



World Health Organization  
Western Pacific Region

# DIET, FOOD SUPPLY AND OBESITY IN THE PACIFIC



# **Diet, food supply and obesity in the Pacific**



World Health Organization  
Regional Office for the Western Pacific  
2003



WHO Library Cataloguing in Publication Data

Diet, food supply and obesity in the Pacific

1. Diet 2. Food supply 3. Obesity 4. Pacific islands

ISBN 92 9061 044 1 (NLM Classification: WA 695)

© World Health Organization 2003

All rights reserved.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

The World Health Organization does not warrant that the information contained in this publication is complete and correct and shall not be liable for any damages incurred as a result of its use.

Publications of the World Health Organization can be obtained from Marketing and Dissemination, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel: +41 22 791 2476; fax: +41 22 791 4857; email: [bookorders@who.int](mailto:bookorders@who.int)). Requests for permission to reproduce WHO publications, in part or in whole, or to translate them – whether for sale or for noncommercial distribution – should be addressed to Publications, at the above address (fax: +41 22 791 4806; email: [permissions@who.int](mailto:permissions@who.int)).

# Table of Contents

Acknowledgements	iv
Executive summary	v
1. Introduction	1
2. Obesity	2
2.1 A diet conducive to good health	4
2.2 Ancient Pacific food patterns	5
2.3 Isolation: protected health and developed conservativeness and homogeneity	7
3. Dietary patterns	9
4. The food supply	34
4.1 Food dependence	37
4.2 Traditional foods and lifestyle	40
5. Discussion points	42
6. References	46
Annex 1	52
Annex 2	55
Annex 3	57
Annex 4	59

# Acknowledgement

**T**his paper was prepared by Mr Robert George Hughes, Research Fellow, University of Queensland, (Royal Brisbane Hospital, PO Box 103, Herston Q.4029, Australia), as a background document for the FAO/SPC/WHO Consultation on Food Safety and Quality in the Pacific, held in Nadi, Fiji, 11-15 November 2002.

# Executive summary

The objective of this paper is to review documented evidence and examine the relationships between the food supply, dietary patterns and obesity in Pacific countries. Obesity and consumption of imported foods seems to be an urban phenomenon in the Pacific. A suitable definition for a recommended proportion of fat in a national diet has been established. Before European contact, the food behaviour of the people of the Pacific region may have remained the same for millennia. The main staples were root crops. Upon European contact, Pacific people were described as strong, muscular and mostly in good health. The leaders and ruling classes appeared to be obese and high value was placed on fatty foods. Daily food intake consisted of large quantities of starchy roots supplemented with leaves, fish, coconuts and fruits.

Fifty years ago in some areas of the Pacific, fat consumption was very low (Papua New Guinea). In other areas (Polynesia), fat provided 38%-42% of energy. Over 64% of fat came from coconut cream and Polynesians and Micronesians may have consistently consumed a diet high in fat. Traditional foods were quickly supplemented with foreign foods with increasing urbanization. Consequently, urban families adopted different cooking methods, changing from fat-free to fat-assisted, and purchased store foods for convenience and low cost. Simultaneously, dietary studies show that urban populations consumed more imported foods, such as flour, sugar, canned fish and meat, and less locally produced foods. Consumption of imported foods seemed to be an addition to, and not a replacement of, the consumption of local foods. Documented records also show that Pacific people consumed large quantities (more than 3 kg/day) of roots crops. This practice continued with the addition of imported staples.

There is little evidence to show the differences in obesity levels between those who consume imported foods and those who consume locally prepared foods. However, evidence from Vanuatu shows that rural populations consumed more total calories than urban populations but had lower prevalence of obesity. The proportion of total fat consumed from imported foods was 44.8% for urban populations and only 8.4% for rural populations. Later it was determined that people were 2.2 times more likely to be obese and 2.4 times more likely to be

diabetic if they consumed fat from imported foods rather than from traditional fat sources. The most commonly consumed imported foods providing fat were identified as oil, margarine, butter, meat and chicken, tinned meat and tinned fish.

Food supply data show that total available energy and fat has increased in all countries. The majority of countries have increased availability of meat, alcohol and milk since 1965. All countries except Australia and New Caledonia comply with the WHO recommendations for fat contribution to total energy. The largest single providers of energy for Pacific countries are cereal products (white flour and rice). However, the largest single increase since 1965 has been in the availability of vegetable oils. Fat availability from all sources except coconuts has increased. Total fat contribution for the majority of countries has increased. Imported fat has been *added to* and has not replaced existing fat sources such as coconuts. The largest single increase in meat products has been the importation of chicken meat, which is relatively high in fat. There is no information on the imports of individual high-fat foods, such as mutton flaps and turkey tails, except for Tonga where imports of mutton flaps have been declining since 1992 in favour of chicken and sausages.

Most Pacific countries are food-dependent. A part of good governance for any population is the freedom to choose from a range of nutritious foods. It appears that many people do not get that choice. Diets that consist mainly of locally produced foods have been shown to prevent and reduce obesity, but only one Pacific community (Hawaii) has attempted to put this into practice. It appears that most Pacific people prefer locally produced foods but, due to social and economic barriers to access, consume nutritionally inferior foreign foods. Making changes in the food supply to improve access and availability of locally produced foods may allow preferences to be met and, in addition to behaviour change, may be a better option than encouraging behaviour change alone.

# 1.

---

# Introduction

**T**his paper attempts to collect documented evidence to examine the relationships between the food supply, dietary patterns and obesity in Pacific countries. It draws from dietary studies and reviews undertaken over the last 80 years and documented accounts of diets since evidence of root crop consumption in the Pacific was established over 28 000 years ago.

Firstly, a short account of obesity is given, emphasizing that it is a growing epidemic that has affected urban communities. Section 2 discusses and defines a healthy diet for a population. In section 3, a view of food consumption patterns is given from Pacific pre-civilisation and pre-European contact times to show the conservative and homogeneous nature of Pacific communities. Pacific dietary studies are reviewed in section 4, with emphasis on the contributions of macronutrients to energy. The section starts with individual country data, listing countries alphabetically. The food supply is then examined and analysed, with data from FAO Food Balance Sheets from seven Pacific countries. This section ends with a short account of food dependence. Conclusions are then given in section 5. There is a large reference list, and food supply data are provided in the Annexes.



## 2.

---

# Obesity

**O**besity is a rising epidemic in the Pacific. Literature reviews have determined the prevalence rates and identified the populations at risk (1; 2). The latest review by Coyne summarizes as follows.

1. “Overweight and obesity are major epidemics in much of the modern world today
2. The prevalence of obesity is increasing dramatically in many Pacific countries and is reaching alarming levels in several countries.
3. Rates of overweight and obesity combined in adults are over 50% in at least 10 Pacific countries. These Pacific countries also tend to be the most economically developed.
4. Rates for overweight and obesity combined as high as 75% have been reported in Nauru, Samoa, American Samoa, Cook Islands, Tonga and French Polynesia.
5. The still evolving Pacific obesity epidemic is characterised by increasing urbanization and the consumption of high-fat foods that require little physical activity to acquire.
6. The early trends indicate that women become obese earlier than men, but now the rates for men are slowly becoming as high as those for women.
7. Obesity is more prevalent in urban areas, but recently urban/rural differences have been diminishing.
8. Overweight and obesity are closely associated with increased risk of hypertension, cardiovascular disease and diabetes.

9. It appears that weight gain occurs early in adulthood, between 20 and 45 years of age. The apparent lower BMIs of older population groups may reflect cohorts of less-obese survivors rather than a trend to lose weight with age.

10. There is also cause for concern that obesity is starting in infancy or early childhood.” (1: 171)

Items 5, 6 and 7 are of particular interest as they identify the pattern of obesity across the Pacific as a product of urbanization and that the highest prevalences occur in urban populations.

**Table 1** shows comparisons between the levels of urbanization and obesity in some Pacific island countries. These data were taken at different times and by different methods and cannot, therefore, be compared directly. However, they do give an idea of trend. For comparison, the 1999-2000 obesity prevalence figures for Australia show that 65% of men and 45% of women are overweight (BMI  $\geq$  25). (3)

**Table 1: Urban populations and overweight prevalences in Pacific countries**

Country	%urban	% BMI $\geq$ 25	
		male	female
American Samoa	48	83.6	87.6
Tonga	32	65.5	84.1
Nauru	100	77.3*	77.1*
Samoa	21	56.9*†	74.3*†
Cook Islands	59	70.6	73.0
French Polynesia	53	73.5	71.6
New Caledonia	71	46.3	69.4
Fed. States of Micronesia	27		65.1
Vanuatu	21	61.2†	64.7†
Fiji Islands Fijian	46	43.2	64.0
Marshall Islands	65		61.0
Papua New Guinea	15	37.7**†	56.3**†
Solomon Islands	13	12.0	40.0
Fiji Islands Indian	46	18.0	33.7
Com. Northern Mariana Islands	90		
Palau	71		
Tuvalu	42		
Guam	38		
Kiribati	37		
Niue	35		
Tokelau	0		
Wallis and Futuna	0		

Source: SPC Demography projections 2001 and Coyne 2000

\* = obesity only (BMI  $\geq$  30)

\*\* = pre-obese only (BMI 25.0 - 29.9)

† = urban populations only

Obesity in infants and children is a growing concern. Infant growth monitoring studies undertaken in Cook Islands in 1998 and Tonga in 1999 show that proportions of macrosomic infants (birth weight >4000 g) were 13.1% and 26.6%, respectively. Additionally, the mean birth weight of Tongan infants increased by 300 g (8.8%) between 1972 and 1998 to 3677 g (4; 5). There is evidence that macrosomia and increased birth weight may be associated with obesity in childhood, adolescence and adulthood (6-8).

A recent WHO survey of nearly 4000 school children aged 6-12 years from 27 schools in 13 Pacific countries found that in some Polynesian schools up to 27.9% of children were obese, using the NCHS reference population of US children (Hughes RG. 2002 unpublished report). It is not known what role the consumption of high-fat foods plays in the diet of children. Dietary surveys among Pacific children are needed to clarify the issue.

## 2.1 A diet conducive to good health

In the past there has been some contention over what proportions of fat, carbohydrate and protein as a proportion of energy contribution, constitute an appropriate diet for good health. Recommendations for the consumption of appropriate proportions of fat, carbohydrate and protein were made in 1998 and are contained in the WHO publication, *Preparation and use of food-based dietary guidelines* (9). More recent recommendations have also been produced (10,11). These recommendations are shown in **Tables 2 and 3**.

**Table 2: WHO (1998) Recommended upper and lower intakes of fat, carbohydrate and protein as percent contribution to energy**

Nutrients	Lower	Median	Upper
	%	%	%
Fat	15	25	35
Carbohydrate	55	65	75
Protein	8	10	12

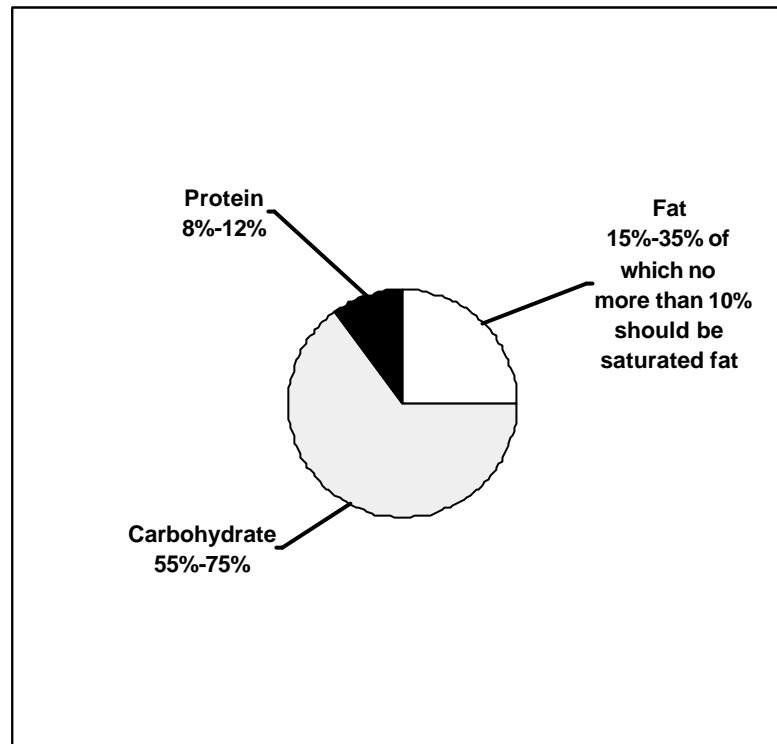
**Table 3: IDECG (1999) Working Group recommendations for fat and carbohydrate intakes as percent contribution to energy**

Nutrients	Lower	Median	Upper
	%	%	%
Fat	15	22.5	30
Saturated fat (C12-16)			10
Carbohydrate	33		

As can be seen in **Tables 2 and 3**, the recommendations are slightly different. However, for the purpose of this background paper, it may be more appropriate to take the WHO recommendations, as laid out in **Table 2**, as they are complete for all macronutrients. To avoid ambiguity for total population intakes, the mean values will be referred to rather than the maximum and minimum limits.

This provides a means of comparison with existing food supply data and information from dietary studies. The mean proportions are shown in Fig 1. Dietary guidelines in many countries usually recommend a desirable level of the contribution of fat to total energy. For example, in Australia it is recommended that fat should contribute no more than 30% of total energy (12).

**Figure 1: WHO recommendations for proportions of energy derived from macronutrients**



It cannot be assumed that within populations whose food supply and/or consumption patterns are consistent with the proportions of macronutrients shown in Figure 1 there will not be unacceptable numbers of overweight or obese people. Other factors are involved in the etiology of obesity, especially physical activity. Individual variation within any population should make for a wide range of individual weights and heights. However, Pacific countries are mostly homogeneous populations. Within any Pacific community, therefore, it may be expected that the majority of individuals have similar consumption patterns.

## 2.2 Ancient Pacific food patterns

There is some agreement that Meganesia, the landmass including Australia, Papua New Guinea and Tasmania, was colonized before the Pleistocene age, 45 000-60 000 years ago, and that the inhabitants shared a common, ancestral culture (13). Kingdon calls these people the Banda (Austroloid and the ancestors of the Melanesians) after the inner and outer arcs of islands north of Australia (14). They were littoral dwellers, living off the seashores of many islands. They exploited the near-shore environments so well they literally ate their way

down what is now the Malay Archipelago, Papua New Guinea, and reached the northern Solomon Islands about 32 000 years ago (15). Flannery (13) hypothesized that the reason they moved down from Asia was a fear of large predators such as leopards. Piles of shells (middens) eaten by occupants 32 000 years ago have been found in New Ireland. Easy pickings were soon found inland which abounded with large docile land animals and flightless birds. Trade had started as there is evidence that obsidian was being transported from New Britain to New Ireland 20 000 years ago (16).

The next movement of people to the south seems to have occurred about 8000 years ago, when most Austroloid peoples of South-East Asia were replaced by Mongoloids (Non-Austronesian ancestors of Polynesians and Micronesians). Their food base was very different as it depended on rice and millet agriculture. They developed pottery, had domestic dogs, chickens and pigs, and were great seafarers, entering the Pacific islands area 2300-3000 years ago. They are called Non-Austronesian, but were better known as the 'Lapita' people because they left distinctive pottery on many Pacific islands. Archaeological sites show that Vanuatu, New Caledonia and Fiji were reached 2300-3000 years ago, with Samoa and Tonga following 2000-2100 years ago. Lastly, New Zealand was reached 800 years ago (13, 15).

Food remained the central theme during occupation by the first inhabitants. The account given by Flannery (13) maintains that, not only did the Austronesians eat their way down through Melanesia, but the Non-Austronesians did likewise through Micronesia and Polynesia until the large land-based animals and flightless birds became extinct (13).

The long genetic and cultural isolation of the Austronesians from other Pacific and South-East Asian populations was recently determined by Serjeantson and coworkers, who analysed genetic distances between populations in terms of human leukocyte antigens (HLA). They were able to determine that Australian Aborigines, Papua New Guinea Highlanders and some coastal populations had the least genetic admixture, thus reflecting the most isolation (17). Migration from about 15 000 years ago provided a strong genetic and linguistic influence (Austronesian) that still exists today. Approximately 8000 years ago, coincidental to the introduction of the pig to Papua New Guinea, the separation with the Austroloid was complete and Non-Austronesian languages dominated. This study not only shows genetic uniqueness, but also provides an insight into the conservative nature of the cultural and physical ecology in most of the Pacific islands.

This conservative ecology is reflected in food consumption patterns. Root crops have been the main staple in the Pacific for millennia. Archaeological evidence uncovered by Loy and others found scrapings of taro and sweet potato on stone artefacts 28 000 years old on Buka Island in the Northern Solomon Islands (18). There is also evidence that sago may have been used for food in the lowlands of mainland Papua New Guinea for as long as 20 000 years (19). However, during this extremely long occupation, the natural environment has not been a changeless backdrop (16).

### **2.3 Isolation: protected health and developed conservativeness and homogeneity**

Conservative food ecology amongst Pacific peoples is described as ‘robust culture’ by Fitzpatrick. The author notes that Polynesians possess a homogeneous culture spreading across many countries (20). The geographic isolation and the relative abundance of food provided early Pacific people with the elements of a healthy life.

Descriptions given by the early European explorers provide evidence. The French explorer Louis de Bougainville recorded that the Tahitians were almost godlike and lived in an environment overflowing with natural abundance: “I never saw men better made” and “I thought I was transported into the garden of Eden” (16).

The journals of Captain James Cook, written on three voyages between 1768 and 1780, support Bougainville’s view, with descriptions of the health and diet of people living in Tahiti, Tonga, Cook Islands, Vanuatu and New Caledonia (21).

A very good description of the physique of Pacific island people comes from Houghton, who gives accounts from the chronicles of Magellan (1521) and Quiros (1606) and many other later European explorers for inhabitants of most of the Pacific islands (15). The author shows that the descriptions given by the early explorers of Pacific people are remarkably consistent – “of a singularly tall, muscular and well-proportioned people” (15:31). As the islands enlarged, particularly in Vanuatu, Solomon Islands and Papua New Guinea, so the people appeared shorter and less robust. For these islands also the coastal people were described as “stocky” contrasting with “more gracile” for people living inland.

The death of Captain James Cook in the Hawaiian islands at the end of 1700s marked the beginning of a colonial period. Over the next 300 years, disease and death caused major population reductions. Added to this was the incremental loss of many diverse cultures to the colonists’ culture, which included religious conversion, trade and resource exploitation. Two world wars changed the face of the Pacific forever (20).

Most Pacific economies were based on social networks and subsistence, which made the Pacific view of food and land very different from that of the colonists (22). Consequently, the vast majority of Pacific countries are now dependent on developed countries.

Pollock highlights some basic distinctions of Pacific people, especially a very different social economy to that of the Europeans (22). The author explains that Pacific economies were based on wide social networks and land was more important for determining identity and traditional ties than it was for providing food. Health was a group concept – a shared sense of well-being and food had symbolic and economic importance rather than being a biological necessity. This was epitomized by the Pacific aristocracy and leaders. The chiefs were the symbolic leaders of the clan and, as a result, were usually the largest (obese) people in the community. The author estimates that Pacific people were vegetarian 85% of the time. The high value placed on starchy foods still persists.



Meat and fish were consumed but, in Polynesian society, pork was denied to the lower classes. Feasts were not all that common. The traditional diet of the people was mainly large quantities of starchy root crops with a side of green leaves, seafood and coconut. This has been slowly replaced by imported foods to the point of food dependency in the 1980s.

The themes of large serving sizes, as much as 4 kg per day, and the replacement of starchy roots with less nutrient-dense but high-energy foods is continued in reviews by McGee for Vanuatu and Parkinson for Fiji and are reviewed below (23, 24).

### 3.

---

## Dietary patterns

**B**elow is a selection of dietary studies and accounts of food patterns that have been undertaken over many years, by country. Some studies make particular reference to obesity.

### ***Cook Islands***

One of the first nutritional status assessments of Cook Islanders took anthropometric and biochemical measurements of 365 adults and children in the village of Arorangi on Rarotonga in 1951 (25). No nutritional deficiencies were found. However, the investigators found that many people, especially women, appeared to be obese, although the researchers found no suitable way of measuring it. Heights and weights taken indicate that Rarotongan children were smaller than New Zealand Maoris but similar to New Zealand European children. Milk was given to schoolchildren at that time and, although the main diet was kumera, taro, breadfruit, arrowroot and bananas, store foods were also eaten, mainly tinned meat, flour, sugar and biscuits.

Holmes explained that, in early times, puraka, a taro-like root, was a staple of the Cook Islands diet (26). Coconut, pandanus, kumara (sweet potato), banana, pawpaw, breadfruit and considerable amounts of fresh and dried fish made up most of the traditional diet.

In 1957, Fry reported that on Rarotonga, villagers engaged in subsistence agriculture regularly consumed bread and sugar (27). The average family was consuming 1535 grams of white bread and 106 grams of sugar per day. The macronutrient composition of the diet was estimated for families and residents at a Missionary Training School (**Table 4**). Over 64% of the fat for families was provided by coconut cream. The author also took anthropometric measurements of the people in two villages and compared them with Tongans and Americans for each age group. While the weights of Tongan men and women exceeded Cook Island Maori men and women by 19lbs and 16lbs, respectively, the weights of Cook Island Maori men and women exceeded US men and women by 10lbs and 12lbs, respectively. The author concluded that Cook Islanders had greater muscularity and were not obese until later in life (27, 28).

**Table 4: Macronutrient contribution to energy: Rarotonga 1957**

	Total calories (%)	
	Families	Training School
CHO	49.4	49.5
Fat	37.8	42.3
Protein	12.8	12.1

A later dietary survey was conducted in 1962 in Rarotonga, Atiu and Mitiaro in the Southern Group of the Cook Islands, including 756 people (29). In Rarotonga, which had come under considerable western influence, the energy and protein intakes greatly exceeded those of the Atiu–Mitiaro islanders. However, the percentage of energy coming from fat was higher for Atiu–Mitiaro than Rarotonga and also differed in quality. For Rarotongans, 86% of fat intake came from animal sources, while 89% came from coconuts for the Atiu–Mitiaro islanders.

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

The 1954, 1962 and 1966, surveys showed that much of the higher carbohydrate consumption of the urban dwellers appeared to come from sucrose. Fat consumption was similar but there had been a change from coconut-based (vegetable) fats to animal fats. The diet in Rarotonga showed an increasing reliance on imported foods. The population was consuming more sugar, salt and animal fat, and less bulky, starchy foods and fibre. The diet had become a combination of local and imported foods. However, traditional staple foods, such as taro, fish and pork, were still very much valued and were an important part of ceremony and custom (31).

In 1987, a dietary survey, using the 24-hour dietary recall method, was conducted with the participation of 384 Rarotongans (32). This study showed that the energy intake was above the recommended levels at the time. The dietary intake was also high in saturated fats and all vitamins and minerals analysed were above recommended levels, except for thiamine, riboflavin, vitamin A and calcium. Imported foods represented 60% of total daily food intake.

A 24-hour dietary recall survey was undertaken in 1993 on 127 adults in the village of Tutakimoa on Rarotonga (32). Total energy intake was 2815 kcals for men and 2524 kcals for women. This intake, as well as the intake of fat and carbohydrate, was appropriate compared to current recommendations.

Recently, in 2002, the Paruru no te Oraanga Meitaki Project was undertaken to determine the prevalence of diabetes and hypertension in a small Rarotongan community of approximately 3600 people, called Puaikura Vaka (33). Crude (unpublished) results show that at least 80% of the individuals screened were overweight or obese, 12% had diabetes and nearly one-third had high blood pressure (these rates may be reduced when the adjusted figures are released).

The report identifies concern over consumption of high-fat, high-energy foods. Recommendations of the report include a review of import policy and introduction of legislation to only allow imports of chicken, meat and tinned meat with a minimum amount of fat.

School surveys carried out in Arorangi School in Puaikura Vaka 1991 and 1996 show an increasing trend in overweight among primary school children. In 1991, 6% of children were found to be underweight and no children were found to be overweight. In 1996, no children were found to be underweight but 12% were classed as overweight. In 2002, a WHO survey at the same school showed the proportion of children overweight to be 15.7% (Hughes R. 2002 unpublished report).

### ***Federated States of Micronesia***

A survey published in 1970 by Hankin and colleagues compared the diets of Chamorro living a traditional way of life on the island of Rota and Palau with those living in a totally cash economy in Guam and California. The daily total energy intake was higher among the traditional-living groups, but the major difference was the proportion of energy from fat and carbohydrate. In California and Guam the proportion of energy coming from fat was much higher than in the rural groups. The difference was mostly due to an increase in saturated fats. Energy from carbohydrate decreased from the rural to the urban setting. Taro and cassava were the predominant carbohydrate foods in Palau, rice in Rota, rice and bread in Guam, and bread in California. Protein intakes did not differ appreciably among the groups. The use of meat and poultry was greater in California and Guam than in Rota and Palau, while fish consumption showed a reverse pattern (34).

A survey, including the Mariana Islands, Marshall Islands, Palau, Pohnpei, Truk and Yap, was conducted in 1973 by Kincaid (35). The method of the survey was a 24-hour recall of the food cooked within the homes of 295 families. Kincaid concluded that although sufficient and appropriate food was available for an adequate diet, it was not consumed — perhaps due to ‘economic and social changes brought about by Western education and development’.

Fritz (36) examined the impact on infant nutritional levels of the changing roles of women in Truk. Her paper is based only on a literature search. Fritz describes the traditional diet of Micronesians as consisting of fish, taro, yams, breadfruit, tapioca, banana, coconuts, fruits, such as mangoes, papayas and guavas, and leafy vegetables. The people lived off the land and the sea. Older children ate the same kinds of foods as the adults. The infants received mother’s milk. Fritz reported that dependence on imported foods was greater in district centres, particularly among the migrant families from outer islands. The children of these families were fed exclusively on imported foreign foods.

A national nutrition survey, carried out in 1987–88, included women aged 15 to 49 years and children aged 0 to 4 years in a randomly selected sample covering 28% of the population (37). An analysis of the dietary patterns of women showed that fat consumption was slightly lower in the rural outer island areas compared with urban areas. Greens and vegetables were almost nonexistent in the diet of both rural and urban women. The number of women consuming fruit or fruit juice was extremely low, but nearly all fruits consumed were local

(except on the main islands). The consumption of sugar was highest in urban areas. The number of women drinking alcohol was low. Imported foods were more commonly consumed in main island areas where people had easier access to stores than in rural areas.

A 2002 review of the food and nutrition literature, undertaken with the aim of understanding the underlying issues related to dietary change in the Federated States of Micronesia found that one of the reasons why the country has suffered a great loss in production and consumption of local foods is inconsistent external and internal government policies and food aid programmes (38). The author found little evidence of malnutrition before the Second World War, since which the national diet had changed considerably from local to imported foods high in fat, sugar and salt. Simultaneously, increasing vitamin A deficiency (VAD) and chronic diseases had emerged. The author argues that the big changes in lifestyle and infant feeding practices in the 1970s were the causal agents that triggered the emergence of VAD in the 1980s. VAD in the Federated States of Micronesia has been documented as among the most prevalent in the world, with 55-76% of children suffering from VAD in Chuuk State, 51% in Pohnpei, 63% in Kosrae and 34% in Yap. Anaemia (38% women, 33% children) and malnutrition (10% stunted, 13% underweight) are prevalent and obesity (33% of women), hypertension (17%) and diabetes (12%) continue to rise.

## ***Fiji***

Fiji may be the least homogeneous of the Pacific islands as the islands are inhabited by two different ethnic populations in approximately equal proportions; Fijians and Indo-Fijians.

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

A number of quantitative and qualitative food-consumption surveys were carried out between 1952 and 1994 at Naduri, a rural village not far from Sigatoka town. The purpose of the surveys was to describe changes that might have occurred in the dietary patterns of the Naduri people during the development of a Naduri Co-operative Farm project, directed by the Sigatoka Agricultural Station. The first surveys were conducted in the middle of 1952 and at the beginning and end of 1953 by Langley (39). Two or three times daily, households were visited and all food was weighed. The percentage loss from peeling, from kai (freshwater mussel) shells or other items was also determined. The nutrients consumed per capita were calculated on the basis of mean edible portions consumed. Langley noted that, at the end of 1953, there was an increase in the consumption of store foods, particularly cereal products such as rice, bread, biscuits and flour. Store foods were slowly replacing the locally grown root crops for the morning meal. Cassava was the main root but had decreased in quantity in the diet because a greater variety of root crops were being consumed.

A ten-year follow-up survey was conducted by Wilkins in 1963 (40). A significant increase in total energy, protein, fat and carbohydrate was observed, but the proportion of those different nutrients had not changed dramatically. Another study was conducted in Naduri in 1982 by Parkinson and colleagues (41). Their findings showed that, since 1952, there had been a 50% increase in

the mean energy intake from 2098 to 2993 kilocalories. There had been an increase in the consumption of fat, carbohydrate and protein, with the additional carbohydrate intake being in the form of sugar, rice and wheat starch. There had also been a decrease in intake of vitamin C and some B vitamins, a reduction in daily iron intake and an increase in vitamin A intake.

In 1994, another survey was conducted in Naduri (42). Data on the quantitative and qualitative food consumption pattern was collected from each household over a period of seven days. The survey showed clearly the change from traditional patterns of food consumption to that of a more cereal-based diet. For example, bread was being consumed for breakfast and roti (flat bread made from coarsely ground white flour) was being taken to school instead of the traditional root crops. There was a greater variety of foods in 1994: 107 food items were recorded, compared with 42 items in 1982. On average the diet was nutritionally adequate but a rather high prevalence of goitre was reported (5% of the study group). Between 1952 and 1994 there had been a steady increase in total energy, protein and fat intake, with a decrease in carbohydrates.

O'Loughlin conducted a survey in 1954 among 71 Indo-Fijian households on the outskirts of Suva (26). In 1963, another survey was undertaken among 18 Indo-Fijian households selected from an urban centre and cane farming settlements around Rakiraki, which is a rural area (43). During the intervening decade there appears to have been an increase in total energy intake (from 1966 to 2764 kilocalories) and in the intake of fat (38g to 60g per day), protein (63g to 71g per day), and carbohydrate (367g to 484g per day). The contribution of carbohydrates and protein in the total energy intake had decreased from 74% to 70% and from 13% to 10% respectively, while the contribution of fat to the total energy intake had increased from 17% to 20%.

A survey was conducted which included 160 persons living in the settlements of Vaileka, Narai and Naivunivuni over a period of one week (44). The majority of the families had an adequate intake of energy, protein, iron and calcium. Vitamins A and B1 (thiamine) were low and signs of thiamine deficiency were observed in women.

A national dietary survey, using a 24-hour recall methodology, was carried out in 1980 among 3625 Fijians, 1165 Indo-Fijians and 174 persons from other ethnic groups (45). For Fijians the most important foods were cassava, *dalo* (taro), rice, breadfruit, sugar, *lolo* (coconut cream), fresh fish, tinned fish, *rourou* (taro leaves) and *bele* a green leafy vegetable (*hibiscus manihot*). The most important source of carbohydrate was cassava (78.4% of the households). Fresh fish was the protein food most consumed, followed by canned fish and meat. Twenty-one per cent of the households used milk, but it was being consumed in small amounts in tea or coffee. Fruit consumption was also very low considering the abundance of fruit. *Rourou* and *bele* were the two vegetables consumed in the largest amounts. For Indo-Fijian families the most important foods were rice, *roti* (flat bread made from wheat flour), bread, sugar, *dahl* (lentil curry), milk, canned fish, mutton, eggs and curried vegetables. The main carbohydrate foods were rice and *roti* and the main protein food was *dahl*, followed by milk and canned fish. As in the Fijian diet, fruit consumption was rather low. Vegetable curry was providing the main source of vegetables in the diet.



Taylor and colleagues (46) carried out a 24-hour dietary recall survey among 510 people in 1980. For each ethnic group and each gender the total energy intake was found to be higher in rural areas than in the urban setting, but the percentage of energy from fat was higher in all urban groups. The percentage of energy from carbohydrate was lower in the urban groups than the rural groups.

The Taylor survey can be compared with a survey that was conducted from 1952 to 1969 by Wilkins (40), who examined the changes taking place in food consumption in Fiji. Among Indo-Fijians there was an increase in the percentage of energy derived from fat and protein and a decrease in carbohydrate energy. For Fijians this trend appeared to be slightly reversed.

A 24-hour dietary recall survey was conducted in 1993 among 4606 individuals as part of the National Nutrition Survey (47). The diet of Fijian and Indo-Fijian groups in both rural and urban areas included a high proportion of cereals, animal fat and sugar. For the Indo-Fijians, *dahl* was the major source of protein. They were also eating more light-coloured vegetables, such as garlic, eggplant, chillies or beans than Fijians. More green leaves were being consumed by Fijians than by Indo-Fijians.

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

An excellent review of 34 dietary studies, written by Parkinson (24), covers many of the studies reviewed above. However, the appendices of the publication give details of feeding groups of Pacific people from as far back as 1877. In 1877, Polynesian immigrants were fed a ration of 7 lbs (3.14 kg) of taro per day as staple food. In 1888, native patients, medical students, nurses and servants were fed a choice of either 4.4 kgs of yam or 3.5 kg of kumala per day at the Colonial War Memorial Hospital in Suva. Accounts of rations fed to prisoners in Suva prison also show that Pacific people were fed very large quantities of native root crops each day. In 1879, non-European prisoners were fed 2.65 kgs of cooked yams (or equivalent) daily, whereas European prisoners only received 440 grams. In 1907, the daily ration for non-European prisoners had risen to 4.4 kgs of yam or banana or 3.5 kgs of kumala or dalo (taro), but now included 880 grams of bread or biscuit and 56 grams of sugar. Nevertheless, the total ration, together with the rest of the ration of meat, vegetables and salt and sugar, only amounted to 3367 kilocalories. A revision of daily food rations in 1919 saw native roots reduced to 1.3 kgs per prisoner. As late as 1959, the ration was back up to 1.85 kgs of cooked roots, but by 1978 the ration was down to 550 grams. The total ration provided 3300 kilocalories.

These are some of the oldest documented accounts of quantities of staple foods consumed by Pacific island people. These accounts show that Pacific people were able and used to eating large quantities of food at mealtimes.

### **French Polynesia**

In 1995, a nutrition survey was conducted jointly by the Health Department of the Territory of French Polynesia and the Territorial Institute of Medical Research Louis Malardé (48). A cross-sectional survey, using a food frequency questionnaire, was carried out on a random sample of 1273 people aged 16 years or older who had been born in French Polynesia and had lived there for at least 10 years.

The average energy intake was 3752.7 kcal/day, with a significant difference between males (4404 kcal/day) and females (3350.6 kcal/day) ( $p < 0.001$ ). The intake decreased with age. Fat and protein intakes were above the WHO recommended levels, while carbohydrate intake was below.

The intake of major nutrients in French Polynesia was assessed according to WHO recommendations. If energy intake is lower than 80% of the WHO recommendations there is a risk of deficiency; if it is higher than 120% of the recommendations, it is considered excess energy. A large majority of the total population exceeded the WHO recommendations for energy (62.2% of the population), fat (71.6%), protein (72.6%) and cholesterol (83%). Eighty-four per cent of the total population had low intake of carbohydrate. For all the major nutrients, intake decreased with age.

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

### **Guam**

There is little information regarding the current dietary patterns of inhabitants of Guam. Nutritional surveys conducted by Hankin and colleagues (34) reveal higher fat and lower carbohydrate patterns in urban Guam compared with the consumption of traditional foods in rural areas.

Traditional foodstuffs in Guam are taro, breadfruit, yams and rice. They were traditionally used as the basis of the regular food intake. Arrowroot, *fadang* (a cycad nut) and bananas also played an important role. Sweet potato, corn and, less importantly, cassava arrived with the Spaniards coming from Mexico. It is a good diet since it is high in fibre and low in fat, salt and refined sugars. The people of Guam have continued to rely on taro, yam and some breadfruit in spite of the introduction of Spanish and American foods (49).

### **Kiribati**

Early surveys in Kiribati found vitamin A and riboflavin deficiency, but by 1984 there were no more reports of vitamin B deficiency. The survey conducted by Taylor and colleagues (50) showed that the diet in Kiribati had changed with urbanization.

In 1948, Turbott (51) interviewed 12 families, including 52 adults and 36 children, about their food intake over a period of two months. The diet was calculated to contain 3000–3500 kilocalories per person. Riboflavin, calcium and vitamin A were below recommended standards, but all other nutrients were present in adequate amounts.

Holmes (52) conducted two nutrition surveys in Kiribati in 1953. One survey was in the rural atoll of Maiana and the other in a boarding school for boys in the administrative centre of Tarawa. The latter survey reported a high carbohydrate intake in the schoolboys' diet, which came from rice, flour, and sugar. Their diet was lacking in riboflavin and ascorbic acid. The fat content of the rural diet came mainly from coconuts.

A follow-up study to the Holmes survey was made by Willmott in 1968 (53). Between 1948 and 1968 there had been at least a 40% increase in the consumption of flour, white rice and sugar, and the consumption of all three was significantly higher in the urban centre of Betio than in the rural island of Maiana. Dental caries, clinical signs of vitamin A deficiency (Bitot's spots) and riboflavin deficiency (angular stomatitis) were reported in all age groups in both areas, but more frequently in the urban centre.

A small dietary survey of 16 families in Betio and Bikenibeu, conducted by Thompson in 1977 (54), revealed that imported foods made up 40-50 % of the total energy of the diet. In 1980, Zimmet and colleagues (55) calculated the proportion of energy derived from imported foods, using a 24-hour dietary recall method. Among both genders and at each age group, the consumption of imported energy was lower in the rural population. The differences were highly significant.

Taylor and colleagues (50) conducted a dietary study in 1981. A 24-hour dietary recall method was selected for the survey. A stratified random subsample was selected to represent both rural and urban sectors of Kiribati. The rural population was from the area of Tabiteuea north and the urban population consisted of residents of Betio, the administration and commercial centre of Kiribati. Individuals over the age of 20 were interviewed.

There was no significant difference between rural and urban females in mean energy intake, but there was a trend for rural males to have a higher energy intake than urban males. The mean percentage contributions of protein and carbohydrate were not significantly different between urban and rural residents, but there was a higher vegetable fat contribution for rural adults compared with urban adults. This difference was mainly due to consumption of coconuts, which was much higher in rural than in urban areas. Alcohol consumption by women was negligible in both the rural and urban samples. Imported foods were contributing significantly more energy to the urban diet than to the rural diet.

The mean daily protein intake observed in both rural and urban adults was adequate. When standardized for age, rural Tabiteuean males were eating significantly more protein than their urban counterparts. In Tabiteuea a large variety of seafood was being consumed, which was not being eaten in urban Betio.

Rural adults were eating more carbohydrate than urban residents and less imported sugars than urban people. Imported rice and flour were major contributors to total starch intakes on both Tabiteuea and Betio. Rural females were consuming significantly less starch from both local and imported foods than urban females. No significant difference was observed in the mean intake of total sugars between the rural and urban subsample. Mean crude fibre intake in Kiribati decreased with urbanization.

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

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

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

### ***The Marshall Islands***

The principal foods grown in the Marshall Islands are coconut, breadfruit, pandanus and taro. Small quantities of sweet potato, banana, papaya, lime, watermelon, cucumber and cassava are also grown. A few pigs and poultry are raised on a limited scale and are normally consumed on special occasions. Fish and seafood provide the main local sources of protein. By 1985, local food production was not sufficient to feed the whole country and three-quarters of the nation's food requirements were being imported (56). Thomas (16) estimated that 90% of all foods consumed in the Marshall Islands are imported. Agriculture and food production play a relatively insignificant part in the daily activities of many Marshall Islanders.

A survey conducted in Mili, Namu and Majuro atolls in 1999 (57) shows that, in the rural atolls (Mili and Namu), there was a higher consumption of local foods and a lower consumption of imported fish and meat. Across the atolls there was no great difference in rice consumption. Mili had the highest levels of fruit and vegetable consumption and in urbanized Majuro there was a much higher level of milk consumption.

The national survey carried out in 1990–91 (58) reported nutrient intakes of 1144 women aged 15 to 49 years. The per capita energy intake was 1430 kcals, composed of 188 g carbohydrates, 66 g proteins and 47 g fat. The intake of iron was 11 mg per capita per day. Clinical signs of vitamin A, B and C deficiencies were also reported.

### ***Nauru***

Since the beginning of the last century, the diet in Nauru has changed from traditional to practically totally Western. Today, almost all foods are imported. The traditional diet of Nauruans consisted almost entirely of fish and the products of the coconut and pandanus trees. By 1957, after the discovery of phosphate and the coming of Europeans at the turn of the twentieth century, the diet had changed completely. Kirk in 1958 (59) described the changes that had occurred in less than 20 years as from coconuts and fresh fish to imported foods, including tinned fish.

A dietary survey was conducted in Nauru in 1976 by Ringrose and colleagues (60). An adjusted 24-hour recall method was used and 77 adult Nauruans were interviewed. The results show an extremely high mean energy intake (6092 kcals) for females and males combined, which is more than twice the WHO Interim Standards for developing Western Pacific countries (61). There are several explanations for this high rate: first, the phenomenon of ‘feast and famine’ which is due to fluctuations in agricultural crops and dependence on food availability in relation to the frequency of cargo ships and air services. Second, the survey coincided with the mango season — a fruit highly consumed. Therefore, it is possible that the high caloric intake in this survey may not be totally representative of normal intake as a result of supply and availability of foodstuffs. Third, the high calorie intake found in the survey may not be totally representative of normal intake but may be a result of supply and availability of foodstuffs.

Ringrose found that the sources of carbohydrate were rice and sugar, and occasionally potatoes. Very few of the traditional starchy vegetables were being consumed. The percentage of protein in the diet was fairly high, imported meat and fish, and the cash to buy them, being easily available. The moderate fat contribution may have been due to the custom of cooking meat and fish in island fashion directly over an open fire. Although Nauruans eat little fresh fruit and vegetables, there was no ascorbic acid deficiency. However, it appeared that Nauruans were not consuming sufficient thiamine for their needs. In 1976, the mean daily alcohol consumption represented 7% of total energy intake for males and 1% for females.

In 1982, Ringrose (62) conducted a second dietary survey of 399 Nauruan adults aged 20 years and over. This study was carried out in conjunction with a diabetes and heart disease prevalence survey. Data from the 24-hour recall method were collected from a subsample of survey respondents. Protein, fat and carbohydrate intake to total energy intake was found to be half that found in 1976 and reflected that of Caucasian populations. The main foods being consumed were rice, fresh fish/meat, canned fish/meat, flour-based products, sugar, tinned milk and cordials and confectionery. The dietary fibre intake of Nauruans was much lower than that of Caucasians (data not shown). Thiamine intake was low and ascorbic acid intake was above the RDI. Alcohol

consumption was significantly much higher for males than females, 14% of energy for males being derived from alcoholic beverages. The energy provided by imported foods represented 82% for males and 81% for females.

### ***New Caledonia***

In New Caledonia the diet has changed with acculturation, but differences still exist between the different ethnic groups. In 1953, Malcolm (63) visited the rural villages of Ponerihouen and Poindimie on the east coast of mainland New Caledonia, where living conditions seemed representative of the population in that area. The villagers were using a wide variety of local roots, greens, fish, shellfish and some wild game. Of the imported foods, sugar was being used regularly but rice, bread and tinned fish and meat rarely.

Loison (64) wrote in 1973 that, in the bush, diets seemed to be mainly vegetarian. There was an exchange of food between coastal and mountain tribes and imported fruit plants, such as citrus and avocado, were currently popular. Cereals had been cultivated but in very low quantity and rice had become a staple food. Food contained little salt and dairy products were rarely eaten. Little by little the consumption of imported tinned foods was increasing.

Taylor and Zimmet (65) suggested that in Noumea the diet was very different from that of the east coast rural Melanesian communities.

In 1991, a dietary survey, using a 24-hour recall methodology, was conducted by the University of Hawaii (66) on a population of 192 Melanesian people. They found that fibre, minerals and vitamins were above the recommended intake and saturated fat and cholesterol intakes were excessive. One recommendation was to replace imported meats with fish.

In 1995, Tassie (67) compared nutrient intakes in Melanesians, Polynesians and Europeans living in urban and rural areas in New Caledonia using a 24-hour dietary recall methodology. In the urban groups, total energy intake (kilocalories) was higher (except for European males) and was composed of less carbohydrate and protein and more fats (not significant) than in the rural groups. The composition of energy varied among the three ethnic groups. Among Melanesians, more than 55% of energy was derived from carbohydrate. The proportion was less for Polynesians and Europeans. The difference in carbohydrate intake was mainly due to greater consumption of starchy roots by Melanesians. The contribution of fat to the energy intake was higher for Polynesians (male 70.9g female 56.9g) and Europeans (male 72.6g, female 65.2g) than for Melanesians (male 44.0g, female 41.9g). There were no differences in fibre intake between the groups, which was surprising given the higher consumption of root vegetables by the Melanesian people. Root crops are known to be rich sources of dietary fibre.

### ***Niue***

Langley (39) studied the daily food consumption of a sample of the population of two villages in Niue, Avatele and Liku, in 1953. Inhabitants of 32 households were interviewed. The study showed low riboflavin and calcium intakes. The mean dietary intake was 2030 kcals, approximately 70% carbohydrates, 20% fat and 10% protein. Langley described the Niuean meal



pattern as a mixture of several starchy roots cooked either alone or mixed with coconut cream in the stone oven or by boiling. A relish was served with the roots and could be fish or shellfish, meat or chicken or green leaves. If the relish was made as soup no other liquid was served. Fresh water, green coconut water, or sweetened tea was drunk otherwise.

A 24-hour dietary recall survey was conducted in 1987 involving 1646 Niueans (68). The results showed that a very high percentage of people were overweight and obese, especially women and girls aged between 8-11 years of age. Niueans relied heavily on imported protein, staples, fat and sugar. The frequency of consumption of fresh fruit, green leafy vegetables and other vegetables was low, especially when compared with the high consumption of imported foods (mostly rice and flour). Even though the consumption of fruit was higher than that of vegetables, it was still inadequate. People were consuming too much energy, but less fibre and less of some of the vitamins and minerals which could be found in the local staples.

### ***Palau***

In 1970, Hankin and colleagues (69) conducted a 24-hour dietary recall survey in Koror, the administrative centre of the district, Peleliu, an intermediate island in the south of Koror, and Ngarchelong, an isolated island in the northern part of the largest island of the district. The survey included 261 persons over the age of 20. The estimated mean intake of energy was higher in rural Ngarchelong (1960 kcal) than in Peleliu (1725 kcal) and Koror (1835 kcal). The total fat intake was greater in Ngarchelong due to the use of ripe coconut. Intakes of calcium, iron, vitamin A and thiamine were also higher due to the frequent eating of fish and green vegetables. The greater intake of cholesterol and niacin in the Koror sample was due to a higher consumption of meat and eggs. Except for vitamin A and ascorbic acid, the Peleliu sample had lower intakes of all nutrients. In Ngarchelong there was a higher consumption of indigenous foods than in Koror and Peleliu.

### ***Papua New Guinea***

The delicacy of nutritional status in rural Papua New Guinea was first described by Cilento in 1926 as a minimum metabolic balance within a range of physiological resiliency. There is a fine line between adequate nutrition and malnutrition. Anything that upsets this balance, such as a change in food pattern or disease, results in malnutrition and often death because natural defences are already weakened (70).

The traditional diet in Papua New Guinea is predominantly based on a small number of staple crops. Meggitt gives a very interesting account of agriculture, hunting and fishing among the Enga-speaking people of the Enga Province (71). The main starchy crops in the lowlands are sago and banana. Sweet potato, taro and yam are the main staples in the Highlands.

In 1956–57 a dietary survey was conducted in the village of Yobakogl in the Simbu area of the Highlands of Papua New Guinea (72). The intakes of protein were found to be low, but energy intakes were adequate. Imported foods were not mentioned.

A study by Hitchcock and Oram (73) in 1962 revealed that energy intake in a poor migrant settlement (Rabia camp) in the capital of Port Moresby was 1200 kilocalories for men and 1035 kilocalories for non-lactating women. These rates are the lowest ever recorded in Papua New Guinea. Seventy-two per cent of the energy came from flour, rice, sugar, bread and biscuits. Sugar provided 11% of the energy, while starchy root vegetables only 9%.

A 1965 study to determine the energy value of the diet in relation to body weight was carried out in two groups of people: the inland mountain dwelling Pari people and the coastal village people of Kaporaka (74). This study was one of the first to identify imported foods as making a contribution to the diet and to identify metabolic differences in nitrogen metabolism. Mean daily energy intakes for men were found to be 2360 calories for Pari and 1640 calories for Kaporaka. For non-pregnant, non-lactating women, the mean daily energy intakes were 1605 calories for Pari and 1300 for Kaporaka women. Both populations were healthy, although infant and child mortality was 177/1000 in Pari and 41/1000 in Kaporaka. The diet of the Pari contained very little fat (5.5-13.9 g/day/person), but the Kaporaka had access to coconuts that boosted their intake to 19.2-26.6 g/day/person. Imported foods were contributing 12% of energy and 10% of protein to the Kaporaka diet in the form of tinned meat, rice, sugar and bread. Seafoods was also providing a substantial proportion of protein to the Kaporaka diet. A group of 10 lactating Pari women under constant observation showed a mean urine Sodium/Potassium ratio of 0.22 compared with a norm for Europeans of 2.8. The authors suggested that this should be confirmed and the significance assessed in relation to existing nitrogen metabolism.

Oomen (75) suggested that in the Highlands in 1971 the average adult's intake was 1880 kilocalories, while 1470 was the average in the lower regions. In the Highlands low protein intakes were common and were dependent on the variety of sweet potato available. Generally, the vitamin and mineral composition of the diet was sufficient.

A dietary survey undertaken in the Western Highlands in 1972 showed that the diet consisted almost entirely of sweet potato. The daily energy intake was 2300 for males and 1770 kilocalories for females. Of the total energy intake, 94% was derived from carbohydrate, 3% from protein and 2.4% from fat (76). Adults were consuming only 25g of protein per day. By contrast, Australians derive 40% of their calories from fat and consume approximately 100g of protein per day. However, in spite of their low protein intake, the New Guineans represented a remarkably healthy group.

In a low-income urban setting in Lae, protein was found to represent 12% of the total energy intake (38% from animal sources) and refined carbohydrates 77% in 1973 (77).

Norgan and colleagues (78) conducted a survey in two villages in 1974: Kaul in a coastal region and Lufa in a Highland region. Approximately 200 individuals were investigated during a period of 5–7 consecutive days. All the food to be eaten by each individual was weighed after cooking and immediately before consumption. The mean daily energy intake was 1940 kcal for Kaul men and 2520 kcal for Lufa men, 1420 kcal for Kaul women and 2105 for Lufa women. The intakes of protein were low and there was no large difference in

protein intake between the two villages. Fat provided about 10% of the energy in the highland diet and 17% in the coastal diet. Most of the energy and protein in the diets came from the staple root vegetables (taro in Kaul and sweet potato in Lufa). Carbohydrate intake was higher in the Highland village than in the coastal community.

Jeffries (79) described the dietary differences between a rural village, Awande in the Eastern Highlands, and one in the urban centre of Lae in 1979. Dietary patterns were assessed using a 24-hour recall method of frequency for types of food eaten. The rural diet was high in complex carbohydrate, low in protein, low in fat and high in physical bulk (fibre). Sweet potato provided 85% of the energy and 65% of the protein in the diet. The diet of people living in Lae was higher in refined carbohydrate, and rice was the main staple. On the whole the urban diet was more refined, sweeter, higher in fat and, therefore, less bulky and probably lower in some vitamins and minerals.

In 1980, Martin and colleagues (80) conducted a dietary survey in the rural village of Kalo and in a relatively affluent suburb of Port Moresby (Koki) as part of a diabetes epidemiology survey. The village people were eating a diet in which yams, cassava and bananas were most commonly consumed, with very little refined food; in contrast, the urban population had a diet in which bread, polished rice and tinned foods were most common. The energy intake of urban dwellers was estimated to be 2300 kcals and 1400 kcals for rural people.

A survey was carried out by Date (81) in 1981 in the Eastern Highlands Province. Men aged from 20 to 29 years were reported to have a daily energy intake of 2814 kcals (Figure F14), with 91% derived from carbohydrates, 6% from protein and 3% from fat.

In order to assess the effect of economic development, another survey was carried out in 1981 among 67 individuals in the village of Yobakogl in the Simbu area of the Highlands (82). Intakes of individual villagers were assessed by weighing food before consumption and asking about other foods eaten. The intakes of both energy and protein were much higher than those found in the Kaul and Lufa surveys (78). The increases had occurred largely because of increased consumption of imported foods, such as cereals, tinned fish or meat. The investigators suggested that younger members of the community might have acquired a greater taste for imported foods as opposed to adults who still had a greater reliance on traditional foods. Sweet potato remained the most important item in the diet but the source of protein now came from cereals, meat and fish.

A nutrition survey was carried out in 1978 at Kalugaluvi near Lufa in the Eastern Highlands Province (83). The food intake of 18 healthy adults, aged from 20 to 40 years, was measured over two or three consecutive days. The 24-hour individual weighed-intake method was employed. Both raw food before cooking and cooked foods before eating were weighed. Leftovers and edible portions were also weighed and subtracted from the initial weight. The mean daily energy intake was  $2390 \pm 540$  kcal and the daily protein intake was  $35.2 \pm 10.7$ g. Of the total energy intake, 78.1% came from carbohydrates, 16.8% from fat and 5.2% from protein. These results are probably exceptionally high in energy and fat because the survey was held during the yearly festival season of the village when the people often ate fatty pork.

The Papua New Guinea Department of Agriculture studied the price of food in the five major urban markets of Papua New Guinea between 1971 and 1986 (84). During that period, the prices of imported foods fell and imported staples were the cheapest form of energy for urban consumers. The result was “that the rational urban consumer now prefers rice and wheat flour to his/her traditional diet”. The study in rural areas showed that the price still favoured the traditional staples. This appears to be a fundamental finding in the Pacific. Where there is a cash economy, there are cheap imported foods. Where there is no cash, there is less expensive local produce.

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

### ***Obesity in Papua New Guinea: an urban phenomenon***

One of the first studies of nutrient intake and energy expenditure was undertaken in 1969–71 by Norgan and associates. Two communities were included in the survey. The first community, Kaul, consisted of four villages several kilometres inland on the island of Karkar. The people were mainly subsistence farmers. The yield of staple foods (taro and banana) was fairly high and the work was not too demanding, so that there was a reasonable amount of extra time for such activities as house-building, canoe-making, pig husbandry and hunting. The people of Kaul were smaller in stature and lighter in weight, with less variability in body build, than most European populations. There were virtually no endomorphs, obvious malnutrition was uncommon and the general health of the people was moderately good by European standards. The second survey area, Lufa, comprised seven villages near a government station. The people of Lufa were also subsistence farmers with gardens often situated in secondary forest and occasionally up to four kilometres from the villages and from 300 meters higher to 1000 meters lower. Physically, they were of approximately the same height and mass but were much more muscular than the people of Kaul. There were no endomorphs and overt malnutrition was uncommon (78).

Martin and colleagues carried out health surveys in 1977 among rural villages and in urban communities, and among young civil servants in the capital city of Port Moresby in 1979 (85). Urban residents had greater BMIs than civil servants and both were heavier than rural residents. The civil servants were on the whole younger than the rural and urban residents.

The two villages of Gamuri and Gimisave in the Asaro Valley, not far from the town of Goroka, were chosen for a prospective study of noncommunicable diseases in 1983 (86). Both villages were involved in coffee production and a cash economy. Of the two villages, Gamusi was more remote in the Highlands and the diet was more traditional than the village of Gimisave, although both villages had some Western influences in their diet. The prevalence of diabetes in both villages was zero, although in the less traditional Gimisave 2-hour plasma glucose concentrations were significantly higher than in Gamusi. There were no significant differences for males between the villages in mean BMI, triceps

skinfolts, subscapular skinfolts or the sum of the skinfolts. The females in Gamusi, however, had significantly lower BMI, triceps skinfolts, subscapular skinfolts and sum of skinfolts compared with the females of Gimisave.

Surveys of noncommunicable diseases were conducted in six communities during 1985–86 (87). The communities included a rural village (Gamog) and two semirural villages (Marup and Kaul) on Karkar Island, two coastal villages (Napapar – rural and Matupit – peri-urban) in East New Britain Province, and a village (Masilakaiufa) close to the town of Goroka, the administrative capital of the Eastern Highlands region. Communities were classified as semirural if they were rural but had easy access to towns or imported consumer goods. Periurban communities were those close to a major town. The lowest mean BMI values were reported from the rural and semirural villages (mean BMI ranged from 20.1 to 22.5 kg/m<sup>2</sup>), while the highest BMIs were found in the coastal communities (mean BMI ranged from 22.4 to 25.4 kg/m<sup>2</sup>).

A small study was carried out among Bougainville males in 1988–89 by Iser (88). Three groups, each composed of 50 men, were studied. One group maintained a traditional way of life in villages at least 20 km from the main town. The urban group comprised manual labourers and office workers from the town of Arawa. A third group was composed of mine workers and catering staff who obtained all of their meals during working hours at the company canteen. Only men who had lived in these communities for two years or more were included in the study. As might be expected, the mineworkers had the highest mean BMI, followed by the town men. The village men had significantly lower BMI than either of the other two groups. BMI was strongly correlated to serum cholesterol levels for the overall group, the town men and the miners, but not the village men when analysed by group.

In 1990, Lindeberg and colleagues (89) examined subsistence horticulturists aged 20 to 86 years in Kitava, Trobriand Islands for cardiovascular risk factors. The dietary habits of these traditional farmers had been virtually unaffected by Western imports. The average amount of money being spent on imported food was USD\$3.00 per year. BMI, waist circumference, triceps skinfold measurements, mid-arm circumference and arm muscle circumference were all significantly below Swedish norms. Only four out of 203 Kitavans had a BMI above 25.

A 1991 survey, conducted by the International Diabetes Institute, compared prevalence rates of diabetes and obesity in three Papua New Guinea communities (90). The urban centre was Koki, a relatively affluent suburb of Port Moresby, the capital of Papua New Guinea. Two rural centres were also chosen. The village of Wanigela is about 200 km east of Port Moresby and many of the residents of Koki originated from there. The second village of Kalo is on the coast about mid-way between Wanigela and Port Moresby. In Kalo there were several small stores and good access to the nearby government station. The study found an alarmingly high prevalence of diabetes among urban Papua New Guineans living in Koki (27.5% in men and 33% in women) and significantly higher BMIs than in either of the rural villages. The prevalence of obesity was higher in the urban Koki settlement than the rural village of Kalo. Males in the rural village of Wanigela had much higher rates of obesity those in rural Kalo, which is surprising given the similarities in the lifestyles of the two communities. There was little difference between the rates of obesity among the Wanigela

females and the rural Kalo women. The authors estimated that modernity – the socioeconomic and environmental factors associated with modernization and, to a lesser extent, genetic susceptibility determined the rising trends in obesity (91, 92).

### **American Samoa and Samoa**

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

Malcolm (93) described the traditional eating pattern of Samoans. Taro, yams, coconut, bananas and breadfruit were the traditional major staples. Domestic pigs and chickens were available, but these were probably reserved for special occasions and did not provide a significant contribution to the everyday diet, especially the diet of women and children, who were largely excluded from eating these foods.

Bindon and colleagues (94) administered 24-hour recall questionnaires to 330 Samoan adults in American Samoa and Hawaii in 1982 in order to study the effect of modernization on the Samoan diet. The traditional diet had been substantially altered after 150 years of exposure to missionaries, traders and military personnel. The data revealed a trend of increasing reliance on purchased foods and decreasing reliance on traditional Samoan items, especially the energy staples of breadfruit, banana, taro and coconut. Canned corned beef, canned fish and fresh beef had become important sources of calories and protein, and bread and rice had partially replaced the traditional starchy crops.

In 1984, in order to study the relationship between diet and migration, Brown (95) conducted a survey of three different population groups: from the island of Ta'u, the most traditional area of American Samoa, from the outlying Manu'a group, and those who had migrated to Oahu, Hawaii. There had been no major changes in the caloric intake or in the nutrient quality of the diet as a result of migration to Hawaii. However, there had been changes in the types of foods consumed. For example, green bananas had become the most frequently consumed foods in Manu'a, while rice was the most popular food item in Hawaii.

Pollock (96) carried out a study that highlighted the food preferences of Samoans living in the Wellington region of New Zealand in 1989. For the Samoan people, their island foods remained important in their daily lives even though many other types of foods were readily available and often cheaper. Their island foods allowed them to affirm their Samoan values and identity. The eating pattern of the Samoans in New Zealand was described as consisting of taro, fish, and green bananas, together with coconut cream, because those were the foods that people could buy at the local greengrocer. Breadfruit, which they would eat in season back in Samoa, does not travel well so was unavailable in Wellington.

As early as 1951, Holmes (97) suggested that in the villages near Apia, the main urban centre of Uplou, Samoa, there was a tendency to replace root vegetables with bread. Moreover, the traditional coconut cream and fish dishes were being replaced by sweet tea and jam. However, Holmes noted that when taro and breadfruit could be obtained they were still preferred.



Pelletier (98) conducted a dietary survey in 1984 among Samoan men, including rural villagers, urban workers and sedentary urban workers aged 18–40 years. The assessment employed a 24-hour recall interview as the primary source of information on the men's dietary patterns. The study revealed that caloric intake was higher among active workers (4300 kcals) and villagers (4192 kcals) than among sedentary workers (3794 kcals). There were no significant differences in macronutrient composition of the diet between the different groups of men.

In 1992, Quested and colleagues (99) described the Samoan diet as consisting of taro, green bananas, fish, chicken and pork, with dietary fat being provided in the form of coconuts. There had been a significant increase in the consumption of imported foodstuffs such as mutton flaps, turkey tails, white rice, flour and sugar. The increase in the consumption of imported foods was result of those items being cheaper than better quality local foods.

In 1992, a survey of 130 adult Samoans in Siumu, Sisifo, 66 kms from Apia, was conducted by Sparling (100), using a food frequency methodology. The total energy intake was found to be  $3193 \pm 1256$  kilocalories. The contribution of carbohydrates, protein and fat to total energy was 48%, 16% and 36%, respectively. Modern foods were contributing higher amounts of calories from protein and fat than the traditional foods. On the other hand, the carbohydrate intake from traditional foods, as a percentage of energy, was slightly higher than the intake of carbohydrate from modern foods.

A dietary survey was conducted in 1990 in American Samoa and in 1991 in Samoa, covering 455 American Samoans and 491 Samoans aged between 25 and 55 years (101). Dietary intake was measured by the 24-hour recall method. Differences between the kilocalories and nutrient intakes of men and women were noted, and substantial differences were found between residents of American Samoa and those of Samoa. The mean energy intake of American Samoans was 2468 kcals and that of Samoans 2835 kcals. The American Samoans were consuming significantly more carbohydrate and protein and less fat and saturated fat. The consumption of coconut cream may explain the higher contribution of fat and saturated fat in the diet of Western Samoans. The energy-adjusted intakes of cholesterol and sodium were higher among American Samoans than Samoans.

### ***Solomon Islands***

Several surveys have shown an adequate intake of nutrients in Solomon Islands. In 1971, dietary surveys were conducted by Jansen and Willmott in the capital city of Honiara, the second largest town of Auki and the Ngella district, a rural agricultural area (102). In all three areas, the total energy, fat, protein and carbohydrate intakes were adequate and did not vary significantly. The intake of vitamins A and B depended on the availability of fruits and vegetables for the household. The types of foods eaten, however, were quite different for the three groups. The urban group were consuming more imported food and meat and the villagers were eating more root vegetables. The rural diet was described as root-based with green leafy vegetables added in the form of a soup which often contained the coconut cream.

A dietary survey was conducted in 1980 by the Harvard Solomon Islands Project (103), using both a 24-hour recall method and a diet habit interview. The survey of dietary habits and nutrient intake among six Solomon Island groups showed considerable diversity, depending on habitat, local custom and degree of cultural change. All groups were heavily dependent on root crops, chiefly sweet potato and taro, which are major sources of energy and very low in fat. Other important dietary staples included both local foods and imported items, such as rice or flour. Diets for all groups were adequate in protein and for most vitamins. Clinical observations indicate that nutritional deficiencies were uncommon among all six Solomon Island groups.

In 1985, Eason conducted a dietary survey in three areas in the Western Province of Solomon Islands. Traditional (Paradise), more urbanized Melanesians (Munda) and semitraditional Micronesian (Solstar) communities were compared (104). Approximately 1000 people aged 18 years and over received a 24-hour dietary recall interview. For all groups, sweet potato was the main starch portion of the dietary carbohydrate intake and refined sugar or toddy was the sucrose component. The principal protein source was fresh fish, and fats were derived mainly from reef fish, tinned fish, meat and coconuts. Traditional villagers of Paradise were consuming more root vegetables, complex carbohydrates and crude fibre than the urbanized Melanesians of Munda. The urban Melanesians were consuming more imported cereals, such as rice and flour, tinned goods, refined carbohydrates, salt and alcohol. Micronesians had the highest intake of refined carbohydrate and animal fat and the lowest intake of complex carbohydrates. Micronesians also had the highest intake of energy and the lowest intake of fibre. Fifteen per cent of the daily energy intake of Micronesians was being derived from drinking toddy, which was not being consumed by Melanesians.

A 24-hour dietary recall survey was conducted among children aged 0 to 4 years and women aged 15 to 49 years as part of the 1989 National Nutrition Survey (105). In Honiara and the periurban areas the intakes of rice, flour, biscuits, sugar, sugar snacks and other snacks were high. The main protein foods were fresh fish, seafood and nuts; other animal and imported protein sources were less common. Women in the higher economic activity levels were consuming more protein foods and sugar and less green vegetables than women from bush villages.

### ***Tokelau***

In 1968, 222 Tokelauans living on the isolated atoll of Fakaofu were interviewed about their food intake. It was found that their protein intake was coming mainly from fresh fish, since pigs and chickens were reserved for feasts (106).

Another survey was conducted in 1974 over a seven-day period on 55 Tokelauans who had migrated to New Zealand (107). The energy intake of this group was higher than that of the atoll people (106), perhaps because there were more young adults in the New Zealand group. With migration to New Zealand, protein and carbohydrate intakes had increased and fat intake had decreased. The increase in protein intake could be explained by the increasing consumption of meat and fish among the New Zealand Tokelauans, while fat

intake had decreased since coconuts were no longer a mainstay of the diet. In Fakaofu in 1968, coconut was supplying 69% of energy. The increase in carbohydrate intake among the New Zealand Tokelauans was notably due to bread, rice and particularly sugar consumption. Moreover, the use of salt was markedly higher in New Zealand than on the atoll. On the atoll almost no processed foods were being used and rarely was salt or even sea water used in cooking. The increased intake of meat and use of butter and eggs had led to an intake of cholesterol four times higher for the migrant group than for those on the atoll.

Around the same time, Jardin (108) described food and dietary patterns in Tokelau. The Tokelauans' diet was rich in fish, pork and poultry. Almost every family had one or two pigs and some poultry, so eggs and chicken were being widely eaten. Toddy or coconut sap, either fermented or fresh, was a speciality of the Tokelau Islands. Coconut sap is also used to make a kind of molasses. Later, in 1979, McKenzie and colleagues (109) confirmed that the traditional diet was very low in both zinc and copper.

Naylor visited Tokelau in 1989 to review health services (110). One of the review's findings was that the dietary habits of Tokelauans were undergoing considerable change. Fresh fish, traditional root and leaf vegetables were being consumed less often, while highly refined processed foods with salt and sugar additives were being used more frequently. The refined foods contained less fibre, vitamins and minerals than the traditional foods. It was suggested that to improve their diet Tokelauans would need to create opportunities to catch more fish, grow more vegetables and promote a market on each atoll for the sale of local foods.

### ***Tonga***

In dietary studies in Tonga in the early 1950s, vitamin intake was frequently said to be marginal, especially for vitamins B, A and C (111). In a 1972 survey, Jansen found a great lack of green vegetables and fruit in the diet. More emphasis was placed on flour products in Nuku'alofa, the capital city of the main island of Tongatapu, than in Ha'apai and Vava'u, the two island groups to the north of Tongatapu (112).

More recent surveys, found in a review by Englberger (113), report excessive energy and high protein intakes among adults. Starchy root crops, fruit, coconut and fresh fish were generally found to be the most common foods, particularly in rural areas. At this time urban/rural differences in dietary patterns were increasing. A high consumption of sugar was noted. All the surveys suggested that the diet in all outer islands and in both rural and urban areas lacked protective foods, such as fruits and vegetables, with the exception of Niuaus, which is an island accessible only by plane. In Niuaus, foods came mainly from local sources rather than from imported sources. It was also interesting that urban dwellers were consuming local foods whenever they could, so there was not a total switch in diet away from traditional foods. Younger people were eating more imported foods than the older age groups. In Tongatapu, the consumption of sugar and sugary snack foods was particularly high, as seen in previous studies. Overall, meals were not well balanced and morning meals in both urban and rural areas tended to be the least balanced.

In 1973, Finau (114) conducted a survey in Nuku'alofa, the main urban area, and on Foa, a coral atoll. The study sample comprised adults aged 20 to 69 years and the 24-hour recall method was used. The Nuku'alofa population were consuming significantly more imported foods than the population on Foa, and the preparation of these foods also showed urban–rural differences. These trends showed that food availability might not be the only factor in the dietary revolution among the Tongan population. Nuku'alofa people were consuming Western-type foods, whereas the Foa people were eating traditional crops. More fresh fish and shellfish were being consumed on Foa than in Nuku'alofa, where the urban population ate more tinned fish. In Nuku'alofa, people were also eating more imported chicken, beef or mutton.

A national survey was carried out in 1986, comprising randomly selected women aged 15 to 49 years, men aged 20 to 49 years and children up to 4 years old (115). The 24-hour recall method was employed. The study found a low incidence of anaemia among women, except in one area where the incidence of mild anaemia was high. The survey also indicated that the differences in dietary patterns between urban and rural areas were attributable to availability of foods. Rural adults tended to consume more local produce. Consumption of imported foods was highest among urban adults. The rural–urban differences were probably due to a combination of factors, including a greater availability of foods, an inconsistent supply of local foods or the lower cost and convenience of preparation and cooking of staples. For the Ha'apai islands, the group of islands between Vava'u and Tongatapu, the diet consisted predominantly of local starchy roots or fruit crops, coconut cream at most meals, and fish, which was usually eaten only once a day.

A later 1995 report by Englberger (116) showed that there was an increased consumption of fatty meat, especially of mutton flaps and lamb flaps. It is thought that mutton flaps may be a major contributing factor to the increasing prevalence of overweight in Tonga and to the related noncommunicable diseases, diabetes, hypertension and heart disease.

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

In 1995, a weight loss competition was undertaken. This competition was very successful and was followed by annual competitions between 1996 and 1999. For the three competitions the total weight loss per competition was between 1168 kg and 1335 kg and the number of people who participated was between 983 and 1133. Prizes were given to those who lost most weight and also to those who reached their healthy weight. These competitions have led to a better understanding of the importance of nutrition in Tonga (117-120).

A 2001 study examined why imported foods were increasingly being consumed instead of locally produced foods (121). A total of 430 Tongans were asked to complete a questionnaire to rate their preferences for particular foods. The researchers rated all foods based on frequency of consumption. The results show that the most preferred foods were eaten less frequently than

the less preferred foods. The less preferred foods included imported mutton flaps, chicken pieces, corned beef and sausages. Tongans' knowledge of the nutritional values of locally produced and imported foods was very good. They rated imported simple carbohydrates and fatty meats as of low nutritional value.

The authors concluded that Tongans were well aware of the nutritional value of the foods they were consuming and that food preference was not the motivation behind consumption. Thus cost and convenience appeared to be the motivating factors to frequent consumption, rather than preference and knowledge about nutrition.

The authors show how imports of mutton flaps have increased over the years from 1435 tonnes in 1976 to 2941 tonnes in 1996, accompanied by a corresponding increase in cost from T\$29 cents/kg to T\$1.52/kg. An apparent fall from a 1992 peak of 3543 tonnes to 1837 tonnes in 1999 was offset by huge increases in the imports of chicken parts and sausages between 1989 and 1999 of 326% (789 tonnes to 2569 tonnes) and 856% (59 tonnes to 505 tonnes), respectively.

### **Tuvalu**

Wicking (122) has reviewed how changes in the traditional diet of Tuvalu have occurred. He states that, before Western influence, the customary diet on this atoll island consisted of fish, coconut, breadfruit, taro, banana and puluka (a variety of taro). During the 1940s, the establishment of an Allied naval and air base brought considerable change to the island way of life. By 1976, four years after hurricane Bebe, the island of Funafuti was dependent on imported foods for 80% of its total food needs.

Wicking conducted a 24-hour recall survey among 113 indigenous Funafutians in 1976. Funafuti was representative of an urban area and had seen progressive socioeconomic changes in the previous 30 years. The energy intake was 3133 kcals for males and 2624 for females. The mean energy intake of approximately 3000 kcals was made up of nearly 80% imported foods (sugar, flour, rice). These were all concentrated carbohydrate foods with low traditional value. The distribution of energy from protein (14%), fat (37%) and carbohydrate (47%) was similar to the urban surveys and quite different from the distribution found in more traditional diets (52, 123). The major source of protein in the diet was fresh fish, supplemented by small amounts of tinned fish and meat. The main source of fat was coconut, lard or meat dripping.

In a 1994 study on the food and nutrition situation in Tuvalu, Johnson noted that the country had a heritage of good nutrition (124). He described the traditional diet as consisting of a great variety of fish, other seafood (such as crabs, mussels, sea snails, turtles and turtle eggs), wild birds and pigs, the latter being used primarily for festive occasions. Women had changed their diet from one based on traditional carbohydrate foods, high in fibre and bulky, to imported carbohydrate foods (rice, flour, sugar), which are low in fibre. The diet was also more energy dense since more fat was consumed: butter or margarine spread on bread or oil used in frying and roasting. There was a cultural tendency for the women to eat last in the family; thus they were more likely to eat large quantities of the carbohydrate staple often prepared in coconut cream. Men, on

the other hand, ate first and they were able to consume more protein and protective foods. Fruit and vegetable intakes have always been low but the consumption of these foods had increased in an attempt to avoid vitamin and mineral deficiencies.

### **Vanuatu**

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

The earliest known nutrition survey in Vanuatu was conducted in 1951 in Port-Vila and in the neighbouring villages of Mele, Pango and Erakor. The study also reviewed the eating patterns in a rural area on the island of Tanna (125). In 1952, Malcolm described the diet as consisting mainly of root crops, green leaves and coconut. Fruits were being eaten in season. Sweetened tea was a popular drink when it was available. Tinned meat and fish, rice, bread and biscuits were being eaten in small amounts by those close to the stores. Because of their extensive use of local foods and cooking methods, the adults of Tanna were consuming a diet adequate for the maintenance of good nutritional status.

Dye (126) conducted a nutrition survey in the rural village of Walarano (Malekula) by visiting 26 households over a three-day period in 1976. The amount of energy, vitamin A and riboflavin provided by the majority of the families' diets was estimated to be marginal. Families with high economic status were eating meat, poultry and cereals more often. The protein intake of families with low economic status was mainly from starchy roots, tubers and vegetables. There was also a limited consumption of vitamin A sources (beta-carotene). Inadequate energy intake was possibly related to the low fat content and the non-varied nature of the diet.

Badcock and colleagues (127) carried out a 24-hour dietary recall survey in 1985. The sample consisted of 267 males (134 in the capital city of Port-Vila, 67 on the island of Nguna [intermediate] and 66 on rural Tanna) and 164 pregnant or lactating women. Only the results for the males are presented here.

With increasing urbanization, there had been a decrease in total energy intake and an increase in the percentage of energy derived from imported foods, as shown in **Table 5**. There had also been an increase in the percentage of energy from protein and fat, with an increase in the proportion of these foods being imported. The intake of carbohydrate had decreased with urbanization but there had been an increase in the percentage of carbohydrate coming from imported sources.

In urban Port-Vila, animal foods, margarine and oils had progressively replaced the traditional coconut as a source of fat. White rice, white bread and sugar had also become an alternative to traditional root crops, resulting in a decrease in dietary fibre intake. Urban residents had high meat and fish consumption, while in rural areas root crops and leafy green vegetables were predominant. Thus the urban diet contained more readily absorbable haem iron

than the rural diet. Calcium, iron, vitamin A and vitamin C intakes for these males were above the RDI for Australia, but these intakes were decreasing with increasing urbanization. Urban males were consuming more alcohol than rural males. With increasing urbanization there was greater use of salt.

**Table 5: Total energy intake and percentage of distribution in the total energy intake for males in Vanuatu by level of urbanization, 1985**

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

Source: (127)

A national nutrition survey, conducted in 1996, included 2122 mothers (15–49 years) and 1437 of their children under 5 years (128). A 24-hour recall method was used. The rural mothers were found to be consuming more traditional staples and less protein and imported foods than the urban mothers. The amount of traditional foods in the diet of urban women had decreased since 1985.

The most recent study available is a food frequency survey carried out in 1998 (129). The survey sample comprised of 47.5% urban people and 52.5% non-urban (intermediate and rural) people aged 20 years and over, who were asked how often they ate 37 common food items. More than 60% of the respondents were eating root crops, vegetables and fruits daily, but only 17.1% were preparing root crops into traditional dishes every day. Rice and bread were being eaten daily by 56.4% of the respondents. Only 18.3 to 21.0% of people were eating meat, fish or poultry on a daily basis. Twice as many respondents were using coconut cream than people consuming oils (66.2% to 30.4%). Most of the people were using salt every day (93%) while sugar was being used daily by 62.2%. Soft drinks and other beverages, such as milk, milo, coffee or tea, were not popular everyday drinks in Vanuatu. Urban residents were found to be 2.23 times more likely to be obese or overweight than those living in non-urban areas.

The 1998 study also found strong associations between the source of fat in the diet (local vs. imported) and obesity and diabetes. **Table 6** shows that participants were 2.19 times more likely to be overweight or obese if they ate imported fat sources compared with traditional fat sources such as coconut. Urban residence, non-smoking and light physical activity levels were also positively associated with obesity. The individual foods providing the fat in the urban diet were identified as oil, margarine, butter, meat and chickens, tinned

meat and tinned fish. It is not known if urban respondents were consuming more fat, because the survey used a food-frequency questionnaire, but it is known that urban respondents were consuming a greater range of high-fat foods.

**Table 6. Factors associated with overweight/obesity: Vanuatu 1998 odds ratios (OR) and 95% confidence interval**

Variable	OR	Confidence interval	
		Lower	Upper
Level of urbanization (urban vs rest)	2.23	1.79	2.78
Smoking (no vs yes)	2.02	1.59	2.58
Consumption of non-traditional fat sources (daily vs not daily/no)	2.19	1.75	2.74
Age	1.02	1.01	1.03
Physical activity (light/medium vs heavy)	1.59	1.12	2.25

In rural areas the proportion of daily consumers of traditional food items was higher than in urban areas, where bread, rice, tinned foods, oil and soft drinks were more available. Although the methodologies used in this study were different from the previous studies of 1985 (127) and 1996 (128) (24-hour recall), the differences between the urban diet and the rural traditional diet were similar.

### **Wallis and Futuna**

The inhabitants of Wallis and Futuna have diets similar to those of French Polynesia except that they eat less meat and more starch. They consume similar amounts of fat and sugar (130).

Loison and colleagues (131) suggested in 1999 that the food staples on Wallis and Futuna Islands were generally rice, potato and bread, which were cheaper sources of energy than local vegetables. Fish was still the traditional food. Tinned fish and meat were easy to prepare and thus helped avoid complex meal preparations. Sometimes fresh meat was used instead of tinned meat, but pigs were prepared only for feasts. At breakfast, coffee or tea with bread, and sometimes butter and milk, were being consumed. The main meal was at midday when fruit and vegetable consumption was rare. The evening meal consisted of already prepared vegetable soup in a sachet. Bread accompanied each meal.

A record of daily diet and activities was made using of daily visits to 10 households over a four-day period in 1979 and again in 1980 by Taylor and Zimmet (65). One or more adults in each household were asked to list everything they had eaten and drunk that day. The data show an average total intake of about 2700 kcals for weekdays and about 3300 kcals for Sundays. The proportion of local to purchased foods was 43% of calories consumed, but 66% by weight.



## 4.

---

# The food supply

Seven Pacific countries, Fiji, French Polynesia, Kiribati, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu, have FAO food balance records from 1961-1994, which can be obtained from the FAOSTAT databases (<http://apps.fao.org/>) and a 1996 publication (132). The data have been analysed and tables and figures are presented in **Annexes 1, 2 and 3**. The tables in **Annexes 1 and 2** show food availability figures in three-year groupings from 1961-2000.

Tables in **Annex 1** include information about Australia intended to provide a comparison of a country that is fully developed and self-sufficient. From these tables it can be clearly seen that Australia consumes the most energy, fat, meat, alcohol and milk and the least root crops of all the countries presented. Of interest are the fruit availability figures, as they reflect different uses. In most Pacific countries, large quantities of fruits, such as bananas and breadfruit, are consumed as staples and thus provide a substantial proportion of energy, whereas in the more developed countries fruits are more of an accompaniment or addition.

Total available energy has increased since 1963 for every country. This is due to increases in fat, meat, milk and fish. The largest increase in imported meats is in poultry products. In fact the majority of countries show increases in all the foods listed. The available energy figures for Australia in 2000 are between 45% (Papua New Guinea) and 7% (Kiribati) more than the other countries.

**Annex 2** shows per capita availability of fat for each Pacific country. Vegetable oils (includes margarine) or coconuts provided the largest proportion of fat to the diet of all the countries listed. The trends in contributions from vegetable oils and coconuts show that the contribution of fat provided from coconuts has remained almost unchanged since 1963, whereas the contribution provided from vegetable oils (except Solomon Islands and Vanuatu) has increased dramatically. In other words, fat from vegetable oils has been added to the existing fat contributed by coconuts. Tables in **Annex 2** also show that, in 2000, fat from meat and offal provided the second largest contribution to total fat for five countries, with the greatest increase in availability in Fiji and French Polynesia.

**Annex 3** shows the macronutrient contributions to energy for the food supply to all the countries including Australia. Australia fails to fall within the WHO recommended ranges given in **Figure 1** in section 2 of this paper for all macronutrients. For most Pacific countries, supplies are within the recommended ranges with the exceptions of French Polynesia. The only other country to fall lower than the recommendations is New Caledonia, with less than the recommendation for carbohydrate. However, the contributions made by alcohol and sugar to energy may mask carbohydrate contributions.

Figures for each country on the contribution to energy of selected foods are given in **Annex 4**. The figures show that the major contributors for most countries are cereals, providing between 32% and 43% of energy. The vast majority of cereal products imported into Pacific countries are white rice and white flour, which are low in fibre and micronutrients. Starchy roots provide between 24% and 34% of energy for Papua New Guinea, Solomon Islands and Vanuatu. Over 19% of energy is contributed by coconuts for Kiribati. Sugar provides between 3% (Solomon Islands) and 15% (Kiribati) of energy. Alcohol provides significant contributions in French Polynesia.

The figures in **Annex 4** show that the major contributors to energy in food supply for the most urbanized Pacific countries, Fiji (46% urban), French Polynesia (53% urban) and New Caledonia (71% urban), are low in fibre. The major contributors to energy for the less urbanized countries of Papua New Guinea, Solomon Islands and Vanuatu contain far more complex carbohydrate, starch and fibre.

The changes in foods supplying energy are best explained by examining the balance sheets for Fiji from 1965-2000. **Table 7** shows that calories from vegetable oils and meat have almost doubled, while calories from coconuts and root crops have declined. The difference between coconuts and vegetable oils as providers of energy is that coconuts are less energy-dense (coconut cream contains about 66% water), and provide fibre (6.6%-8.7%) and carbohydrate (12%-17%).

**Table 7: Energy available and change per capita: Fiji 1965-2000**

	calories		change
	1965	2000	%
alcohol	21	29	38.1
animal fats	96	154	60.4
cereals	1030	1214	17.9
coconuts	221	184	-16.7
meat and offal	89	256	187.6
milk and eggs	125	100	-20.0
seafood	37	41	10.8
starchy roots	574	217	-62.2
sugar	289	168	-41.9
vegetable oils	103	281	172.8
vegetables & fruit	73	154	111.0
TOTAL	2658	2798	5.3

The increase in availability of vegetable oils and cereals, especially bread and rice, also suggests changes in cooking methods – from fat-free earth-oven cooking to frying. This was first documented in 1973 by Parkinson, who identified urban life as not conducive to traditional (umu) cooking because of lack of space and time for city people (133). Therefore, many families have changed to frying foods that are accompanied by rice and bread (that is again spread with margarine, thus adding more vegetable oil).

Kiribati is in a state of transition between rural and urban and deserves further investigation. Root crops were the main staple food for Kiribati since food balance sheets were developed in 1961 until 1989, when cereals (mainly flour, bread and rice) took over as the principal staples. **Table 8** shows that the energy value of the food supply in Kiribati has increased by 135% since 1965. This mirrors the 135% increase in the total weight of foods available per capita since 1965 (from 1084 g to 1400 g). Significant increased contributions have been made by most foods except coconuts, root crops and meat and offal.

**Table 8: Energy available per capita and change: Kiribati 1965-2000**

Year	Calories					%Change Since 1965
	1965	1975	1985	1995	2000	
cereals	480	648	691	948	926	+92.9
coconuts	605	587	564	524	566	-6.4
sugar	213	300	305	359	425	+99.5
starchy roots	294	405	308	236	251	-14.6
vegetable oils	140	150	172	193	209	+49.3
meat and offal	167	135	112	146	153	-8.4
veg and fruit	117	137	133	137	139	+18.8
seafood	92	98	128	140	131	+42.4
milk and eggs	5	18	27	43	46	+920.0
animal fats	16	36	16	47	40	+250.0
alcohol	8	15	7	12	15	+87.5
<b>Total</b>	<b>2137</b>	<b>2529</b>	<b>2463</b>	<b>2785</b>	<b>2901</b>	<b>+35.8</b>

The proportion of energy provided by fat has remained approximately the same since 1966, at 32%-42% . What seems to have changed is that there has been an increase in the proportion of cereals, vegetable oils and foods with “empty calories”, such as sugar. Additionally, the type of fat consumed has changed over the years. The 764 kcal/capita/day increase between 1965 and 2000 can be accounted for by increases in cereals (446 kcal), sugar (212 kcal), vegetable oils (69 kcal) and animal fats (24 kcal). Cereals, sugar and vegetable oils provided 54% of energy in 2000, as opposed to 39% in 1965.

The two major sources of fat in 1965 were coconuts (74.6%) and local pig meat (11.4%). In 2000, the major sources were coconut (50.5%), imported vegetable oils (22.3%) and imported meat (11.1%). However, during that time total fat per capita increased from 97.9 g/day to 106.6 g/day. From these figures it appears that the I-Kiribati consume a greater volume of foods that include

more foods of high energy value, more processed foods and less dietary fibre. Coconuts provided most of the energy in 1965, followed by cereals and root crops. In 2000, cereals provided most of the energy, followed by coconuts and sugar.

Meat and offal availability has increased for most countries. Identification of particular kinds of meat reveals that poultry imports have drastically increased, not only in absolute volume (shown in the tables in **Annexes 1 and 2**), but as a proportion of all meat imports. **Table 9** shows this quite vividly.

**Table 9: Poultry imports percentage of all meat imports: 1965-2000**

Country	Poultry imports (%)	
	1965	2000
Fiji	3.0	10.1
French Polynesia	14.8	44.4
Kiribati	0.0	50.7
New Caledonia	22.0	60.5
Papua New Guinea	2.6	1.0
Solomon Islands	0.9	46.2
Vanuatu	0.0	54.7

Chicken meat contains, by weight, about 18% fat raw and 28.4% cooked, but can contain far more depending on the cooking method. Although other meats may contain more fat initially, the sheer volume of chicken meat consumed, plus the favoured way of cooking chicken (frying, which adds more fat), ensures that far more fat gets to consumers from chicken than other meats.

#### 4.1 Food dependence

Food dependence is a term used to describe situations where consumers depend on others to produce their foods. For example, a food supply that consists of a large proportion of imported foods may be described as a threat to food security because there are many factors that may interrupt or block the supply. For the Pacific islands these factors may include, cyclones, storms and rough seas, as well as changes in currency exchanges, price increases and decreasing food quality.

McKee was one of the first writers to identify Pacific examples of dependence on imported foods (134). In 1957, he described the situation in the Tuamotu Islands in French Polynesia, where very few subsistence crops were grown. The islands then provided 25% of the copra produced in French Polynesia. McKee explained that in general imported foods were nutritionally inferior to locally produced foods. However, while conditions in the Tuamotus were suitable favourable for producing coconuts, they were not favourable for other crops and it was not surprising that imported foods were paid for from the revenues of exported copra. However, this does not explain why fertile high islands like Tahiti consumed similar high proportions of imported foods.

**Table 10** shows daily calories per head McKee collected from customs returns for three countries in 1953-54. The figures show that French Polynesia imported much more flour, sugar, rice and butter than either American Samoa or Samoa.

**Table 10: Calories/day/head from imported foods 1953-1954**

Food	Western Samoa 1954	American Samoa 1953	French Polynesia 1954
Flour	225	140	666
Sugar	202	114	221
Rice	55	33	138
Butter	12	12	52
Canned fish	44	28	-
Canned meat	60	84	-
Canned meat/fish	104	112	80
Biscuits	21	36	27
Confectionary	9	7	18
Potatoes/roots	4	2	15

Source: McKee (1957)

The author suggested that the diets of people specializing in cash-crop production should be monitored to determine their nutritional status compared with those on a traditional diet. It appears that the trend to consume high proportions of imported foods spread from those on a cash income, such as copra producers, to subsistence producers. Some people were already selling nutritionally valuable (local) foods only to purchase nutritionally inferior foods such as sugar, soft drinks and alcohol.

Historically, most Pacific islands had a good supply of food that was described as “subsistence affluence” (135, 136). The development of malnutrition in the South Pacific was a product of urbanization according to Parkinson (133). In 1973, he recorded that the classical forms of malnutrition in the traditional subsistence economies before colonization were uncommon, and that repeated South Pacific Health Services nutrition surveys undertaken from 1951-1970 substantiated this claim. Traditional food patterns were nutritionally adequate and were a good source of vitamins and minerals. There is no name in the indigenous languages for malnutrition and the first reports of beri beri were found in indentured labourers from China who lived mainly on imported foods. “The fine physique of the modern Pacific islander is a result of generations of good nutrition”.

This all began to change with the movement of people towards the large towns. Supplies of root crops were scarce and cost up to 10 times the price that they would fetch in rural areas. Migrants from rural areas were unskilled and on low (or no) incomes. They had little knowledge of budgeting. They had no space in or around their homes (mainly in squatter settlements) to prepare and cook foods in the traditional (umu) way and were forced to use one pot on a primus stove. Consequently, the nutritional value of family meals declined and

children were found to be suffering from malnutrition in urban areas of Apia, Suva, Betio and Port Moresby. The author suggested that urban dietary patterns could be improved by better urban planning and development, thus making fresh foods more readily available. The provision of extension education by nutrition extension officers would then enhance the food preparation and budgeting skills of urban families.

Food dependence, termed “Dietary colonialism” (changes initiated by colonial contact and control), was the theme of a 1975 discussion paper (137). The paper examined the factors that brought about the situation where self-sufficient societies in the Pacific had become increasingly dependent on imported foods. The author, McGee, argued that food dependency was not a necessary concomitant of the process of modernization and that self-reliance in food production was urgently needed.

Four factors that contributed to food dependency were identified:

1. Changes in the pattern of agricultural production from subsistence to cash-cropping.
2. Urbanization – the growth of commercial centres acting as intermediaries in the import/export process (these centres created a substantial demand for both imported and locally produced foods).
3. “Labour camp” style of workplaces, where the foods consumed by the expatriate managers of cash crop businesses were provided to the indigenous labour force. Consumption of imported foods and liquor were part of the “good life” that quickly spread to other sectors of the community.
4. Export-based development that ignored the potential for marketing indigenous foods.

The threats of “dietary colonialism” were identified as:

1. Food imports made up an increasing proportion of overseas exchange purchases and negative balances were met by overseas aid.
2. The dietary changes brought about by increased food imports created nutrition problems that were not apparent before colonization.
3. Food imports limited the possibilities for growth of indigenous food production for cash sale because the populations of urban centres increased at the expense of rural expertise in food production.
4. Economic growth, as a consequence of consuming imported foods, made people “worse off” because they entered a dependent relationship with suppliers that will always make them “better off”.

The solution given was to increase consumption of locally produced foods by (1) making estimates of the production mix of the locally produced foods needed; (2) developing an island marketing system; and (3) regulating the importation of foods to supplement local food availability.

Pollock reviewed the issue of food dependency in the Pacific and developed a model for food planning in 1993 (138). He referred to the welfare view of food as a fundamental human right before it becomes a commodity. Food is the key item in interdependency of households, communities and nations. *‘Food is a means of establishing security...’* However, it will take public action to establish that security. Pollock’s model of food planning builds upon what McGee suggested: increasing consumption of locally produced foods by directing food preferences, food choices and marketing towards local foods.

## 4.2 Traditional foods and lifestyles

Documented evidence exists to show that reverting back to traditional lifestyles and foods not only overcomes food dependence but can correct serious existing noncommunicable diseases such as diabetes and obesity (139, 140). Ways around food dependence and the pathway to better health have been explored.

A return to a traditional Hawaiian diet was prescribed by Shintani and colleagues in 1991. The diet was called the Wai’anae Diet Program, named after the community where the trial took place. The death rate from heart disease among pure Hawaiians in the early 1990s exceeded the US national average by 278%, cancer by 226%, stroke by 245%, and diabetes by 688%. Twenty native Hawaiians were placed on a pre-Western contact diet for 21 days. The diet consisted of unlimited amounts of native root crops and vegetables accompanied by limited amounts of fish and meat (142-198 gram/day). Each day the participants were asked if they were hungry by use of a satiety scale. If they were not satisfied, they were encouraged to eat more and to take enough snacks to meet their satisfaction. Body weight, blood pressure, serum cholesterol, LDL, HDL, triglycerides and glucose were measured before and after the 21-day dietary period.

The results show an average 41% reduction in energy intake, 7.8kg weight loss, 14.1 % serum cholesterol reduction and slightly improved serum HDL levels. There were substantial decreases in serum triglycerides and glucose levels. Blood pressure fell significantly by 7.8% systolic and 11.5% diastolic. The researchers showed that the change to a Western diet, rather than over-eating, was the cause of obesity. Energy contribution made from fat, carbohydrate and protein from the Wai’anae diet was 7%, 78% and 15%, respectively. In contrast, the pre-programme diet energy contribution was estimated to be 32%, 51% and 17%, respectively. The authors report that the average fat contribution to energy in Hawaiians was about 38% from fat. This study is a clear demonstration that (1) reversion back to traditional foods and dietary patterns can be done; (2) there are immediate health improvements.

O’Dea found similar results in 1984 when a group of Australian Aboriginals turned back to traditional hunting and gathering and consumption of native foods (140). Ten Aboriginal diabetics (five men, five women) who were middle-aged ( $53.9 \pm 1.8$  years) and overweight (BMI  $27.2 \pm 1.1$ ) agreed to return to their traditional country as hunter-gatherers for seven weeks. At the end of that time they had all lost an average of 8 kg in weight. Additionally, there was a significant fall in fasting glucose, postprandial glucose clearance, plasma insulin concentration and fasting plasma triglycerides of 5.0 mM, 3.3 mmol/L/h, 11 mU/L and 2.8 mM, respectively.

Food intake analysis showed a sharp decline in energy intake to an average of 1200 kcal/person/day. Although animal foods provided 64% of energy, the diet was low in fat (13%). This was because the wild animal diet was low in fat. It was estimated that the subjects' physical activity levels were not particularly high, but were greater than that of an urban setting. The author concluded that the results support the concept of a multifactorial basis for improvement in lipid and carbohydrate metabolism. A traditional hunter-gatherer diet provided low energy intakes that resulted in weight loss and thus corrected the subjects' diabetes and overweight problems. It was also stated that the reduced stress of a traditional lifestyle may have contributed, but it was not measured.

In a later paper the author reviewed 55 published papers on the impact of Westernization on obesity, diabetes and coronary heart disease and concluded that intervention strategies to prevent chronic diseases should be directed at lifestyle modification and developed and implemented at the community level (141). In another paper, one year later, the same author concludes that solutions to the problem of increasing chronic diseases, including obesity, revolve around two main strategies: behaviour change and changes to the food supply. The major change in the food supply would be to reduce the total amount of fat entering the food supply by modifying the composition of processed foods to include far more fibre, carbohydrate and micronutrients and much less fat (142).



## 5.

---

# Discussion points

**T**he objective of this paper is to review documented evidence and examine the relationships between the food supply, dietary patterns and obesity in Pacific countries.

1. Obesity in the Pacific seems to be an urban phenomenon and follows trends in urban growth. Consumption of imported foods is also a Pacific urban characteristic.
2. A suitable definition for a recommended proportion of fat to the national diet has been established. This does not apply to individual or family diets. However, it does assume that, as fat availability increases, the price of high-fat foods will decrease. Choice for individuals and families, therefore, may be swayed towards high-fat foods, especially if low-fat alternatives are more expensive or not so freely available.
3. The review of documents focussing on Pacific pre-history has shown that the food behaviour of the people of the Pacific region may have remained the same for millennia until the arrival of Europeans. The main staples were, and still are, root crops. It is possible that no other cultures can lay claim to maintaining the same food patterns for such a long continuity of time anywhere in the world.
4. Pacific people were described by early European explorers as strong, muscular and mostly in good health. There seemed to be an abundance of food and the leaders appeared to be obese. Food cultures were strong and, although high value was placed on fatty foods, daily food intake consisted of large quantities of starchy roots, supplemented with leaves, fish, coconuts and fruits.
5. The Pacific island countries are on the geographic fringe. They are remote, isolated and fragmented. As a consequence they were protected from intrusion for a long time. Together with conservative food culture,

it has been shown that many Pacific communities were maintaining a delicate (ecological) balance. Intrusion from outsiders has resulted in disease and death and the beginning of an epidemiological transition.

6. The review of dietary studies shows how traditional food patterns, built up over thousands of years, quickly changed to include many foreign foods. This quick change was a nutrition transition that was accompanied by changes in demography towards urbanization, including the development of large towns and cities that did not exist before. Many urban families found it difficult to grow or buy traditional staples or to continue traditional cooking methods such as (fat-free) cooking in earth ovens. This caused a change in cooking methods and the use of fat to assist cooking methods such as roasting and frying. Additionally, with the development of cash economies in many Pacific countries, urban families were able to purchase store foods that were more convenient and in many cases cheaper than locally produced foods.
7. In Papua New Guinea, early studies show that fat consumption was very low in rural areas. In 1947, fat provided less than 5% of calories and in 1965 in coastal villages it provided less than 8% of energy. In contrast, in Rarotonga in 1957, fat provided 38%-42% of energy. Over 64% of fat came from coconut cream, indicating that Polynesians and Micronesians may have consistently consumed a diet high in fat. These early dietary differences between the present-day racial groups may still exist. Documented records also show that Pacific people consumed large quantities (more than 3 kg/day) of roots crops. There is evidence that consumption of large quantities of food continued and included imported foods.
8. The presence of obesity was first reported in urban areas in Fiji, Samoa, Tonga and Vanuatu from 1953. Simultaneously, dietary studies show that urban populations were consuming more imported foods, such as flour, sugar and canned fish and meat, and less locally produced foods. Consumption of imported foods seemed to be an addition to, and not a replacement for, consumption of local foods.
9. There are very few documents that provide evidence to show the differences in obesity levels between those who consume imported foods and those who consume locally prepared foods. Vanuatu is the exception. In 1985, rural populations consumed more total calories than urban populations, but were much less obese (in men, rural 13%, urban 53%). Total energy contributed by imported foods for urban populations was 53.5%, as opposed to 10.5% for rural populations. The proportion of fat from imports was 44.8% for urban populations and 8.4% for rural populations. In 1998, it was determined that people were 2.2 times more likely to be obese and 2.4 times more likely to be diabetic if they ate imported fats than if they ate traditional fat sources. People living in urban areas were consuming a wider variety of high-fat foods than those living in rural areas. The individual foods that provided the fat in the urban diet were identified as oil, margarine, butter, meat and chickens, tinned meat and tinned fish.

10. Food supply data show that total available energy and fat has increased up to 64% and the majority of countries have increased availability of meat, alcohol and milk since 1965. Compared with the WHO recommendations for macronutrient contributions to energy, all countries, except Australia, French Polynesia and New Caledonia, comply.
11. The largest single providers of energy for Pacific countries are cereal products (white flour and rice). However, the largest single increase since 1965 has been in the availability of vegetable oils. **Table 11** shows the major sources of fat in the food supply for Pacific countries. The argument for including fish and seafood, due to increased availability of canned products containing oil, is confusing and so they were not included.

**Table 11: Change (%) in the contribution of selected foods to total calories per capita: 1965-2000**

	Change (%) 1965-2000						
	Fiji	French Polynesia	Kiribati	New Caledonia	Papua New Guinea	Solomons	Vanuatu
animal fats	60.4	0.9	150.0	1.5	-4.8	26.7	-26.0
coconuts	-16.7	27.0	-6.4	-42.0	94.1	4.0	29.3
meat and offal	187.6	106.3	-8.4	4.0	33.9	19.0	-17.6
milk and eggs	-20.0	27.8	820.0	-5.9	50.0	23.5	-2.2
vegetable oils	172.8	16.6	49.3	80.2	1833.3	-6.5	-11.2
<b>TOTAL</b>	<b>76.8</b>	<b>35.7</b>	<b>200.9</b>	<b>7.6</b>	<b>401.3</b>	<b>13.3</b>	<b>-5.5</b>

**Table 11** shows that there were large increases in fat availability from all sources except coconuts. However, coconuts were, and still are, consumed in large quantities and are shown to be a major contributor in most countries. The important result in the table is that the total contribution for all countries, except Vanuatu, has increased, thus showing that imported fat has been **added to** and has not replaced existing fat sources.

12. The largest single increase in meat products has been in the importation of chicken meat. For example, no poultry was imported into Kiribati in 1965, but in 2000 poultry accounted for 51% of all meat imported into the country. There is no information on the imports of individual high-fat foods, such as mutton flaps and turkey tails, except for Tonga, where imports of mutton flaps have been declining since 1992.
13. Most Pacific countries are food-dependent. A part of good governance for any population is the freedom to choose from a range of nutritious foods. It appears that many people do not get that choice.

14. Diets that consist of mainly locally produced (traditional) foods have been shown to prevent and reduce obesity in some populations. However, only one Pacific community (Hawaii) has attempted to practise this. This is not “turning back the clock”, as other separate studies have shown that most Pacific people prefer locally produced foods but consume nutritionally inferior foreign foods due to social and economic barriers to access. Making changes in the food supply to improve access to and availability of locally produced foods may allow preferences to be met and may be a better option than encouraging behaviour change alone.

## 6.

---

# References

1. Coyne T. Lifestyle diseases in Pacific communities. Noumea, New Caledonia, Secretariat of the Pacific Community, 2000 (SPC Technical paper No.219).
2. Coyne T. *The effect of urbanization and western diet on the health of Pacific Island populations*. Noumea, New Caledonia, South Pacific Commission, 1984.
3. Australian Institute of Health and Welfare. *Heart, stroke and vascular diseases - Australian facts 2001*. Canberra, National Heart Foundation of Australia, National Stroke Foundation of Australia, 2002 (AIHW Cat. No. CVD13).
4. Tairea, K *et al*. *Report of the 1998 Rarotonga infant growth monitoring project* Noumea, New Caledonia, Secretariat of the Pacific Community, 1999 (SPC Technical Paper No 212).
5. Halavatau V, Hughes RG, Hughes MC. *1999 Tongatapu infant growth monitoring project; Report to the Tonga National Food and Nutrition Committee*. Noumea, New Caledonia, Secretariat of the Pacific Community, 2000 (SPC Technical Paper).
6. Vohr BR, McGarvey ST. Growth patterns of large-for-gestational-age and appropriate-for-gestational-age infants of gestational diabetic mothers and control mothers at age 1 year. *Diabetes Care*, 1997, 20:1066-1072.
7. Vohr B, McGarvey S, Coll C. Effects of maternal gestational diabetes and adiposity on neonatal adiposity and blood pressure. *Diabetes Care*, 1995, 18:467-475.
8. Seidman D *et al*. Macrosomia does not predict overweight in late adolescence in infants of diabetic mothers. *Acta Obstet Gynecol Scand*, 1998, 77:58-62.
9. WHO. *Preparation of food-based dietary guidelines: Report of a joint FAO/WHO consultation*. Geneva, World Health Organization, 1998 (WHO Technical Report Series 880).
10. Bier DM *et al*. Report of the IDECG Working Group on lower and upper limits of carbohydrate and fat intakes. *Eur J Clin Nut*, 1999, 53:S177-S178.
11. Durnin JVGA *et al*. Report of the IDECG Working Group on lower limits of energy and protein and upper limits of protein intakes. *Eur J Clin Nut*, 1999, 53:S174-S176.
12. National Health and Medical Research Council. *Dietary guidelines for Australians*. Canberra, Australian Government Publishing Service, 1994.
13. Flannery TF. *The future eaters*. Sydney, Reed New Holland, 1998.
14. Kingdon J. *Self-made man and his undoing*. London, Simon and Schuster, 1993.
15. Houghton P. *People of the great ocean*. Cambridge, Cambridge University Press, 1996.
16. Kirch PV, Hunt TL, eds. *Historical ecology in the Pacific islands*. New Haven, Yale University Press, 1997.
17. Serjeantson SW, Ryan DP, Thompson AR. The colonization of the Pacific: The story according to human leukocyte antigens. *Am J Hum Genet*, 1982, 34:904-918.
18. Loy TH, Spriggs M, Wickler S. Direct evidence for human use of plants 28,000 years ago: starch residues on stone artifacts from northern Solomon Islands. *Antiquity*, 1992, 66:898-912.

19. Ulijaszek SJ. *Persistence and change in food use in Papua New Guinea and its effects on nutrition*. United Kingdom, Smith-Gordon, 1994.
20. Fitzpatrick JM. *Endangered peoples of Oceania: Struggles to survive and thrive*. Westport, CT: Greenwood Press, 2001.
21. Beaglehole JC. *The journal of Captain James Cook on his voyage of discovery; the voyage of the Endeavour 1768-1771*. Cambridge, Cambridge University Press, 1968.
22. Pollock NJ. *These roots remain*. Hawaii, The Institute for Polynesian Studies, University of Hawaii, 1992.
23. McGee TG, Ward RG, Drakakis-Smith DW. *Food distribution in the New Hebrides*. Canberra, Australian National University, 1980.
24. Jansen AAJ, Parkinson S, Robertson AFS, eds. *Food and nutrition in Fiji: A historical review. Volume 1*. Suva, Fiji, Department of Nutrition and Dietetics, Fiji School of Medicine and the Institute of Pacific Studies, University of the South Pacific, 1990.
25. Faine S, Hercus CE. The nutritional status of Cook Islanders. *Brit J Nutr*, 1951, 5:327-343.
26. O'Loughlin C and Holmes S. A survey of economic and nutritional conditions in Indian households. Suva, Fiji, South Pacific Health Services, 1954.
27. Fry PC. Dietary survey on Rarotonga, Cook Islands. Part 1 General description, methods and food habits. *Am J Clin Nutr*, 1957, 5:42-50.
28. Fry PC. Dietary survey on Rarotonga, Cook Islands. Part II Food consumption in two villages. *Am J Clin Nutr*, 1957, 5:260-273.
29. Hunter JD. Diet, body build, blood pressure and serum cholesterol levels in coconut-eating Polynesians. *Fed Am Soc Biol*, 1962, 21:36-43.
30. Prior IA *et al*. *The health of two groups of Cook Islands Maoris*. Wellington, New Zealand Department of Health, 1966 (Special Report Series 26).
31. Dumbrell S *et al*. Prevention and control of non-communicable disease: present activities in the Cook Islands - Report No. 2. Noumea, New Caledonia, South Pacific Commission, 1984.
32. Swinburn B *et al*. *Tutakimoa life-wise project*. New Zealand, University of Auckland, 1995.
33. Tepai A. *Puaikura Vaka. Paruru no te Oraanga Meitaki*. Rarotonga. Cook Islands, Department of Health, Cook Islands Ministry of Health, 2002.
34. Hankin J *et al*. Dietary and disease patterns among Micronesians. *Am J Clin Nutr*, 1970, 23:346-357.
35. Kincaid PJ. *Nutrition survey*. Trust Territory of the Pacific Islands-Health Services, 1973.
36. Fritz, V. S. *Impact of changing roles of women on infant nutritional levels in Micronesia: primarily in Truk*. University of Hawaii Thesis, 1982
37. Elymore J *et al*. *The 1987/88 national nutrition survey of the Federated States of Micronesia*. Noumea, New Caledonia, South Pacific Commission, 1989 (SPC Technical Report).
38. Englberger L, Marks GC, Fitzgerald MH. Insights on food and nutrition in the Federated States of Micronesia: a review of the literature. *Journal of Public Health Nutrition*, 2002; (forthcoming).
39. Langley D. *Dietary surveys and growth records in a Fijian village, Naduri, June 1952-November 1953*. Suva, Fiji, South Pacific Health Services, 1953.
40. Wilkins RM. *Dietary survey in a Fijian village, Naduri, Nadroga, November 1963*. Suva, Fiji, South Pacific Health Services, 1963.
41. *Dietary survey in a Fijian village, Naduri, November 1982*. Suva, Fiji, National Food and Nutrition Committee, 1982.
42. Tunidau-Schultz J *et al*. *Report of the fifth decennial Naduri nutrition and health survey*. Suva, Fiji, National Food and Nutrition Committee, 1996.
43. Wilkinson R. *Dietary survey of and Indian settlement at Rakiraki*. Noumea, New Caledonia, South Pacific Health Services, 1964.
44. Wilkinson R. *Dietary survey in a Fijian village*. Noumea, New Caledonia, South Pacific Health Services, 1963.
45. Johnson JS and Lambert JN. *The national food and nutrition survey of Fiji*. Suva, Fiji, United Nations Development Programme, 1982.

46. Taylor R *et al.* Dietary intake, exercise, obesity and noncommunicable disease in rural and urban populations of three Pacific Island countries. *J Am College Nut*, 1992, 11:283-293.
47. Saito S. 1993 *National nutrition survey, main report*. Suva, Fiji, NFNC, 1995.
48. Ministère de la Santé et de la Recherche. *Enquête sur les maladies non transmissibles en Polynésie Française. Etude de la prévalence de l'hypertension, du diabète, de la goutte et de l'obésité en relation avec les habitudes alimentaires*. Papeete, Tahiti, Polynésie Française, Direction de la Santé en Polynésie Française; Institut Territorial de Recherche Médicale Louis Malardé, 1998.
49. Pollock NJ. Food habits in Guam over 500 years. *Pacific Viewpoint*, 1986, 27:120-143.
50. Pargeter, K *et al.* *Kiribati: A dietary study*. 1482/84. Noumea, New Caledonia, South Pacific Commission, 1984.
51. Turbott IG. Diets, Gilbert and Ellice Island colony. *Journal of Polynesian Society*, 1949, 58:36-46.
52. Holmes S. *Nutrition survey in the Gilbert Islands*. Suva, Fiji, South Pacific Health Services, 1953.
53. Willmott, J. V. *Gilbert and Ellice Islands Colony: Report on a visit made by Nutritionist, South Pacific Health Service*. Suva, Fiji, South Pacific Health Service, 1968.
54. Thompson, J. *Feasibility study, Tarawa, Gilbert Islands*. Noumea, New Caledonia, South Pacific Commission, 1978
55. Zimmet, P, Beriki, T, and Taylor, R. *Diabetes and cardiovascular disease survey, Kiribati: preliminary report*. Melbourne, Royal Southern Memorial Hospital, 1981.
56. de Brum, O. *Situation analysis of the Marshallese child*. Majuro, Republic of the Marshall Islands, Office of Planning and Statistics, Republic of the Marshall Islands, 1990.
57. Burton ML, Nero KL, and Pollock NJ. *Food consumption patterns in the Marshall Islands: A preliminary report*. 1999. Unpublished.
58. *The Republic of Marshall Islands National Nutrition survey 1991: technical report*. Republic of the Marshall Islands, Ministry of Health Services, 1991.
59. Kirk N. Nutrition in native peoples: some observations on the food habits of Nauruans. *Journal of Health*, 1958, 8:79-82.
60. Ringrose H, Zimmet P. Nutrient intake in an urbanized Micronesian population with a high diabetes prevalence. *Am J Clin Nutr*, 1979, 32:1334-1341.
61. *Health aspects of food and nutrition*. Manila, Philippines, WHO Regional Office for the Western Pacific, 1979.
62. Ringrose H *et al.* Nutrient intakes of a Pacific population with a high diabetes prevalence-rate and marked obesity. *Proc Nutr Soc Aust*, 1982, 7:170-170.
63. Malcolm, S. Nutritional investigations in New Caledonia. Noumea, New Caledonia, South Pacific Commission, 1953 (SPC Technical Paper No. 50).
64. Loison G, Jardin C, Crosnier J. Alimentation et nutrition dans le Pacifique Sud. *Medecine Tropicale*, 1973, 33:143-161.
65. Taylor R and Zimmet P. *Preliminary report of 1980 Noumea/Wallis survey and interim report of 1979 Ouvea survey*. Noumea, New Caledonia, South Pacific Commission, 1980.
66. Rapport technique Enquete epidemiologique sur les facteurs de risque du cancer lies au mode de vie en nouvelle caledonie. 1991
67. Tassie JM. *Factteurs nutritionnels et diabete non insulino dependant suivant l'origine ethnique et l'environnement en Nouvelle-Caledonie*. Paris, France, Universite de Paris, 1995.
68. Mitikulena M *et al.* The 1987 national nutrition and dietary survey of Niue. Noumea, New Caledonia, South Pacific Commission, 1993 (Technical paper No. 202).
69. Hankin J, Dickinson LE. Urbanization, diet, and potential health effects in Palau. *Am J Clin Nutr*, 1972, 25:348-353.
70. Cilento RW. Food deficiencies in the Territory of New Guinea. *Med J Aust*, 1926, 2:309-313.
71. Meggitt MJ. The Enga of the New Guinea Highlands: some preliminary observations. *Oceania*, 1958, 28:253-330.

72. Venkatachalam PS. *A study of the diet, nutrition and health of the people of the Chimbu area, New Guinea Highlands*. Papua New Guinea Department of Public Health Monograph 1962, No.1:
73. Hitchcock N, Oram ND. Rabia camp, a Port Moresby migrant settlement. *New Guinea Research Bulletin*, 1962, 14:
74. Hipsley EH and Kirk NE. *Studies of dietary intake and expenditure of energy by New Guineans*. Noumea, New Caledonia, South Pacific Commission, 1965 (Technical Paper No 147).
75. Oomen HA. Ecology of human nutrition in New Guinea: Evaluation of subsistence patterns. *Ecology of food and nutrition*, 1971, 1:3-18.
76. Sinnott P. Nutrition in a New Guinea highland community. *Human Biology in Oceania*, 1972, 1:299-305.
77. Malcom LA. Need and demand for health and medical care in urban Lae, Papua New Guinea. *Papua New Guinea Med J*, 1973, 16:157-167.
78. Norgan NG, Ferro-Luzzi A, Dumin JVGA. The energy and nutrient intake and the energy expenditure of 204 New Guinean adults. *Philos Trans R Soc Lond B Biol Sci*, 1974, 268:309-348.
79. Jeffries DJ. *From Kaukau to Coke: a study of rural and urban food habits in Papua New Guinea*. Canberra, Australia, Australian National University, 1979.
80. Martin FIR *et al*. Diabetes mellitus in urban and rural communities in Papua New Guinea. *Diabetologia*, 1980, 18:369-374.
81. Date C, Fujita Y, Okuda T. Relation of dietary intake to health status in highlands of Papua New Guinea. In: *Proceedings of the Twelfth International Congress of Nutrition 1981*: 42.
82. Harvey PW and Heywood P. *Twenty-five years of dietary change in Simbu Province, Papua New Guinea*. Papua New Guinea Institute of Medical Research, Goroka. 1999. (Unpublished).
83. Okuda T *et al*. Nutritional status of Papua New Guinea highlanders. *J Nutr Sci Vitaminol*, 1981, 27:319-331.
84. Joughin J, Kalit K. Food prices in Papua New Guinea - A guide to the changing urban diet. *Papua New Guinea Med J*, 1988, 31:133-139.
85. Martin FIR *et al*. Diabetic surveys in Papua New Guinea - Results and implications. *Papua New Guinea Med J*, 1981, 24:188-194.
86. King H *et al*. Glucose tolerance in a highland population in Papua New Guinea. *Diabetes Research*, 1984, 1:45-51.
87. King H *et al*. Blood pressure, hypertension and other cardiovascular risk factors in six communities in Papua New Guinea, 1985-1986. *Papua New Guinea Med J*, 1994, 37:100-109.
88. Iser DJ. Has westernization influenced serum cholesterol levels in Bougainvillian males? *Papua New Guinea Med J*, 1993, 36:311-315.
89. Lindeberg S *et al*. Age relations of cardiovascular risk factors in a traditional Melanesian society: the Kitava study. *Am J Clin Nutr*, 1997, 66:845-852.
90. Dowse GK *et al*. Extraordinary prevalence of non-insulin-dependent diabetes mellitus and bimodal plasma glucose distribution in the Wanigela people of Papua New Guinea. *Med J Aust*, 1994, 160:767-774.
91. Hodge AM *et al*. Modernity and obesity in coastal and Highland Papua New Guinea. *Int J Obes Relat Metab Disord*, 1995, 19:154-161.
92. Hodge AM *et al*. Prevalence and secular trends in obesity in Pacific and Indian Ocean Island populations. *Obes Res*, 1995, 3:77s-87s.
93. Malcolm S. *Diet and nutrition in American Samoa*. Noumea, New Caledonia, South Pacific Commission, 1954 (SPC Technical Paper No. 63).
94. Bindon JR. Breadfruit, banana, beef, and beer: modernization of the Samoan diet. *Ecology of food and nutrition*, 1982, 12:49-60.
95. Brown VJ, Hanna JM, Severson G. A quantitative study of native and migrant Samoans. *Am.J.Phys.Anthropol*, 1984, 63:
96. Pollock NJ. Food and identity: Food preferences and diet of Samoans in Wellington, New Zealand. *Publications de l'Université Française du Pacifique*, 1989, 1:45-49.



97. Holmes S. *Report on a qualitative nutrition study in Western Samoa*. Suva, Fiji, South Pacific Health Services, 1951.
98. Pelletier DL. *Diet, activity and cardiovascular disease risk factors in Western Samoan men*. The Pennsylvania State University, 1984.
99. Qusteded, C., Lui, O., and Lamb, J. *Samoa country paper for the International Conference on Nutrition in Rome, 1992*. Samoa, NFNC, Health Department, 1992.
100. Sparling M. *The influence of a modern diet on body mass index in a transitional village in Western Samoa*. University of Hawaii Masters Thesis, 1997.
101. Galanis DJ *et al.* Dietary intake among modernizing Samoans: implications for risk of cardiovascular disease. *J Am Diet Assoc*, 1999, 99:184-190.
102. Jansen AA and Wilmott JV. *Nutrition and dietary survey of urban and rural populations in British Solomon Islands protectorate, part II: Solomon Islands special conditions*. Suva, Fiji, South Pacific Health Services, 1973.
103. Friedlaender JS. *The Solomon Islands project. A long-term study of health, human biology, and culture change*. Oxford, Clarendon Press, 1987.
104. Eason RJ, Pada J, Wallace R, Henry A, Thornton R. Changing patterns of hypertension, diabetes, obesity and diet among Melanesians and Micronesians in the Solomon Islands. *Med J Aust*, 1987, 146:465-469.
105. Paterson J, Laura A, Harris R, and Tauriki P. *Solomon Islands National Nutrition Survey 1989: Summary report*. Solomon Islands, 1990.
106. Davidson F. The Tokelau island migrant study: Atoll diet. In: Stanhope JM, ed. *Migration and health in New Zealand and the Pacific: Proceedings of a Seminar 1975*. Wellington: Epidemiology Unit, Wellington Hospital, 1977:109-112.
107. Harding W. The diet of Tokelau island migrants in New Zealand. In: Stanhope JM, ed. *Migration and health in New Zealand and the Pacific: Proceedings of a Seminar 1975*. Wellington: Epidemiology Unit, Wellington Hospital, 1977:113-116.
108. Jardin C. *Food and dietary habits in the Cook Islands, Niue and Tokelau*. 1999. Unpublished.
109. Mckenzie JM, Guthrie BE. Zinc in Tokelau Islands diet (letter). *NZ Med J*, 1979, 118-119.
110. Naylor R. *A review of health services of Tokelau*. Noumea, New Caledonia, South Pacific Commission, 1990.
111. Langley D. *Nutrition survey of the Kingdom of Tonga*. Suva, Fiji, South Pacific Health Services, 1952.
112. Jansen AA. Malnutrition and child feeding practices in the Kingdom of Tonga. *J Tropical Pediatrics*, 1982, 28:202-208.
113. Englberger L. *Review of past food and nutrition surveys in Tonga*. Tonga, NFNC, 1983.
114. Finau SA, Prior IAM, Maddill J. Food consumption patterns among urban and rural Tongans. *Review USP*, 1987, 8:35-41.
115. Maclean E, Bach F, and Badcock J. *The 1986 National nutrition survey of the Kingdom of Tonga - Summary report. 200*. Noumea, New Caledonia, South Pacific Commission, 1992 (SPC Technical Paper).
116. Englberger L. *Mutton flaps in Tonga: A policy paper prepared for the Tonga National Food and Nutrition Committee*. 1997. Unpublished.
117. Englberger L. *First Tonga healthy weight loss competition 1995-1996*. Tonga, Central Planning Department, Government of Tonga, 1996.
118. Englberger L and Halavatau V. *Second Tonga healthy weight loss competition*. Tonga, Central Planning Department, Government of Tonga, 1996.
119. Englberger L and Halavatau V. *Tonga National weight loss programme 1995-1997*. Tonga, Central Planning Department, Government of Tonga, 1997.
120. Englberger L, Yasuda H, and Yamazaki R. *Third Tonga healthy weight loss competition*. Tonga, Central Planning Department, Government of Tonga, 1998.
121. Evans M *et al.* Globalization, diet, and health: an example from Tonga. *Bulletin of the World Health Organization* 2001, 79:856-862.
122. Wicking J *et al.* Nutrient intake in a partly westernized isolated Polynesian population: The Funafuti survey. *Diabetes Care*, 1981, 4:92-94.

123. Walker JD. *Nutrition report in relation to a study of diet, blood cholesterol levels and coronary disease in Polynesians of the Cook Islands*. Suva, Fiji, South Pacific Health Services, 1960.
124. Johnson B. *The Food and Nutrition situation in Tuvalu: The need for a national food and nutrition policy in Tuvalu*. Noumea, New Caledonia, South Pacific Commission, 1994.
125. Malcolm S. *Nutritional investigations in the New Hebrides*. Noumea, New Caledonia, South Pacific Commission, 1952 (SPC Technical Paper No 23).
126. Dye EL. *A survey of nutrient intakes and food habits in a New Hebridean village*. Noumea, New Caledonia, South Pacific Commission, 1979.
127. Badcock J *et al*. *Vanuatu dietary study 1985. Summary Report. 203/94*. Noumea, New Caledonia, South Pacific Commission, 1993 (SPC Technical Paper).
128. Carlot-Tary M, Harvey P, and Menere R. *Second National Nutrition Survey 1996 Report*. Republic of Vanuatu, Health Department, 1998.
129. Carlot-Tary M, Hughes RG, and Hughes MC. *1998 Vanuatu Non-communicable diseases survey report*. Noumea, New Caledonia, Secretariat of the Pacific Community, 1999 (SPC Technical Paper) .
130. Doumenge JP, Villenave D, and Chapuis O. *Agriculture, foods and nutrition in four South Pacific archipelagoes*. France, Centre D'Etudes de Geographie Tropicale, 1995.
131. Loison G, Jardin C, Crosnier J. Alimentation et nutrition dans les territoires francais du Pacifique. *Medecine Tropicale*, 1999, 33:363-368.
132. *FAO Food balance sheets 1992-94 average*. Rome, Statistics Division, Food and Agriculture Organization of the United Nations, 1996.
133. Parkinson SV. Some observations of the cause of malnutrition in Pacific island urban communities. In Harre J, ed. *Living in town: problems and priorities in urban planning in the South Pacific*. Suva, Fiji, South Pacific Social Sciences Association & the School of Social and Economic Development, University of the South Pacific, 1973: 85-91.
134. McKee HS. Some food problems in the Pacific islands. Noumea, New Caledonia, South Pacific Commission, 1957 (Technical Paper No. 106).
135. Fisk EK. Planning in a primitive economy: special problems of Papua New Guinea. *Economic Record*, 1962, 38:462-478.
136. Fisk EK. Planning in a primitive economy: special problems of Papua New Guinea. *Economic Record*, 1964, 40:156-174.
137. McGee TG. *Food dependency in the Pacific: A preliminary statement*. Canberra, Development Studies Centre, Australian National University, 1975 (Working Paper No.2).
138. Pollock NJ. Food dependency in the Pacific revisited. In: Walsh AC, ed. *Development that works! Lessons from Asia-Pacific*. Palmerston North, Amokura, 1993: C8.1-C8.7
139. Shintani TT *et al*. Obesity and cardiovascular risk intervention through the ad libitum feeding of traditional Hawaiian diet. *Am J Clin Nutr*, 1991, 53:1647S-1651S.
140. O'Dea K. Marked improvement in carbohydrate and lipid metabolism in diabetic Australian Aborigines after temporary reversion to traditional lifestyle. *Diabetes*, 1984, 33:596-603.
141. O'Dea K. Westernisation, insulin resistance and diabetes in Australian Aborigines. *Med J Aust*, 1991, 155:258-264.
142. O'Dea K. Obesity and diabetes in the land of milk and honey. *Diabetes/Metabolism review*, 1992, 8:373-388.

# ANNEX 1

## FAO Pacific Island Food Balance Sheets\*

**Table 1: Total energy (kilocalories) available per person per day in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	3041	3069	3150	2987	2977	3040	3088	3051	3079	3080	3140	3142
Fiji	2601	2637	2435	2322	2516	2571	2615	2691	2829	3025	2761	2827
French Polynesia	2536	2677	2844	2854	2759	2760	2779	2802	2808	2880	2849	2854
Kiribati	2114	2202	2379	2549	2510	2477	2501	2554	2583	2638	2850	2932
New Caledonia	2667	2739	2933	2766	2767	2722	2765	2836	2841	2870	2789	2762
Papua New Guinea	1741	1807	1939	1996	2184	2166	2179	2321	2335	2237	2194	2177
Solomon Islands	2214	2247	2208	2193	2234	2228	2227	2179	2158	2046	2212	2267
Vanuatu	2514	2486	2520	2487	2560	2627	2709	2690	2700	2703	2518	2584

**Table 2: Total fat (grams) available per person per day in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	108.1	107.6	112.3	105.1	107.0	112.4	116.4	117.5	118.5	119.9	128.5	133.8
Fiji	60.6	62.5	61.5	69.9	88.1	85.1	84.9	93.1	98.2	109.7	97.1	99.3
French Polynesia	62.1	73.9	86.5	89.1	90.9	95.1	100.1	101.1	100.5	106.6	107.2	112.7
Kiribati	98.1	97.1	93.2	99.1	96.6	98.7	98.1	94.3	93.4	99.0	101.7	106.6
New Caledonia	81.6	82.8	88.6	90.4	90.9	94.1	97.0	97.0	99.2	107.8	107.7	109.3
Papua New Guinea	30.7	32.2	32.2	35.6	41.3	44.0	44.5	53.2	50.0	52.1	44.5	43.7
Solomon Islands	36.9	40.5	41.8	50.1	50.7	51.4	48.0	45.7	47.2	43.3	44.9	44.5
Vanuatu	87.8	89.9	89.6	96.1	97.4	96.6	99.2	99.5	102.5	103.9	92.1	91.7

\* Yearly amounts of food available are grouped according to FAO 1996.

**Table 3: Starchy root vegetables (grams) available per person per day in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	115.3	115.0	143.5	115.8	136.3	146.7	153.9	157.7	164.5	161.0	158.8	160.2
Fiji	730.7	662.6	544.8	120.5	127.3	224.5	278.2	167.6	153.3	242.0	252.2	259.0
French Polynesia	312.9	327.7	325.8	314.6	257.6	198.8	167.3	150.9	155.2	180.2	159.3	164.8
Kiribati	366.9	338.4	409.9	449.0	376.7	369.3	350.4	282.0	276.8	266.9	268.6	280.6
New Caledonia	366.9	393.4	305.5	249.4	246.7	243.7	227.0	217.1	199.3	205.3	186.4	193.0
Papua New Guinea	865.4	863.2	858.0	884.6	824.1	797.3	779.7	760.0	738.9	702.5	624.5	600.1
Solomon Islands	1339.6	1327.9	1210.1	1116.5	1024.2	984.8	949.8	913.6	897.7	829.3	840.0	844.4
Vanuatu	875.8	815.1	746.6	671.0	657.9	711.6	718.4	739.2	774.5	798.1	625.9	630.8

**Table 4: Fish and seafood (grams) available per person per day in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	30.4	36.4	37.5	37.5	38.3	42.2	45.7	48.5	49.0	49.3	57.2	58.6
Fiji	28.7	37.8	53.4	67.1	103.2	108.1	112.0	110.9	109.0	93.9	77.8	91.2
French Polynesia	91.2	124.6	99.1	98.3	98.0	92.5	91.4	94.5	97.7	98.0	144.3	138.8
Kiribati	130.3	151.1	160.7	168.7	181.2	186.2	189.7	196.9	200.7	201.5	213.8	210.5
New Caledonia	14.0	16.4	12.6	30.1	51.5	51.2	50.1	56.1	62.4	54.8	68.7	73.1
Papua New Guinea	40.2	46.5	53.1	49.6	61.6	60.0	66.0	68.7	62.7	60.5	43.8	40.8
Solomon Islands	133.9	136.6	153.0	164.3	168.7	164.8	154.4	157.4	156.6	62.4	136.1	141.8
Vanuatu	81.9	81.9	117.2	117.7	109.2	90.9	101.6	86.0	97.5	73.4	103.8	92.8

**Table 5: Meat & offal (grams) available per person per day in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	310.5	312.7	320.1	335.4	323.6	312.9	317.0	319.5	323.6	318.1	310.5	337.9
Fiji	39.2	41.6	55.6	67.6	84.9	88.4	94.7	102.1	117.5	135.2	127.0	128.1
French Polynesia	88.2	98.8	127.6	144.0	155.8	164.5	179.3	199.6	217.7	253.3	267.8	274.3
Kiribati	56.1	60.8	53.9	57.5	56.7	49.8	48.2	53.7	52.8	53.9	71.4	82.7
New Caledonia	145.9	151.7	187.3	176.0	162.4	158.0	159.3	159.9	172.8	198.2	191.6	191.4
Papua New Guinea	45.7	49.0	54.5	61.3	65.2	64.6	69.5	74.5	74.2	80.8	82.7	68.7
Solomon Islands	27.7	31.5	38.9	40.5	41.1	43.3	43.5	39.7	33.9	27.1	26.6	20.0
Vanuatu	124.6	130.0	131.4	136.3	113.6	107.6	112.0	95.8	98.6	130.3	100.8	113.1

**Table 6: Alcohol (grams) available per person per day in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	301.2	319.2	367.1	417.8	418.9	401.9	383.6	369.9	363.6	333.2	315.9	316.5
Fiji	21.9	27.4	45.2	79.9	81.6	79.4	70.1	62.4	71.2	68.4	62.7	63.0
French Polynesia	105.1	201.8	235.2	213.0	179.1	190.3	189.7	164.0	160.7	167.8	163.4	153.9
Kiribati	8.8	15.6	21.9	34.5	29.0	17.0	14.0	14.5	14.8	17.8	21.4	27.1
New Caledonia	220.7	259.5	355.1	168.1	157.2	151.4	123.2	154.1	165.9	172.5	204.8	212.2
Papua New Guinea	7.4	11.0	24.4	36.4	44.6	40.5	39.4	38.3	35.3	33.1	27.9	28.7
Solomon Islands	11.5	10.7	13.1	16.7	24.1	26.8	30.4	18.6	17.5	23.8	7.9	5.7
Vanuatu	71.5	60.8	58.6	49.8	48.5	38.3	37.5	30.1	24.1	20.3	15.6	13.1

**Table 7: Fruit (grams) available per person per day  
in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	229.2	234.4	262.6	236.3	246.4	246.4	268.9	262.3	267.2	288.3	236.0	244.2
Fiji	29.0	32.3	39.4	51.5	55.9	55.3	54.2	56.4	53.4	52.0	75.8	73.6
French Polynesia	107.9	191.9	185.9	172.2	189.2	167.8	182.6	175.5	180.7	198.2	163.7	154.1
Kiribati	135.5	148.1	159.3	174.1	177.1	173.9	175.2	164.8	167.8	172.2	181.2	190.6
New Caledonia	256.8	248.0	246.4	207.0	218.8	213.3	194.1	173.6	138.3	119.1	150.9	159.6
Papua New Guinea	633.3	632.2	671.6	665.3	632.7	615.5	591.6	613.6	621.5	610.8	585.1	565.1
Solomon Islands	173.6	171.1	161.0	150.0	142.6	141.8	134.4	131.4	134.7	120.5	101.8	100.8
Vanuatu	139.9	132.8	141.5	176.3	235.5	266.1	283.4	285.6	292.4	295.1	275.2	264.2

**Table 8: Vegetables (grams) available per person per day  
in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	149.8	161.0	171.4	164.3	173.3	185.4	195.2	206.4	216.3	205.9	245.3	254.9
Fiji	32.0	37.5	40.8	51.7	52.0	49.8	59.1	69.3	66.3	73.1	90.3	101.6
French Polynesia	124.8	173.0	167.6	154.7	168.1	176.3	187.3	194.7	176.9	153.0	162.9	161.3
Kiribati	150.6	156.3	158.0	162.4	162.1	160.2	159.3	149.8	150.3	155.2	161.5	164.5
New Caledonia	126.2	127.3	156.1	157.2	122.7	138.0	140.2	162.4	156.6	147.3	115.3	113.1
Papua New Guinea	219.8	229.7	230.8	230.3	234.1	238.7	240.9	238.2	234.6	230.5	228.3	241.2
Solomon Islands	56.4	56.7	53.9	52.0	50.4	47.6	46.8	45.4	47.4	37.8	42.4	44.9
Vanuatu	128.4	132.0	144.3	142.9	151.1	145.7	148.1	144.6	143.7	139.6	113.9	136.6

**Table 9: Milk available per person per day  
in several Pacific Island countries 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Australia	626.7	650.0	655.4	670.8	669.1	725.0	725.5	740.3	726.9	746.3	684.5	678.7
Fiji	115.5	192.5	144.6	169.7	136.9	166.7	138.3	120.5	139.9	163.4	151.4	124.8
French Polynesia	89.5	151.7	196.3	171.7	180.4	176.3	186.2	194.1	215.7	219.0	266.7	242.3
Kiribati	115.5	192.5	144.6	169.7	136.9	166.7	138.3	120.5	139.9	163.4	151.4	124.8
New Caledonia	189.7	188.9	218.5	210.0	223.7	231.3	319.8	442.2	415.9	440.2	433.1	345.5
Papua New Guinea	9.6	11.0	15.9	19.2	17.0	17.5	18.6	23.3	21.4	19.7	16.4	13.4
Solomon Islands	25.2	40.5	40.0	34.8	41.6	33.9	32.0	31.5	23.0	24.1	23.8	20.5
Vanuatu	43.0	52.0	71.2	80.8	110.3	70.9	69.0	75.8	79.9	82.7	56.1	55.6

\* Yearly amounts of food available are grouped according to FAO 1996.

# ANNEX 2

## FAO Pacific Island Food Balance Sheets\*

**Table 1: Fat available (g/capita/day): Fiji 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Veg oils	14.0	12.2	9.3	14.3	27.5	30.0	27.2	33.8	36.3	33.7	29.1	31.7
Meat & offal	6.7	7.2	9.6	11.8	14.2	14.5	16.0	17.1	19.2	22.2	20.0	20.3
Animal fats	8.3	9.3	10.9	12.5	16.4	9.1	11.4	12.6	12.2	14.1	16.9	17.4
Coconuts	20.3	19.0	17.8	16.9	15.5	16.2	16.4	16.0	16.3	15.4	15.5	15.3
Milk & eggs	4.1	6.8	5.1	6.3	4.9	5.8	4.5	4.8	5.6	6.4	6.1	5.7
Cereals	3.0	3.6	3.1	3.2	3.3	3.6	3.4	3.6	3.7	4.1	4.3	4.3
Fish & seafood	1.3	1.6	2.1	2.7	3.8	3.6	3.5	2.9	2.4	2.4	1.8	1.4
Starch roots	2.0	1.8	1.4	0.3	0.3	0.5	0.7	0.4	0.5	0.6	0.6	0.6

**Table 2: Fat available (g/capita/day): French Polynesia 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Veg oils	16.9	18.5	23.9	24.9	24.4	25.5	27.5	26.2	25.5	30.6	27.4	34.4
Meat & offal	14.6	16.1	19.5	23.7	24.5	26.2	27.9	30.1	29.1	28.0	28.7	29.6
Animal fats	8.9	13.1	15.3	14.1	14.2	15.0	14.8	14.7	14.6	13.7	14.4	12.7
Milk & eggs	3.9	7.0	9.4	8.0	8.7	8.7	9.2	9.4	9.1	9.0	10.0	10.1
Coconuts	9.2	7.6	7.4	7.7	7.8	8.6	9.2	8.9	9.1	9.1	8.8	9.5
Cereals	3.5	4.4	4.6	4.5	4.8	4.7	4.7	4.9	5.3	6.1	6.6	5.5
Fish & seafood	3.0	4.1	3.2	1.0	3.0	2.9	2.9	3.1	3.1	3.2	4.0	3.9
Starch roots	0.7	0.6	0.6	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.2

**Table 3: Fat available (g/capita/day): Kiribati 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Coconuts	58.6	57.2	56.3	55.1	54.7	54.3	53.1	49.2	48.3	48.9	52.8	53.5
Veg oils	16.3	15.2	13.3	17.4	17.6	22.9	23.0	21.8	21.6	26.3	21.6	23.6
Meat & offal	12.8	13.7	11.8	11.4	10.9	9.5	9.1	9.7	9.6	9.4	11.0	11.9
Fish & seafood	2.9	3.3	3.1	3.2	3.2	3.4	4.6	4.8	4.8	5.2	5.0	4.6
Animal fats	1.4	1.6	1.4	3.7	3.1	2.2	2.0	2.0	2.1	2.1	3.3	4.5
Cereals	2.1	2.3	2.8	2.7	2.0	1.8	1.8	2.2	2.3	2.3	3.1	2.6
Milk & eggs	0.3	0.3	1.0	1.1	1.5	1.2	1.0	1.4	1.5	1.5	1.5	2.3
Starch roots	0.8	0.7	0.8	0.9	0.7	0.7	0.7	0.6	0.5	0.5	0.5	0.6

\* Yearly amounts of food available are grouped according to FAO 1996.

**Table 4: Fat available (g/capita/day) : New Caledonia 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Veg oils	21.9	22.7	21.6	26.0	28.6	36.3	39.6	38.4	39.2	41.8	40.1	39.6
Meat & offal	25.2	25.2	28.3	26.8	23.7	22.3	21.9	22.2	23.8	26.2	25.2	24.8
Milk & eggs	7.5	7.4	8.5	8.1	9.5	8.4	10.5	10.2	9.9	12.9	14.5	13.1
Animal fats	7.7	8.1	10.2	10.6	11.1	7.3	7.0	7.7	8.2	7.9	7.5	9.8
Cereals	3.9	3.8	4.5	4.5	4.6	4.4	4.7	5.3	5.3	5.5	6.9	7.3
Coconuts	12.7	12.4	12.2	10.9	8.8	8.3	8.1	7.6	7.6	7.2	7.2	7.2
Fish & seafood	0.3	0.3	0.2	0.7	1.4	1.7	1.7	1.8	2.0	1.7	1.8	1.9
Starch roots	0.6	0.7	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3

**Table 5: Fat available (g/capita/day): Papua New Guinea 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Veg oils	3.8	5.1	7.7	8.6	8.2	10.5	9.9	19.6	18.3	20.7	11.7	13.1
Meat & offal	8.5	9.0	9.9	10.6	11.4	11.1	11.6	12.0	12.2	12.8	14.5	13.1
Coconuts	2.7	2.8	2.9	3.4	5.9	6.8	7.2	6.0	4.7	6.5	4.8	5.4
Animal fats	1.4	1.5	1.8	2.1	1.9	1.8	1.8	1.6	1.5	1.4	3.3	2.2
Cereals	0.9	1.1	1.4	1.1	1.5	1.4	1.5	1.6	1.8	1.5	2.0	2.0
Starch roots	1.9	1.8	1.8	2.0	1.8	1.7	1.7	1.7	1.6	1.5	1.3	1.3
Fish & seafood	1.6	1.8	2.1	2.2	2.9	2.6	2.8	3.0	2.7	2.6	1.4	1.2
Milk & eggs	0.2	0.3	0.4	0.4	0.6	0.7	0.8	0.9	0.9	0.9	0.7	0.6

**Table 6: Fat available (g/capita/day): Solomon Islands 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Coconuts	17.3	17.6	17.5	18.2	17.0	18.0	17.7	18.5	19.0	19.2	18.9	18.7
Veg oils	0.9	2.8	2.4	8.5	10.1	9.6	7.3	4.7	6.0	6.3	6.1	7.0
Meat & offal	5.9	6.5	8.1	9.0	8.9	9.3	9.1	8.7	8.1	7.2	6.2	5.3
Fish & seafood	2.9	3.0	3.9	4.2	4.6	4.5	4.1	4.8	5.3	2.0	5.2	5.2
Starch roots	3.5	3.5	3.1	2.9	2.6	2.6	2.5	2.4	2.3	2.2	2.2	2.2
Cereals	0.8	0.9	1.2	1.0	1.5	1.7	1.9	1.6	1.5	1.6	1.8	1.9
Animal fats	2.5	2.9	2.6	3.0	3.0	3.0	2.8	2.6	2.6	2.7	2.1	1.9
Milk & eggs	0.7	0.8	0.8	0.9	1.0	0.8	0.8	0.7	0.7	0.7	1.0	1.0

**Table 7: Fat available (g/capita/day): Vanuatu 1963-2000**

	63	66	71	76	81	84	86	89	91	94	97	00
Coconuts	25.8	25.2	24.9	25.3	28.0	28.5	28.6	33.4	37.6	29.0	30.7	32.2
Meat & offal	27.9	27.9	27.3	27.1	25.1	24.9	25.5	21.2	21.1	26.3	21.1	23.1
Vegetable oils	15.1	16.3	13.3	16.7	18.2	19.7	20.8	21.5	23.8	24.0	16.4	14.4
Animal fats	6.7	7.5	6.4	6.5	5.7	4.8	5.1	5.9	6.0	7.5	6.5	6.0
Fish & seafood	3.4	3.5	4.0	3.9	3.6	2.8	2.9	2.4	2.4	2.1	2.9	2.7
Milk & eggs	2.0	2.4	2.9	2.9	2.5	2.5	2.6	2.4	2.6	2.6	2.4	2.3
Cereals	1.9	2.5	3.3	3.4	2.1	2.1	2.2	1.9	1.7	1.8	2.3	2.0
Starch roots	1.8	1.6	1.5	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.1	1.2

\* Yearly amounts of food available are grouped according to FAO 1996.

# ANNEX 3

Figure 1: Macronutrients contribution to energy: Fiji 2000

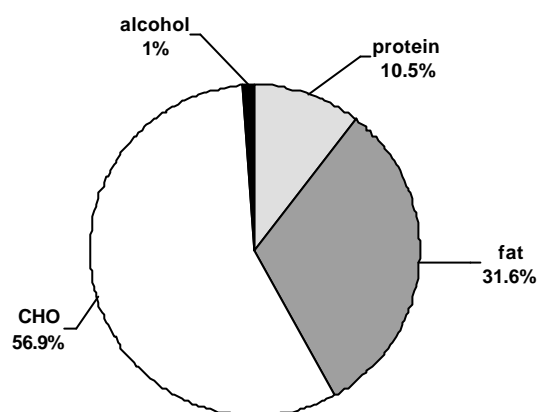


Figure 2: Macronutrients contribution to energy: French Polynesia 2000

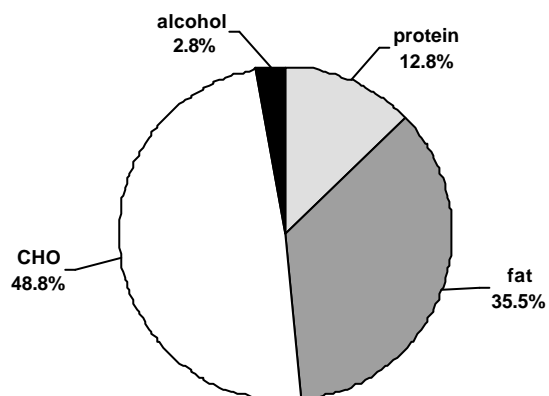




Figure 3: Macronutrients contribution to energy: Kiribati 2000

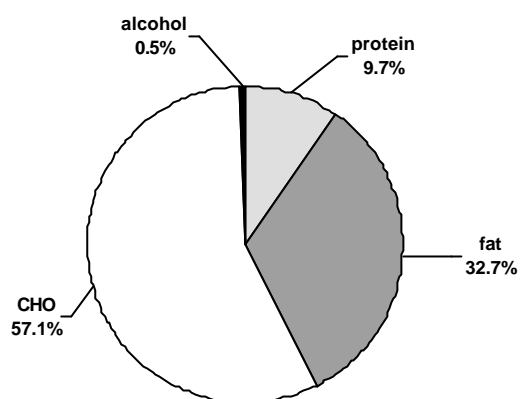


Figure 4: Macronutrients contribution to energy: New Caledonia 2000

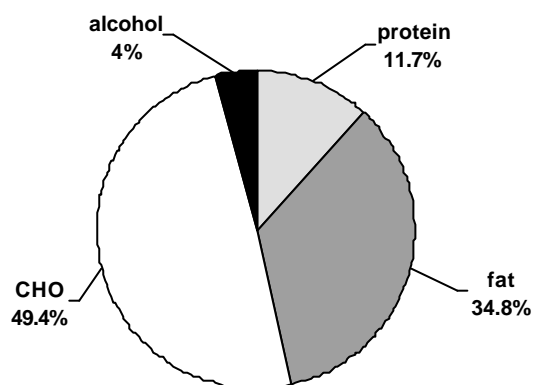


Figure 5: Macronutrients contribution to energy: Papua New Guinea 2000

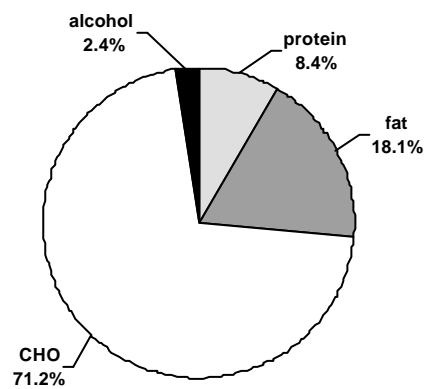


Figure 6: Macronutrients contribution to energy: Solomon Islands 2000

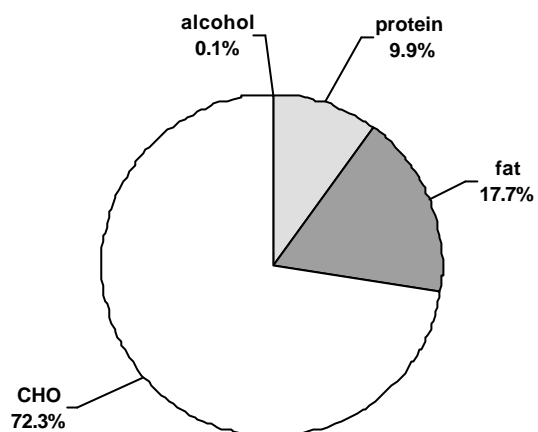


Figure 7: Macronutrients contribution to energy: Vanuatu 2000

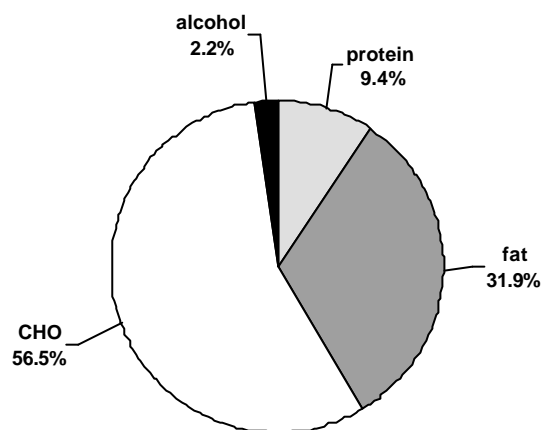


Figure 8: Macronutrients contribution to energy: Australia 2000



# ANNEX 4

Figure 1: Foods contributing to energy: Fiji 2000

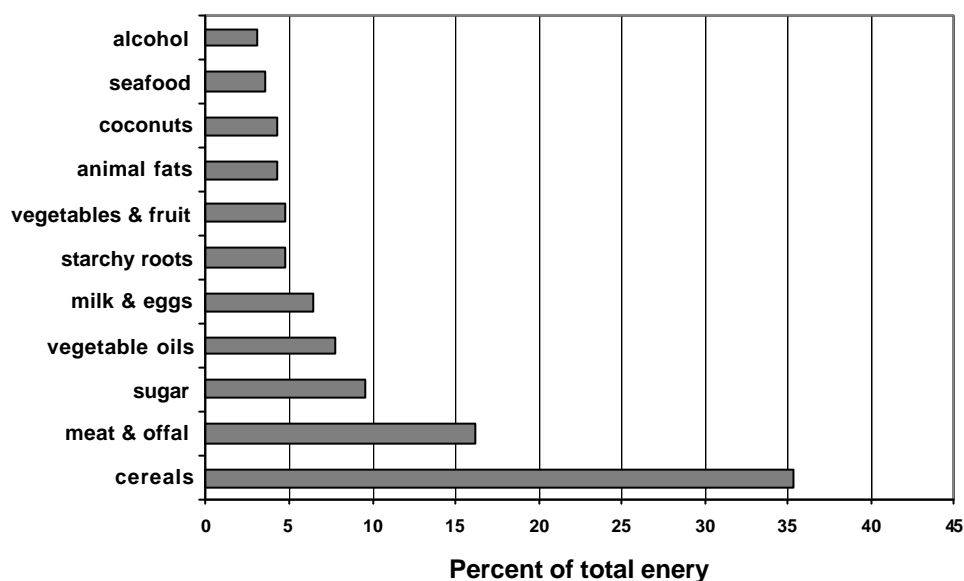


Figure 2: Foods contributing to energy: French Polynesia 2000

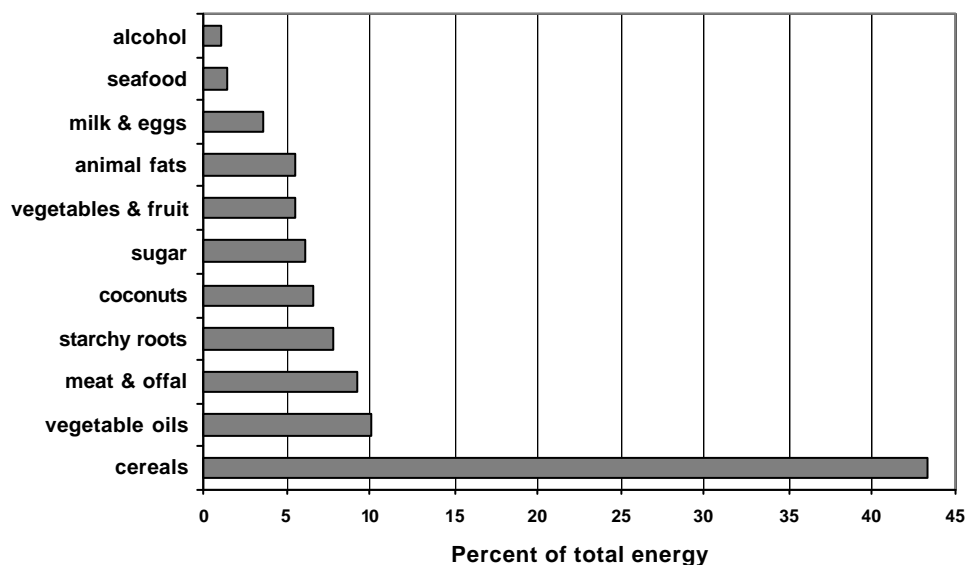


Figure 3: Foods contributing to energy: Kiribati 2000

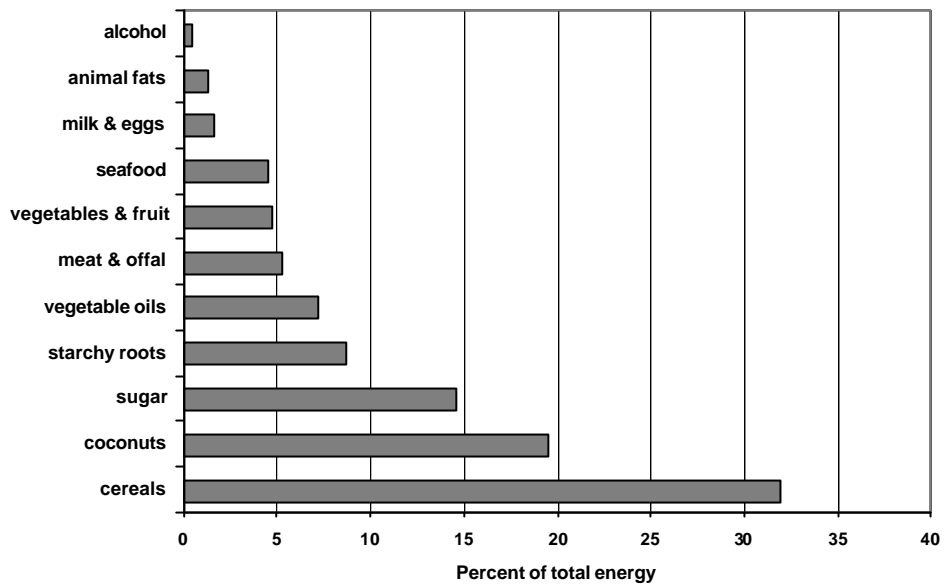


Figure 4: Foods contributing to energy: New Caledonia 2000

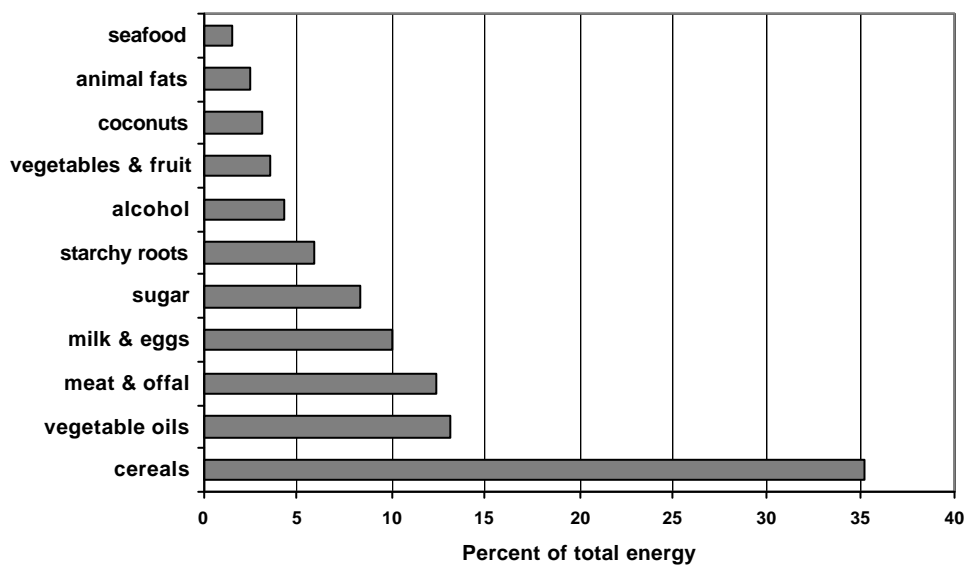


Figure 5: Foods contributing to energy: Papua New Guinea 2000

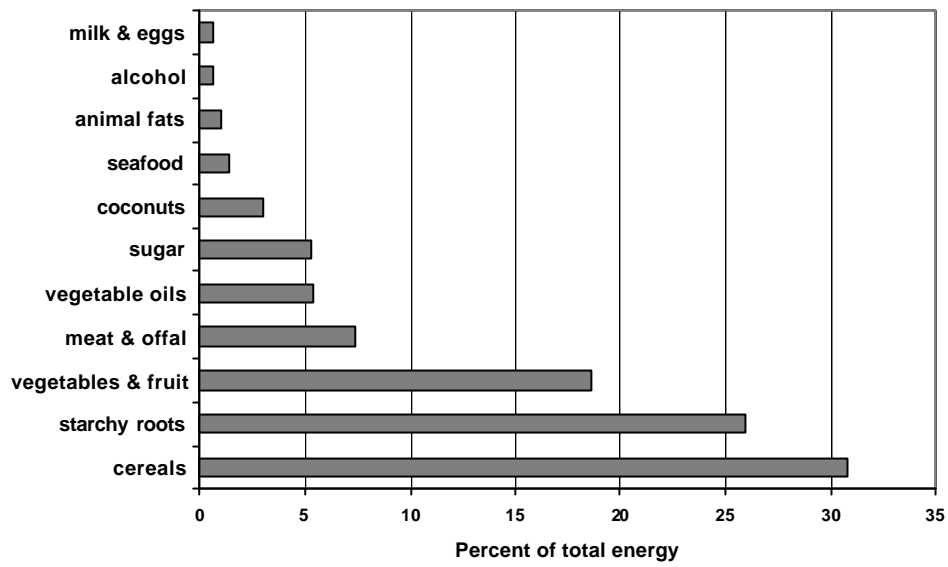


Figure 6: Foods contributing to energy: Solomon Islands 2000

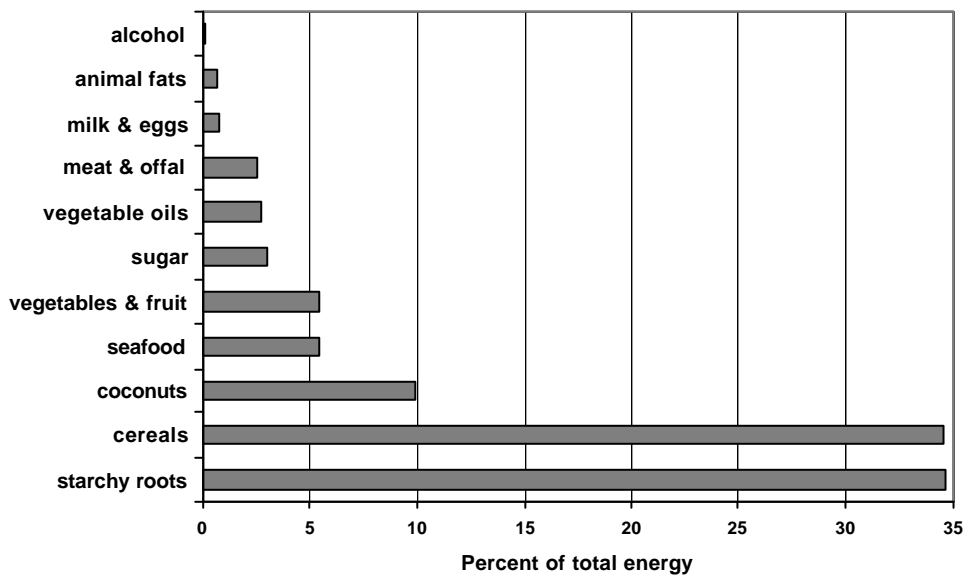


Figure 7: Foods contributing to energy: Vanuatu 2000

