 4 and 5 years (Graph No. 9 bis). These relatively insignificant differences are due to the diminishing thickness of the fatty tissue at this age.

Distribution

$\geq$ P 50 : 29/85 (34.1 per cent)
$<$ P 50 : 57/85 (67 per cent)

All children were within 20 per cent of P 50.

Height

The group median was below P 50 (Graph No. 6 bis).

At age 6, retardation was 3.5 cm in the apparently normal group, and 7 cm in the group showing clinical symptoms of chronic malnutrition (melanodontia, enlarged parotids, abnormal hair growth, enlarged liver).

Head circumference : For the group as a whole, there was retardation, with a median of P 3 (below normal). At age 6, retardation was 0.5cm in the normal group, (Graph No. 7 bis), and 1.2 cm (group suffering from chronic malnutrition.

The pattern was identical to that noted for boys.

Overall distribution (girls) :

$\geq$ P 50 : 20/85 (23 per cent)

$<$ P 50 $\geq$ P 3 : 39/85 (45.9 per cent)

$<$ P 3 : 26/85 (30 per cent)

The retarded group, $<$ P 3 : 30 per cent, is comparable to that noted for the previous age group (27 per cent of 3-year olds). In other words, recovery did not take place in respect of height and head circumference, although there was a clear improvement in average weight.

(b) Clinical information

Number of children examined : 105 (58 M - 47 F).

(i) Protein-calorie malnutrition (clinically detectable) : nil

(ii) Sequels of sub-clinical malnutrition

- Abnormal hair growth : 7/105 = 6.7 per cent
- Enlarged liver : 20/105 = 20 per cent
- Enlarged parotids : 6/105 = 5.7 per cent
- Melanodontia : 49/105 = 46.7 per cent (Degrees I, II, III)

(iii) Anaemia (clinical) : nil

(iv) Vitamin deficiencies :

- Vitamin A deficiency : perifollicular hyperkeratosis : nil
  thickening of conjunctiva : 1 case
- Vitamin B2 deficiency (ariboflavinosis) :
  angular cheilosis : nil
  depapillating glossitis : 4/105 = 3.8 per cent.

- Vitamin C deficiency : 3 cases of gum bleeding (Vaipae)
  Glossitis : 1 case of raspberry tongue

- Rickets (deformities of thorax) : 4/105 = 3.8 per cent

(v) Dental state :

- Caries (melanodontia not included)

DMF I (less than 3 caries) : 15/105

DMF II (between 3 and 10 caries) : 60/105

DMF III (more than 10 caries) : 2/105

Total showing caries = 75/105 = 71.4 per cent

- Periodontal disease : 3 cases of gum bleeding = 3 per cent

(vi) Skin hygiene : Pyoderma - impetigo : 75/105 = 7 per cent
(Fungus) Pityriasis versicolor : 5/105 = 5 per cent

From the clinical point of view, the 5 to 6 year old child was regarded as the test-bracket.

Five to six is a transitional phase between home-life and school-life with its consequent environmental changes. Coming just after the recovery period that follows the peak of the weaning crisis, it tends to compound many nutritional sequels of the previous stages : melanodontia in particular, is most clearly observable during this phase, just before the deciduous (baby) teeth are replaced by the permanent ones.

Total of children aged 5 to 6 years : 69.

Clinically observable PCM : nil

Probable sequels of sub-clinical malnutrition:

- Abnormal hair growth : 0
- Enlarged liver : 9/69 = 13 per cent
- Enlarged parotids : 3/69 = 4.3 per cent
- Melanodontia : 34/69 = 49.9 per cent

(c) Summary and conclusions for pre-school children

Clinical observations and body measurements combine to confirm, and even accentuate, the trends recorded towards the end of the previous phase.

The effects of the nutritional crisis which reaches its peak between 18 months and 2 years, appear to be carried over into the 3 to 6 phase in a large number of cases.

A certain degree of recovery does occur, as far as weight, skinfold thickness and arm circumference are concerned.

Discrepancies between individuals, however, become more marked. While a gradually diminishing "high" group goes on developing normally in terms of all the parameters considered, a "low" group, comprising about 25 per cent of the children examined, falls behind in weight, height and head circumference. In some cases, retardation is very significant.

Distinct protein - calorie malnutrition of the moderate Kwashiorkor type is no longer observed, but chronic sub-clinical malnutrition - or nutritional imbalance - appears in new forms, often associated in the same individual (enlarged parotid glands, enlarged liver), and is most clearly reflected by the very high incidence of melanodontia.

Simultaneously or not, a large number of caries in the deciduous teeth was observed.

Between 5 and 6 years of age, the above symptoms are compounded, which means that nutritional recovery is not complete by the time the child starts school.

(d) Recommendations : children aged 3 to 6 years

(i) Medical supervision of growth and nutritional status of children aged 3 to 6 years should be systematically continued as for infants and toddlers.

Check-ups should include :

- Weighing, and measuring height (standing posture) each month if possible, or at least every other month.
- Measuring skinfold, arm circumference and head circumference, where staff and equipment are available.
- Simple clinical examination, within the competence of para-medical staff, to detect :

Pretibial oedema
Muscle wasting
Parotid enlargement
Abnormal features in tongue, gums and teeth
Obesity.

On the basis of such check-ups, a clinical assessment could be made, facilitating curative measures and personalising health education.

The indexed cards already available to health workers should be used to record all relevant data and enable follow-up of these children.

(ii) Upon school entrance, follow-up should be conducted in co-operation with the school medical services and should include assessment of nutritional status and growth. Special attention should be paid to children who are retarded in body development as these are more liable to suffer mental retardation as well.

Nutrition education should be given at school by the teachers themselves, according to the children's educational level and environment; teachers should incorporate practical nutritional knowledge into all their subjects, as part of their function to prepare their charges adequately for later life.

3. General recommendations for children 0 to 6 years

From our findings for both sexes over the period considered, we have drawn the following general conclusions :

At Aitutaki, development of children, male and female, is generally excellent, in respect of all parameters, during early infancy, i.e., for approximately 8 months.

During this period, all measurements taken were above the US reference mean.

No clinical nutritional symptom was recorded : anaemia, in particular, was practically non-existent.

This is the "perfect baby" phase.

Measurements and clinical observations combine to reveal the existence of a nutritional crisis beginning around the age of 8 months (but with marked variations between individuals) and peaking between 18 months and 2 years. It is usually mild. Weight lag is the first sign to appear, but retardation in height and head circumference soon follow.

Protein-calorie malnutrition of the clear-cut clinical type (with oedema) is rare, but 25 per cent of children between 1 and 6 years show significantly retarded development in respect of weight, height and head circumference.

Between 1 and 5 years, two extreme groups tend to emerge: a high group in which individuals are above the reference mean (and even above the top reference curve) and a low group which increases rapidly up to age 3 and then remains stationary at around 25 per cent.

Between 3 and 4 years of age, some recovery does take place, mainly in terms of weight, skinfold and arm circumference. It remains very incomplete however, up to age 6, and in some cases the gulf between the "low" group and the "high" and "middle" groups further widens.

From 18 months or 2 years onwards, clinical symptoms of chronic disorders make their appearance:

- enlarged parotid glands;
- enlarged liver;
- melanodontia.

They seem to be connected with chronic protein malnutrition on the one hand, and with multiple caries in the deciduous dentition on the other, which would point to a dietary imbalance that is also conducive to tooth decay. This clinical picture persists up to school age (6 years).

From the point of view of control and prevention, the 0 to 6 years age-bracket must be considered as a whole, each phase being responsible for the subsequent one.

For the purpose of prevention, it is important to remember, that dietary factors cannot be dissociated from hygienic and psychological ones (comparative neglect by families of children over 3 years).

Both these factors must therefore be taken into account in the implementation of health education programmes, which should, for this age group, be primarily directed towards mothers.

As for the diet, stress should be placed on more rational utilisation of local food resources which, though potentially rich, are not being used to best advantage as far as proteins are concerned.

4. School age children (6 - 13 years)

(a) Body measurements

Number of children examined - 426 (209 M - 217 F)

(i) Boys

Weight (Graph No. 5)

The local mean consistently remains below P 50 from 6 to 13 years. Weight lag at 6 years amounts to 2 kilos and at 13 years is still the same.

Distribution is as follows :

Overweight $\geqslant$ P 90 : 10/209 = 4.7 per cent

Average to heavy $<$ P 90 $\geqslant$ P 50 : 38/209 = 18.1 per cent

Total heavy : 48/209 = 22.8 per cent

Average to light $<$ P 50 $\geqslant$ P 3 : 122/209 = 58.3 per cent

Underweight $<$ P 3 : 39/209 = 18.6 per cent

Total light : 161/209 = 77.2 per cent

The proportion of lightweight boys is markedly greater than that of lightweight girls (60.3 per cent).

Skinfold (Graph No. 8)

The local mean as regards subcutaneous fatty tissue thickness consistently and distinctly remains above the reference mean, but there are great discrepancies between sub ects.

Distribution is as follows :

Excess fat : 120 per cent of normal skinfold 59/209 = 28.2 per cent

Between 120 per cent of normal skinfold and P 50 : 69/209 = 33 per cent

Total above P 50 : 61.2 per cent

Between P 50 and 80 per cent of P 50 : 53/209 = 25.4 per cent

Under 80 per cent of P 50 : 28/209 = 13.4 per cent

Total under P 50 : 48.8 per cent

It can be seen that skin fatness increasesafter 7 to 8 years, and reaches an abnormally high level in 28.2 per cent of the cases.

Arm circumference (Graph No. 9)

Contrary to what was observed for skinfold, the mean here remains consistently and clearly below the standard curve from 6 to 13 years.

At 6 years the WHO standard mean is : 17.3 cm

the local mean is : 16 cm (- 1.3 cm)

At 13 years, the standard WHO mean is : 22.2 cm

the local mean is : 20 cm (- 2.2 cm).

Distribution is as follows :

> standard mean : 27/209 = 12.9 per cent

< P 50 > 80 per cent of P 50 : 169/209 = 80.9 per cent

> 80 per cent of P 50 : 13/209 = 6.2 per cent

Total below standard : 93.8 per cent

The last fraction of the group shows marked muscular under-development.

There is a striking contrast between the high skinfold readings (61.2 per cent) and the low arm circumference measurements recorded. This would seem to indicate inadequate muscle development.

It seems obvious that below standard weight is a result of inadequate muscle development while at the same time the level of fatty structures is comparatively high. This may be attributed to protein deficiency in the diet or to a lack of physical activity. It must be noted also that the extreme groups have shrunk, as compared with the previous age bracket.

Height (Graph No. 6)

The local mean remains below P 50 in normal subjects, up to the age of 12 years, then rises rapidly and crosses over the P 50 standard at 12½ years.

Average height retardation at 6 years is insignificant : 1cm
at 10 years it is 2.5 cm
at 13 years, height has caught up with P 50 and overtaken it by 2 cm.

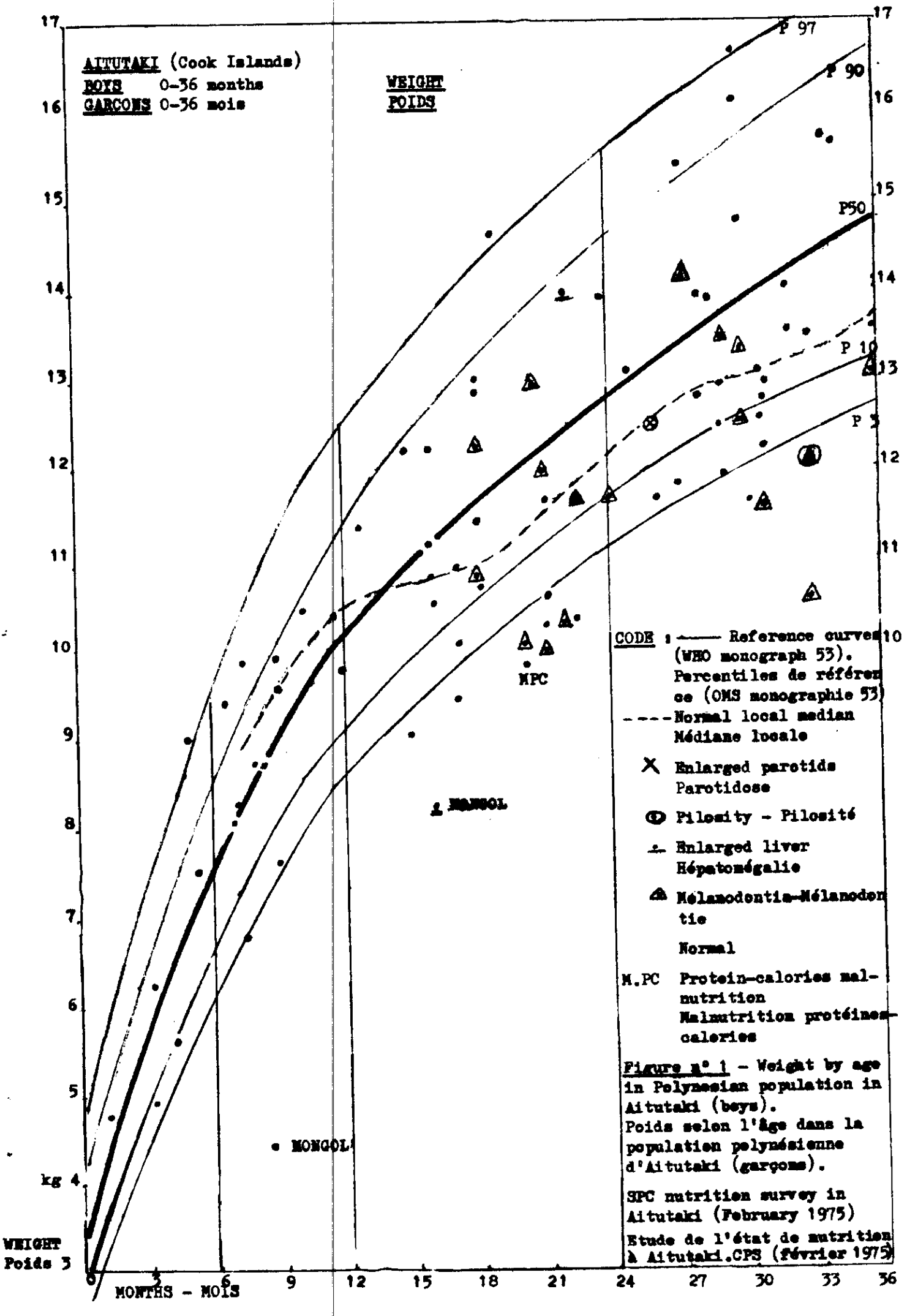


Figure n° 1 - Weight by age in Polynesian population in Aitutaki (boys).
Poids selon l'âge dans la population polynésienne d'Aitutaki (garçons).

SPC nutrition survey in Aitutaki (February 1975)
Etude de l'état de nutrition à Aitutaki.CPS (février 1975)

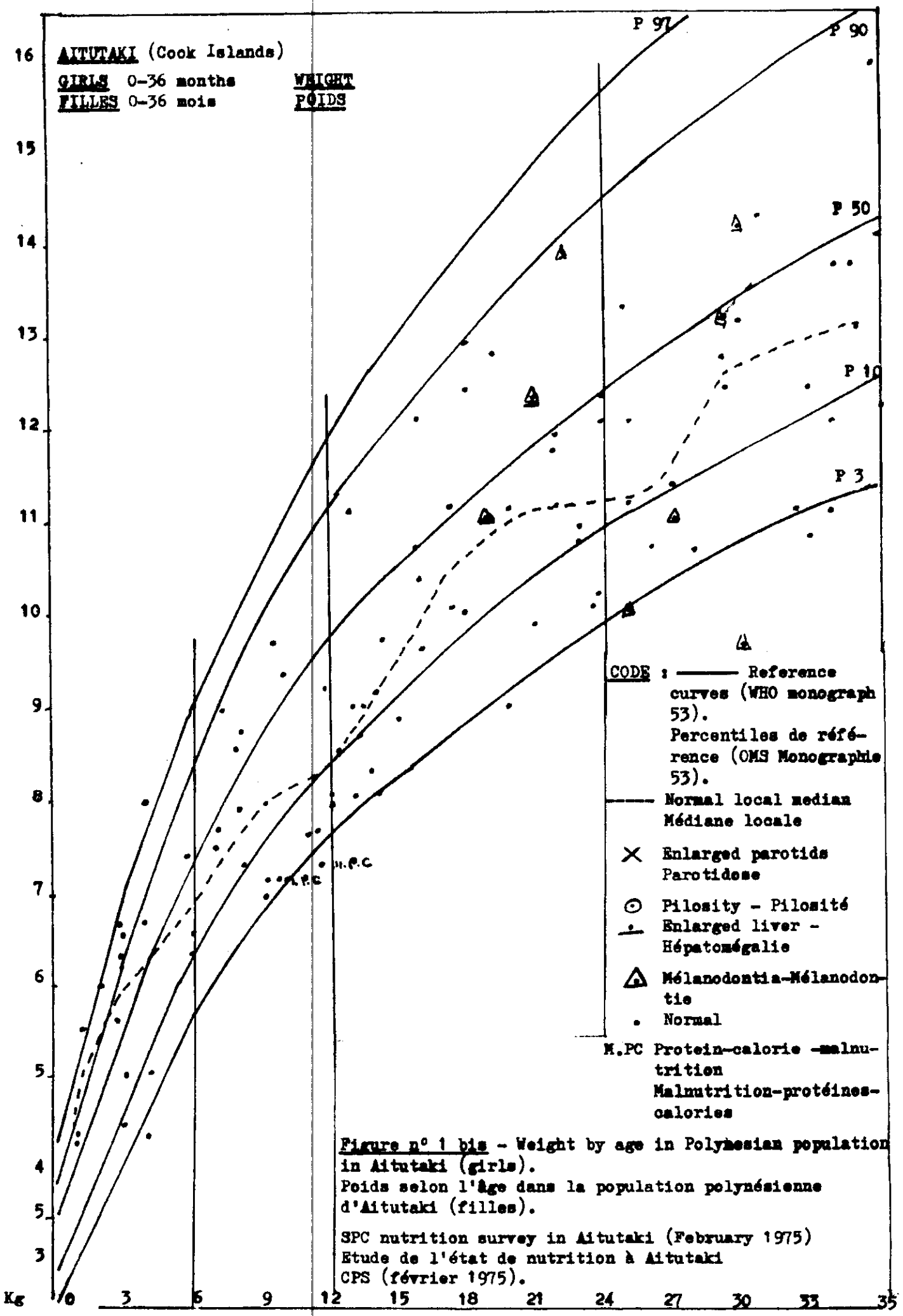


Figure n° 1 bis - Weight by age in Polynesian population in Aitutaki (girls).
Poids selon l'âge dans la population polynésienne d'Aitutaki (filles).

SPC nutrition survey in Aitutaki (February 1975)
Etude de l'état de nutrition à Aitutaki
CPS (février 1975).

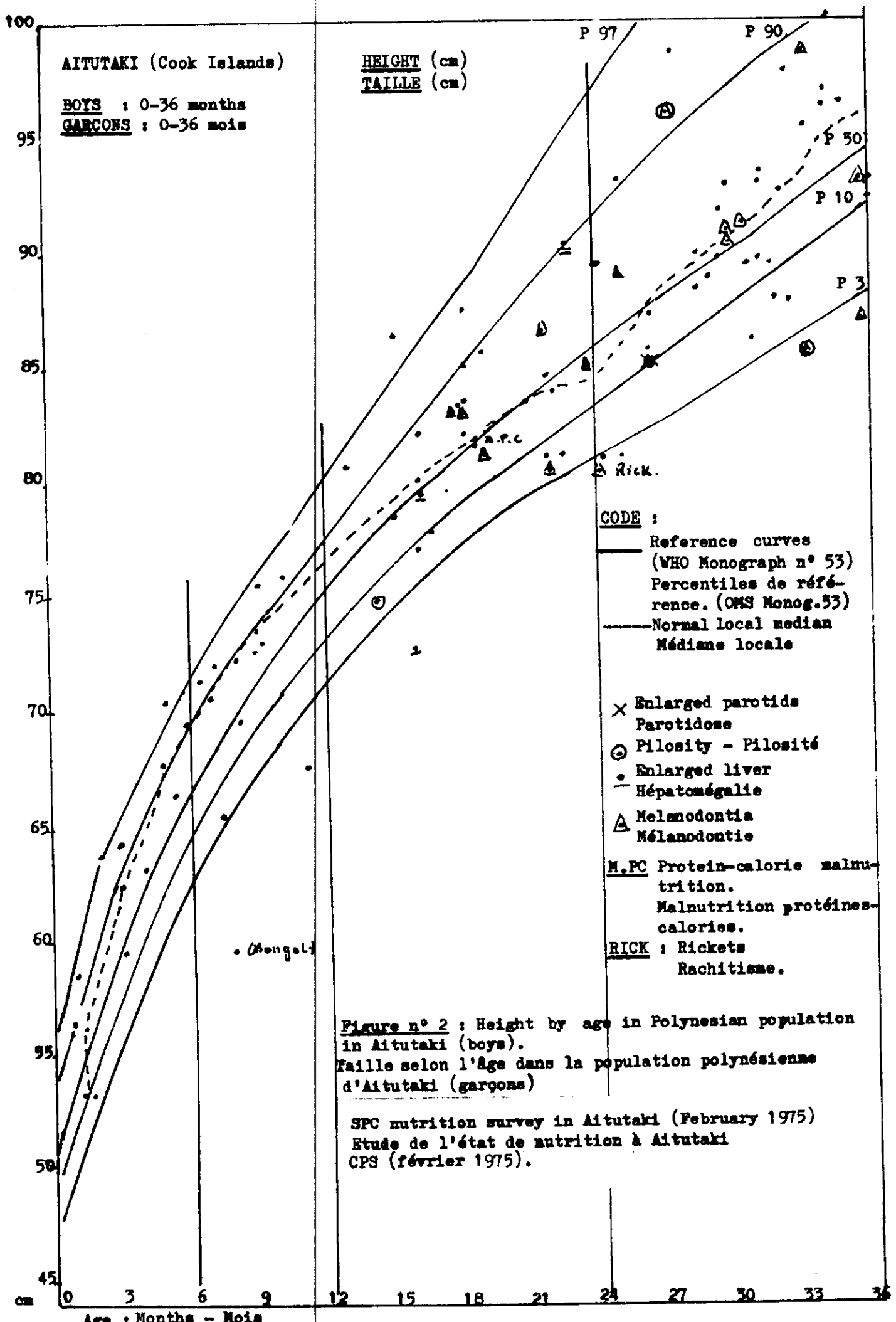


Figure n° 2 : Height by age in Polynesian population in Aitutaki (boys).
Taille selon l'âge dans la population polynésienne d'Aitutaki (garçons)

SPC nutrition survey in Aitutaki (February 1975)
Etude de l'état de nutrition à Aitutaki
CPS (février 1975).

Distribution is as follows :

| | | |
|---|---|---|
| ⩾ P 90 : 9/204 : 4.8 per cent | } | 30.6 per cent |
| < P 90 ⩾ P 50 : 54/209 : 25.8 per cent | | |
| < P 50 ⩾ P 3 : 105/209 : 50 per cent | } | 69.8 per cent |
| < P 3 : 41/209 : 19.6 per cent | | |

The very short group (well below minimum standards) which was 27 per cent in the 3 to 6 bracket has somewhat diminished but still remains significant (19.6 per cent). This can be accounted for by the high incidence, in this particular group, of subjects showing clinical syndromes : melanodontia, enlarged liver, enlarged parotids. The mean is very low indeed for this category.

At 6 years their height was 7 cm below US standard
4 cm below local "normal" mean

At 13 years retardation was 12.5 cm compared with US mean
15 cm compared with local norm.

Head circumference (Graph No. 7)

Between 6 and 11 years, the mean head circumference remains practically stationary, constituting a retardation which reaches 1 cm at 11 years of age. Between 11 and 13 years, this lag is made up and the local mean subsequently follows the P 50 line, overtaking it at 15. The overall retardation recorded in the 6 to 10 year group is due to children suffering from chronic malnutrition whose average retardation at 10 years is 1.8 cm. The mean of these under-nourished subjects is in the vicinity of or less than P 3. A detailed study of the substandard group will be made in Chapter IV. Wide discrepancies between individuals were noted.

Distribution is as follows :

⩾ P 90 : 7/209 = 3.3 per cent

< P 90 ⩾ P 50 : 59/209 = 28.2 per cent

< P 50 ⩾ P 3 : 107/209 = 51.2 per cent

< P 3 : 41/209 = 19.6 per cent

These results are strikingly similar to those obtained for height. The retarded group gradually diminishes as the children near 13 years of age and thereafter distribution becomes normal.

(ii) Girls

Weight (Graph No. 5 bis)

At 6 years of age, the local mean for girls is well below P 50 and it remains at the same distance from the standard up to about 11 years. At that age it begins to draw closer to P 50 joining it around 13 years and crossing it at 14 years.

Distribution is as follows :

$\geqslant$ P 90 : 10/217 = 4.6 per cent

$<$ P 90 $\geqslant$ P 50 : 68/217 = 31.8 per cent

Total heavy : 36.4 per cent

$<$ P 50 $\geqslant$ P 3 : 106/217 = 48.8 per cent

$<$ P 3 : 25/217 = 11.5 per cent

Total light : 60.3 per cent

Skinfold (Graph No. 8 bis)

The local mean closely follows the reference mean up to 11½ years, then rises and crosses over around 13 years.

Distribution is as follows :

Very fat :
$\geqslant$ 20 per cent above reference mean : 45/217 = 20.7 per cent

Moderately fat :
$<$ 20 per cent above $\geqslant$ P 50 : 65/217 = 29.5 per cent

Total fat : 110/217 = 51.2 per cent

Moderately thin :
$<$ P 50 $\geqslant$ 80 per cent of P 50 : 80/217 = 36.9 per cent

Very thin :
$<$ 80 per cent of P 50 : 27/217 = 12.4 per cent

Total thin : 107/217 = 49.3 per cent

Overall, average skinfold is normal but there is an excessively fat group (20.7 per cent) as well as a small, excessively thin group (12.4 per cent).

Arm circumference (Graph No. 9 bis)

The local mean remains very much below P 50. It drops sharply between 6 and 11 years. Maximum retardation, compared with the reference mean, is 2.5 cm at 10 years. Between 10 and 13 years, the local mean rises rapidly, draws close to P 50, and crosses over at 14½ years.

Distribution is as follows :

$\geqslant$ P 50 : 37/217 = 17 per cent

$<$ P 50 $\geqslant$ 80 per cent of P 50 : 170/217 = 78.3 per cent

$<$ 80 per cent : 10/217 = 4.6 per cent

Total below P 50 : 180/217 = 82.9 per cent

As was the case for boys, average arm circumference decreases while skinfold remains normal or above standard indicating muscular under-development.

Height (Graph No. 6 bis)

The local mean remains clearly and consistently below the reference standard P 50.

Retardation at age 6 is 2.5 cm. At age 13, 3.5 cm.

Overall retardation is low but great discrepancy between subjects is apparent :

Very tall : $\geqslant$ P 90 : 8/217 = 3.7 per cent

Comparatively tall : $<$ P 90 $\geqslant$ P 50 : 59/217 = 27.2 per cent

Total tall : 30.9 per cent

Comparatively short : $<$ P 50 $\geqslant$ P 3 : 107/217 = 49.8 per cent

Very short : $<$ P 3 : 41/217 = 18.8 per cent

Total short : 68.6 per cent

Height recovery is thus incomplete in this age bracket. The extremely tall group here has diminished as compared with the top group in the 3 to 6 age bracket; the extremely short group stays approximately the same.

Head circumference (Graph No. 7 bis)

The local mean remains consistently below P 50 up to 11 years and then tends to rise, reaching P 50 at 13 years. At this age recovery appears complete. It occurs earlier than in boys (on account of earlier puberty). At 6 years retardation was 9 mm.

Distribution is as follows :

Very big $\geqslant$ P 90 : 6/217 = 2.8 per cent

Comparatively big $<$ P 90 $\geqslant$ P 50 : 49/217 = 22.5 per cent

Total big : 25.3 per cent

Comparatively small $<$ P 50 $\geqslant$ P 3 : 105/217 = 48.4 per cent

Very small $<$ P 3 : 57/217 = 26.3 per cent

Total small : 74.7 per cent

On the whole, head circumference retardation is more substantial in girls than in boys.

There is an extremely retarded group amounting to about one quarter of the 217 girls examined. However, this group has diminished, as compared with the 3 to 6 age bracket where it represented 54.8 per cent. Between 11 and 13 years the lag gradually decreases, and the overall local mean thereafter coincides with P 50.

(b) Clinical data

Number examined : 426 (209 M - 217 F)

6 to 8 years : 54 M - 64 F = 119

9 to 12 years : 154 M - 153 F = 307

(i) Protein-calorie malnutrition : 1 case with oedema, M : 9 years

(ii) Sequels of malnutrition :

Abnormal hair growth : 14/426 = 3.3 per cent

Enlarged liver : 14/426 = 3.3 per cent

Enlarged parotids : 20/426 = 4.7 per cent

Melanodontia (in remaining first teeth) : 28/426 (of no statistical significance).

(iii) Clinical anaemia : 1 case (with PCM)

(iv) Vitamin deficiencies : No perifollicular hyperkeratosis

Vitamin A deficiency : Thickening of conjunctiva : 29/426 = 6.8 per cent

Fatty deposits : 3.3 per cent

Pterygium : 0.5 per cent

Riboflavin $B_2$ deficiency : Angular cheilosis : 3 (associated with glossitis)

Depapillating glossitis : 9

Total : 9/426 = 2.1 per cent

Other types of glossitis : Raspberry tongue : 2 cases = 0.5 per cent

Vitamin C deficiency : nil

Ricketts (sequels) : 4/426 = 0.9 per cent

(v) Dental status : periodontal diseases : 0

Caries DMF I : 52/426 = 12.2 per cent

DMF II : 107/426 = 25 per cent

DMF III : 15/426 = 3.5 per cent

Total : 174/426 = 40.8 per cent

(vi) Skin hygiene : Pyoderma : 2 = 0.5 per cent

Dermatomycosis (fungus) : 2 = 0.5 per cent

On the whole, children of primary school age very rarely showed signs of vitamin deficiency. The single case of PCM was accidental. Abnormal hair growth and liver enlargement prevailed to a moderate degree. Incidence of parotid enlargement was low (4.7 per cent) compared with that recorded in the other two SPC pilot areas surveyed, and had very slightly dropped in comparison with the previous age bracket (5.7 per cent).

Up to 9 years, melanodontia could be seen in the remaining first teeth, but this is of no statistical importance. A fairly significant percentage of conjunctival thickening (6.8 per cent) was observed, but cannot be linked to Vitamin A deficiency. Sub-conjunctival fatty deposits occurred, usually associated with obesity.

Pterygium appeared at an early age.

Vitamin $B_2$ (Riboflavin) deficiency symptoms were recorded. They are rare (2.1 per cent) but not negligible and usually associated with protein deficiency.

The most significant result is the high incidence of tooth decay. About 40 per cent of the children examined presented caries and the situation worsened with age. In the adult group we shall again strike this problem. It is associated with obesity and related to exaggerated consumption of cariogenic foods (sugar - sweets - bread - soft drinks). Oral hygiene was adequate on the whole.

We observed 11 cases of pyoderma (2.6 per cent), usually associated with scabies.

(c) General conclusions for school-age children

During school age, weight - height growth is normally slow from 6 to 10 or 11 years in girls, up to 11 or 12 years in boys. Head circumference in particular only increases very slowly and slightly at this stage. The child has had a chance to acquire personal immunity, or else undergone artificial immunisation (vaccination). Furthermore, he is now living in a well-controlled and generally hygienic environment.

On the other hand, it is at this age that the child tends to become infested with intestinal parasites (our survey did not deal with these) which results in loss of nutrients.

A secondary result of the anti-filariasis campaign carried out at Aitutaki in collaboration with WHO, is thought to have been a substantial reduction in the rate of ascaris infestation. However, the dietary factor is still very much in evidence : a fairly large group, comprising mainly boys and representing about 20 per cent of the children examined, showed signs of under-nutrition.

Arm circumference measurements revealed lack of muscle development. Symptoms of chronic protein deficiency (parotid enlargement, liver enlargement, abnormal hair growth, melanodontia) were far from negligible. Vitamin deficiencies were the exception rather than the rule, but dental caries were increasingly common and serious. The most significant findings were:

- Retarded development of bony structures (height : 20 per cent, skull : 25 per cent), especially noticeable in girls and a direct consequence of retardation in the preceding phases.

- A strong tendency, in girls, to put on excess fat which becomes even more marked between the ages of 9 and 13. The overall proportion of adipose subjects was around 30 per cent.

(d) Recommendations concerning school age

They follow on from the recommendations made in connection with the previous age bracket.

Growth, and hence nutritional status, should be checked at regular intervals which may, however, be somewhat longer. Weight and height should be measured once every term, or at the very least twice yearly, at the beginning and the end of each school year.

Body measuring should be performed at school, by the teachers themselves, with the assistance of the older pupils.

Figures showing weight and height according to age should be recorded on collective graphs, one for each school, which would allow instant assessment of any given situation, as in the graphs included in this report. WHO centimeter scales should be adopted, in order to achieve standardisation and facilitate comparison with international references. This matter of graphs is quite independent of the keeping of school health cards, the sorting out and interpretation of which would require trained statisticians. The recommended procedure is not time-consuming and can easily be carried out by school teachers, with the help of pupils, which, in itself, is highly educational.

Where it is difficult to organise rational school meals, supplementary protein should be given, until the combined influence of socio-economic development and health education improves overall nutrition. These protein supplements, which would necessarily be imports or gifts for the time being, could be items like milk biscuits (from New Zealand) or dried, roasted peanuts. Distribution could be limited to children whose nutritional status was discovered to be inadequate (retarded development, deficiency symptoms). Periodic antifilariasis treatment with Diethylcarbamazine should be continued. Prevention and treatment of caries in the permanent teeth should be intensified. A proper school health service should be set up to implement the above recommendations using the data collected during the survey.

5. Puberty and adolescence (13 to 17 years)

Number examined : 189 (78M - 111F)

This figure does not reflect the true size of the age group, as only a small fraction of the adolescents officially domiciled in Aitutaki actually live there. Many attend school in other localities, and a large number of youngsters who have left school migrate either to Rarotonga or to New Zealand. It is an exceedingly mobile age group, especially where boys are concerned, which accounts for the small number we were able to examine.

As from 16 years, the lag is completely made up and all subjects are within normal limits.

We can conclude that, in boys, head circumference retardation disappears during the adolescence spurt of growth.

(ii) Girls

Weight (Graph No. 5 bis)

The local mean, which had joined up with P 50 at 12 years, rises rapidly thereafter towards the upper reference curve, reaching P 90 at 15 years. At that age there are no thin subjects.

Overall distribution from 13 to 18 years is as follows :

Overweight $\geq$ P 90 : 26/111 = 21.5 per cent

Comparatively heavy $<$ P 90 $\geq$ P 50 : 40/111 = 36 per cent

Total heavy : 66/111 = 59.5 per cent

Comparatively light $<$ P 50 $\geq$ P 3 : 38/111 = 34.2 per cent

Underweight $<$ P 3 7/111 = 6.3 per cent

Total light : 40.5 per cent

The overweight trend becomes more marked. Not a single girl after the age of 15 is underweight.

Skinfold (Graph No. 8 bis)

Local mean overtook standard mean at 10 years. Between 13 and 15 years it soars across and beyond the upper reference curve.

Distribution according to skin fat is as follows :

Extremely fat : $\geq$ 25 mm : 4/111 = 3.6 per cent ) Very fat :
Very fat $<$ 25 mm $\geq$ 20 mm : 13/111 = 10.7 per cent) 14.3 per cent

Moderately fat $<$ 20 mm $\geq$ 15 mm : 83/111 = 72.1 per cent

Thin $<$ 15mm $\geq$ 5 mm : 11/111 = approx. 10 per cent

Very thin $<$ 5mm : 0

There is a striking contrast between the high percentage of girls with above-standard skinfold readings and the high percentage of girls with sub-standard arm circumference measurements. This may be accounted for, as in the previous phase, by inadequate muscle development.

Arm circumference (Graph No. 9 bis)

The local mean which had remained consistently below the standard mean since the age of 4 years crosses it only at 15, and even then largely as a result of excessive fat formation.

The local mean, which stands at 21.4 cm at 13 years (1cm below standard), reaches 24 cm at 18 years.

Distribution was as follows :

| | | |
|---|---|---|
| > 120 per cent of standard : 6/111 = 5.4 per cent | ) | large circumference : 27.8 per cent |
| ≤ standard < 120 per cent : 26/111 = 22.4 per cent | ) | |
| < standard ≥ 80 per cent : 76/111 = 68.4 per cent | ) | small circumference : 72.2 per cent |
| < 80 per cent of standard : 3/111 = 2.7 per cent | ) | |

As already noted in connection with preceding age brackets, arm circumference was on the small side whereas skinfold was clearly above the norm, indicating a preponderance of fatty tissues over muscle.

Height (Graph No. 6 bis)

The local mean in respect of height reaches P 50 only at 17 years, but most girls were near the standard mean from 16 years onwards.

Overall distribution was as follows :

| | | |
|---|---|---|
| Very tall ≥ P 90 : 7/111 = 6.6 per cent | ) Tall = 43 per cent | |
| Tall < P 90 ≥ P 50 : 41/111 = 36.2 per cent | ) | |
| Comparatively short < P 50 ≥ P 3 : 56/111 = 50.4 per cent | ) Short = 57 per cent | |
| Very short < P 3 : 7/111 = 6.6 per cent | ) | |

Height lags were made good in all cases by 16 or 17 years, and the local mean thereafter coincides with the US standard mean.

Head circumference (Graph No. 7 bis)

The local mean exactly ccincides with the standard mean up to 15½ years when it levels out for good, as growth ceases at that age.

Distribution is as follows :

> P 90 : 6/111 = 5.4 per cent

< P 90 ≥ P 50 : 40/111 = 37 per cent

< P 50 ≥ P 3 : 54/111 = 48.6 per cent

< P 3 : 11/111 = 10 per cent

(b) Clinical findings

13 to 17 years (inclusive) ——————→ 18

Number examined : 189 ( 72 M - 111 F )

(i) Protein-calorie malnutrition : 1 (with oedema)

(ii) Malnutrition sequels :

Abnormal hair growth : 1/189 = 0.5 per cent

Enlarged liver : 0/189

Enlarged parotids : 1/189 = 0.5 per cent (associated with gynaecomastia)

(iii) Clinically detectable anaemia : 1 (with PCM)

(iv) Vitamin deficiencies

Vitamin A deficiency :

- Thickening of conjunctiva : 27/189 = 14.3 per cent
- Fatty deposits (associated with general obesity) : 29/189 = 15.3 per cent
- Pterygium : 3/189 = 1.5 per cent
- Vitamin $B_2$ (riboflavin) deficiency : nil
- Other : Glossitis : nil
- Sequels of rickets : nil

(v) Dental state

- Periodontal disease (Pyorrhea) : 2/189 = 1.1 per cent

- Caries

| | | |
|---|---|---|
| DMF I | : | 45 |
| DMF II | : | 26 |
| DMF III | : | 3 |
| | | 74/189 = 39 per cent (as against 40.8 per cent in the 7 to 12 year group) |

(vi) Skin hygiene

- Pyoderma : 2 = 1.1 per cent

- Pityriasis : 5/189 = 2.5 per cent

The most noteworthy clinical findings were :

- disappearance of (clinical) malnutrition sequels;
- non-existence of (clinical) anaemia (1 exception);
- low incidence of vitamin deficiencies;
- high incidence of tooth decay;
- good general skin condition.

(c) Summary and conclusions : puberty and adolescence

After age 13 growth proceeded rapidly in all parameters for nearly all subjects examined. It is impossible to say whether this particular generation enjoyed better food conditions than the following one, or whether sequels of undernutrition - malnutrition are spontaneously wiped out during puberty.

Whatever the case may be, clinical syndromes of conventional malnutrition had all but disappeared, while height and head circumference measurements had caught up with US figures, the local and standard means coinciding exactly.

Only two problems were evident during adolescence :

(1) A tendency to put on fat, especially marked in girls and heralding in adult obesity; about 20 per cent of the subjects were affected.

(2) The high rate of tooth decay : even after the natural loss of carious first teeth during the preceding period, 39 per cent of adolescents still showed one or more caries, many being in stage II (3 to 10 DMF).

Changes in the bulbar conjunctiva were recorded in a fair number of adolescents, and appeared to be related to the fatty metabolism : conjunctival thickening, pterygium and, in particular, subconjunctival fatty deposits (15.3 per cent), the latter being generally associated with incipient obesity.

Apart from the above-mentioned facts, which constitute potential hazards rather than real problems for the time being, nutritional status of adolescents was, on the whole, excellent.

The question is, however : might it not be better still if lags and losses had been avoided in the previous phases?

(d) Recommendations

On account of its mobility, this age group defies medical follow-up. Nevertheless, treatment and prevention of tooth decay should be organised as a matter of some urgency.

As regards the tendency to put on surplus fat, it should be checked, by promoting a more balanced diet and controlling excessive consumption of alcohol (beer) in young males, but especially by developing physical, social and cultural activities. Not only should modern sports (volleyball, basketball, etc.) and traditional dances be encouraged in both girls and boys, but youngsters should be induced to expend surplus energy on useful and creative pastimes such as :

- Fishing in canoes or sailing boats which is quite safe and highly rewarding in the lagoon and would serve the double purpose of supplying valuable protein and building strong muscles.

- Growing vegetables, especially legumes (peas, beans, peanuts, lupins, soya) in school or home gardens.

Government or international assistance might well be necessary to initiate the activities suggested.

N.B. The Fisheries Section of the South Pacific Commission study aimed at developing fisheries at Aitutaki, in February-March 1976.

In addition, adolescent girls should be given training in :

- home economics;
- child care;
- small-stock farming;
- gardening.

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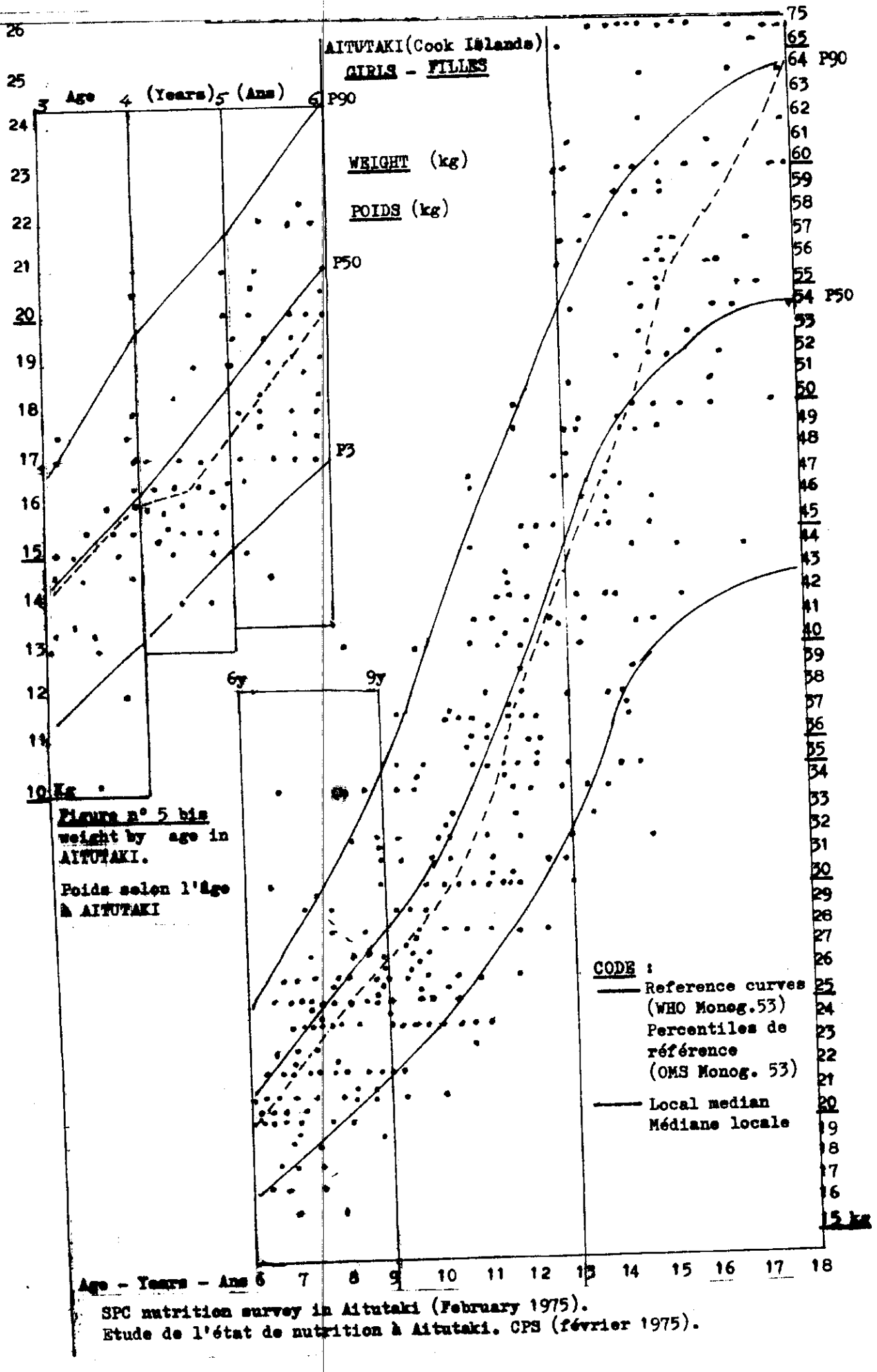


**Figure n° 5 bis**
weight by age in AITUTAKI.

Poids selon l'âge à AITUTAKI

SPC nutrition survey in Aitutaki (February 1975).
Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

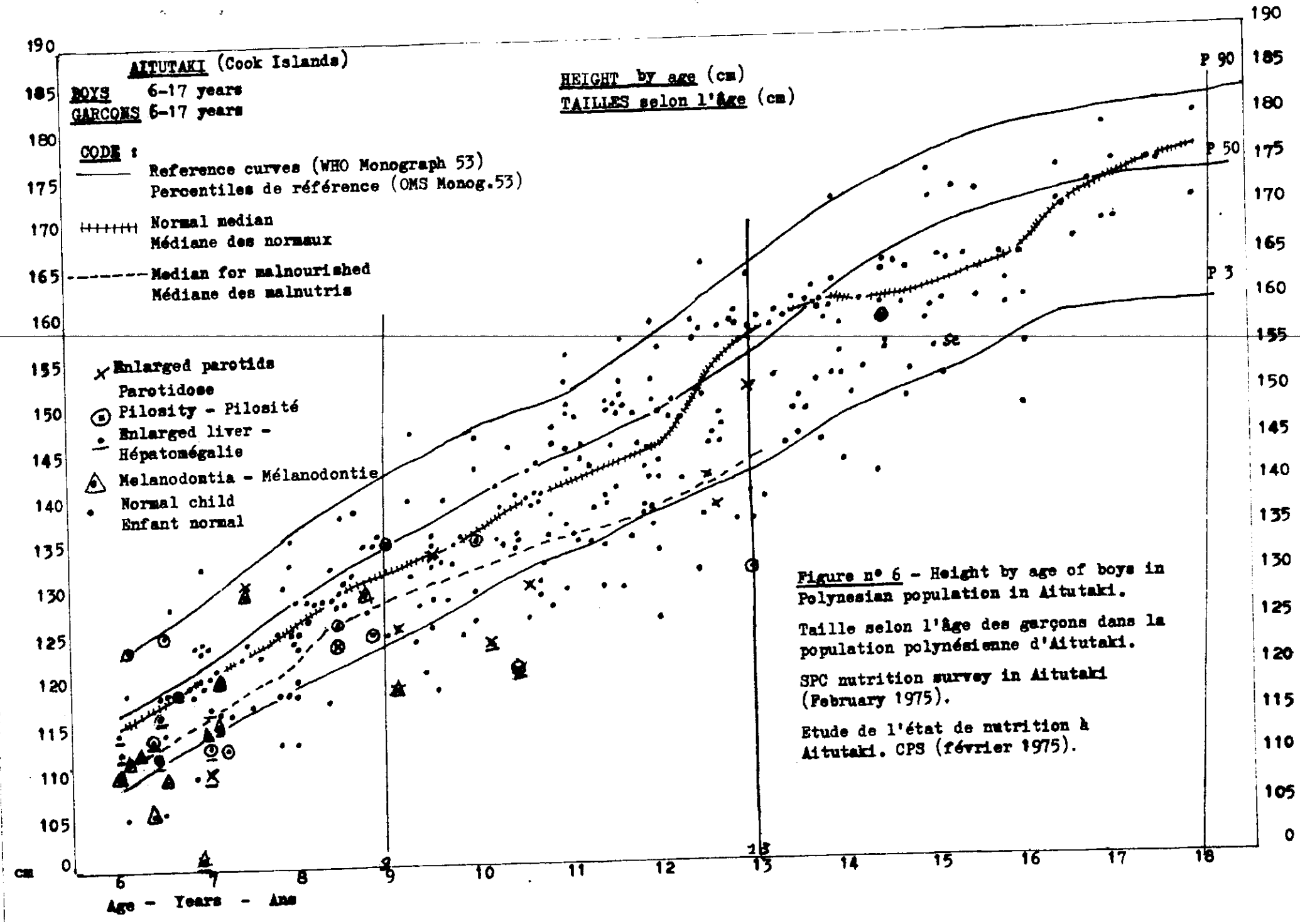


Figure n° 6 - Height by age of boys in Polynesian population in Aitutaki.

Taille selon l'âge des garçons dans la population polynésienne d'Aitutaki.

SPC nutrition survey in Aitutaki (February 1975).

Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

AITUTAKI (Cook Islands)

BOYS 6-17 years
GARCONS 6-17 ans

HEAD CIRCUMFERENCE (cm)
PERIMETRE CRANIEN (cm)

Figure n° 7 - Head circumference by age
Distribution par âge du périmètre crânien

Comparison with WHO references (Monograph 53-1971) from E.W. WATSON - P.H. LOWREY.
Comparaison avec les références OMS (Monographe 53-1971) par E.W. WATSON - P.H. LOWREY.
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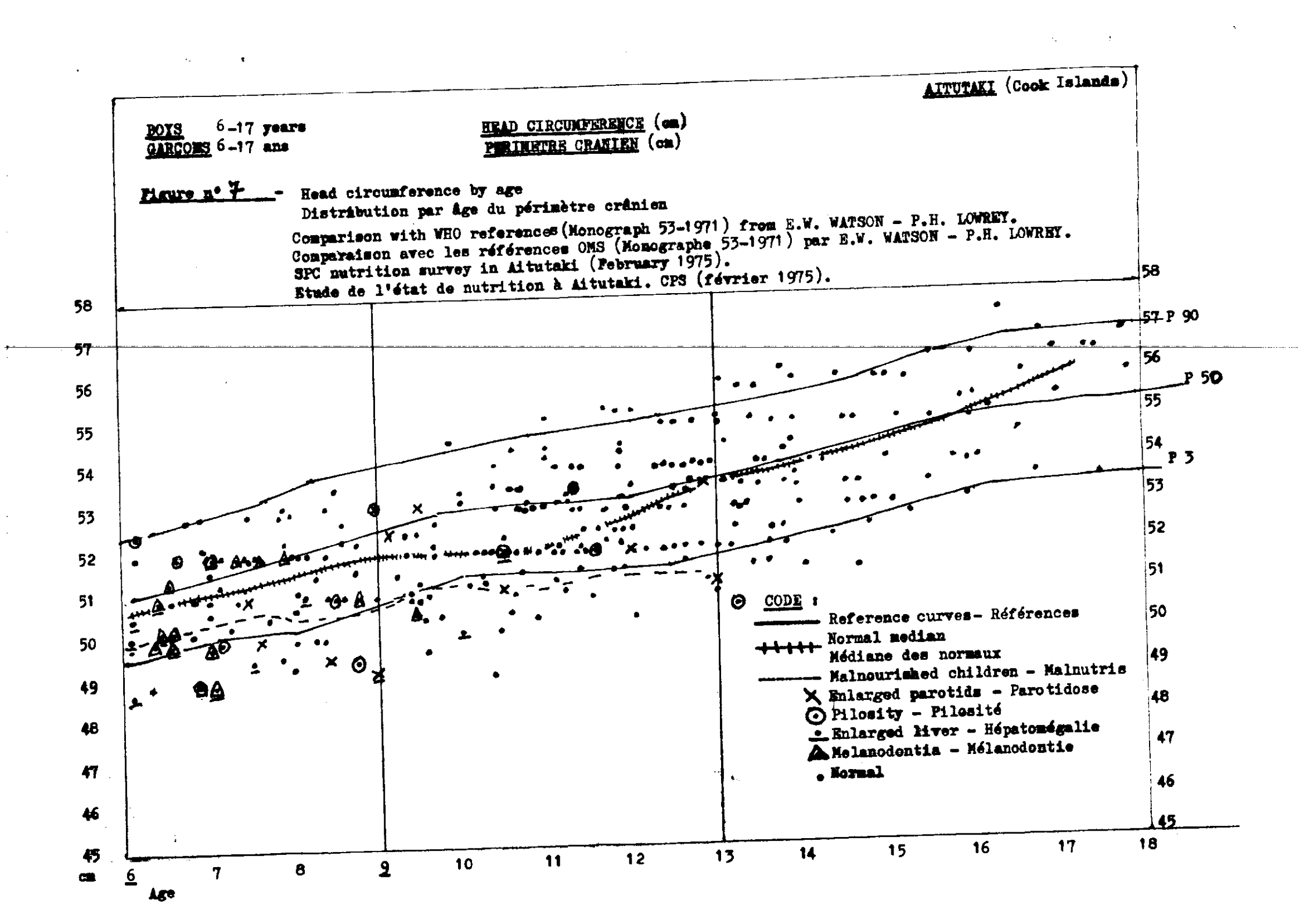

AITUTAKI - COOK ISLANDS

**GIRLS** 6-17 years
**FILLES** 6-17 ans

## HEAD CIRCUMFERENCE - PERIMETRE CRANIEN

Figure n° 7 bis - Head circumference by age
Distribution par âge du périmètre crânien

Comparison with WHO references (Monograph 53-1971) from E.W. WATSON - P.H. LOWREY.
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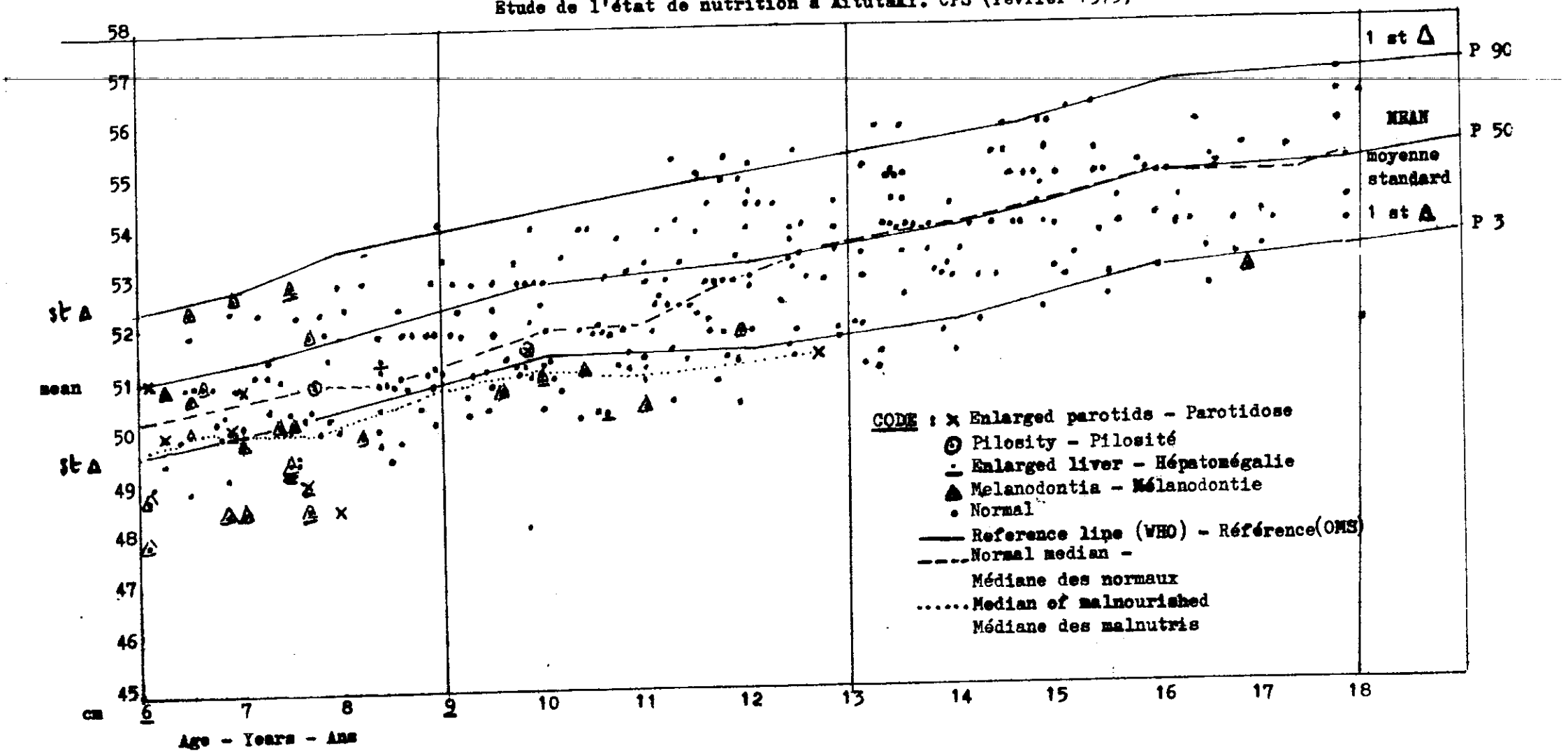


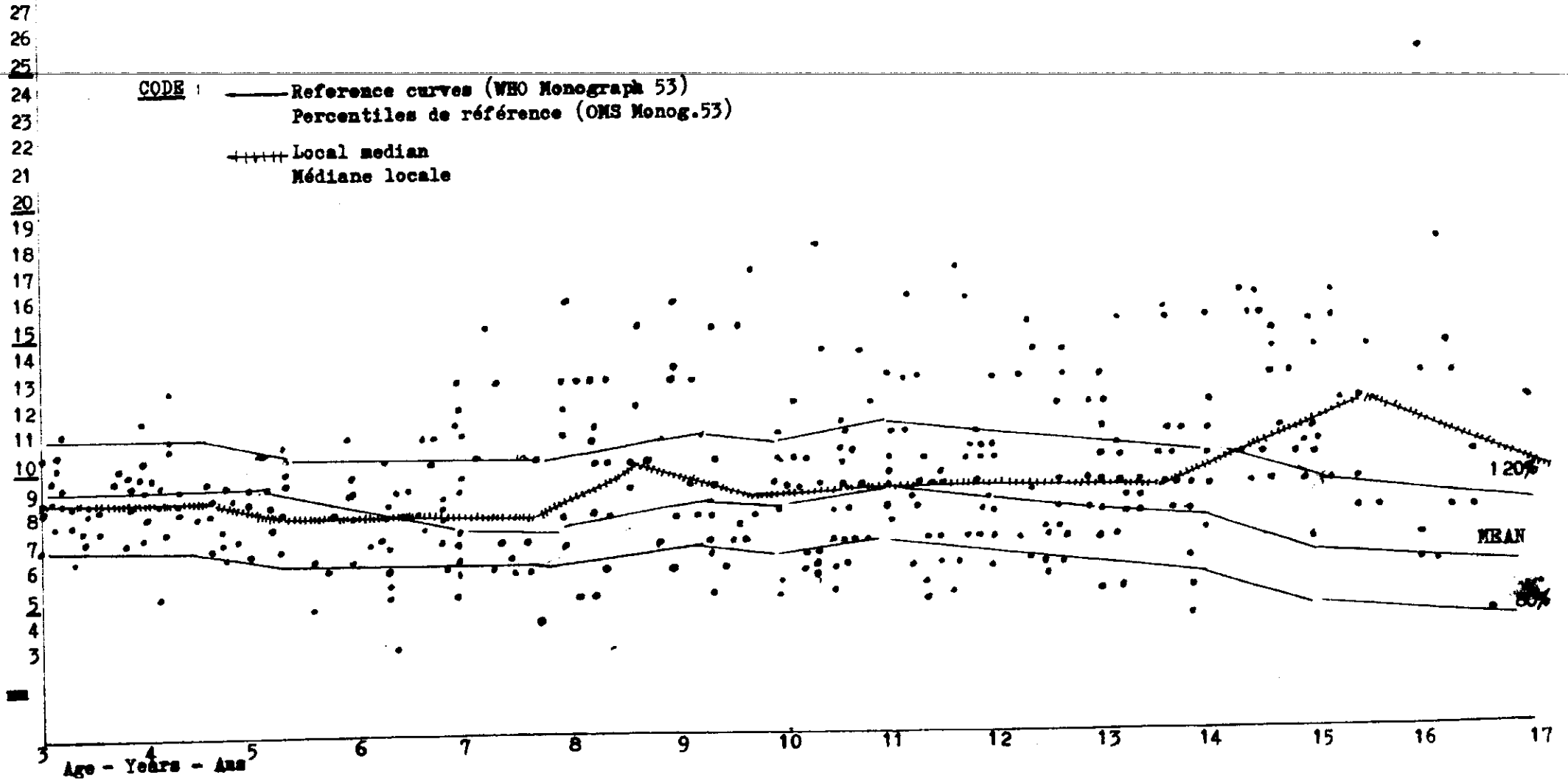
AITUTAKI (Cook Islands)

BOYS : 3-17 years
GARCONS : 3-17 ans

SKINFOLD (TRICIPITAL left arm) (mm)
PLI CUTANE TRICIPITAL (bras gauche) (mm)

Figure n° 8 · Distribution of skinfold thickness for boys.
Distribution du pli cutané tricipital des garçons.

SPC nutrition survey in Aitutaki (February 1975).
Etude de l'état de nutrition à Aitutaki. CPS (février 1975).



AITUTAKI (Cook Islands)

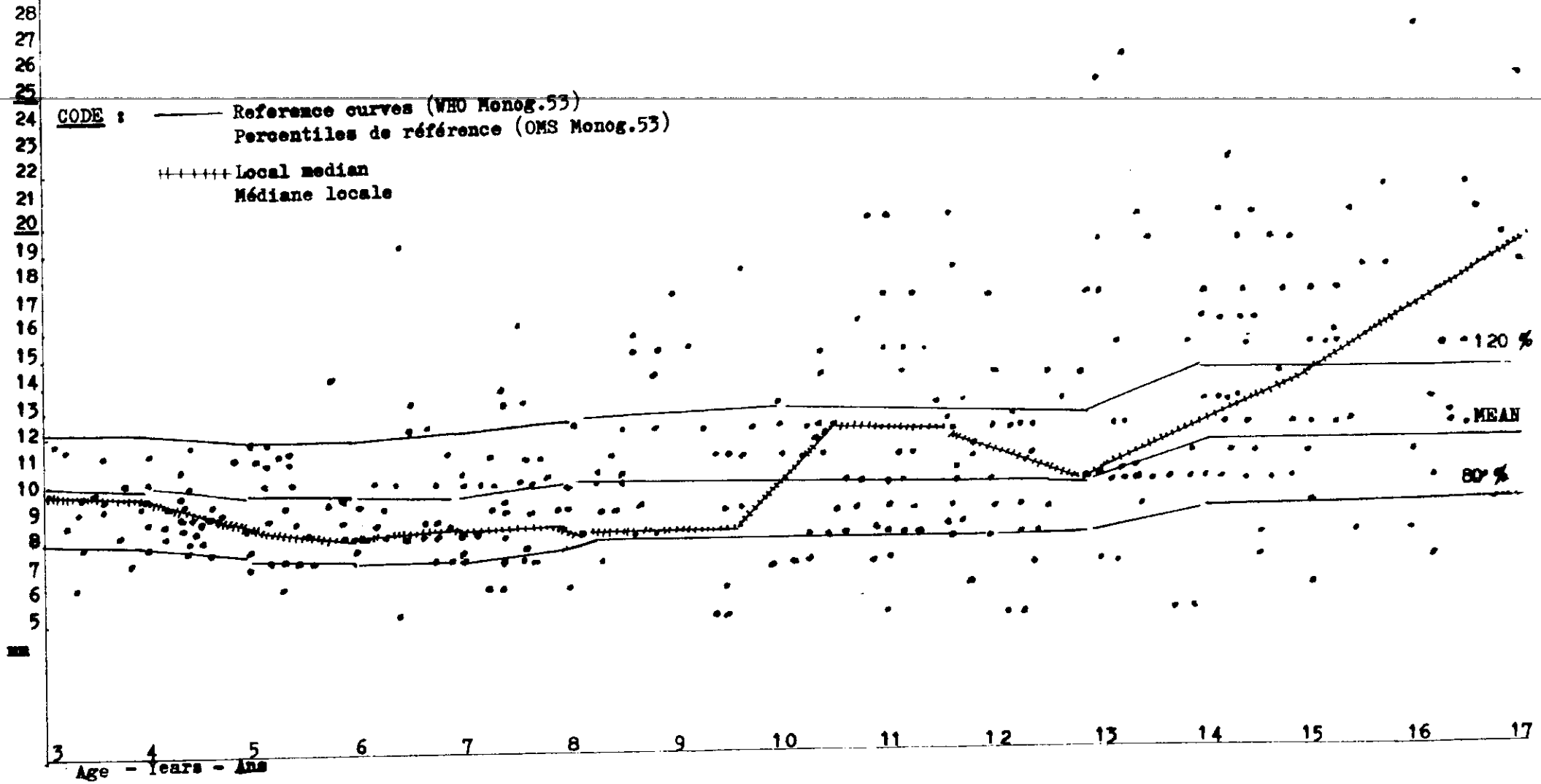
SKINFOLD (TRICIPITAL (left arm) (mm)
PLI CUTANE TRICIPITAL (bras gauche) (mm)

GIRLS : 3-17 years
FILLES : 3-17 ans

Figure n° 8 bis

Distribution du pli cutané tricipital des filles.

SPC nutrition survey in Aitutaki (February 1975).
Etude de l'état de nutrition à Aitutaki (février 1975).



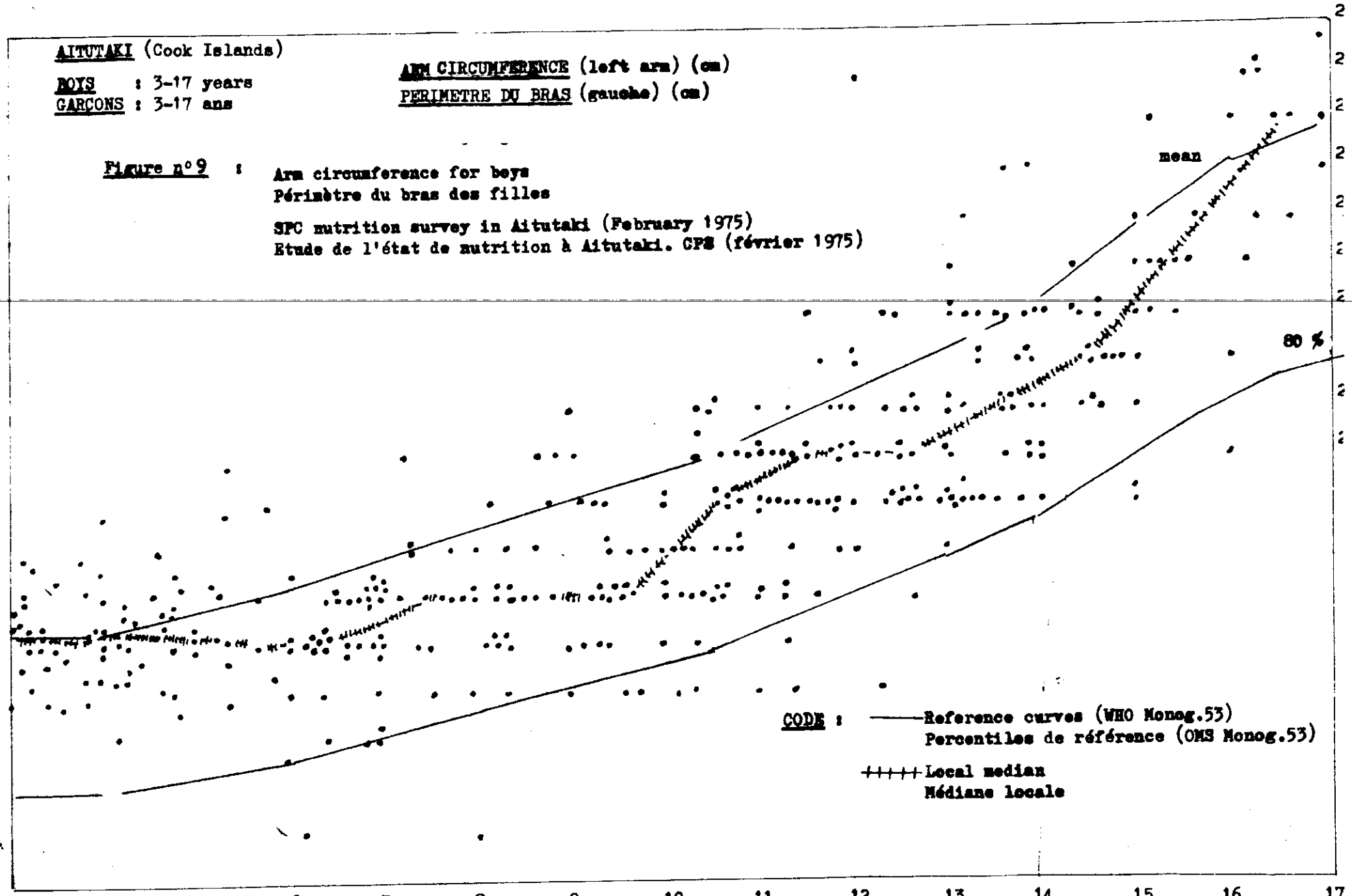
AITUTAKI (Cook Islands)

BOYS : 3-17 years
GARÇONS : 3-17 ans

ARM CIRCUMFERENCE (left arm) (cm)
PERIMETRE DU BRAS (gauche) (cm)

Figure n° 9 : Arm circumference for boys
Périmètre du bras des filles

SPC nutrition survey in Aitutaki (February 1975)
Etude de l'état de nutrition à Aitutaki. CPS (février 1975)



# CHAPTER IV

# NUTRITIONAL STATUS OF ADULTS

## Clinical findings

### 1. Anaemia

Clinical forms are practically non-existent : only one case of severe anaemia, with oedema was recorded, in a pregnant woman. Glossitis was similarly very rare: only 2 cases, of the black patch type were recorded, whereas in the Melanesian populations surveyed it was far more common among anaemic subjects. Ankylostomiasis is exceedingly rare and malaria non-existent.

### 2. Protein malnutrition (with oedema) : nil

### 3. Various vitamin deficiencies

Vitamin A deficiency : None of the skin changes indicative of Vitamin A deficiency (dryness, hyperkeratosis) were observed.

Ocular symptoms : Thickening of the bulbar conjunctiva, with or without pigmentation, was fairly common.

Already noted in the preceding age brackets (school age children and adolescents), it was found to affect adults (over 18 years) in 37 cases out of 428, i.e., 8.6 per cent. This rate is very much below that recorded on Malekula.

The significance of this condition, which is characterised by the formation of thickened folds of conjunctiva near the nasal area, is not very clear. Vitamin A shortage is often incriminated, but since carotene intake appears to be adequate - due to the inclusion of sweet potato in daily diets - and since no other symptoms of Vitamin A deficiency were observed, we should be inclined to suspect faulty metabolism of fatty acids or a shortage of polyunsaturated fatty acids. The condition should be studied further, in relation to overall body development.

Vitamin B deficiency :

- No symptom of beriberi (Vitamin $B_1$ deficiency)
- No symptom of pellagrous dermatosis (PP deficiency)
- No case of filiform acne - "dyssebacea" ($B_2$ deficiency)
- No case of cheilosis
- No case of raspberry tongue
- Two cases of magenta tongue with central depapillation
- Two cases of black patch tongue (aetiology unknown)

4. Ocular symptoms

(a) Pterygium :

Fairly common but far less so than on Malekula (New Hebrides).

Ninety cases were recorded out of 428 subjects, i.e. 21 per cent. Incidence rose with age. This lesion is usually found in the senile eye, but here it is present from adolescence. Its nutritional significance is not clear.

(b) Sub-conjunctival fatty deposits (Pingueculae) : 28 per cent

These are generally more or less yellowish in colour and located on the outer side of the sclera. They are most commonly, but not exclusively, associated with obesity.

Related to xanthelasma, which are deposits of cholesterol crystals, they may be useful as a key-symptom if it were possible to prove their connection with arterial atheroma, since they are easily detectable. Their presence can be linked to high consumption of fats (coconut oils) and to obesity.

(c) Cataract :

Eye examination was not very detailed and thorough: 8 cataracts were found in adults over 45, 3 of which had been operated. Cataracts are known to occur more frequently among diabetics and to be associated with old age.

5. Dental status :

Examination of teeth was somewhat cursory, carried out by a general practitioner. Tooth decay is a recognised problem throughout the Cook Islands and a large-scale effort is being made to deal with it: many caries have been filled, most of the over-forties who have lost their natural teeth have been supplied with dentures, and oral hygiene is good in the urban adult.

A detailed survey will be conducted during 1976 by Dr J.D. Speake, the South Pacific Commission's Dental Public Health Officer.

To express the results of our examinations we have used the simplest WHO classification, i.e. : Decayed - Missing - Filled I : less than 3
Decayed - Missing - Filled II : between 4 and 10
Decayed - Missing - Filled III : More than 10

(a) Distribution according to age (adults M & F)

| | Between 18 and 45 years | Between 45 and 60 years | Over 60 years |
|---|---|---|---|
| DMF I | 4.7 per cent | 2.3 per cent | 0 per cent |
| DMF II | 15.4 per cent | 5.8 per cent | 2.2 per cent |
| DMF III | 26 per cent | 41.9 per cent | 69.2 per cent |
| TOTAL | 46 per cent | 50 per cent | 71.4 per cent |

(b) Overall results for adults (from 18 to over 60 years)

DMF I : 3.1 per cent DMF II : 10.3 per cent DMF III : 4 per cent

6. Skin hygiene

On the whole, meticulous cleanliness is the rule and general skin condition is excellent.

Skin infections are rare (0.25 per cent) in spite of aggression by mosquitoes.

Fungus affections (dermatomycosis) of the Pityriasis versicolor type are slightly more common (1.8 per cent) but far less so than on Malekula (New Hebrides).

Three cases of leprosy (recognised and treated) and three cases of long-standing elephantiasis were seen in the course of our survey; one of the latter was in an emaciated alcoholic with very enlarged parotid glands.

7. Metabolic disorders

- Gout : 6 cases, recognised and treated
- Diabetes of middle age : 4 cases reported and treated, but this figure is certainly far below the actual situation.

Since no laboratory tests were performed, the above data must be regarded as very incomplete.

During this first survey the pilot area we concentrated on the most obvious metabolic problems, mainly obesity. At a later date it may become feasible to explore the subject more thoroughly, in collaboration with specialised laboratories and the metabolic diseases research and treatment unit which is to be established at Avarua.

Chapter V will be devoted entirely to the study of obesity.

* * *

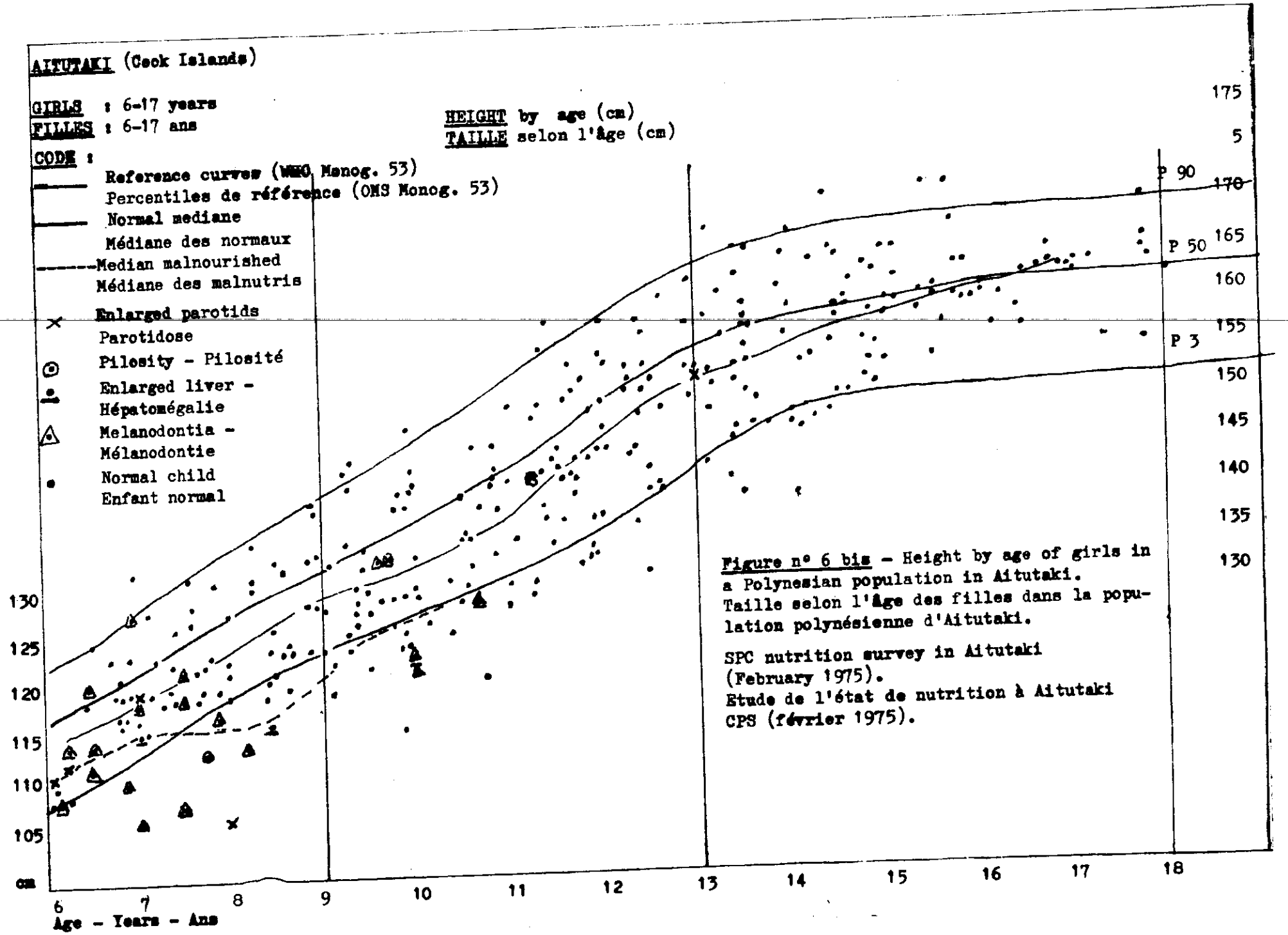



**Figure nº 6 bis** – Height by age of girls in a Polynesian population in Aitutaki.
Taille selon l'âge des filles dans la population polynésienne d'Aitutaki.

SPC nutrition survey in Aitutaki (February 1975).
Etude de l'état de nutrition à Aitutaki CPS (février 1975).

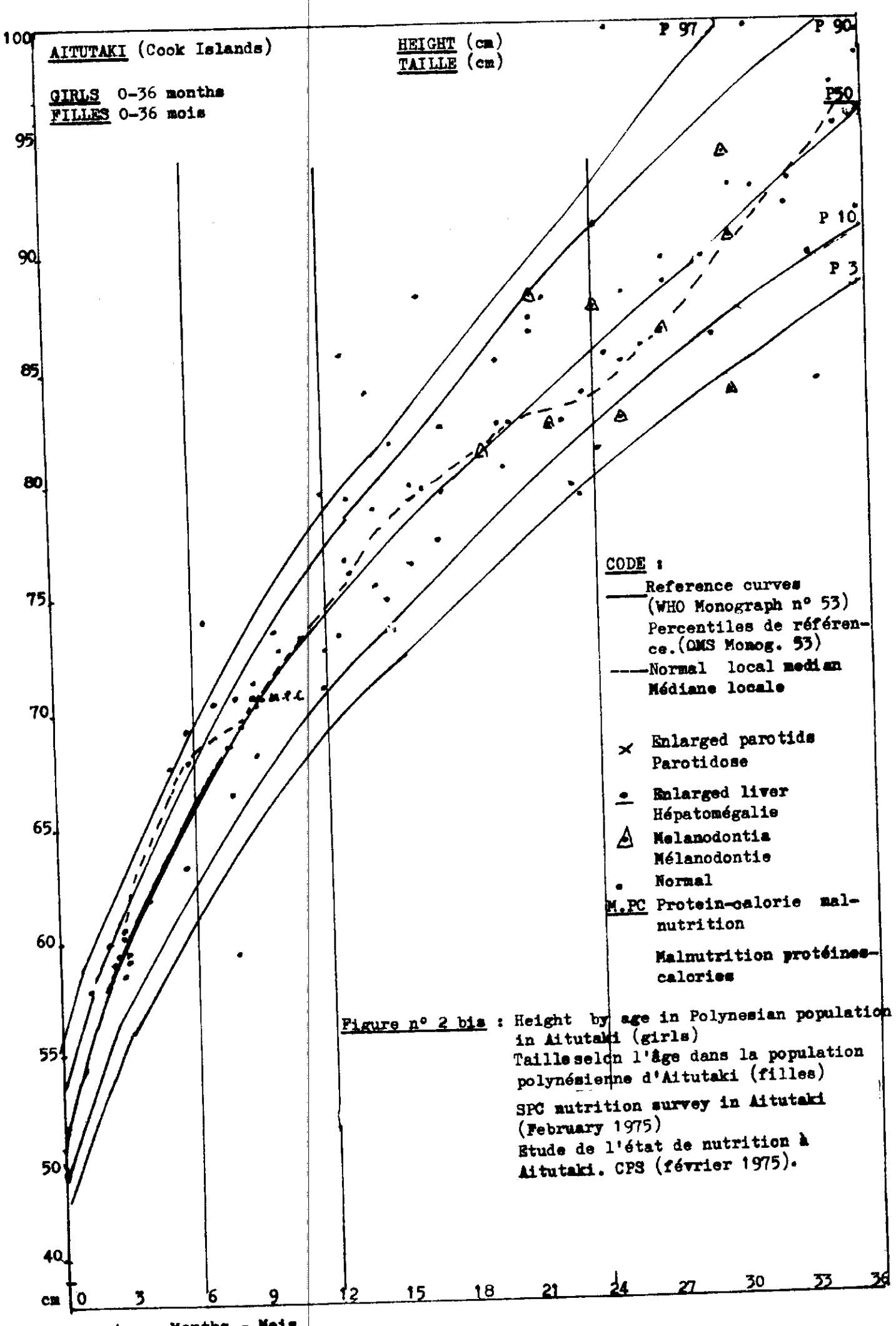


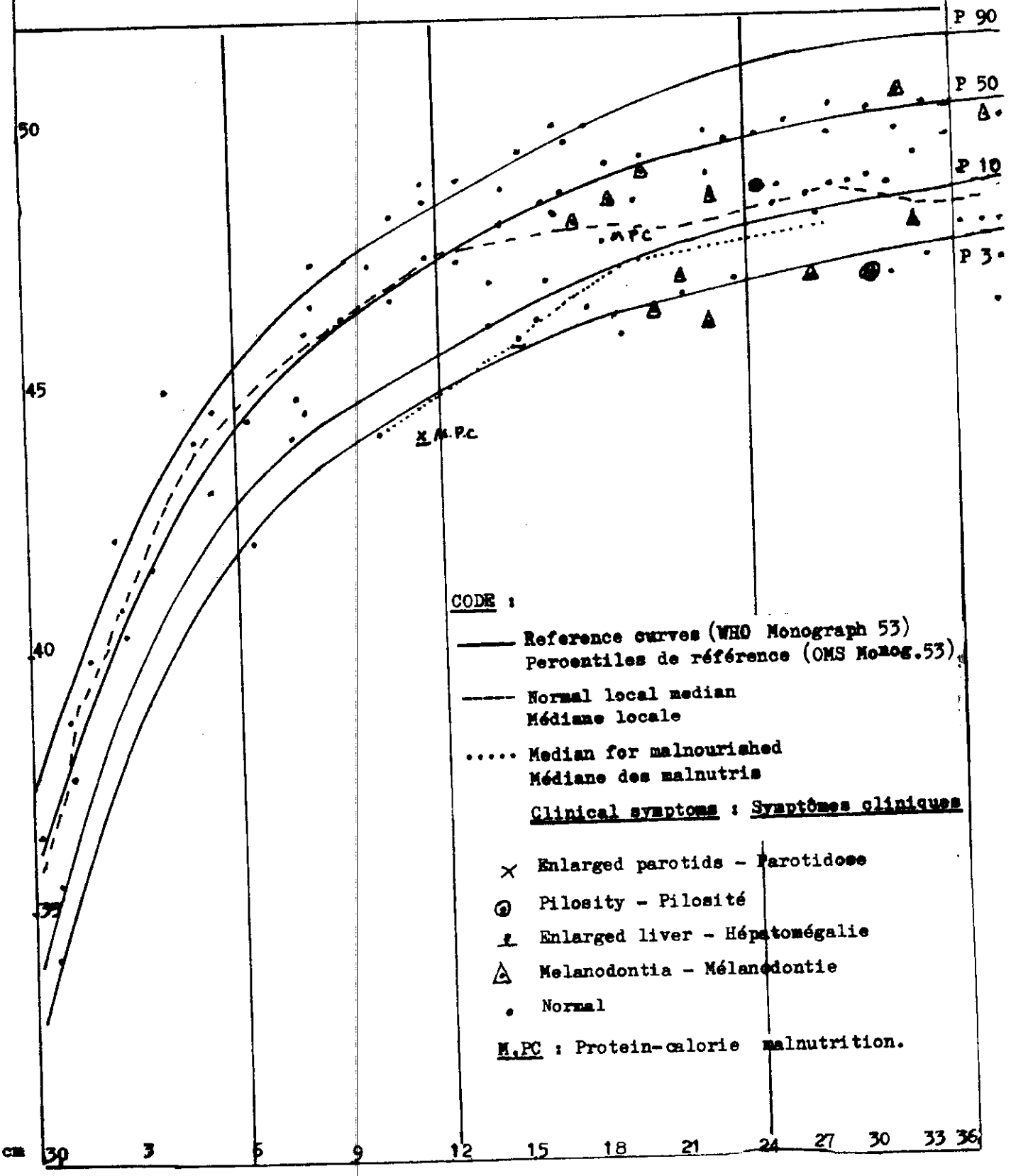

Figure n° 2 bis : Height by age in Polynesian population in Aitutaki (girls)
Taille selon l'âge dans la population polynésienne d'Aitutaki (filles)

SPC nutrition survey in Aitutaki (February 1975)
Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

AITUTAKI (Cook Islands)
BOYS : 0-36 months
GARCONS : 0-36 mois

HEAD CIRCUMFERENCE (cm)
PERIMETRE DU CRANE (cm)

Figure n° 3 : Head circumference by age in Polynesian population (boys) in Aitutaki
SPC nutrition survey in Aitutaki (February 1975).
Périmètre du crâne en fonction de l'âge (garçons) dans la population polynésienne d'Aitutaki.
Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

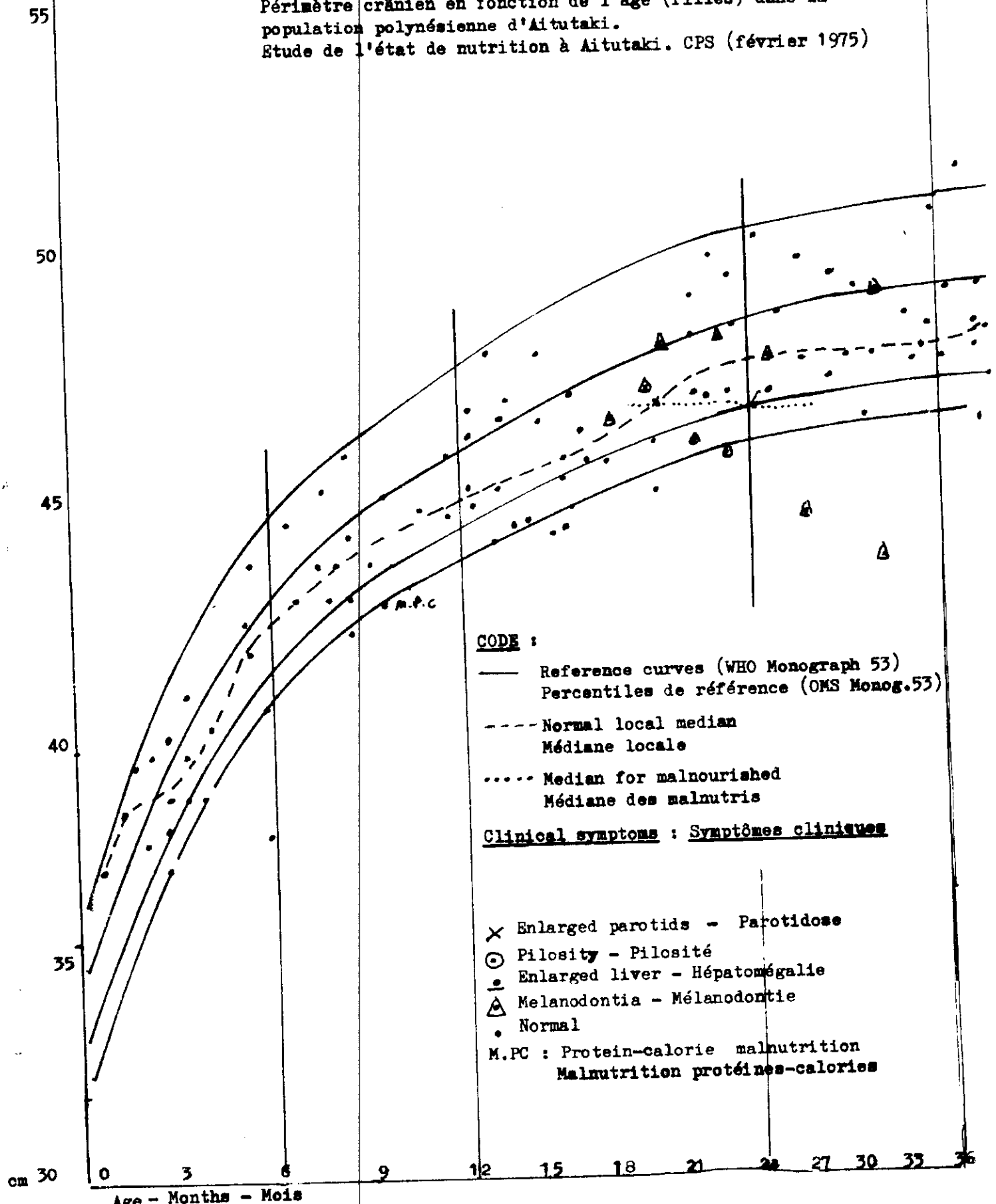


AITUTAKI (Cook Islands)
GIRLS : 0-36 months
FILLES : 0-36 mois

HEAD CIRCUMFERENCE (cm)
PERIMETRE DU CRANE (cm)

**Figure n° 3 bis** : Head circumference by age in Polynesian population (girls) in Aitutaki.
SPC nutrition survey in Aitutaki (February 1975)

Périmètre crânien en fonction de l'âge (filles) dans la population polynésienne d'Aitutaki.
Etude de l'état de nutrition à Aitutaki. CPS (février 1975)



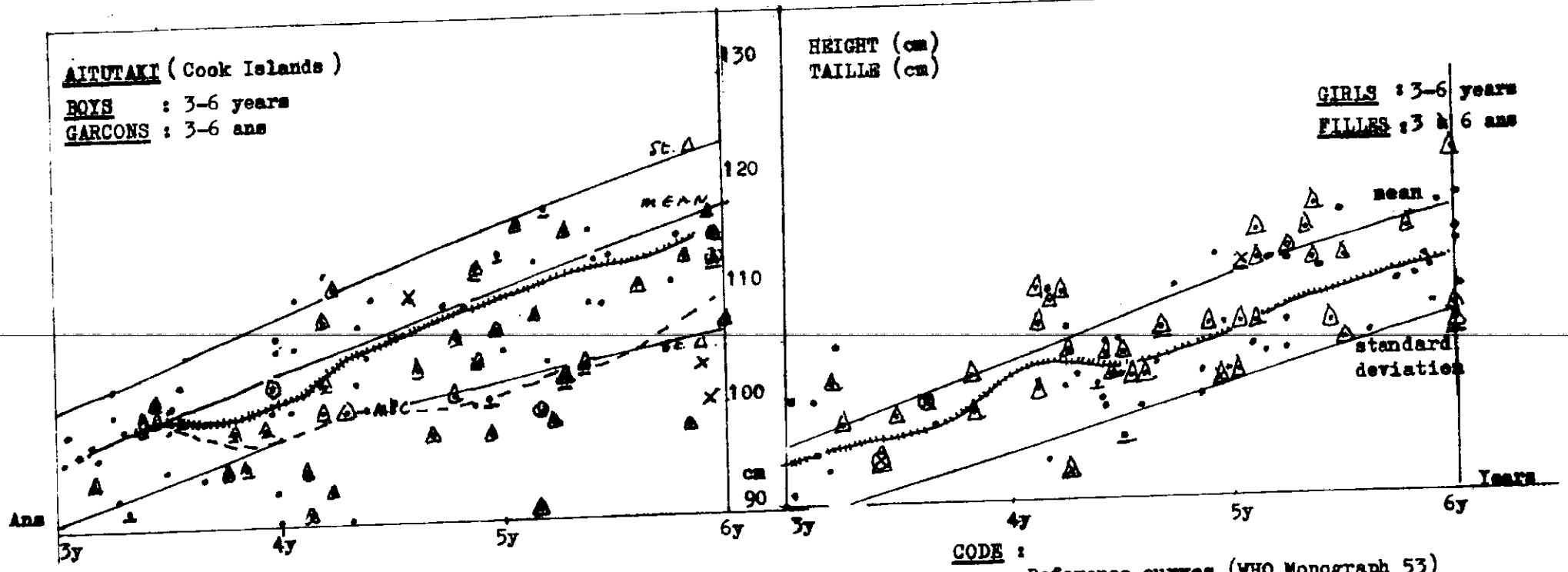



**Figure n° 4** – Height by age (boys and girls) in Polynesian population in Aitutaki.

Tailles selon l'âge dans la population polynésienne d'Aitutaki (filles et garçons).

SPC nutrition survey in Aitutaki (Feb. 1975).

Etude de l'état de nutrition à Aitutaki.
CPS (février 1975).

CODE :

——— Reference curves (WHO Monograph 53)
Percentiles de référence (OMS Monog.53)

– – – – – Normal local median
Médiane locale

. . . . . Median of malnourished children
Médiane des malnutris

× Enlarged parotids – Parotidose

· Enlarged liver – Hépatomégalie

⊙ Pilosity – Pilosité

△ Mélanodontia – Mélanodontie

. Normal

M.P.C Protein-calorie malnutrition
Malnutrition protéines-calories

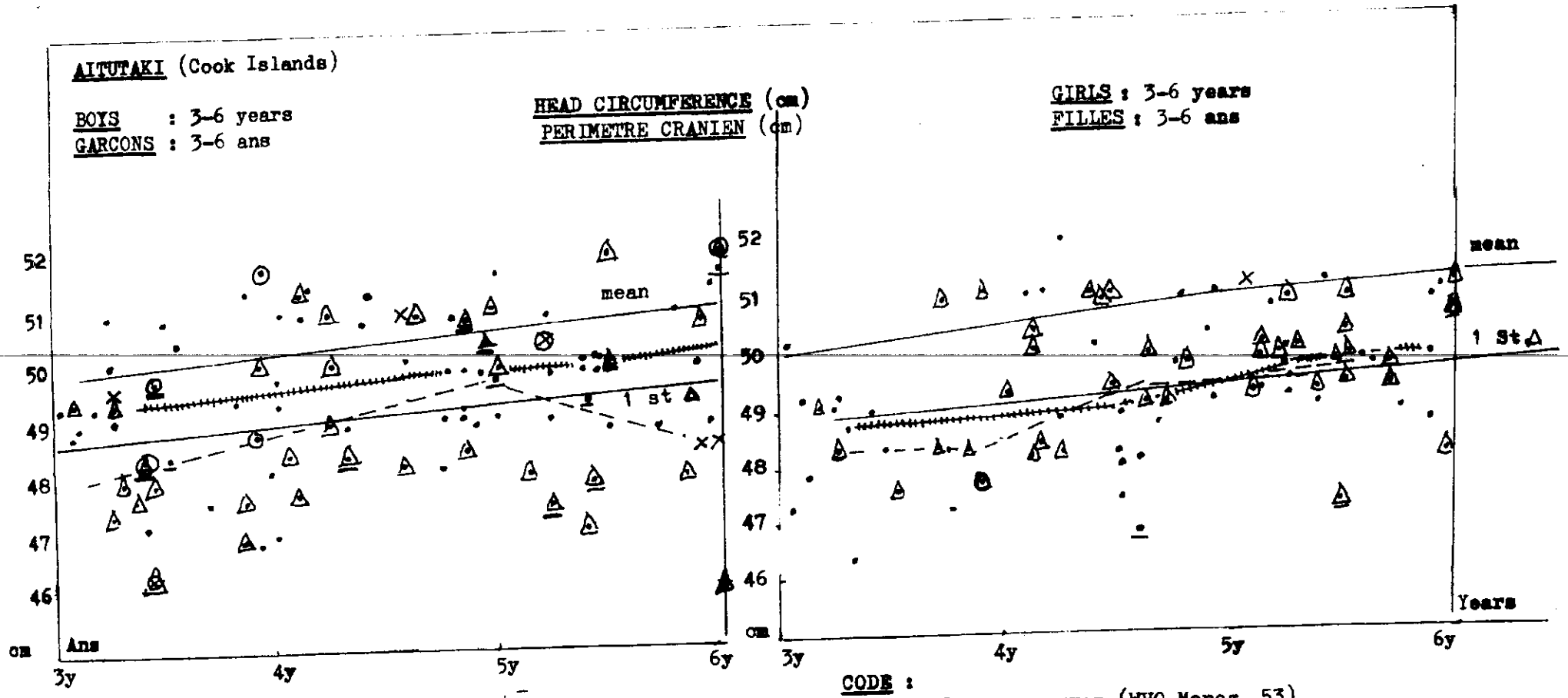



Figure n° 4 bis - HEAD CIRCUMFERENCE for boys and girls in a Polynesian population in Aitutaki.
Périmètre crânien des garçons et filles dans la population polynésienne d'Aitutaki.

SPC nutrition survey in Aitutaki (February 1975).
Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

CODE :

——— Reference curves (WHO Monog. 53)
Percentiles de référence (OMS Monog. 53)

+++++ Normal local median
Médiane locale

- - - - - Median of malnourished children
Médiane des malnutris

× Enlarged parotids - Parotidose

⊙ Pilosity - Pilosité

⊥ Enlarged liver - Hépatomégalie

△ Melanodontia - Mélanodontie

. Normal

M.P.C : Protein-calorie malnutrition
Malnutrition protéines-calories

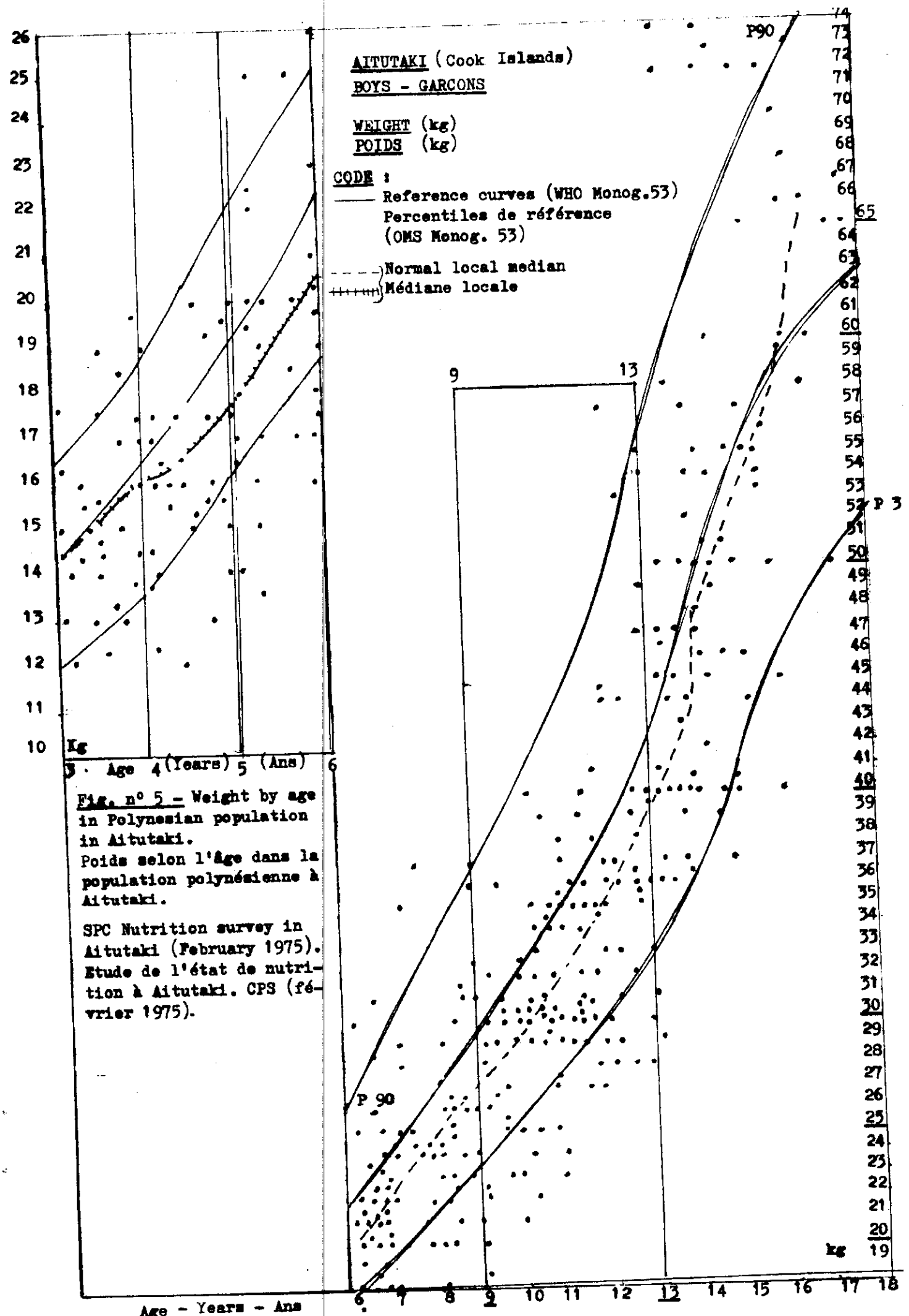



Fig. n° 5 - Weight by age in Polynesian population in Aitutaki.
Poids selon l'âge dans la population polynésienne à Aitutaki.

SPC Nutrition survey in Aitutaki (February 1975).
Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

# CHAPTER V

## COMPARATIVE STUDY OF OBESITY IN SPC PILOT AREAS WITH SPECIAL REFERENCE TO AITUTAKI

This study involved 807 persons over 18 years (311 men - 496 women) and was carried out between September 1974 and February 1975 :

In Wala-Rano, a district comprising a group of Melanesian villages, located on the North-East coast of Malekula (New Hebrides) and at the Norsup school, about 10 kms away.

At Tagabe, a suburb of Vila (New Hebrides) settled by recent migrants, largely Melanesian (75 per cent), partly Polynesian (from Wallis Island).

On Aitutaki, an island in the Southern Cooks, with a succinct sampling at Avarua (Rarotonga).

### 1. Description of methods

The same methods were used by the same operator in all three locations :

(a) To determine weight/height ratio for each sex and in relation to certain set standards;

(b) To measure triceps skinfold thickness, with constant pressure calipers;

(c) To detect syndrome combinations that appear to be associated with obesity, such as :

(i) enlarged parotid glands (parotidosis)

(ii) arterial hypertension (high blood pressure)

On the basis of the data collected, we analysed :

(a) the weight/height ratio, which uses total weight (sum of active muscle mass and fatty mass), in order to determine possible overweight;

(b) the triceps skinfold measurements, which reflect the amount of fatty tissue present and thus help to determine possible obesity.

#### Methods based on weight/height ratio

Among existing methods for estimating degrees of obesity, the simplest and most commonly used is to take a standard weight/height ratio and to calculate overweight in terms of deviation from, or percentiles of, that standard.

Many systems of calculation have been proposed at various times, in various countries, but they all have one drawback in that they do not take into account somatotype and morphotype (endo-, meso-, ectomorphy), that is to say, constitutional differences in body form and structure, since weight is the sum of muscle, fat, bone and water; nor do they differentiate between endocrine types (android, gynoid, or intermediate).

For this reason, the more recent anthropometric techniques incorporate not only weight and height, but various other measurements (circumferences and diameters) into the general frame of reference. We have adopted the system evolved by Albert R. BEHNKE and presented at the Symposium on obesity organised in San Francisco in 1969 by the University of California (c.f. "Obesity", ed. Nancy L. WILSON, pub. F.A. DAVIS, Philadelphia). We have regarded as undesirable excess, in relation to height, any weight figure exceeding the 2 standard deviations defined by BEHNKE. In practice, this represents an overweight of 20 per cent above the standard mean.

2. Comparison of results obtained using weight/height ratio (Graphs 11 and 11 bis)

The population was divided into three groups :

Group I : equal to or lighter than the mean

Group II : between the mean and two standard deviations

Group III : heavier than 2 standard deviations.

The following table shows comparative results for Wala Rano, Malekula (New Hebrides); Aitutaki (Cook Islands) - highest level; and Tagabe, Vila (New Hebrides) - intermediate level.

(a) According to ethnic group

| Men | Wala Rano : 99 (Melanesians) | Tagabe : 37 (Melanesians - Polynesians) | Aitutaki : 150 (Polynesians) |
|---|---|---|---|
| | Group I : 67% | 54.1% | 16% |
| | Group II : 27.3% | 45% | 37.4% |
| | Group III : 4% | 2.7% | 46.6% |
| Women | 126 | 56 | 277 |
| | Group I : 31.7% | 23.2% | 2.3% |
| | Group II : 46.8% | 48.2% | 24.8% |
| | Group III : 21.4% | 28.5% | 72.2% |

Comparison of Group III percentages led to several interesting conclusions.

To give a rough idea of the situation :

The population of Wala Rano - both male and female - is very active physically, being composed of subsistence farmers.

On Aitutaki, the population is less homogeneous, comprising civil servants, shopkeepers, fishermen and farmers, and its female fraction is, generally speaking, physically inactive. Standard of living is higher than in Wala Rano, but varies widely between families.

Tagabe is an artificial suburban community made up of migrant families working in Vila, whose living standard is low. Ethnically, it is similar to the Wala Rano population.

(b) <u>According to activities</u>

Minute analysis of the Aitutaki population reveals appreciable differences between farming communities (Vaipae), fishing communities (Reureu and Nikaupara), intermediate, "fishing-farming" communities, as in the village of Tautu, and the urban residents, composed of civil servants, shopkeepers and pensioners.

Were classified in Group III (substantial overweight) :

| Villages | Men | Women |
|---|---|---|
| Vaipae (farmers) | 45% | 54% |
| Tautu (farmers and fishermen) | 53% | 80% |
| Arutanga, Ureia, Amuri (urban dwellers) | 16% | 71.7% |
| Nikaupara, Reureu (fishermen) | 7.4% | 83.9% |

Various factors, apart from main occupation, account for the differences recorded :

- distribution by age and sex, which varied with each community;
- excessive food intake, reflecting standard of living;
- physical activity.

A striking illustration of this are the fishing villages, where the men are among the most hard-working on Aitutaki and also the thinnest, while the women are very much overweight.

## 3. Results obtained using triceps skinfold measurements (Graphs 12 and 12 bis)

### (a) Significance

Triceps skinfold was measured in millimetres, with constant-pressure calipers, on the upper part of the left arm, in accordance with WHO-recommended technique.

Skinfold measurements give a better indication of body fat than does weight/height ratio which necessarily includes the weight of bone, muscle and water, the proportion of which varies considerably according to endocrine characteristics, morphotype and physical activity.

The figure shown on the calipers represents double the thickness of the skin (estimated at 1.5 mm) and double the layer of subcutaneous fat.

Determination of the thickness of the adipose layer, which contains very little water on this part of the body, provides a very simple method for assessing body fat, hence obesity, which is far more reliable than the estimation based on weight/height ratio.

### (b) Standards

WHO (in Monograph No. 53) gives 12.5 mm as standard thickness for men, 16.5 mm for women.

For our purposes, it appeared simpler to regard any figure over 15 mm, for men, and over 20 mm, for women, as denoting obesity.

### (c) General distribution and differences according to sex (on Aitutaki)

| | Women | Men |
|---|---|---|
| 3 to 5 mm | 1.8% | 3.3% |
| 6 to 10 mm | 9% | 24.4% |
| 11 to 15 mm | 22.7% | 37.3% |
| 16 to 20 mm | 28.9% | 17.3% |
| 20 to 25 mm | 17.3% | - 8% |
| 25 to 30 mm | 13% | - 8% |
| 30 to 35 mm | 6.1% | - 8% |
| > 35 mm | 1.1% | - 0% |
| over 20 mm | 37.5% | over 15 mm : 33% |

N.B. Skinfold measurements yielded lower obesity ratings than did weight/height ratio, which were :

Group III : 46.6 per cent for men (cf. Graph No. 11)
72.2 per cent for women (cf. Graph No. 11 bis)

(d) Skinfold variations according to age (Graphs No 12 and 12 bis)

The mean (standard skinfold) divides the population into an upper group and a lower group, each representing exactly one half. This was the case both in men and in women.

| Age | Men | Women |
|---|---|---|
| 18 to 20 years | 10 mm | 16.6 mm |
| 21 to 25 years | 14 mm | 18 mm |
| 26 to 30 years | 10.5 mm | 16 mm |
| 31 to 35 years | 17 mm | 22 mm |
| 36 to 40 years | 14 mm | 22 mm |
| 41 to 45 years | 14 mm | 25.5 mm |
| 50 to 55 years | 12.5 mm | 20 mm |
| 55 to 60 years | 12 mm | 20 mm |
| > 60 years | 12 mm | 14 mm |

(e) Proportion over set standard

| Men (over 15 mm) | Women (over 20 mm) |
|---|---|
| 18 to 20 years : 10% | 18 to 20 years : 12.8% |
| 21 to 25 years : 14% | 21 to 25 years : 27.5% |
| 26 to 30 years : 15.4% | 26 to 30 years : 32.3% |
| 31 to 35 years : 50% | 31 to 35 years : 44.7% |
| 36 to 40 years : 40% | 36 to 40 years : 39.1% |
| 41 to 45 years : 38.5% | 41 to 45 years : 56.2% |
| 46 to 50 years : 28.6% | 46 to 50 years : 47.1% |
| 51 to 55 years : 50% | 51 to 55 years : 47.8% |
| 56 to 60 years : 44% | 56 to 60 years : 46.2% |
| > 60 years : 29.4% | > 60 years : 30% |
| Total over 15 mm : 33.3% | Total over 20 mm : 37.5% |

In men, skinfold values are lowest in the very young adult and highest between 31 and 35 years : 50 per cent. There is another sharp increase between 50 and 60 years, due to reduced physical activity, and a tendency to drop thereafter, as old age sets in.

In women, skinfold values rise regularly up to pre-menopausal age (56.2 per cent between 40 and 45 years), then gradually fall with increasing age. Beyond 60 years, the proportion of fat men and women is the same : around 30 per cent.

4. Analysis of some pathological signs

(a) Arterial hypertension

(i) The incidence of hypertension increases with age.

(ii) It also increases in proportion to weight. However, since weight itself increases with age ..... how significant is the positive correlation between overweight and hypertension?

(iii) We have divided hypertension readings into two sections :

Moderate systolic blood pressure $\geqslant$ 14 cm, $<$ 18 cm
(Vaquez Laubry gauge)
High systolic blood pressure $\geqslant$ 18 cm

(b) Incidence of hypertension according to weight group in the three pilot areas

(i) In Wala Rano (Malekula, New Hebrides - Melanesians)

Women

Group I : Moderate : 3/40 = 7.5 per cent
High : 0 = 0%

Group II : Moderate : 9/59 = 15.9 per cent
High : 2/59 = 3.4 per cent
) 19.3 per cent

Group III : Moderate : 4/27 = 14.8 per cent
High : 2/27 = 7.4 per cent
) 22.2 per cent

Total high systolic blood pressure : 4/126 = 3.2 per cent

Men

| | | | | |
|---|---|---|---|---|
| Group I | : | Moderate | : | 10/68 |
| | | High | : | 0 |
| Group II | : | Moderate | : | 4/27 |
| | | High | : | 0 |
| Group III | : | Moderate | : | 1/4 |
| | | High | : | 0 |

Not a single Wala Rano man had high blood pressure.

(ii) At Tagabe (Vila, New Hebrides - Melanesians)

Women

Group I : Moderate : 23.1 per cent
High : 0

Group II : Moderate : 29.6 per cent
High : 0

Group III : Moderate : 6.2 per cent
High : 25 per cent

Total high blood pressure : 4/56 = 7.1 per cent

Men

Group I : Moderate : 0
High : 0

Group II : Moderate : 11.7 per cent
High : 11.7 per cent

Group III : Moderate : 0
High : 1

Total high blood pressure : 3/37 = 5.3 per cent

(iii) On Aitutaki (Cook Islands)

Women

Group I : Moderate : 2/6 = 33.3 per cent
High : 0/6 = 0

Group II : Moderate : 6/61 = 9.8 per cent ) 9.8 per cent
High : 0 = 0 )

Group III : Moderate : 30/197 = 15.2 per cent ) 30.9 per cent
High : 31/197 = 15.7 per cent )

Total High Blood Pressure : 31/264 = 11.7 per cent

It can be seen from the above that moderately high to high blood pressure ratings are most prevalent in Group III women; this is the only group moreover, where "dangerously high" blood pressure occurs.

Men

Group I : Moderate : 1/28 = 3 per cent ) 10.7 per cent
High : 2/28 = 7.1 per cent )

Group II : Moderate : 11/61 = 18 per cent ) 27.8 per cent
High : 6/61 = 9.8 per cent )

Group III : Moderate : 8/71 = 11.3 per cent ) 36.7 per cent
High : 18/71 = 25.4 per cent )

Total High Blood Pressure : 26/160 = 16.3 per cent

The overall percentage was higher in men than in women, but here too blood pressure was found to rise in proportion to weight.

(c) Hypertension at Aitutaki, according to other factors

We also investigated other factors, in addition to weight, that might have a significant correlation with blood pressure :

(i) Life-style (break-down according to village)
(ii) Age
(iii) Adiposity (skinfold)
(iv) Parotidosis (parotid enlargement)

Graphs 12 and 12 bis show distribution by age of hypertension and parotid enlargement. Graphs 13 and 13 bis compare hypertension and adiposity while Figures B and B bis give a detailed summary of the relationship between hypertension, obesity and parotidosis.

(i) Incidence of hypertension and parotidosis according to life-style

| Men | Hypertension | Obesity and Overweight Group III | Parotidosis |
|---|---|---|---|
| VAIPAE (farmers) | 25.8% | 25% | 9.1% |
| TAUTU (farmers and fishermen) | 6.6% | 53% | 9.1% |
| ARUTUNGA - AMURI - UREIA (urban dwellers) | 16% | 16% | 15.7% |
| NIKAUPARA - REUREU (fishermen) | 3.7% | 7.4% | 6.5% |

The contrast between the subsistence farmers of VAIPAE and the fishermen of NIKAUPARA and REUREU is particularly striking.

| Women | Hypertension | Obesity and Overweight Group III | Parotidosis |
|---|---|---|---|
| VAIPAE | 88% | 54% | 8.3% |
| TAUTU | 23.3% | 80% | 9.3% |
| ARUTUNGA - AMURI - UREIA | 4.1% | 71.7% | 6.9% |
| NIKAUPARA - REUREU | 19.7% | 83.9% | 15% |

The most noteworthy feature of the above table is that, in the fishing villages, only the men are very active.

(ii) Incidence of hypertension according to age

Only high blood pressure ( > 18 mm) has been considered here.

In the young adult, high blood pressure is very rare in men (2.7 per cent) and does not occur at all in women (0 per cent).

In the mature adult, (31 to 45 years), incidence rapidly increases reaching 10 per cent in men and 11.8 per cent in women around 40 years.

In middle age, (46 to 60 years) incidence increases even further, but more markedly in men (20.8 per cent) than in women (12.1 per cent).

In old age, (over 60 years) incidence reaches a maximum both in men (17.1 per cent) and in women (24 per cent).

Conclusion : the incidence of high blood pressure increases with age.

(iii) Incidence of hypertension according to adiposity (based on skinfold thickness)

Using 15 mm and 20 mm as standards for men and women respectively, we obtained the following results :

| | Skinfold | Hypertension |
|---|---|---|
| Men | $\leq$ 15 mm | 6 per cent |
| | $>$ 15 mm | 20 per cent |
| Women | $\leq$ 20 mm | 11.1 per cent |
| | $>$ 20 mm | 14.4 per cent |

In very obese subjects, $>$ 25 mm skinfolds, the percentage was 25 per cent for men and 19.6 per cent for women.

(iv) Relationship between hypertension and parotid enlargement

Incidence of parotid enlargement

1. According to age :

| | | |
|---|---|---|
| Young | Men : 5.4 per cent | Women : 1.3 per cent |
| Mature | Men : 10 per cent | Women : 14 per cent |
| Middle-aged | Men : 11.1 per cent | Women : 7.5 per cent |
| Old ( $>$ 60) | Men : 15.6 per cent | Women : 7.6 per cent |

2. According to skinfold thickness :

| | |
|---|---|
| Men $\leq$ 15 mm : 8 per cent | Women $\leq$ 20 mm : 4 per cent |
| Men $>$ 15 mm : 20 per cent | Women $>$ 20 mm : 13.5 per cent |

3. In relation to hypertension

This constitutes the most original finding of our survey.

In men without parotid enlargement incidence of hypertension was 9.1 per cent.

In men with parotid enlargement incidence of hypertension was 22.2 per cent.

In women without parotid enlargement, incidence of hypertension was 9.8 per cent.

In women with parotid enlargement incidence of hypertension was 42.9 per cent.

We were unable to draw any conclusions as to the significance of this substantial difference, since no testing for diabetes was carried out in the course of our survey. Enlarged parotids are known to be frequently associated with diabetes.

Our findings also showed that, while incidence of hypertension increased regularly with age, parotidosis was, on Aitutaki, most prevalent at maturity and decreased thereafter. There was, furthermore, a distinct difference between the sexes.

In young and mature adults :

Out of 6 men with enlarged parotids, 0 had high blood pressure,

Out of 13 women with enlarged parotids, 6 had high blood pressure,

whereas in subjects without enlarged parotids, hypertension was markedly more prevalent in men (11.4 per cent) than in women (6.3 per cent).

These discrepancies can only be explained by reference to endocrine factors. In old women, moreover, atrophy of the parotid glands sometimes occurs. Impossible to diagnose clinically, this phenomenon is discernible by Sialography.

For the time being, we must confine ourselves to merely pointing out this association between parotid enlargement and hypertension. The relationship between obesity and parotid enlargement, as between obesity and diabetes, has long been recognised.

No systematic testing for diabetes was conducted. The four diabetics reported by the local medical practitioner were long-standing cases (3 women and 1 man) who had suffered acute symptoms. All were obese and had enlarged parotids.

Among the women examined, several were strikingly masculine in appearance, with strong muscle development, excessive body hair density and truncal android-type obesity. Four of these virile women were highly overweight, 110 kgs - 106 gs - 95 kgs - 98 kgs, and three of the latter had enlarged parotids.

Figure B bis AITUTAKI (Cook Islands)
AITUTAKI (Iles Cook)

RELATIONSHIP BETWEEN HYPERTENSION, OBESITY AND PAROTIDOSIS : WOMEN
RELATIONS ENTRE HYPERTENSION, OBESITE, PAROTIDOSES : FEMMES

(a) SELON LE GROUPE D'AGE - BY AGE GROUP

| Age groups<br>Groupes d'âge | Population examined<br>Population examinée | Hypertension ⩾ 18 syst. No. Hypertension | % | Hypertension without parotidosis<br>Hypertension sans parotidose Nb | % | Subjects with parotidosis<br>Sujets avec parotidose No | % | Parotidosis and hypertension<br>Parotidoses et hypertension No | |
|---|---|---|---|---|---|---|---|---|---|
| 18 - 20 | 16 | 0 | | | | 1 | 63 | 0 | 0 |
| 21 - 25 | 34 | 0 | | | | - | - | - | - |
| 26 - 30 | 31 | 0 | | | | - | - | - | - |
| Total young - jeunes | 81 | 0 | 0 | 0 | 0 | 1 | 1,3 | - | - |
| 31 - 35 | 38 | 3 | 7,9 | 2 | | 3 | 7,9 | 1 | 1/3 |
| 36 - 40 | 23 | 1 | 4,3 | 0 | | 2 | 8,7 | 1 | 1/2 |
| 41 - 45 | 32 | 7 | 21,9 | 3 | | 8 | 25 | 4 | 4/8 |
| Total mature - mûres | 93 | 11 | 11,8 % | 5/80 | 6,3 | 13 | 14 | 6 | 6/13=46,2% |
| 45 - 50 | 17 | 2 | 11,8 | 2 | 11,8 | 0 | 0 | 0 | 0 |
| 51 - 55 | 23 | 4 | 17,4 | 3 | 15,8 | 4 | 17,9 | 1 | 1/4 |
| 55 - 60 | 13 | 3 | 23,1 | 3 | 23,1 | 0 | 0 | 0 | 0 |
| Total mid-life à mi-vie | 53 | 11 | 20,8 | 8/48 | 16,5 | 4 | 7,5 | 1 | 1/4=25% |
| Total old 60 - âgées | 50 | 12 | 24 | 10/47 | 21,3 | 3 | 6 | 2 | 2/3=66 |
| Total general - Total général | 277 | 34 | 12,3 | 25/256 | 9,8 | 21 | 7,6 | 9 | 9/21=42,9% |

(b) SELON LE DEGRE D'ADIPOSITE - FOLLOWING ADIPOSE TISSUE THICKNESS

| | No | No | % | No | % | No | % | No | % |
|---|---|---|---|---|---|---|---|---|---|
| Skinfold - Pli cutané | | | | | | | | | |
| 4 - 5 mm | 5 | 1 | 1/5 | 1/4 | | 1 | 1/5 | 0 | 0 |
| 6 - 10 mm | 25 | 3 | 12 | 1/23 | | 2 | 8 | 2/2 | |
| 10 - 15 mm | 63 | 6 | 95 | 6/63 | | 0 | 0 | 0 | |
| 16 - 20 mm | 80 | 9 | 11,3 | 6/80 | | 4 | 5 | 3/4 | |
| Total 20 mm | 173 | 19 | 11,1 | 14/166 | 8,4 | 7 | 4 | 5/7 | 71,4 % |
| 21 - 25 | 48 | 3 | 6,3 | 2/40 | | 8 | 16,7 | 1/8 | |
| 26 - 30 | 36 | 5 | 13,9 | 3/32 | | 4 | 11,1 | 2/4 | |
| 31 - 35 | 17 | 5 | 29,4 | 4/15 | | 2 | 11,8 | 1/2 | |
| 35 - 40 | 3 | 1 | 33,3 | 1/13 | | 0 | 0 | 0 | 0 |
| Total 20 mm | 104 | 15 | 14,4 | 10/90 | 11,1 | 14 | 13,5 | 4/14 | 28,6 % |
| Total général | 277 | 34 | 12,3 | 25/256 | 9,8 | 21 | 7,6 | 9 | 42,9 % |

Figure B AITUTAKI (Cook Islands)
AITUTAKI (Iles Cook)

RELATIONSHIP BETWEEN HYPERTENSION, OBESITY AND PAROTIDOSIS : MEN
RELATIONS ENTRE HYPERTENSION, OBESITE, PAROTIDOSES : HOMMES

(a) BY AGE GROUP - SELON LE GROUPE D'AGE

| Age group<br>Groupe d'âge | Population examined<br>Population examinée | Hypertension >18 cm Hg<br>No. Hypertension | % | Hypertension without parotidosis<br>Hypertension sans parotidose<br>Nb | % | Subjects with parotidosis<br>Sujets avec parotidose<br>No | % | Parotidosis and hypertension<br>Parotidoses et hypertension<br>No. | % |
|---|---|---|---|---|---|---|---|---|---|
| 18 - 20 | 10 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 - 25 | 14 | 1 | 7,1 | 1/14 | 7,1 | 0 | 0 | 0 | 0 |
| 20 - 30 | 13 | 0 | 0 | 0 | 0 | 2 | 15,4 | 0 | 0 |
| Total young - jeunes | 37 | 1 | 2,7% | 1/35 | 2,9% | 2 | 5,4 | 0 | 0 |
| 31 - 35 | 16 | 1 | 6,3 | 1/16 | 6,3 | 0 | 0 | 0 | 0 |
| 36 - 40 | 10 | 2 | 20 | 2/9 | 22 | 1 | 10% | 0 | 0 |
| 41 - 45 | 13 | 1 | 7,7 | 1/10 | 10 | 3 | 23,1 | 0 | 0 |
| Total mature - mûrs | 39 | 4 | 10 % | 4/35 | 11,4 | 4 | 10% | 0 | 0 |
| 45 - 50 | 14 | 2 | 14,3 | 2/11 | | 3 | 21,4 | 0 | 0 |
| 51 - 55 | 10 | 0 | 0 | 0/7 | | 3 | 30% | 0 | 0 |
| 55 - 60 | 9 | 2 | 16,7 | 1/8 | | 1 | 11,1 | 1/1 | |
| Total mid-life à mi-vie | 33 | 4 | 12,1 | 3/27 | 11,1 | 6 | 18,2 | 1/6 | 16,7 |
| Total old 60 - âgées | 41 | 7 | 17,1 | 4/35 | 11,4 | 6 | 15,6 | 3/6 | 50 % |
| Total general - Total général | 150 | 16 | 10,7 | 12/132 | 9,1 | 18 | 127 | 4/18 | 22,2 % |

(b) BY SKINFOLD THICKNESS - SELON L'EPAISSEUR DU PLI CUTANE

| Skinfold - Pli cutané | No | No | % | No | % | No | % | No | % |
|---|---|---|---|---|---|---|---|---|---|
| 3 - 5 mm | 5 | 0 | 0 | 0/5 | | 0 | 0 | 0 | |
| 6 - 10 mm | 39 | 4/4 | 10 | 0/39 | | 1 | 5,1 | 0 | |
| 11 - 15 mm | 56 | 2 | 3,6 | 1/50 | | 6 | 10,7 | 1/6 | |
| Total thin - Total minces | 100 | 6 | 6 | 5/92 | 5,4 | 8 | 8 % | 1/8 | 12,5 % |
| 16 - 20 | 26 | 4 | 15,4 | 2/19 | | 5 | 19,2 | 2/5 | |
| 21 - 25 | 12 | 3 | 25 | 2/10 | | 2 | 16,7 | 1/2 | |
| 26 - 30 | 12 | 3 | 25 | 3/9 | | 3 | 25 | 0 | |
| Total adipose - Total adipeux | 50 | 10 | 20 | 7/4 | 17,5 | 10 | 20 % | 3 | 30 % |
| Total general - Total général | 150 | 16 | 10,7 | 12/132 | 9,1 | 18 | 12,7 | 4 | 22,2 % |

## 5. Development of obesity from infancy to adulthood. Comparative results for the four pilot groups.

Adult obesity is partly predetermined by childhood obesity. The likelihood of fat teenagers developing into fat adults has long been recognized, but recent research has proved that the foundations of adult obesity may be laid much earlier, during the first months of infancy.

Adipose tissue has been shown to augment in two ways :

- by increase in the number of adipose cells (hyperplasia)
- by increase in the size of adipose cells (high lipid content).

Increase in the number of adipose cells begins in the first weeks and months of infancy, probably even earlier - in the last pre-natal months, continues through childhood and adolescence, and ends when growth is complete (18 to 20 years).

Multiplication of adipose cells, in response to food intake and genetic factors, may lead to obesity since these cells tend to fill with fat; the larger the number of adipose cells present in the body, the greater the obesity potential.

We investigated adipose tissue formation in the three pilot areas already mentioned, as well as at the Norsup school (Malekula), where the boarders were Melanesians, as in Wala Rano, but whose calorie intake was higher than that of Wala Rano schoolchildren.

(a) Average skinfold thickness in the school-age child

| Age | Wala Rano | | Norsup (school with canteen) | | Tagabe | | Aitutaki |
|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | F |
| 5½ | 5 mm | 6 mm | 5 mm | 7 mm | 5 mm | 6 mm | 8 mm |
| 6½ | 4.8 | 5.5 | 6 | 6.5 | 5.5 | 6.8 | 8.2 |
| 7½ | 4.5 | 5.8 | 8 | 10 | 5 | 7 | 8.2 |
| 8½ | 5.8 | 6 | 6 | 10 | 5.5 | 7 | 7.9 |
| 9½ | 5.8 | 5 | 7 | 9 | 6 | 6.8 | 8 |
| 10½ | 6 | 6.5 | 9 | 8 | 5 | 7.5 | 12 |
| 11½ | 4 | 6 | 6 | 11 | 5.2 | 6 | 12 |
| 12½ | 6 | 7 | 7 | 12 | 5 | 5.5 | 10 |
| 13½ | 5.8 | 7 | 6 | 12 | 5 | 7 | 10 |
| 14½ | 5 | 7.5 | 6 | 12 | 6 | 9 | 13 |
| 15 | 4.5 | 8.5 | 6 | 13 | 6.5 | 13 | 14 |

At every age considered, there was a tremendous difference in average skinfold thickness and average weight between the four communities, ranging from the very low figures recorded in Wala Rano and Tagabe to the extremely high ones pertaining to Aitutaki.

(b) Excess weight in various age brackets

(i) Excess weight is already substantial in early infancy.

On Aitutaki, out of 27 infants (male and female between 0 and 6 months) : 10 = 37 per cent were considerably overweight i.e., > P 90 or more than 20 per cent above standard weight. Seven were between P 50 and P 90.

Total : 17/27 = 63 per cent were above standard weight.

The figure of 37 per cent exactly tallies with the percentage of obese adults.

(ii) The obesity trend most clearly asserts itself during adolescence (13 years and over).

The weight mean for girls crosses the P 50 standard between 13 and 14 years. At 18 years, local girls were 7.5 kgs heavier than the standard (54.5 kgs), which represents a 14 per cent surplus.

Between 13 and 18 years, 20 per cent of the local girls were above P 90;
45 per cent were between P 50 and P 90.

To sum up, 65 per cent of adolescent girls were above standard weight.

This figure is very close to the Group III percentage for adult women (72 per cent).

In boys, the tendency to obesity was less evident. The local mean only overtakes the standard at 16 years.

At 18 years, mean weight was 4 kgs above the standard (a 6 per cent surplus).

Between 16 and 18 years, 12 boys were above P 50 = 60 per cent
8 boys were below P 50 = 40 per cent
but not a single boy was above P 90.

Variation of skinfold thickness naturally confirms the tendency to obesity in the Aitutaki community. Out of 92 teenage girls examined :

$\leq$ 5 mm : 2 : 2.2 per cent
6 to 10 mm : 25 - 27.2 per cent
10 to 15 mm : 32 - 34.8 per cent
15 to 20 mm : 23 - 25 per cent
20 to 25 mm : 6 - 6.5 per cent
25 to 30 mm : 4 - 4.3 per cent

While 34/92 were below the WHO standard, 58 (i.e. 63 per cent) were above, which bears out the results based on weight.

By contrast, Wala Rano girls in the same age bracket (13 to 17 years) were nearly all below the WHO standard, which reflects persistent under-nutrition. Only 3/39 (i.e. 7.7 per cent) were above.

(c) Conclusions regarding obesity during growth

United States statistics show that 80 per cent of overweight boys and girls grow into obese adults.

It is now commonly recognised that :

(i) obesity may begin during the pre-natal stage, if the foetus has an obese mother, and will result in above-standard weight at birth;

(ii) in the young infant (especially up to 6 months), overfeeding will combine with genetic factors to produce obesity.

The foregoing figures clearly show that obesity is far more common on Aitutaki than in the other communities surveyed, that overweight is already visible in the infant, and that a large proportion of adolescents is excessively fat.

6. Conclusions and recommendations on obesity

Considering

- that high blood pressure and diabetes in middle-age are the main health hazards accompanying obesity;
- that obesity can be prevented by limiting the number and size of adipose cells;
- that obesity develops from earliest infancy;
- that it is far easier to prevent obesity than to reduce it in the adult;

We recommend that an educational campaign be conducted through existing health services and influential associations, along the following lines :

(a) Educating women :

- Elementary ideas on dietary balance;
- Foods that will be converted to body fat if eaten in large quantities;
- Diet during pregnancy;
- Diet of growing children : role of sugar, sweetened milk, sweets, cakes, bread and fats when eaten in addition to local carbohydrates; beer;
- Regular weighing of pregnant women (to prevent unnecessary increase in weight);
- Teaching the pinch method of skinfold assessment;
- Encouraging self-appraisal of ones "looks" (full-length mirror, fashion magazines), especially in girls and young women;

# CHAPTER VI

## THE DENTAL PROBLEM (PREVENTION)

Its two aspects must be considered separately :

1. Prevention of infantile melanodontia, a condition which only affects the deciduous teeth and does not appear to be directly connected with caries in later life.

2. Prevention of caries.

Both aspects of the problem stem from a common cause: excessive consumption of sugar, acting either directly, as in the second case, by inducing calculus formation, or indirectly, as in the first case, by upsetting the dietary balance to the detriment of proteins and other nutrients.

Prevention of caries should be undertaken at school age, at the very latest; this matter is sufficiently serious in the Cook Islands to require stressing again and again.

Fluoridation of drinking water does not appear feasible as there is no community water supply, but distribution of fluoride tablets, which is currently being carried out in schools and at the Well Baby Clinic, should prove very worthwhile.

Oral hygiene needs to be improved.

In the long run, the most tangible results are likely to spring from changes in dietary habits: the value of hard or fibrous foods, the benefits of prolonged chewing, the part played by saliva, should be explained and emphasised. Reduced consumption of sugars and starches is important, furthermore, from the nutritional point of view, for the prevention of obesity.

* * *

# CHAPTER VII

## CONSEQUENCES OF MALNUTRITION AND DIETARY IMBALANCE

### 1. General

Symptoms described in medical literature may reflect either

- past malnutrition,
or present malnutrition,
or chronic malnutrition.

It is difficult to diagnose moderate malnutrition using clinical criteria only, and yet even mild malnutrition may have serious consequences on development.

Biochemical techniques are often complicated and difficult to apply in systematic screening, except where well-equipped research teams are available. Furthermore, they usually represent a mere moment of any developing situation. Only histochemical tests, in conjunction with electronic microscope investigation, might provide definitive answers. We have confined ourselves to determining what clinical signs, easily observable by paramedical workers, can be regarded as sound criteria for assessing past or present malnutrition and how they are related to growth.

(a) Parotidosis (of metabolic origin, and not to be confused with infectious parotiditis) is a chronic, usually bilateral, painless enlargement of the parotid glands. The swelling may vary in size and consistency and is sometimes referred to as asymptomatic parotidosis. Parotid enlargement may be graded according to size by the Shaper technique described in WHO Monograph No. 53 (Grades 1, 2, 3 corresponding to widths of 1 - 2 - 3 fingers beyond the ear lobes.

Significance of parotid enlargement is still under discussion. It appears to be related to protein deficiency resulting either from under-nutrition or from excessive carbohydrate consumption with a proportionate lack of protein intake. It may be preceded by atrophy of the acini (not detectable clinically) or followed by compensatory sclerosis (cirrhotic parotids). Difficult to discern in the very young infant, enlarged parotids are fairly visible from about 2 years, but grading requires some practice.

(b) Hepatomegaly (liver enlargement). The size of the liver should be measured in the course of every clinical examination. Liver enlargement can also be graded. It is occasionally observed in kwashiorkor, but more commonly during the recovery phase: Gomez has described a rehabilitation syndrome consisting of hepatomegaly combined with hirsuties, sometimes with ascitis, and an appearance reminiscent of Cushing's disease.

(c) Abnormal hair growth (pilosis)

This criterion is rarely used in systematic surveys, no doubt because it implies a highly subjective assessment on the observer's part and is difficult to express quantitatively.

Pilosis is far more common in some ethnic groups than in others (very much more so in Melanesians than in Polynesians for example). Similar in appearance to "lanugo" the down-like hair that covers the foetus and some new-born infants, pilosis has been mentioned (by J. Mayer, in Metabolic Adaptation in Nutrition, Pan. Am. Health Organization, WHO, 1971, p. 85) in connection with hormonal overactivity following protein-calorie malnutrition. It may be regarded as a mild form of hirsuties such as occurs in Cushing's disease and was also observed during nutritional rehabilitation of cachectic deportees after World War II.

We have taken pilosis to be a sign of hormonal overactivity in reaction to the nutritional (weaning) crisis, and have endeavoured to find out how it is related to :

- parotid enlargement (nutritional parotidosis);
- liver enlargement (hepatomegaly);
- growth retardation (as regards height and head circumference).

Pilosis generally disappears well before puberty. In adolescent boys, body hair no longer has any nutritional significance. Significant pilosis is that which occurs in young children according to a very definite pattern. On the face the hair grows abnormally low down each cheek, sometimes right to the jaw line, and down the forehead, almost to the eyes. On the back, hair growth is densest between the shoulder-blades, runs down the spine and becomes very thick again in the lumbar area.

Abnormal hair growth is of real value in nutritional assessment only if associated with the other signs mentioned above.

(d) Melanodontia (Beltrami's disease) is a particular type of lesion of the tooth enamel, distinct from caries. The enamel on the labial surface of the tooth changes colour, becoming first chalky, then reddish, finally dark brown with a glazed appearance. Erosion of the enamel sets in and soon affects the dentin too, until the tooth eventually breaks just below the gum-margin, leaving stumps that are usually painless.

Melanodontia first appears symmetrically and simultaneously, in the upper incisors (rarely the lower ones) and may later affect the canines also. It is quite painless, but loss of the incisors interferes with chewing and produces faulty "bite".

Melanodontia occurs only in the deciduous teeth and does not appear to have any effect on the permanent dentition. Its aetiology seems different from that of caries, although both conditions may co-exist. It is thought to be caused by defective formation and maturation of the tooth enamel and there is good reason to believe that the baby's diet during the developmental period plays a major part. Shortages of protein, certain amino acids or metallic trace elements are probable contributing factors.

We attempted to discover :

(1) whether these four symptoms were clinically correlated;

(2) whether they were in any way related to growth retardation, itself a consequence of malnutrition;

(3) whether there was any relationship between the melanodontia, parotidosis and liver enlargement seen in malnourished children.

(e) Chronic malnutrition, growth retardation, retarded skull and brain development

A world-wide survey is currently being carried out to determine the long-term effects of protein-calorie malnutrition. Data analysed over the past few years have led to the conclusion that serious malnutrition during the first year of life substantially delays physical growth and may cause mental impairment as well. Problem-solving ability, language, personal-social development, general intelligence, intersensory integration and perceptual visual competence were significantly poorer in children who had suffered malnutrition during early infancy than in siblings or other control subjects who had been well fed during the corresponding period. (cf. Eighth Report of Joint FAO/WHO Committee on Nutrition, WHO Technical Report Series, No. 477, 1971, page 60).

N.B. Professor Raoult has drawn up a complete nominative list of all children between 3 and 17 years of age who showed sequelae of malnutrition and retarded body or head growth. This list has been forwarded to the Ministry for Health, to be made available - if so desired - to the New Zealand Council for Educational Research.

2. Nutritional parotidosis

The table hereunder compares prevalence of parotidosis in the three communities studied, for the various age groups, starting with the 2 to 3 year bracket where it first appears towards the end of (or following) the nutritional crisis.

(a) Prevalence according to age in the three pilot areas (both sexes)

- From 2 to 3 years
  Aitutaki : 1.8% - Wala Rano : 21.4% - Tagabe : 10%

- From 3 to 6 years
  Aitutaki : 5.7% - Wala Rano : 12.2% - Tagabe : 4.4%

- From 7 to 12 years
  Aitutaki : 4.7% - Wala Rano : 10.6% - Tagabe : 10%

- From 13 to 17 years
  Aitutaki : 0.5% - Wala Rano : 12.9% - Tagabe : 18.2%

- Adults
  Aitutaki : 8.3% - Wala Rano : 4.8% - Tagabe : 5.4%

(cf. Figure C for a comparison Aitutaki - Rarotonga)

On the whole, the more prevalent malnutrition was, the higher the rate of parotidosis.

The highest rates of parotidosis were recorded in the communities and the age groups where malnutrition was most prevalent.

Prevalence during the growing period was highest in Wala Rano, a traditional rural Melanesian community, and at Tagabe, a Vila suburb settled by immigrants, which is in agreement with body measurement data pertaining to these localities. A fresh increase in rate of occurrence was observed during adolescence in the Melanesian communities, but was not seen on Aitutaki, where nutritional status of adolescents is excellent. In adults however, prevalence of parotidosis was highest on Aitutaki and is related to the high percentage of obesity recorded there (cf. Chapter IV).

(b) Prevalence according to sex

There was considerable variation between the sexes in some age groups. On the whole, enlarged parotids are more common in boys than in girls. This is especially marked during puberty in Wala Rano and at Tagabe (in both cases, prevalence in boys peaked between 12 and 15 years, reaching 27 per cent and 50 per cent respectively), but not on Aitutaki, where the percentage drops almost to zero for both sexes.

In the adult, parotidosis affected mainly women over the age of 45 years, presumably because of endocrine changes.

These facts, already observed by the author in Senegal (West Africa), would appear to indicate a relationship between the parotid glands and the endocrine system. Here we must confine ourselves to simply stating our findings, without any attempt at further interpretation.

(c) Parotidosis and retarded bone growth

Stunting was more common in subjects with enlarged parotids than in others. Most of the former were in the low group ( < P 3) as regards height and head circumference. The table below concerns boys from 3 to 17 years.

Comparison of the two main pilot areas

Aitutaki

Height : high group ⩾ P 50 : 5%
middle group < P 50 > P 3 : 5.3%
low group < P 3 : 26%

Head circumference : high group ⩾ P 50 : 8.8%
middle group < P 50 ⩾ P 3 : 2.9%
low group < P 3 : 17.2%

Wala Rano

Height : high group ⩾ P 50 : 0%
middle group < P 50 ⩾ P 3 : 7.5%
low group < P 3 : 22.6%

Head circumference : high group ⩾ P 50 : 8.3%
middle group < P 50 ⩾ P 3 : 20%
low group < P 3 : 18.9%

Similar percentages were obtained for the low groups in both communities.

The graphs are even more revealing than the figures in this regard, since they show some cases of extreme retardation in children with enlarged parotids.

(d) Parotidosis and adult stature

Aitutaki

Women : Average height was 1.625 m

In the above-average height women, parotidosis was 3.03 per cent
In below-average height women, parotidosis was 11.3 per cent

Men : Average height : 1.70 m

Over 1.70 m, parotidosis : 7.5 per cent
Under 1.70 m, parotidosis : 13.8 per cent

Rarotonga

Women : Average height : 1.635 m

Over 1.635 m, parotidosis : 0 per cent
Under 1.635 m, parotidosis : 10.8 per cent

Men : Average height : 1.65 m

Over 1.65 m, parotidosis : 15.2 per cent
Under 1.65 m, parotidosis : 32.2 per cent

Wala Rano

Women : Average height : 1.575 m

Over 1.575 m, parotidosis : 4.7 per cent
Under 1.575 m, parotidosis : 12.7 per cent

It appears legitimate to conclude from these figures that the relationship observed in growing children between statural retardation and the presence of enlarged parotids persists into adulthood, and that a deficit in early life is never entirely made good.

This correlation might well stem from a mild degree of malnutrition upsetting the endocrine balance during the growing period.

(e) Parotidosis and diabetes

Many authors have drawn attention to the close relationship between the pancreas and the parotid glands and to the similarity of the lesions caused by protein shortage in the pancreatic and salivary cells. The coexistence of parotidosis and diabetes is also widely recognised. Some authors regard parotid enlargement as a sign of latent diabetes, quoting as evidence the high incidence of abnormal reactions to the glucose tolerance test among people affected with this condition. If proved beyond doubt this sign would be of great practical value : while investigation of the pancreas is exceedingly difficult without sophisticated medical facilities, diagnosis of parotid enlargement is quite easy and would allow preventive measures to be taken in time.

We intend to explore this subject further in the SPC pilot areas, with the assistance of the New Zealand Medical Research Council, to whom blood samples of subjects with enlarged parotids will be forwarded for testing.

Such research is in line with the recommendations of the Seventh Conference on Health Services (Vila, 9-13 February 1976) concerning epidemiological surveys on diabetes in the South Pacific.

3. Melanodontia (Graphs No. 4 and 4 bis)

Melanodontia is of special interest, not only because this type of enamel dysplasia leads to caries in the first teeth and must therefore be treated and prevented like any other dental disease, but because it seems to reflect the general nutritional status of the individual. It appears to be attributable to malnutrition in early infancy, or even the prenatal period, affecting the formation and maturation of the enamel of the upper incisors, all of which are usually involved. It has been shown experimentally, that low protein diets produced a high incidence of caries in young rats (ref. Effects on the rat's liver and parotid glands of cariogenic diets with varied protein-calorie levels, by Marjorie Wedgwood Bunyard, Brit. Dent. Journal, Vol. 129, No. 7, October 1970).

On Aitutaki, melanodontia was found to be :

(1) very prevalent, except in the fishing villages;

(2) usually associated with other symptoms of past or present malnutrition (parotid enlargement, liver enlargement, abnormal hair growth);

(3) common in some families where overall nutritional status was poor;

(4) connected with growth retardation (stunted height and head circumference).

(a) Comparison of melanodontia prevalence in the pilot areas

Our comparison was limited to the 3 to 6 age bracket. The figures given hereunder may be compared with those obtained by W. Hanson on Rarotonga and Mangaia (cf. Dental Caries in the Cook Islands, SPC Information Doc. No. 21, 1970, Table 13).

Caries in the canine teeth and the molars were not taken into account.

(1) WALA RANO (Malekula, New Hebrides)

3 to 6 year old children - Examined : 67, affected : 11, prevalence : 16.4 per cent

Break-down according to village

RANO (Malekula mainland) - Examined : 24, affected : 3, prevalence : 12.5 per cent
WALA (mainland) - Examined : 23, affected : 6, prevalence : 26.5 per cent
RANO (offshore island) - Examined : 7, affected : 0, prevalence : 0 per cent
WALA (offshore island) - Examined : 13, affected : 2, prevalence : 15.4 per cent

N.B. : Prevalence was lower on the two small offshore islands.

(2) AITUTAKI (Cook Islands)

3 to 6 year old children - Examined : 174, affected : 67, prevalence : 38.1 per cent

(3) TAGABE (Vila, New Hebrides)

3 to 6 year old children - Examined : 45, affected : 12, prevalence : 26.7 per cent

(4) RAROTONGA (Cook Islands)

3 to 6 year old children - Examined : 62, affected : 23, prevalence : 37.1 per cent

Melanodontia was more prevalent in the communities where large quantities of carbohydrates, especially refined imports like sugar, bread and biscuits, are eaten in addition to the traditional starchy foods, (AITUTAKI - TAGABE - RAROTONGA). However, our survey did not include a quantitative estimation of children's food intake.

Aitutaki and Wala Rano are, nutritionally, at opposite poles : overall under-nutrition in Wala Rano, excessive carbohydrate intake associated with moderate protein malnutrition on Aitutaki. Care must be taken not to oversimplify the problem however, as other factors are involved in the caries-resistance noted in Wala Rano : high fluoride content of water, for instance, especially on the offshore island of Rano.

Such anti-caries factors seem to be lacking on Aitutaki, except in the fishing villages, where habitual consumption of sea-fish provides additional protein and valuable minerals and where prevalence of melanodontia was in fact quite low.

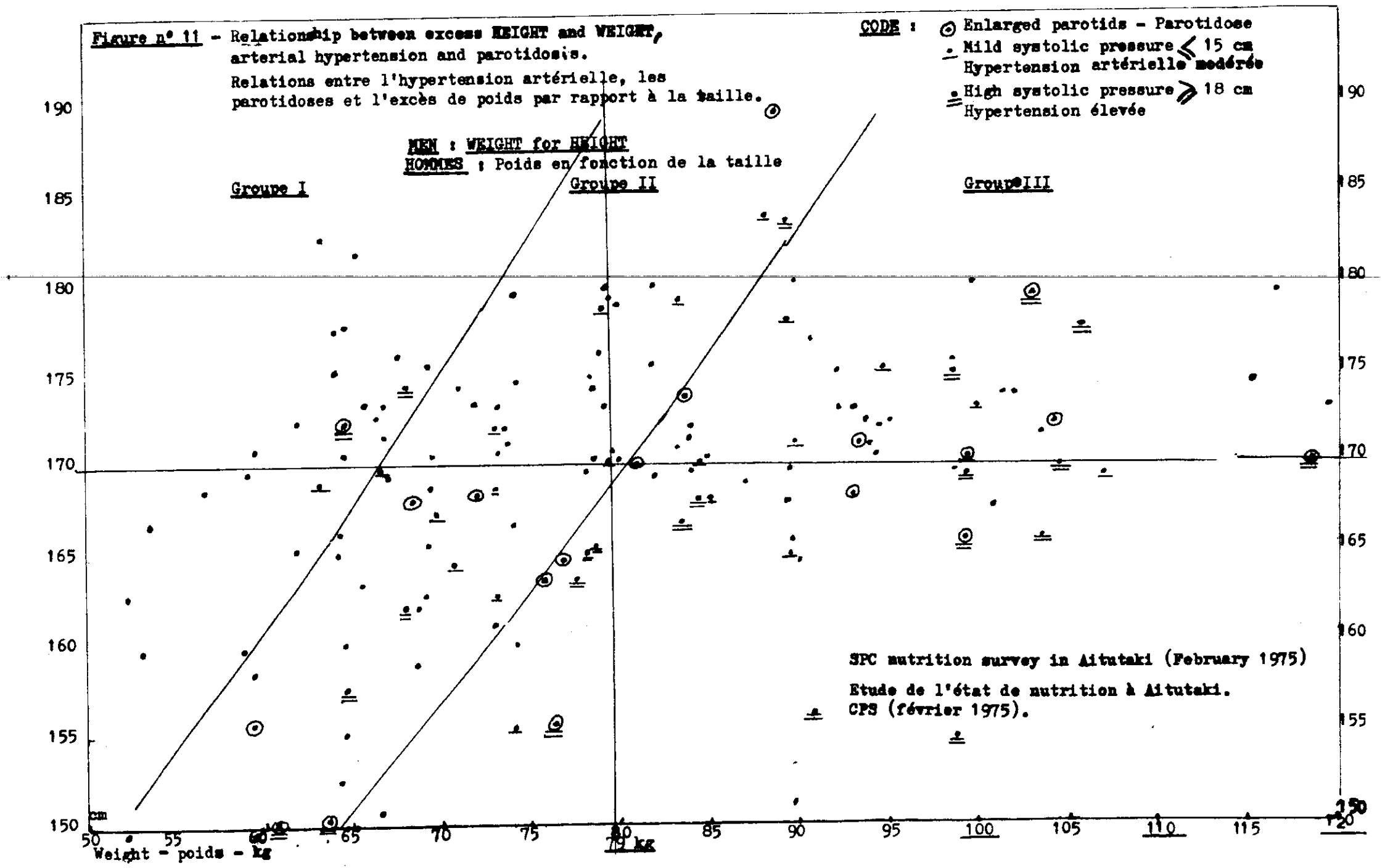
(b) Pattern of prevalence on Aitutaki

| Community | Prevalence |
|---|---|
| TAUTU (farmers) | 52 per cent |
| UREIA - AMURI (urban dwellers) | 51.1 per cent |
| VAIPAE (farmers) | 52 per cent |
| NIKAUPARA - REUREU (fishermen) | 28.6 per cent |
| ARUTANGA (civil servants, shopkeepers) | 21.7 per cent |
| Average for Aitutaki | 38.1 per cent |

The highest prevalence was found in the villages and suburbs where daily diets are made up largely of carbohydrates : bread, sweet snacks and sugar being added to the locally-grown starchy staples. The lowest rates were recorded in the fishing villages and in the urban area of Arutanga where families are well-to-do and diets more balanced.

The overall average for Aitutaki was remarkably close to the prevalence figure for Rarotonga, 38.1 per cent and 37.1 per cent respectively.

AITUTAKI (Cook Islands)



- Dispelling the "the fatter the better" myth as regards child rearing, by informing mothers of accepted weight norms.

(b) Educating men :

- Hazards of obesity, diabetes, high blood pressure;
- Ill-effects of a sedentary life-style and lack of exercise;
- Dietary habits (as for women).

(c) Recommendations concerning adults

While far from exhaustive, our study of the nutritional status of adults confirmed previous surveys and observations carried out in the Cook Islands as regards the prevalence, among adults, of two metabolic disorders :

- arterial hypertension

- diabetes.

We were able to demonstrate a positive correlation between hypertension, overweight and adiposity.

Aitutaki would be eminently suitable for a thorough investigation of the inter-relationships between obesity - diabetes - hypertension and life expectancy.

Systematic detection of latent diabetes by the glucose tolerance test (induced hypoglycemia) could be a useful preliminary for the prevention of serious "overt" diabetes and will be undertaken at a later date.

At the same time, these tests, when applied to subjects with enlarged parotids, would serve to prove or disprove the suspected relationship between diabetes and the parotid glands, and would shed light on the possible action of these glands, together with the pancrease and the hypothalamus, in the regulation of the carbohydrate metabolism.

In any case, as insurance companies the world over have come to realise, overweight is a factor of early death (shortened lifespan).

The influence of overweight on life expectancy was not studied in Aitutaki because of the absence of a large fraction of the adult population, but could be investigated more easily in Rarotonga.

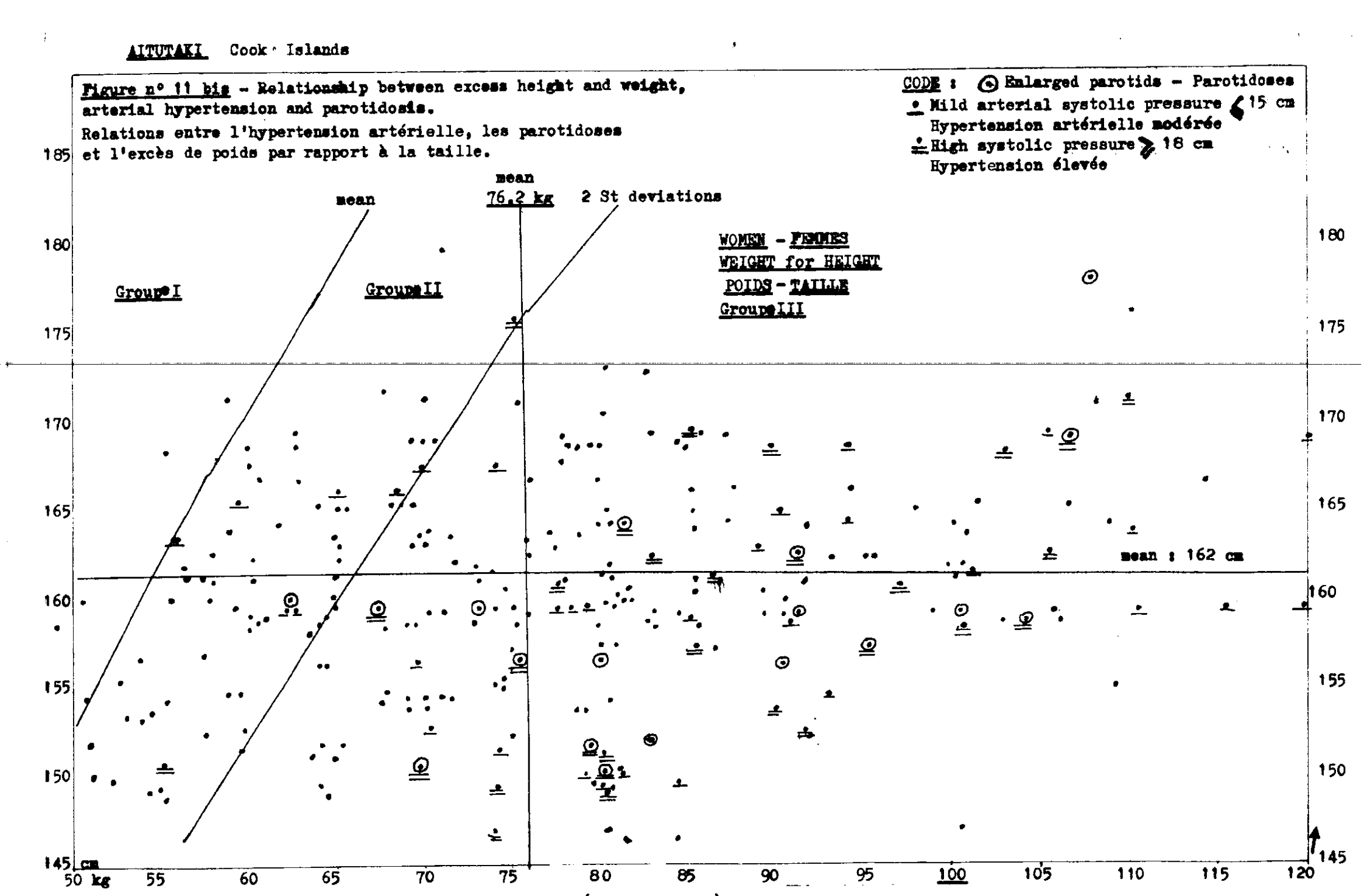
However, the facts established by scientific research in other parts of the world amply justify the launching of an educational anti-obesity campaign.

* * *

**AITUTAKI** Cook Islands

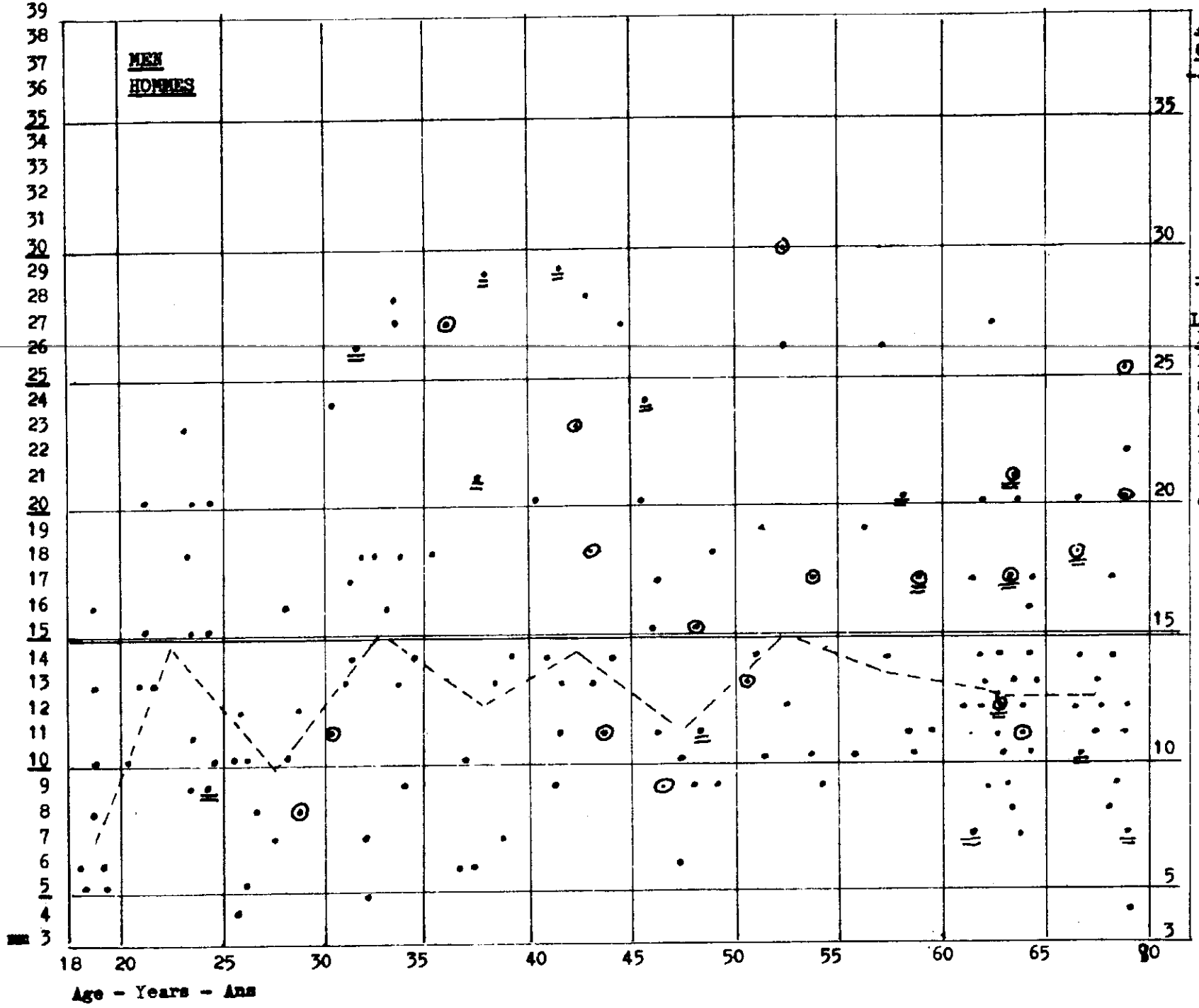
**Figure n° 11 bis** - Relationship between excess height and weight, arterial hypertension and parotidosis.
Relations entre l'hypertension artérielle, les parotidoses et l'excès de poids par rapport à la taille.

CODE : ⊙ Enlarged parotids - Parotidoses
• Mild arterial systolic pressure < 15 cm
Hypertension artérielle modérée
± High systolic pressure ≥ 18 cm
Hypertension élevée




Weight - poids

SPC nutrition survey in Aitutaki (February 1975)
Etude de l'état de nutrition à Aitutaki. CPS (février 1975)




AITUTAKI (Cook Islands)

CODE :

——— Skinfold median
Pli cutané (médiane)

⊙ Enlarged parotids
Parotidose

≐ High blood pressure
Hypertension élevée
≥ 18 cm

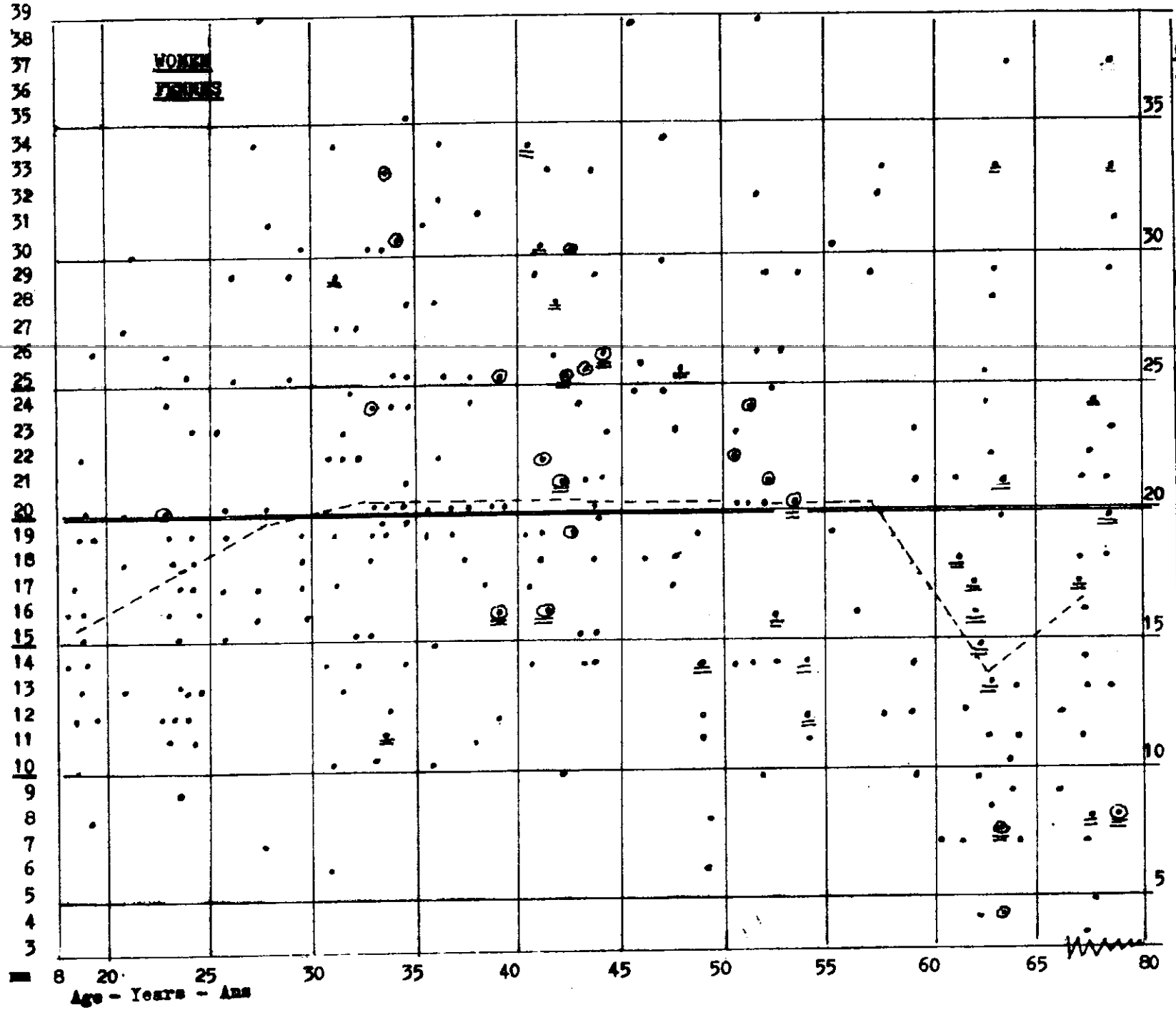
═══ Limit of normal skinfold < 20 mm
Limite du pli cutané normal

**Figure n° 12**

Distribution by age of skinfold, hypertension and parotid enlargement.
Distribution par âge du pli cutané, de l'hypertension artérielle et des parotidoses.

SPC nutrition survey in Aitutaki. (February 1975).

Etude de l'état de nutrition à Aitutaki. CPS (février 1975).




**AITUTAKI** (Cooks)

**CODE :**

——Skinfold median
Pli cutané(médiane)

⊙ Enlarged parotids
Parotidose

: High blood pressure
Hypertension élevée
⩾18 cm

——Limit of normal skinfold ⟨ 20 mm
Limite du pli cutané normal.

Figure n° 12 bis

Distribution by age of skinfold, hypertension and parotid enlargement.
Distribution par âge du pli cutané, hypertension et parotidoses.

SPC nutrition survey in Aitutaki (February 1975)

Etude de l'état de nutrition à Aitutaki. CPS (février 1975).

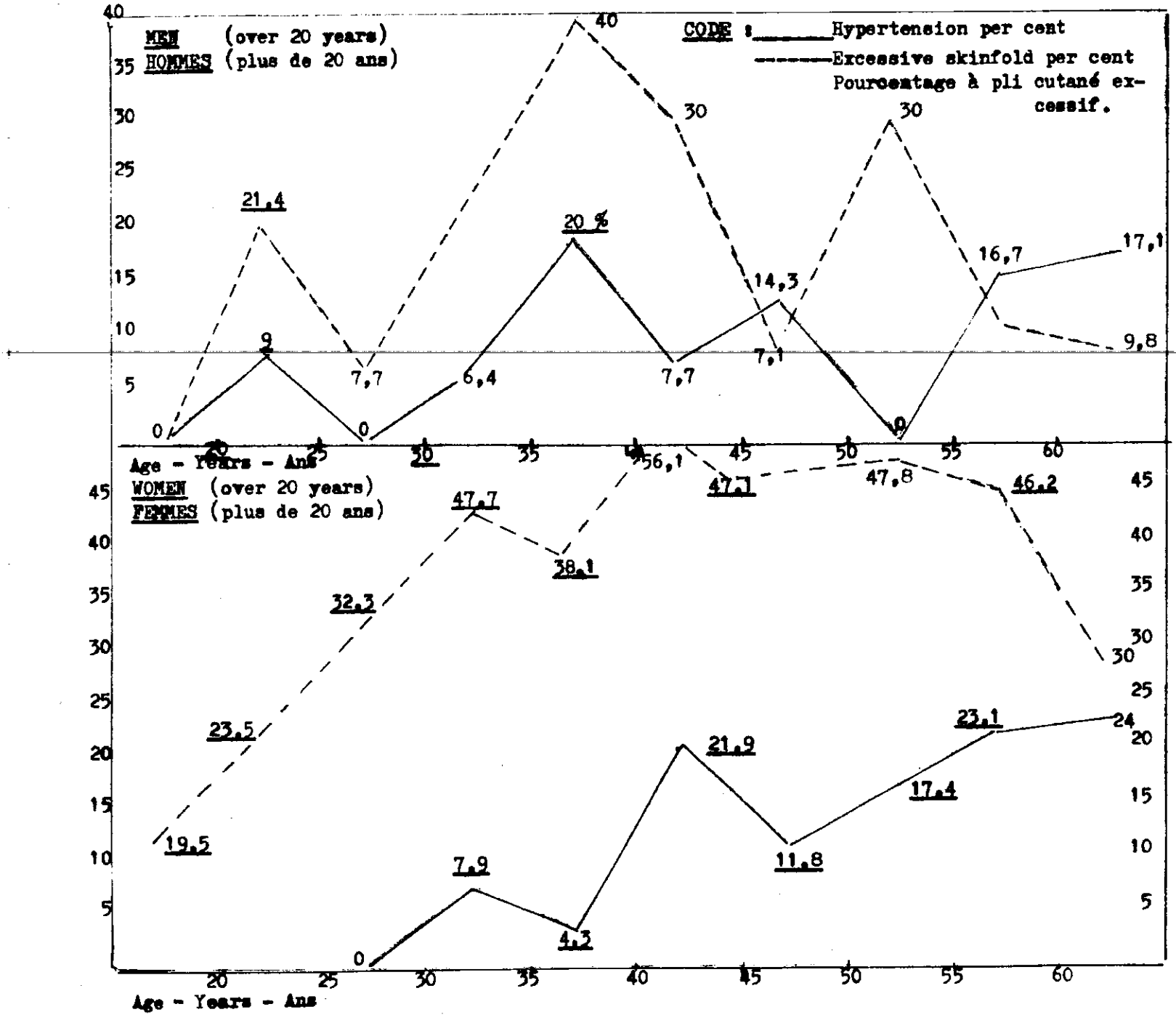



**Figure n° 13** - MEN - HOMMES
**Relationship between arterial hypertension and excessive adiposity (skinfold). Percentage of men with skinfold over 15 mm and of men with systolic blood pressure over 18 cm by age group.**

**Relations de l'hypertension artérielle avec l'excès de tissu adipeux (pli cutané). Pourcentage des hommes présentant un pli cutané dépassant 15 mm et des hommes ayant une pression systolique artérielle supérieure à 18 cm.**

**Figure n° 13 bis** - WOMEN - FEMMES
**Skinfold over 20 mm is considered as excessive.**

**Le pli cutané est considéré comme excessif à partir de 20 mm.**

**SPC nutrition survey in Aitutaki (February 1975).**

**Etude de l'état de nutrition à Aitutaki. CPS (février 1975).**

FIGURE C

COOK ISLANDS; RAROTONGA - AITUTAKI - PAROTIDOSIS
ILES COOK : RAROTONGA - AITUTAKI - PAROTIDOSES

| Age | AITUTAKI | | | | | | | | RAROTONGA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FILLES - GIRLS | | | GARCONS - BOYS | | | Total exam. | % Par. | FILLES - GIRLS | | | GARCONS - BOYS | | | Total exam. | % Par. |
| | Exam. | Par. | % | Exam. | Par. | % | | | Exam. | Par. | % | Exam. | Par. | % | | |
| 2 - 3 | | | not available pas disponible | | | | | | | | not available pas disponible | | | | | |
| 3 - 5 | 51 | 2 | 3,7 | 59 | 4 | 6,7 | 110 | 5,4 | 33 | 0 | 0 | 30 | 0 | 0 | 0 | |
| 6 - 9 | 99 | 4 | 4 | 87 | 14 | 16 | 186 | 9,6 | | | | | | | | |
| 10 - 13 | 107 | 4 | 3,7 | 117 | 6 | 5,1 | 224 | 9,3 | | | | | | | | |
| 14 - 18 | 83 | 0 | 0 | 77 | 0 | 0 | 160 | 0 | | | | | | | | |
| **Ecoliers** | 289 | 8 | 2,7 | 281 | 20 | 7,1 | 570 | 4,9 | - | - | - | - | - | - | - | |
| **Adultes** | 266 | 17 | 6,4 | 163 | 19 | 11,9 | 429 | 8,3 | 37 | 4 | 10,8 | 25 | 6 | 26 | 62 | 16,1 |
| | Total Parot.: 36 | | | | | | | | | | | | | | | |

FIGURE B bis

ILES COOK - AITUTAKI

COOK ISLANDS - AITUTAKI

PLI CUTANE : FEMMES

SKINFOLD : WOMEN

| Skinfold (mm) / Pli cutané (mm) | Age 18-20 | % | Age 21-25 | % | Age 26-30 | % | Age 31-35 | % | Age 36-40 | % | Age 41-45 | % | Age 46-50 | % | Age 51-55 | % | Age 56-60 | % | > 60 | % | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 - 40 | | | | | 1 | 3,2 % | | | | | | | | | 1 | 4,3 % | 1 | 7,7 % | | | 3 | 1,1 % |
| 31 - 35 | | | | | 3 | 9,9 % | | | 4 | 17,3 % | 3 | 9 % | 2 | 11,7 % | 1 | 4,3 % | 1 | 7,7 % | 3 | 6 % | 17 | 6,1 % |
| 26 - 30 | | | 4 | 12,1 % | 4 | 12,9 % | 6 | 15,7 % | 1 | 4,3 % | 9 | 27,2 % | 3 | 17,6 % | 4 | 17,3 % | 2 | 15,4 % | 3 | 6 % | 36 | 13 % |
| 21 - 25 | 2 | 12,5 % | 4 | 12,1 % | 2 | 6,4 % | 11 | 28,5 % | 4 | 17,3 % | 6 | 18,1 % | 3 | 17,6 % | 5 | | 2 | 15,4 % | 9 | 18 % | 48 | 17,3 % |
| Total > 20 mm | 2 | 12,5 % | 8 | 23,5 % | 10 | 32,3 % | 17 | 44,7 % | 9 | 39,1 % | 18 | 56,2 % | 8 | 47,1 % | 11 | 47,8 % | 6 | 46,2 % | 15 | 30 % | 104 | 37,5 % |
| 16 - 20 | 6 | 37,5 % | 11 | 33,3 % | 12 | 38,7 % | 12 | 31,5 % | 11 | 47,8 % | 8 | 24,2 % | 4 | 25,5 % | 5 | 21,7 % | 2 | 15 | 9 | 18 % | 80 | 28,9 % |
| 17 - 15 | 7 | 43,7 % | 12 | 36,3 % | 8 | 25,8 % | 7 | 18,8 % | 2 | 8,5 % | 5 | 15,1 % | 3 | 17,5 % | 6 | 26 % | 4 | 30,7 % | 9 | 18 % | 63 | 22,7 % |
| 6 - 10 | 1 | 6,25 % | 3 | 9 % | 1 | 3,2 % | 2 | 5,2 % | 1 | 4,3 % | 1 | 3 % | 2 | 11,7 % | 1 | 4,3 % | 1 | 7,7 % | 12 | 24 % | 25 | 9 % |
| 3 - 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | | 5 | 10 % | 5 | 1,8 % |
| Total < 20 | 14 | 87,5 % | 26 | 76,5 % | 21 | 67,7 % | 21 | 55,3 % | 14 | 60,9 % | 14 | 43,8 % | 9 | 52,9 % | 12 | 52,2 % | 7 | 53,8 % | 35 | 70 | 173 | 62,5 % |
| Total général | 16 | | 34 | | 31 | | 38 | | 23 | | 32 | | 17 | | 23 | | 13 | | 50 | | 277 | |

FIGURE B

ILES COOK - AITUTAKI

COOK ISLANDS - AITUTAKI

PLI CUTANE : HOMMES

SKINFOLD : MEN

| Pli cutané (mm) Skinfold (mm) | Age 18-20 | % | Age 21-25 | % | Age 26-30 | % | Age 31-35 | % | Age 36-40 | % | Age 41-45 | % | Age 46-50 | % | Age 51-55 | % | Age 56-60 | % | >60 | % | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 - 40 | - | | - | | - | | - | | - | | - | | - | | - | | - | | - | | | |
| 31 - 35 | - | | - | | - | | - | | - | | - | | - | | - | | - | | - | | | |
| 26 - 30 | - | | - | | - | | 3 | 18,8 % | 2 | 20 % | 3 | 23,1 % | - | | 2 | 20 % | - | | 2 | 4,9 % | 12 | 8 % |
| 21 - 25 | - | | 3 | 21,4 % | 1 | 7,7 % | 0 | 0 | 2 | 20 % | 1 | 7,7 % | 1 | 7,1 % | 1 | 10 % | 1 | 11,1 % | 2 | 4,9 % | 12 | 8 % |
| Total > 20 mm | 0 | | 3 | 21,4 % | 1 | 7,7 % | 3 | 18,8 % | 4 | 40 % | 4 | 30,8 % | 1 | 7,1 % | 3 | 30 % | 1 | 11,1 % | 4 | 9,8 % | 24 | 16 % |
| 16 - 20 | 1 | 10 % | 2 | 14,3 % | 1 | 7,7 % | 5 | 31,3 % | 0 | 0 | 1 | 7,7 % | 3 | 21,4 % | 2 | 20 % | 3 | 33,3 % | 8 | 19,5 % | 26 | 17,3 % |
| 11 - 15 | 3 | 30 % | 7 | 50 % | 5 | 35,7 % | 5 | 31,3 % | 2 | 20 % | 7 | 53,8 % | 5 | 35,7 % | 3 | 30 % | 3 | 33,3 % | 16 | 39 % | 56 | 37,3 % |
| 6 - 10 | 4 | 40 % | 2 | 14,3 % | 5 | 35,7 % | 2 | 12,5 % | 4 | 40 % | 1 | 7,7 % | 5 | 35,7 % | 2 | 20 % | 2 | 22,2 % | 12 | 29,3 % | 39 | 24,4 % |
| 3 - 5 | 2 | 20 % | 0 | 0 | 1 | 7,7 % | 1 | 6,3 % | 0 | 0 | 0 | 0 | 0 | 0 | 2 | | 0 | 0 | 1 | 2,4 % | 5 | 3,3 % |
| Total < 20 | 10 | 100 % | 11 | 78,5 % | 12 | 92,3 % | 13 | 81,2 % | 6 | 60 % | 9 | 69,2 % | 13 | 92,9 % | 7 | 70 % | 8 | 88,9 % | 37 | 90,2 % | 126 | 84 % |
| Total général | 10 | | 14 | | 13 | | 16 | | 10 | | 13 | | 14 | | 10 | | 9 | | 41 | | 150 | |

(c) Melanodontia and growth retardation

No mention of such a relationship is to be found in the literature, no doubt because dentists do not normally measure their patients' stature or head circumference. We analysed retarded stature and head circumference, for each sex separately and for both sexes together :

- in relation to U.S. standards,
- in relation to local children without melanodontia.

First of all, we subdivided the melanodontia cases observed into degrees, according to the following classification :

- 1st degree : change in colouring of enamel
- 2nd degree : erosion of enamel on labial surface
- 3rd degree : destruction of dentin and complete abrasion of tooth

Distribution by degree in the various areas

| | Total observed | Degree I | Degree II | Degree III |
|---|---|---|---|---|
| VAIPAE | 41 | 25 : 61% | 13 : 25.5% | 3 : 5.9% |
| TAUTU | 20 | 7 : 35% | 12 : 60% | 1 : 5% |
| REUREU - NIKAUPARA | 20 | 13 : 65% | 5 : 25% | 2 : 10% |
| ARUTANGA | 12 | 3 : 25% | 7 : 58.3% | 2 : 16.7% |
| UREIA | 21 | 7 : 33.3% | 12 : 57.1% | 2 : 9.5% |
| AMURI | 21 | 6 : 28.6% | 12 : 57.1% | 3 : 14.3% |
| | 137 | 61 : 44.5% | 63 : 46% | 13: 9.5% |

(d) Relationship between stature and melanodontia

Boys, 3 to 6 years : 89 examined : melanodontia prevalence according to height group.

Comparatively tall (high group) > P 50 Prevalence : 8/31 = 25.8 per cent
Comparatively short (middle group) < P 50 > P 3 Prevalence : 17/36 = 47.2 per cent
Very short (low group) < P 3 Prevalence : 15/22 = 68.2 per cent

Total prevalence in short and very short boys : 32/58 = 55 per cent

It can be seen, from the above, that melanodontia is significantly more prevalent in staturally retarded boys than in subjects of average or above-average height.

Height retardation in boys with melanodontia, in relation to the local mean for normal boys, was as follows :

at 3 years : 2.5 cm
at 4 years : 5 cm
at 5 years : 7.5 cm
at 6 years : 6 cm

Retardation was even more substantial in some individuals.

Girls, 3 to 6 years : 85 examined :

Retardation was less obvious in girls; the local mean for girls without melanodontia having already dropped quite low, the difference was negligible.

Comparatively tall (high group) $>$ P 50 Prevalence : 12/27 = 44.4 per cent
Comparatively short (middle group) $<$ P 50 $>$ P 3 Prevalence : 28/52 = 53.8 per cent
Very short (low group) $<$ P 3 Prevalence : 3/6 = 50 per cent

= 31/58 = 53.4 per cent

Melanodontia prevalence for boys plus girls according to stature :

| | | | |
|---|---|---|---|
| High group | $\geq$ P 50 | | : 34.4 per cent |
| Middle group | $<$ P 50 | $>$ P 3 | : 51.1 per cent |
| Low group | $<$ P 3 | | : 64.3 per cent |

(e) Relationship between head circumference and melanodontia

(i) In relation to the U.S. reference mean, melanodontia prevalence in boys (89) was as follows :

| | | | |
|---|---|---|---|
| High group | $\geq$ P 50 | | : 6/23 = 26.1 per cent |
| Middle group | $<$ P 50 | $>$ P 3 | : 10/34 = 29.4 per cent |
| Low group | $<$ P 3 | | : 20/32 = 62 per cent |

(ii) In relation to the local mean for boys without melanodontia

- In boys with above-average head circumference, melanodontia : 12/45 = 26.7 per cent

- In boys with below-average head circumference, melanodontia : 24/44 = 54.5 per cent

At $5\frac{1}{2}$ years, in boys with melanodontia :

- retardation in relation to U.S. mean was 1.8 cm

- retardation in relation to local mean was 1 cm

Girls (85)

In relation to the U.S. reference mean, melanodontia prevalence was as follows :

| | | | | |
|---|---|---|---|---|
| High group | ≥ P 50 | | : 5/14 = | 35.7 per cent |
| Middle group | < P 50 | > P 3 | : 20/37 = | 54.1 per cent |
| Low group | < P 3 | | : 18/34 = | 52.9 per cent |

Head circumference retardation in girls with melanodontia, in relation to U.S. mean for girls, was :

1.8 cm at 4 years
1.4 cm at 5 years
1.2 cm at 6 years

Melanodontia prevalence for boys plus girls according to head circumference :

| | | | | |
|---|---|---|---|---|
| High group | ≥ P 50 | | : 11/37 = | 29.7 per cent |
| Middle group | < P 50 | > P 3 | : 30/71 = | 42.3 per cent |
| Low group | < P 3 | | : 38/66 = | 57 per cent |

Total prevalence in children with small and very small heads :
79/174 = 49.6 per cent

These findings are very important, since it is recognised that the size of the brain is proportional to that of the skull. Our figures will need to be confirmed by another survey in a different area, under the direction of the Dental Public Health Officer, and we strongly suggest that such a survey be undertaken, for the problem of impaired brain development as a result of chronic malnutrition is indeed a vital one.

In addition, it will no longer be possible to consider melanodontia as a form of ordinary caries once it is proved to be linked with retarded statural growth, itself a consequence of faulty nutrition, in particular an unbalanced diet that falls short of protein and essential amino acids. If this link were proved, prevention of melanodontia would be concomitant with prevention of stunting and with nutritional rehabilitation, and would lead to prevention of caries, insomuch as the latter are secondary developments in teeth that have been rendered fragile by melanodontia : in this respect, food hygiene and oral hygiene are two aspects of one and the same thing.

(iii) Prevalence of melanodontia in certain families

Melanodontia was often found to "run in the family", affecting several members at the same time.

This does not appear due to any genetic deficiency, but rather to nutritional factors, since, in the families concerned, diets were generally found to be deficient or unbalanced. Our hypothesis is borne out by the coexistence, within the same families, of melanodontia and other symptoms of chronic malnutrition (statural retardation, parotid enlargement, liver enlargement).

(f) Association of melanodontia and other symptoms of malnutrition (in 3 to 6 year old children)

Prevalence of melanodontia in children showing other symptoms of malnutrition :

(a) Parotid enlargement : Out of 10 children, 8 showed melanodontia = 80 per cent.

Liver enlargement : Out of 24 children, 14 showed melanodontia = 58.3 per cent.

Abnormal hair growth : Out of 7 children, 1 showed melanodontia = 13 per cent.

Out of 79 cases of melanodontia, 27 were associated with one or more of the above symptoms, i.e., 24.9 per cent.

(b) Inversely

Prevalence of parotid enlargement in children with melanodontia was 8/79 = 10.1 per cent.

Prevalence of parotid enlargement in children without melanodontia was 2/95 = 2.1 per cent.

Prevalence of liver enlargement in children with melanodontia was 14/79 = 17.7 per cent.

Prevalence of liver enlargement in children without melanodontia was 10/95 = 10.5 per cent.

Prevalence of abnormal hair growth in children with melanodontia : 1/79 = 1.2 per cent.

N.B. : A further visit to Aitutaki, within the Special Project on Nutrition, is to be made during 1976, by Dr J. Speake, the SPC Dental Public Health Officer, who will gather additional statistical data on melanodontia and its correlations.

Similar correlations were found in Wala Rano, in spite of a very different nutritional context :

Out of 11 children (3 to 6 years) with parotid enlargement (11/67 = 16.4 per cent)

- 10 also showed liver enlargement = 90 per cent
- 5 also showed melanodontia = 50 per cent, whereas the overall prevalence of melanodontia was 16.4 per cent.

While it would be premature to infer, from what we know at present, a direct relationship between functional impairment of the parotid glands and occurrence of melanodontia, it might reasonably be suggested that parotidosis, liver enlargement and melanodontia all stem from dietary inadequacies.

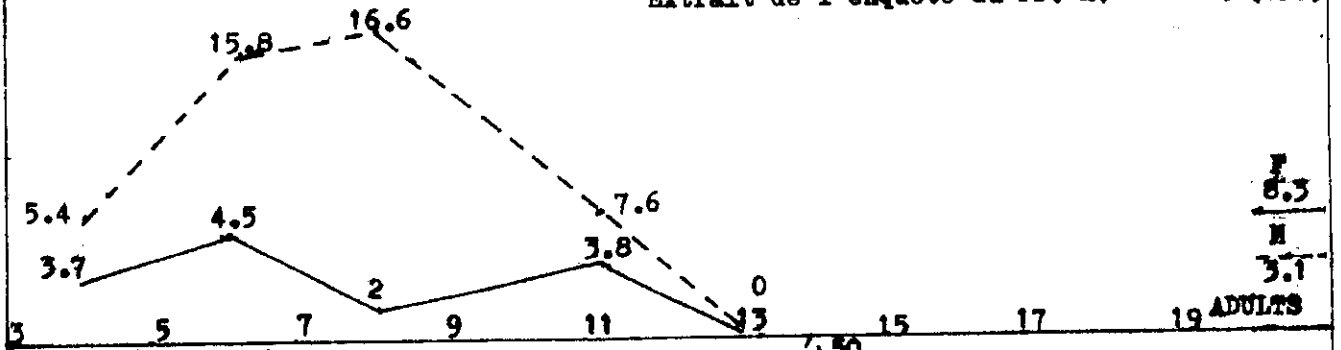
* * *

ALTUTAKI (COOK ISLANDS) February 1975.

Enlarged parotids
Parotidoses
CODE : _____ Females - Femmes
_ _ _ _ _ Males - Hommes

Figure n° 14 - Percentage of enlarged parotid glands by age and sex in three different communities in the South Pacific.
From a survey by Pr A. Raoult. SPC.

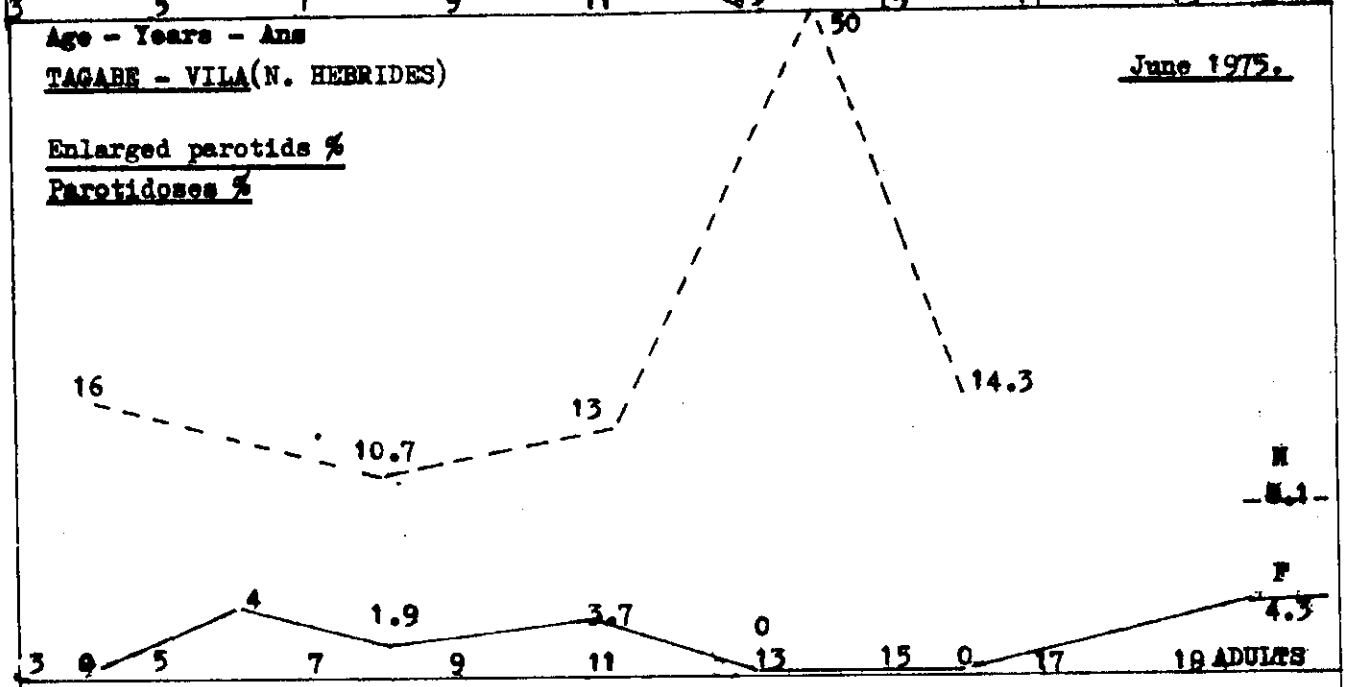
Pourcentage de parotidoses par âge et sexe dans trois communautés du Sud Pacifique.
Extrait de l'enquête du Pr. A. RAOULT. (CPS)




Age - Years - Ans

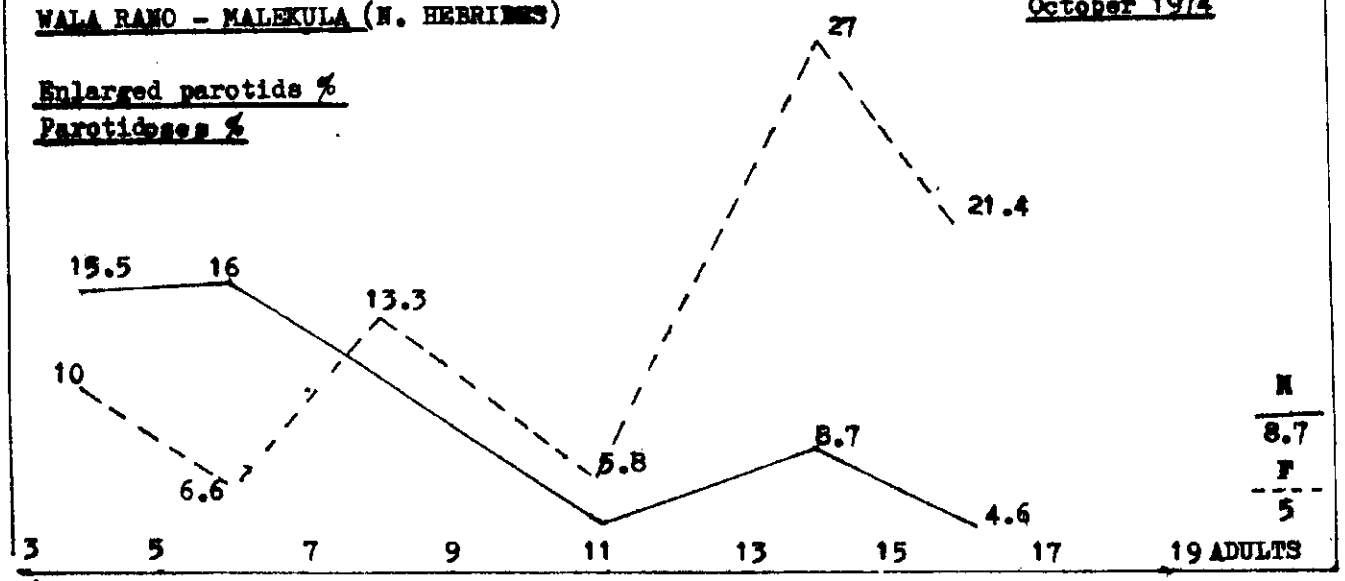
TAGABE - VILA (N. HEBRIDES) June 1975.

Enlarged parotids %
Parotidoses %




WALA RANO - MALEKULA (N. HEBRIDES) October 1974

Enlarged parotids %
Parotidoses %




Age - Years - Ans

## CHAPTER VIII

## EDUCATION : NUTRITION AND HEALTH EDUCATION COURSE AT AVARUA

The course was held after the Aitutaki survey, from 11th to 14th February 1975, with the assistance of Miss Bushra Jabre, SPC Health Education Officer, and Dr A. Raoult, SPC Medical Nutritionist.

It was a multidisciplinary in-service training course dealing with the nutritional problems encountered in the Cook Islands and brought together 22 participants, with their supervising officers :

From the Department of Public Health :

- 10 Public Health Nurses, accompanied by Mrs Poko Nicholas;
- 6 Public Health Inspectors, accompanied by Tatara Samuela;
- Taiora Matenga, Dietician.

From the Department of Education :

- Jill Johnston, Curriculum Development Unit; organising teacher (Home Economics);
- Nolarae Keown, Curriculum Officer (Health and English);
- Mii Tungata, Home Economics Teacher.

From the Department of Agriculture :

- 3 Agriculture Officers.

Training sessions, in the form of group discussions, were held every afternoon from 2 p.m. to 5 p.m. (a total of 15 hours), in the presence of Dr Manea Tamarua. The subjects dealt with included :

(1) From conception to death : the role of nutrition at various stages of life.

(2) Nutrients : variable requirements.

(3) Protein requirement : animal and plant proteins - Group I and Group II foods; practical local aspects.

(4) Energy requirements : carbohydrates - Group III foods; their role; local aspects.

(5) Group IV foods : fats; the coconut.

(6) Group V foods : fruits and green vegetables, rich in vitamins and minerals; practical aspects. Group VI foods : beverages and spices.

(7) Pathology of deficiencies and excesses : the nutritional crisis; protein-calorie malnutrition; obesity; diabetes.

(8) Nutrition, infections, parasites.

(9) Health Education methods.

* * *

# CHAPTER IX

## RECOMMENDATIONS FOR AN EFFECTIVE NUTRITION EDUCATION PROGRAMME IN AITUTAKI

### 1. Introduction

Conclusions and recommendations for the various age groups have already been stated in the relevant sections of this report.

On the whole, nutritional status, both of growing children and of adults, cannot be regarded as satisfactory.

This is all the more to be regretted as the genetic potential of the population and the food resources of the island are particularly good, so that excellent nutritional status and physical and mental development could quite easily be achieved.

Since the main instrument of progress in this field is nutrition education starting in the early years and continuing through life, the following recommendations, made by Miss Bushra Jabre on the basis of the survey, will provide a fitting general conclusion to our report.

### 2. Recommendations (by Miss Bushra Jabre)

In order to have a meaningful and successful nutrition educational programme, several factors have to be taken into consideration :

(i) Setting objectives based on survey findings.
(ii) Having trained personnel to carry out suggested plan of action.
(iii) A method of evaluating results.

#### Objectives

(1) To arouse interest in toddlers' food needs and the relationship of poor food to sickness, physical and intellectual development.

(2) To ensure that toddlers consume adequate amounts of good quality proteins.

(3) To increase attendance at maternity clinics.

(4) To make people aware of the relationship of dental diseases to the consumption of refined foods.

(5) To explain the dangers of obesity and how to control it, taking into consideration the food habits of the people.

#### How can these objectives be achieved?

These objectives can be achieved if collaboration exists between the different categories of personnel :

(i) District Health Nurses
(ii) School teachers
(iii) Women groups

What can each do?

(i) District Health Nurses

(a) Keep close surveillance on growth charts

Weights of infants and children are measured:

- fortnightly for the first year of life;
- monthly for the second year;
- quarterly for the period 2-6 years.

The findings are recorded on the child's card but there is no follow up.

Heights are not measured regularly.

It is recommended that more consideration be given to growth charts and periodic analysis be made, preferably in the presence of the doctor.

(b) With the help of the teacher and the students themselves, growth charts should be kept for every school child and a collective one be made every year according to the model given. The District Nurse, during her weekly or fortnightly visit to the school, can attend to the first-aid and referral cases, whereas the teacher can be in charge of the hygiene and growth charts; a list of signs to be observed can be given to the teacher who would then be able to report any deviation from the normal to the District Nurse and she, in turn, would refer the child to the specialised physician.

(c) Carry out cooking demonstrations in every clinic where the mothers will have the chance of :

(1) seeing how food is being prepared;
(2) discussing the value of the most important body-building food ingredients;
(3) tasting the food themselves;
(4) feeding it to their children (in this way, feeding techniques are demonstrated at the same time).

The mothers should have the opportunity of repeating the demonstration themselves. Actually, if the same demonstration is repeated several times to the same mothers in the course of, say, one month, the mother will be quite confident to prepare the dish herself at home. Mothers could be asked to bring ingredients.

Attention should be given that only locally available materials be used and the District Nurse should always relate the reason behind the demonstration to the existing problems and the actual resources.

In planning cooking demonstrations, each nurse should make sure that :

(1) Seating arrangement is comfortable.

(2) Not too many women are present at one time, since this would hinder the effectiveness of the demonstration; their interest and participation would be greatly reduced.

(3) The demonstrations last for a short time (not more than 15 minutes).

(4) Local materials should be used (pots, pans, fuel, foodstuffs, etc., all should be within the economic reach of each person in the group).

(5) The aim of the demonstration should be clearly explained.

(6) Discussions and participation of the audience should be encouraged.

Evaluation of the programme can be done by two methods :

(a) Progress can be checked from the growth charts of the children (attendance records).

(b) Home visits should be made to coincide during meal times, so that the Nurse can see what the child is being fed.

(ii) Teachers

(a) Should incorporate nutrition in most of their subject matters (language, arithmetic, social studies, etc.).

(b) Supervise the lunch break of the children to make sure that the children are practising what they are being taught and to ensure the adoption of hygienic food habits.

(c) Teaching theory in the classroom is not sufficient; the teacher should plan and conduct practical teaching in the classroom (preparation and tasting of foods, germination of seeds of legumes, etc.).

(d) Practical teaching should also take place outside the classroom:

- visits to well-tended gardens;
- putting theory (agriculture and nutrition) into action through the school garden.

The objective of the school garden is the promotion of the adoption of good food habits. Production from the school garden should contribute to feeding the school children and their families (so that they would be encouraged to plant) and if there is any surplus for sale so much the better as it will show the children and their families the economic advantage of the experiment. However, care should be taken not to make out of the school garden:

(i) a punishment for school children (since this will surely turn them off gardening and agriculture);

(ii) a source of revenue for the school (where the children do not eat the end product of their efforts).

(e) Fishing should be part of the curriculum with the fishing pilot project being in Aitutaki, fish being the main source of protein. Students should be encouraged to develop fishing skills (which should be a valued asset and not something to be looked down on as the young people tend to view fishing and gardening as degrading).

(f) Cooking demonstrations should be part of the curriculum for both boys and girls.

(iii) Women Groups can

(a) organise cooking contests where prizes are given to the woman who cooks a well-balanced dish made out of local products.

(b) organise consumers' education programmes where women learn comparative buying techniques and the value of organising a family budget.

How the SPC can and will help

A. In schools

(1) By organising training sessions in nutrition and health education for the teachers of the primary schools and the high school.

(2) By working out a detailed curriculum with the Home Economics teacher at the high school.

(3) By developing visual aids needed to put the nutrition education into practice.

These are normal activities, included in the special SPC nutrition project, to be carried out by SPC personnel on the request of the Cook Islands Government.

B. With District Nurses

(1) To follow up the programme already started in the various clinics on Aitutaki where cooking demonstrations are being organised.

(2) Strengthening the home visiting programme and making it a meaningful educational experience.

(3) Facilitating the collaboration of the health and education personnel to put into practice the recommendations given.

C. With Women Groups

To initiate the activities suggested.

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# CHAPTER X

## FURTHER SPC PLANS FOR AITUTAKI

1. Health Education

After our initial visit, Miss Bushra Jabre returned to Aitutaki to help with the setting up of a health education programme based on the preliminary findings of the survey, at the same time completing her records by collecting qualitative data on diets at various ages.

2. Professor Raoult will continue his assessment of the nutritional status of the Aitutaki population, concentrating more especially on obesity and diabetes and their link with parotid enlargement. This investigation will be carried out in conjunction with the Metabolic Research Unit in Rarotonga and the New Zealand Medical Research Council.

The following officers plan to visit Aitutaki within the framework of the pilot project :

3. Dr J. Speake, Dental Public Health Officer, to study melanodontia and early caries, their prevention and their link with growth retardation.

4. Mr C. Richard, Public Health Engineer, to investigate sanitation problems.

5. Mr G. Chan, Waste Digester Specialist, to look into the possibility of constructing an integrated farming system in a village.

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