Insights on food and nutrition in the Federated States of Micronesia: a review of the literature

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Abstract

Background: Nutrition-related disorders, including vitamin A deficiency (VAD) and chronic diseases, are serious problems in the Federated States of Micronesia (FSM). Many suggest that these disorders are new problems related to dietary and lifestyle changes. In the past four decades, imported foods, such as white rice, flour, sugar, refined foods and fatty meats, have increasingly replaced local foods in the diet.

Aim: A literature review was conducted to understand underlying issues related to dietary change and obtain insights for nutrition research and interventions.

Method: Published and unpublished papers from different disciplines were reviewed and collated for information on food and nutrition in FSM. Topics covered were historical background, local foods, infant and child feeding, dietary assessment, and nutritional status. Particular focus was on information and data relating to VAD, the primary topic that led to the review of the literature.

Conclusions: FSM, a tropical country of abundant agricultural resources, has suffered a great loss in production and consumption of local foods. Inconsistent external and internal government policies and food aid programmes have contributed to the problem. Further research on the nutrient content of local foods and factors affecting production, acquisition and consumption is needed, as well as a broad, well-planned, intersectoral intervention aimed at dietary improvement for all age groups in the population.

Keywords
Vitamin A deficiency
Chronic disease
Local foods
Infant nutrition
Child feeding
Dietary patterns
Nutritional status
Review
Micronesia

Health and nutrition literature concerning the Federated States of Micronesia (FSM) is limited; however, literature from other disciplines such as anthropology, agriculture, geography, history and environmental science contribute important information for the present situation of food and nutrition. This multidisciplinary review was undertaken to provide background for understanding the food and nutrition situation in FSM, with particular focus on the current status of vitamin A deficiency (VAD) in FSM.

FSM is made up of four states and 607 islands (atoll and volcanic) spread over the western Pacific Ocean. The population is around 107,000 (Chuuk, 53,600; Pohnpei, 34,500; Yap, 11,200; Kosrae, 7,700) and includes people with many cultural identities. Agricultural resources are adequate in general (atoll islands having poorer soils and less rainfall than volcanic islands). Rainfall (≈250–500 cm annually) and temperatures (annual average 27°C) are high. Agriculture, the predominant occupation for most people, is mainly on a subsistence level.

The traditional diet was based on meals of cooked starchy staples, fish and seafood, with fruits and sugar cane eaten as snacks, and vegetables (other than starchy staples) not commonly eaten. This diet has been considered by commentators to be very healthy. In the past there were problems with infectious diseases and intestinal parasites, but diabetes and hypertension were unusual. The diet has changed significantly since World War II. Imported white rice, flour, sweet and refined foods, and fatty meats have increasingly replaced local foods;† During this same period, nutrition-related disorders, including VAD and chronic diseases, have become serious problems and appear to be the consequence of dietary and lifestyle changes.

†Local foods in this paper refer to foods that are grown, harvested, hunted or gathered from the land or sea.
to understand better this apparently diet-related epidemiological transition, this paper looks at past and contemporary diets, in particular those local foods that may impact on VA and nutritional status.

Methods

The paper reviews all identified published and unpublished documents containing information related to food and nutrition in FSM up to October 2001. Government and locally available documents that are not normally available were reviewed, as were primary electronic sources. The analysis was organised around five key headings: historical background, local foods, infant and young child feeding, dietary assessment and nutritional status.

Historical background

Prior to the first recorded European discovery in 1529 of the islands now known as FSM, there are no written records5,34. Although there are few early records related to diet or nutritional status, reports from early visitors to the islands suggest that the people ate a variety of foods and appeared healthy5,19,31.

In the mid-1850s, newcomers brought new foods and cooking methods35 and, unfortunately, introduced new diseases48,50. This resulted in a great loss of lives. From 1885 to 1945, three foreign powers colonised the islands: Spain, Germany5,34 and Japan5,8,37,38. During the Japanese tenure, rice was introduced as a staple food. After the Japanese surrendered at the end of World War II, the islands became a part of the Trust Territories of the Pacific Islands (TTPI) under United States' administration. Several islands became a part of the Trust Territories of the Pacific Islands (TTPI) under United States' administration. Several development efforts focused on export crops62,63. However, US interest was mainly strategic and undermining efforts for promoting small island communities.

One set of controversial programmes that greatly influenced FSM food habits was the United States Department of Agriculture (USDA) supplementary feeding programmes10,44–57. The programmes started in the 1960s, increased in the 1970s6,51 and continued to the early 1990s. USDA surplus commodities, including rice and tinned foods, provided food for school lunches, needy families, the elderly and disaster relief46,49. In 1985, the United Nations criticised the USA for neglecting the islands55, at which time development activities were being shaped48,50. By the 1970s rice had become a major staple in the islands, along with sugar and other refined and tinned foods.

Another US food-related programme (established 1985) was the Expanded Food and Nutrition Education Program (EFNEP)59. Although it had some positive achievements, messages were often US-oriented and culturally inappropriate49, promoting US-type foods and food guides, and undermining efforts for promoting local foods60.

In 1986, Pohnpei, Kosrae, Chuuk and Yap joined to become a nation, signing a compact with the USA61 that provided significant funding and had a strong influence on the economy, food production and consumption, and health programmes. Agriculture polices were however inconsistent, espousing written plans for promoting subsistence local food production but with most development efforts focused on export crops62,63.

Local foods

FSM has an extraordinary diversity of plants64, with a number of cultivars for each of the major food crops62,65. Apart from coconut, the major food crops are breadfruit, banana, giant swamp taro5,8,10–14,18,48 and pandanus5,6,11–14. Because of the importance of these food crops to the overall diet and their potential contribution to vitamin A intake, the review focuses on these. Some cultivars have a yellow edible portion, suggesting carotenoid content66, and yet few have been analysed. In 1998 and 1999, yellow banana and giant swamp taro...
Table 1 Documented diversity (number of cultivars) of breadfruit, banana, giant swamp taro and pandanus in the Federated States of Micronesia

<table>
<thead>
<tr>
<th>Researcher(s) and Year</th>
<th>State</th>
<th>Breadfruit ((Artocarpus) spp.)</th>
<th>Number given</th>
<th>Names listed</th>
<th>Banana ((Musa) spp.)</th>
<th>Number given</th>
<th>Names listed</th>
<th>Giant swamp taro ((Cyrtosperma) chamissonis)</th>
<th>Number given</th>
<th>Names listed</th>
<th>Pandanus ((Pandanus) tectorius)</th>
<th>Number given</th>
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<td>Debnec (2001)¶¶¶</td>
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<td>Kosrae Department of Agriculture (2001)¶¶¶</td>
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</tbody>
</table>

* Of the total number of cultivars, 32 were listed by name.
** Researcher lists numbers and names from other researchers.
*** Incomplete.
† Translated and edited by Ritter and Ritter in the 1930s.
‡ Researcher refers to four Pohnpei outer islands, total number given here for all four.
§ Researcher refers to Pohnpei outer island of Kapingamarangi.
∥ Researcher lists only cultivars of economic importance.
¶ Researcher refers to Pohnpei outer island of Pingelap.
cultivars were found to contain significant amounts of provitamin A carotenoids \(^{67,68}\), suggesting that other yellow cultivars may also be carotenoid-rich. Pandanus was known to be VA-rich \(^{30,69}\). Table 1 summarises the number of cultivars of these staple foods and whether cultivar names were listed \(^{11–14,35,36,62,63,70–80}\).

**Breadfruit (Artocarpus spp.)**

Breadfruit is the traditional staple food most commonly eaten \(^{5,6,10–14,77,81–85}\). In the past, breadfruit was baked or roasted in an earth oven \(^71\). Ripe seeded breadfruit can be eaten raw as a fruit. In recent times, breadfruit has also been boiled or fried \(^{5,63}\). Breadfruit is seasonal, with different cultivars bearing in succession. Preserved breadfruit \(^{85}\) has provided food in times of need as well as between breadfruit seasons, and the fermented food, which is still well-liked by older people, provided variety in taste. The unseeded (Artocarpus altilis) and seeded (Artocarpus mariannensis) cultivars \(^{77}\) are important respectively for the volcanic and atoll islands \(^{86}\). Analyses of unseeded breadfruit indicate a low content of carotenoid \(^{69,85}\), but that it is a good source of energy and dietary fibre, and a reasonable source of vitamin C. Seeds provide protein and thiamin \(^{4,30,86}\) .

**Banana (Musa spp.)**

Banana has long been an important staple food \(^{5–7,11–14,18,63}\). Certain cultivars were mentioned in early reports in the 1800s \(^{12,87}\). Bananas are eaten raw as a fruit, and as a cooked part of the meal in a variety of recipes, either cooked alone or mixed with other starchy staples and coconut cream \(^{18,63}\). They are considered by some as a ‘poor man’s food’ \(^{5,88}\). Bananas, and particularly *kurate* banana, have also been important weaning foods \(^{89}\). Yet in recent years, this banana (now known to be VA-rich \(^{67,68}\)) has become rare, along with a number of other local cultivars. Bananas are a good source of energy, vitamin C, potassium and fibre \(^{4,30}\) .

**Giant swamp taro (Cyrtosperma chamissonis)**

Giant swamp taro is commonly eaten throughout FSM and is the most important traditional food for Yap \(^{5,8,81,82,90}\) and the atoll islands \(^{90,91}\). It can be boiled or ground and baked with coconut cream or mashed banana in a number of recipes. Some cultivars were analysed for nutrient content and found to be low in provitamin A carotenoids \(^{30,92}\), but the yellow-fleshed cultivars were not analysed. Giant swamp taro grows in more saline soils, can remain in the soil for 10 years and still be edible, is not seasonal and endures hurricanes \(^{5,10,93}\), thus providing food security. It is a good source of energy, fibre and calcium \(^{1,30,86,94}\) .

**Pandanus (Pandanus tectorius)**

Pandanus, many cultivars of which are known to be rich in vitamin A \(^{30,69,86,95,96}\), is another plant that can be grown in saline soils and is a major food on atoll islands \(^{95}\). The soft part of the pandanus key is chewed and sucked; on some islands, pandanus has been boiled for eating or dried for storage and made into flour for later cooking \(^{85}\). There have been as many as 19 cultivars on the atoll island Kapingamarangi \(^{7,34,97}\), 14 on Pingelap, 15 on Mokil \(^{73,97}\) and 11 on Kosrae \(^{91}\), although little recognition was given to pandanus in recent agriculture work in Kosrae \(^{80}\). Pandanus is also a good source of vitamin C, thiamin, riboflavin and niacin \(^{30,69,86}\) .

**Other foods**

Dark green leaves, a VA-rich food commonly eaten in other parts of the world, are regarded by many in FSM as pig food, similar to ripe papaya \(^{38,98}\). Green leafy vegetables including chilli pepper leaves, kangkong (*Ipomoea aquatica*), Chinese cabbage and two greens introduced in the 1990s \(^{58}\), *pale* (*Hibiscus manihot*) and *chuya* (*Cnidoscolus chayamansis*), have been promoted, although with limited success \(^{38,98,99}\).

Contrary to common Western perceptions, the traditional Pacific diet did not include an abundance of different fruits. Papaya and mango, which are VA-rich if ripe \(^{30,66,69,98}\), were introduced to Micronesia by Europeans in the 19th century \(^{5,6,11–14,100}\). Yet in FSM papaya and mango are commonly eaten green.

There are considerable differences in the names for foods according to state and island group. Although there is yet no compiled listing of all local names of FSM foods, there are some lists of food plants prepared by state \(^{5,6,11–14,36,62,63,76,82}\) and also a listing of food plants for the Pacific specifying some foods from FSM \(^{101}\).

Local animal foods include fish and other seafood \(^{50}\), which have been the major protein foods in the past. Raw fish liver, which is high in pre-formed VA \(^{29}\), is considered a delicacy \(^{20}\), and some fish are eaten whole with the liver intact.

In summary, there is a great diversity of local foods, some which have potential for impact on VA status. Yet, the trends indicate that cultivar diversity, and knowledge, use and availability of local foods, are decreasing at an alarming rate \(^{11–14,62,63,102}\).

**Infant and young child feeding**

Infant and young child feeding is also an important part of the total food and nutrition situation. In the 1950s initiation of breast-feeding in FSM appeared to be almost universal, and it was common that mothers breast-fed children until the second year of life or later \(^{10,103}\). The situation had changed by the 1970s, with bottle feeding as a major factor in poor infant nutrition \(^{14,101,105}\).

An active breast-feeding campaign was started in the mid-1970s, and there appeared to be some increase in breast-feeding. However, although initiation of breast-feeding was high in the late 1980s (95% of FSM infants were breast-fed in the first three months), duration was
inadequate, with only 49% breast-fed at 12–17 months and most not breast-fed at 18–23 months 50. The Baby Friendly Hospital Initiative, supported by UNICEF and the World Health Organization (WHO), was introduced in the 1990s, providing greater support to breast-feeding. Yet there is still a great lack of exclusive breast-feeding in the first six months of life, and duration of breast-feeding is still inadequate 107.

In the past, mothers did not give their breast (and colostrum) immediately to the newborn 38,37,108, thinking that it was inadequate 108. Young coconut water was given until the milk came in 50; coconut oil lubricant was often given as the first feeding 109. Breast-feeding was ‘on demand’, mothers sleeping with their babies so that nursing could continue through the night 18. When mothers became pregnant or wanted early weaning, chilli pepper or breadfruit tree sap might be applied onto the breasts 57. People believed that one could not breast-feed in pregnancy, as the milk became bad and could harm the child. Weaning was sometimes abrupt and was accomplished by sending the child to stay with relatives until the child. Weaning was sometimes abrupt and was accomplished by sending the child to stay with relatives until the child. Sex taboos during lactation, extending until the child was around one year, were meant to ensure the health of the child and mother 37,106,109,110, but may have led to an early termination of breast-feeding to allow resumption of sexual relations. In recent years the duration of this taboo has shortened 110.

Solid foods have been given at an early age. In the 1980s, 48% of infants were given these by four months of age 50. Local staple foods, often mashed banana or breadfruit, were common first foods, along with fruit, fruit juice and imported staples, including rice 104. One problem identified in child feeding was that caretakers did not believe in the positive qualities of food related to health, and often did not encourage children to eat 38. Pohnpei mothers believed that fish and meat should not be given until babies are 1 year old 39, thinking either that they cause diarrhoea in babies or that these foods should be withheld to avoid the children getting used to them and becoming unhappy if they were unavailable 110.

There have been numerous dietary taboos associated with pregnancy and the postpartum period 110, including some foods such as fish, seafood and meat, which were thought to cause vomiting in pregnancy and difficult deliveries 50. Similar foods were to be avoided during lactation for various reasons; for example eating octopus by a breast-feeding mother was thought to cause skin rash in the baby 110. Foods encouraged during lactation were those made with coconut milk, as it was believed that these foods helped to make more breast milk. Mothers were also advised to drink water and other drinks as these were also believed to help make more breast milk 110, and mothers were supported emotionally and not left alone 109,110. 

Belief in the supernatural is a strong part of the Micronesian belief system 49,89,111–114. Traditionally, people in FSM believed that spirits caused people to become sick if the people were in conflict 5,114 and especially affected a child’s well-being. People consider some illness treatable by Western medicine and other illnesses as those caused by spirits to be best treated by local medicine 99,104. With strong beliefs in the supernatural, the relationship between food and health is not always well appreciated.

In summary, there have been many changes in infant and young child feeding practices in recent years. Campaigns promoting breast-feeding helped to curb the trend towards bottle feeding, although still there are problems with lack of exclusive breast-feeding, insufficient breast-feeding duration, and some other child feeding practices.

Dietary assessment

Only a few population-based dietary studies coupled with nutritional status assessments have been carried out in FSM. These include the 1987/88 FSM National Nutrition Survey 50, and in the year 2000 the Yap and Kosrae Micronutrients Survey 115,116. However, smaller studies have been conducted that also help us understand the local diet 40,44,50,63,78,89,103,115,117–120 (Table 2).

Four studies collected information on quantities of food eaten 40,44,89,117. A review of the dietary assessments clearly showed an increasing reliance on rice, flour, sugar and imported meats. A low intake of VA-rich food was found, although previously it was not known that certain local staple foods contained high or moderate amounts of provitamin A carotenoids, which might have led to an underestimation of VA intake.

Dietary studies and papers since 1973 expressed concern over the increasing use of rice, sugar and flour, and poor food selection 44,45,49,50,58,89,121. Rice was often the sole food for young children 49. Health workers suggested that past feeding programmes based on rice, and expatriate buying patterns, helped lead to erroneous beliefs that rice and imported foods were superior to local foods 48,121. That may no longer be the case. People appear to know now that local food is healthier, due to promotion programmes. Yet, rice, wheat flour and sugar foods are commonly eaten 122 because of convenience, affordability, availability, taste and prestige 50,65.

In 1986, food and beverage imports accounted for more than 40% of the total value of imports. The same study reported that ‘most of the items imported cannot be considered essential or without local substitutes in nutritional terms. Some may actually be nutritionally harmful 47.

Common foods consumed in Pohnpei, Chuuk and Yap in the 1970s are presented in Table 3. Since then, rice has become the main starch food for many people 43,106.

A recent assessment of the diet in Kosrae showed that local fish (reef and pelagic), imported chicken and turkey
Table 2: Summary of dietary assessments in the Federated States of Micronesia 1951–2000

<table>
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<tr>
<th>Researcher(s) (year)</th>
<th>Type of study</th>
<th>Details of study</th>
<th>Main findings of report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murai (1954)</td>
<td>7-day quantified record of hh food intake, describing local foods with local names, recipes, meals and food consumption patterns.</td>
<td>Sampling: all hh on island, n=290; all ages, both sexes. Time: 3.5 months, June–October 1951. Place: Chuuk lagoon island Udot.</td>
<td>Strong reliance on local food. Low intake calculated for vitamins A &amp; C, riboflavin, fat and other nutrients, compared with US NRC allowances. Small fish often eaten whole (including liver). Food intake varies by season.</td>
</tr>
<tr>
<td>Hargreaves and Reichert (1983)</td>
<td>Dietary study carried out as part of a nutrition education programme.</td>
<td>Sampling: all hh on island, n=57 hh. Time: 7–14 November 1983. Place: Pohnpei outer island of Pingelap.</td>
<td>Very high consumption of rice. 33% consuming only rice. 7% consumed rice+taro. 37.5% rice + some source protein, usually fish. 6.5% a variety of rice, fish, taro and/or breadfruit. 16% a variety of foods, plus some fruit or vegetable.</td>
</tr>
<tr>
<td>Reference</td>
<td>Type of study</td>
<td>Sampling</td>
<td>Place</td>
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<tr>
<td>Elymore et al. (1989)</td>
<td>Type of study: 24-hour recall – women 15–49 years, child 0–4 years – for imported or FSM foods: staple, fat, or protein and greens, time of eating, profession, urban/rural and area.</td>
<td>Sampling: randomised national survey including main and outer islands – mothers, n=3781; children, n=1781. Time: May 1987–May 1988 (data collection).</td>
<td>Place: Chuuk, Pohnpei, Kosrae, Yap.</td>
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<tr>
<td>Debunce (1996)</td>
<td>Type of study: PhD geographic study on traditional horticulture, food ways, food preparation, meals.</td>
<td>Sampling: purposive, centred in one village area. Time: 10 months period – 1995.</td>
<td>Place: Malem village area of Kosrae.</td>
</tr>
<tr>
<td>Englberger and Elymore (1999)</td>
<td>Type of study: school survey on VAD, hh production/consumption of karat banana, papaya and dwlv. Sampling: purposive, elementary grades 5, 6, 8, n=347. Time: 3–14 May 1999. Place: four schools throughout Pohnpei – Madolenihm, Nett, Sokes and Ohmine.</td>
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<tr>
<td>Englberger et al. (2001)</td>
<td>Type of study: 7-day HKI FFQ for child 24–59 months (mothers/caretakers as proxies) comparing imported and local staples, fish, eggs, dwlv, papaya eaten at least 3 days. Sampling: randomised survey – Kosrae, n=282; Yap, n=235. Time: 2 weeks Yap, 1 week Kosrae, year 2000. Place: main islands Kosrae and Yap.</td>
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<tr>
<td>Snowdon (2000)</td>
<td>Type of study: 7-day food frequency on hh foods, hh food production, infant feeding, meal patterns, knowledge on vitamin A and iron, family size. Sampling: purposive, 5–10 hh in five lagoon, five outer islands and five communities on main island, total n=27 hh. Time: June–December 1999. Place: throughout islands of Chuuk.</td>
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<tr>
<td>Nero et al. (2000)</td>
<td>Type of study: 1-day recall taken in four waves over 1 year by five regions of island: food eaten by hh, meal patterns, cooking method, food exchange, work related to food. Sampling: randomised, 30 hh from Lelu, 10 each Malem, Utwa, Tafunsak, Walung; adults 15 years and over. Time: four waves of 4 weeks each, 1992–3. Place: Kosrae, all main areas of the island.</td>
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</tbody>
</table>

Abbreviations: child – children; dwlv – dark green leafy vegetable; FFQ – food-frequency questionnaire; hh – household; HKI – Helen Keller International; US NRC – United States National Research Council; XN – night blindness.

* Here, local staple foods refer to cooked breadfruit, taro, banana, yam, sweet potato and cassava.
tail are the major protein foods, and that consumption of canned fish increases when local fish are less available\textsuperscript{78}. Turkey tail* (a fatty frozen product imported from the USA) is commonly eaten throughout FSM\textsuperscript{50,65,78,120}. Turkey tail is another example of the replacement of healthy local foods with inferior food likely to cause health problems, which brings up the issue of food dumping by industrialised countries.

In summary, this section describes the great shift in the diet, with healthy local foods increasingly replaced by foods such as white rice, flour and sugar that contain no provitamin A carotenoids, and by other imported foods that are likely to cause health problems.

**Nutritional status**

This section focuses on vitamin A deficiency, anaemia, weights and heights of children, obesity, diabetes, hypertension in adults, and parasite infection.

**Vitamin A deficiency**

VAD in FSM was first documented in 1988 in a hospital-based study in Chuuk\textsuperscript{123}. Of 60 randomly selected 36–83-month-old children, 12% were found with night blindness and 5% with Bitot's spots, far exceeding WHO cut-offs for a public health problem, 1% and 0.5%, respectively\textsuperscript{124}. VAD was suggested to be a new problem, based on the lack of a local term for night blindness and old people in the community not knowing the problem. A 1991 statewide survey including 455 randomly selected children showed similar results\textsuperscript{125}, and a 1994 study relating VAD with otitis media\textsuperscript{126} confirmed the problem. In 1992 a study of children aged 18–24 months and 3–6 years found that 55–76% of children surveyed had VAD as defined by levels of serum retinol \(\leq 20\) \(\mu\)g/dl, the prevalence varying depending on age group and with higher prevalence rates in older children\textsuperscript{127}. VAD in Chuuk has been documented as among the most prevalent in the world\textsuperscript{124,128}. In 1993, a VA supplementation and dietary improvement programme began\textsuperscript{129,130}.

In Pohnpei, a 1994 Child Health Survey looked at 24–47-month-old children. In that randomised population-based survey \((n = 362)\) 51% of the children had VAD, defined by serum retinol \(< 20\) \(\mu\)g/dl\textsuperscript{131}. Night blindness was reported for 0.3% of the children, under the cut-off level for a public health problem. A VA supplementation and dietary improvement programme began in Pohnpei in 1997, with promotion of VA-rich foods, including the *karai* banana (from 1999)\textsuperscript{132}.

Due to concern about the remaining two FSM states, a population-based survey measuring serum retinol was carried out in January–February 2000 in Kosrae and the main island of Yap. Of the children aged 24–59 months

**Table 3**

Foods mentioned frequently by families in a dietary survey in Pohnpei, Chuuk and Yap, 1973\textsuperscript{*}

<table>
<thead>
<tr>
<th>Area</th>
<th>Principal carbohydrate-rich foods</th>
<th>Principal protein-rich foods</th>
<th>Fruits and vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pohnpei</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kolonia town</td>
<td>Rice, breadfruit, biscuits, bread, mayonnaise, sugar</td>
<td>Canned fish, canned meat, chicken</td>
<td>Mango, banana, watermelon, cucumber</td>
</tr>
<tr>
<td>Other municipalities</td>
<td>45 Rice, breadfruit, doughnuts, sugar</td>
<td>Fresh fish</td>
<td></td>
</tr>
<tr>
<td>Chuuk</td>
<td></td>
<td>Fresh fish, canned meat, octopus</td>
<td>Mango, banana, watermelon, coconut</td>
</tr>
<tr>
<td>Moen</td>
<td>24 Breadfruit, rice</td>
<td>Fresh fish, crab, octopus</td>
<td>Pineapple, watermelon, coconut</td>
</tr>
<tr>
<td>Lagoon islands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer islands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yap (main island)</td>
<td>22 Taro, breadfruit, rice</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Data taken from Kincaid, South Pacific Commission (1973)\textsuperscript{44}. Families interviewed were randomly selected. Note that the author does not specify if foods are listed in decreasing order of frequency of consumption.

*Turkey tails are literally the tails of the turkeys.
serum retinol

58% in Kosrae and 11.7% in Yap had VAD, defined by a of night blindness. Serum retinol measurements were difficult due to the lack of terminology and understanding of night blindness. Serum retinol measurements were taken on mothers and caretakers. Of the women surveyed, 58% in Kosrae and 11.7% in Yap had VAD, defined by a serum retinol <30 μg/dl\textsuperscript{133}, which is a matter of concern particularly in light of the new evidence linking night blindness in pregnancy with increased mortality\textsuperscript{134}.

Anaemia

In the FSM National Nutrition Survey, high rates of mild to moderate anaemia were found in the women studied (15–49 years) in all states, with a greater problem in Kosrae where 37.6% of non-pregnant, non-lactating women had a haemoglobin measurement <12 g/dl\textsuperscript{50}. The 1994 Pohnpei Child Health Study found 33% of children were anaemic, with anaemia defined as haemoglobin <11.5 g/dl. However, anaemia rates in children examined in Yap and Kosrae were 12.6% and 9.8%, respectively, with anaemia defined as haemoglobin <11.0 g/dl measured by the portable HemoCue\textsuperscript{116} instrument. These rates are relatively low given that rates of anaemia are often more than 50% in many communities in developing countries\textsuperscript{135}, and anaemia tends to be high in populations with high rates of VAD\textsuperscript{29}.

Weights and heights of children

The 1987/88 FSM National Nutrition Survey found that, overall, among children 0–4 years old, there were 9.9% stunted and 13.3% underweight (<80% of WHO/National Center for Health Statistics standards). In the Yap and Kosrae study in 2000, 17.1% and 16.2% of children were stunted, respectively. Wasting in both populations was less than 5%. Stunting and wasting were defined as <2 standard deviations below WHO/Centers for Disease Control and Prevention standards for height-for-age and weight-for-height, respectively. These reports can be compared with the WHO proposed classification of worldwide prevalence of low stunting and wasting among children <5 years of age, which are <20% and <10%, respectively\textsuperscript{136}.

Obesity, diabetes and hypertension in adults

Obesity, diabetes and hypertension are now serious problems in FSM. In the 1987/88 FSM National Nutrition Survey\textsuperscript{50}, the weights and heights of 3588 women (15–49 years) were measured, finding a mean body mass index (BMI) of 28 kg m\textsuperscript{2}. Approximately one-third of all women were moderately overweight in every age group, with overweight defined as BMI ≥25 and <30 kg m\textsuperscript{2}. Prevalence of obesity (defined as BMI ≥30 kg m\textsuperscript{2}) was particularly high in Kosrae (77%) in those aged 40–49 years. The Non-Communicable Disease (NCD) study carried out in 1992–94 examined over 4500 adults in all FSM states, and preliminary analyses found high prevalences of obesity, hypertension, diabetes and dyslipidaemia. A further analysis focusing on Kosrae data\textsuperscript{57} indicated that of 1259 females and 908 males examined, 24% were obese (defined as BMI ≥35 kg m\textsuperscript{2}), with average BMI of 31 kg m\textsuperscript{2}. This BMI, exceeding the WHO Grade 2 overweight cut-off\textsuperscript{136}, and the other obesity levels is of concern. Hypertension (systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg) was found among 17% of those surveyed and 12% qualified as diabetic (fasting blood sugar ≥126 mg/dl or 2-hour oral glucose tolerance test ≥200 mg/dl). The highest risk for obesity was in middle age. There seemed to have been little problem with hypertension in former times, with blood pressures low in Pohnpeians in the late 1940s\textsuperscript{25}. A 1970 study found increasing diastolic and systolic pressures with increasing modernity\textsuperscript{20}.

Parasite infection

Parasite infection has a great effect on nutritional status and health and has been a serious problem in FSM\textsuperscript{20,27,39,89}. In Kapingamarangi in 1953, 36.4% of those 275 people examined had at least one parasite\textsuperscript{29}. In 1975 one-third of all hospitalised children had intestinal parasites\textsuperscript{27}. With sanitation improvements, parasite infection has been reduced in recent years, although there are few data available. Along with VA supplementation in Chuuk and Pohnpei, all children from 1 to 12 years are now treated for parasite infection twice annually\textsuperscript{130}. In summary, although parasite and infectious disease have decreased in FSM in recent years, the emergence of vitamin A deficiency, obesity, hypertension and diabetes are serious concerns.

Conclusions

This review brings together, for the first time, a diverse body of data on food and nutrition for FSM. This shows that nutritional status prior to European contact was apparently good, and there was a diversity of local staple foods. The data available indicate that these foods contain at least minimal amounts of carotenoids, and some have high levels\textsuperscript{67}, important for protection against VAD and apparently against certain types of cancer, cardiovascular disease, diabetes and age-related macular degeneration. The replacement of local foods with foods such as white rice, flour and sugar, which contain no VA\textsuperscript{30}, and increased use of breast-milk substitutes, is a matter of concern particularly in relation to child health.

The great changes in diets and infant feeding practices in the 1970s, which preceded the apparent emergence of VAD in the 1980s, appear to be a main causal component in the present-day nutrition problems. The coherence and
consistency of the collection of studies provide a basis for arguing that the dietary and lifestyle changes are in fact largely responsible for the present-day VAD and chronic diseases problem. Inconsistent external and internal government policies and food aid programmes contributed to the dietary changes.

The review indicates that there is a need for further research into the nutritional content of local foods and underlying factors affecting their consumption, as well as information on dietary intake. Such information is essential in understanding better how and when local foods could be realistically and reasonably promoted to contribute to improved nutritional status. Finally, this review indicates that local foods have been important in the past in maintaining the health of FSM people. Serious consideration should be given to the establishment of a broad, well-planned, intersectoral intervention aimed at increasing the production and consumption of local foods and dietary improvement for all population age groups.

Acknowledgements

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References

4 Secretariat of the Pacific Community. The Staples We Eat. Noumea, New Caledonia: Secretariat of the Pacific Community, 1999.
10 Pollock NJ. These Roots Remain: Food Habits in Islands of the Central and Eastern Pacific since Western Contact. Laie, HI: The Institute for Polynesian Studies, 1992.
33 Mares-Perlman JA, Millen AE, Ficek TL, Hankinson SE. The
Food and nutrition in Micronesia: literature review


40 Murai M. Nutrition study in Micronesia. 15 Jul 2017 at 01:53:22


52 Severance CJ. Food for Pias: interests, linkages and the impact of federal feeding programs on a peripheral atoll. Presented at Symposium on Dependency and Development in Oceania at 9th Annual Meeting of the Association for Social Anthropology in Oceania, Galveston, TX, 26 February–2 March 1980.


69 Murai M, Pen F, Miller CD. Some Tropical South Pacific


