Ecology of Food and Nutrition, 44: 307–338, 2005

ISSN: 0367-0244 print / 1534-5237 online
DOI: 10.1080/03670240500187369

Routledge
Taylor & Francis Group

VITAMIN A INTAKE AND FACTORS INFLUENCING IT AMONGST CHILDREN AND CARETAKERS IN KOSRAE, MICRONESIA

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A cross-sectional study was undertaken in Kosrae, Federated States of Micronesia to assess preschool children and caretaker dietary intake of vitamin A (VA) (including provitamin A carotenoids) and other nutrients contributing to VA status and to investigate relationships between VA intake and factors affecting dietary intake. Ethnography, food sample analysis, two

Acknowledgement is made to The University of Queensland for provision of the International Postgraduate Research Scholarship for the primary author, who collected the data as part of her PhD research project. The Task Force Sight and Life, Thrasher Research Fund, and the Centers for Disease Control and Prevention provided funding support. All those providing assistance in the ethnographic study and dietary assessment are warmly thanked, including Dr. Eliuel Pretrick, Dr. Hiroshi Ismail, Mayble Sigrah, Jocelyn Charley, Cathy Wakuk, Isabel George, Matchuko Talley, Dr. Vita Skilling, and Procula Jackson.

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dietary assessment methods (7-day food frequency questionnaire and quantitative 24-hour recall for three nonconsecutive days) administered by trained interviewers to a random sample group, and cultivar difference specification (yellow-fleshed versus white-fleshed bananas) contributed to the richness of the study. Vitamin A intake was low, approximately half of the estimated requirements for children (n = 65) and caretakers (n = 65), whereas protein intake was high. There were no clear significant relationships associated with gender, caretaker education, caretaker occupation, and socio-economic status with VA intake, indicating that a broad-based intervention over all population segments is needed to change dietary behavior. The ethnographic approach was critical for survey instrument development and data analysis.

KEYWORDS dietary assessment, vitamin A, provitamin A carotenoids, preschool children, women, ethnography, food frequency questionnaire, 24-hour recall, Micronesia

INTRODUCTION

Vitamin A deficiency is a major public health problem among children and women in developing countries (WHO, 1995; McLaren and Frigg, 2001). Whereas inadequate diets and high rates of infection are well-recognized as causes of vitamin A deficiency, there are limited data on the patterns and determinants of dietary intake of different sources of vitamin A (VA) (Ramakrishnan et al., 1999). Animal sources of VA itself (retinol, a fat-soluble vitamin stored in the liver) include liver, egg, and milk. Provitamin A carotenoids, which may be converted to VA in the body, are mostly obtained from plant sources, such as yellow and orange-colored fruits and vegetables and dark green leafy vegetables (McLaren and Frigg, 2001).

Assessment of dietary VA intake is difficult for many reasons. For example, some VA-rich foods, such as liver, contain high levels but are infrequently consumed, leading to great day-to-day variability of VA intake. Thus, a greater number of days are needed to calculate usual intake compared to most other nutrients (Basiotis et al., 1987; Beaton et al., 1983; Nelson et al., 1989). Some regions have foods with unknown VA and other nutrient content, pointing to the need for doing nutrient analysis of locally available foods, especially when working cross culturally and in communities where diets may be significantly different from those that commonly form the basis for developing nutrition education and intervention programs. Nutrient analysis may also be needed to determine the impact of processing or ripening that is specific for a particular region. There are difficulties using food composition tables for calculating dietary VA intake. The use of different languages and nomenclature for identifying items, discrepancies in nutrient values, and inadequate information on sampling and analyses make it difficult to determine whether differences are due to natural and/or analytical variation (Kuhnlein and Pelto, 1997). There are great differences in the biological utilization of provitamin A carotenoid-rich items (Institute of Medicine, 2001), which are not reflected in food tables.

The Helen Keller International (HKI) Food Frequency Method (FFM) was developed as an innovative method to assess community risk of VA deficiency among children from 1 to 5 years of age (Rosen et al., 1993). It uses a 7-day food frequency questionnaire (FFQ), capturing dietary variety over a 7-day period. As specific amounts of food consumed are not collected, the HKI FFQ has the advantage of being easier to use than quantitative dietary assessment methods. The caretaker is asked about the number of days in the last 7 days that the child ate the listed foods (28 food items are listed) (Rosen et al., 1993). Community scores are calculated for animal VA and total VA sources.[1] Although data on amounts eaten are not collected, the HKI FFQ is semi-quantitative in that only foods providing about 100 Retinol Equivalents (RE[2]) per 100 g are included in the scores. The HKI FFM was shown valid for identifying VA deficiency in a few countries, although it had a high false positive rate (Sloan et al., 1997). Critics showed that it may underestimate VA intake if sustained breastfeeding is common and if milk is a normal dietary component, as neither breast or other milk is reflected in the scores (Persson et al., 1998, 1999). Due to findings that provitamin A carotenoid bioavailability is less than was once thought, the method of calculating the score now no longer reflects current conversion factors[3] (de Pee et al., 1998; Institute of Medicine, 2001).

[1]An individual HKI FFQ animal score reflects the number of days eating animal sources of VA. An individual total score equals the animal score plus the number of days eating plant sources of VA divided by 6 (reflecting conversion of provitamin A carotenoids to VA). Community animal and total scores are calculated by averaging the individual animal and total scores.

[2]RE is a unit quantifying VA activity in foods, referring to 1 μg all-trans-retinol (VA). The RE is defined as equivalent to 6 μg of dietary all-trans-β-carotene.

[3]The Retinol Activity Equivalent unit was recently recommended for quantifying VA activity in foods and is equivalent to 12 μg of dietary all-trans-β-carotene. However, the RE is still used in food composition tables.

Vitamin A intake may also be underestimated in dietary assessments if cultivar differences are ignored. Recent analyses reveal a great range in provitamin A carotenoid content in ripe banana, giant swamp taro, breadfruit, and pandanus cultivars, some containing high levels (Englberger et al., 2003b, 2003a, 2003d). In most of these foods, a yellow- or orange-colored edible flesh was a good carotenoid content indicator. Many banana (including plantain) varieties in the world have yellow- or orange-fleshed edible flesh (Englberger et al., 2003c; INIBAP, 2003). Some are documented as carotenoid-rich in certain food composition tables (Puwastien et al., 1999; Siong, 1985; Abdon and del Rosario, 1980). Yet, dietary studies in these regions have generally considered bananas as all having a low carotenoid content (Nimsakul et al., 1994; Sloan et al., 1997; Tarwotjo et al., 1982). Or, they do not specify whether yellow-fleshed banana cultivars are included in the yellow VA-rich fruits group or not (Mele et al., 1991; Solon et al., 1978). On the other hand, an Indonesian study identified *Pisang Raja* banana as one of the 47 foods contributing most of the VA to the diet of 265 preschool children (Humphrey et al., 2000).

Carotenoid levels in food increase with greater maturity and ripeness (Rodriguez-Amaya, 1997). Bananas are similar to papaya and mango (and in the Pacific, breadfruit) in that they are eaten green and in the half-ripe and ripe stages. Thus, if these foods are included as potential VA-rich foods on an FFQ assessing VA intake, the maturity at which these foods were eaten must be specified in order to provide a valid dietary assessment instrument.

In March 2000, a randomized population-based study was carried out in Kosrae, Federated States of Micronesia (FSM), identifying a serious problem of VA deficiency based on low serum retinol measurements among preschool children and their female caretakers (Centers for Disease Control and Prevention, 2001; Sowell et al., 2000). There were no reported cases of night blindness or other VA deficiency disorder among children, although some Kosrae mothers reported night blindness in the last pregnancy (questioning was difficult due to the lack of terminology and understanding of night blindness). Although a dietary assessment was made using a modified HKI FFQ (Englberger et al., 2001), there were no data in this earlier study assessing the diet in relationship to estimated requirements and determinants of dietary intake. Thus, the aims of the study reported here were to: 1) develop an appropriate tool for measuring and monitoring dietary VA among preschool children in

Kosrae, FSM and their caretakers; 2) assess and describe dietary VA intake for children and women; and 3) investigate relationships between dietary intake and factors influencing it.

STUDY SITE AND RESEARCH METHODS

The study, using a variety of methods, was carried out in Kosrae and Pohnpei, two of the four FSM states. Many of the foods of the two islands are similar. Kosrae consists of a single island state. Pohnpei, the seat of the FSM national government, consists of a main island, also called Pohnpei, and several outer islands. Many Kosraeans live in Pohnpei (main island).

The primary data collection of this cross-sectional food habits study was carried out in Kosrae, using a randomly selected subsample of the group that participated in the 2000 survey assessing prevalence of VA deficiency. Only one child per family (aged 24–59 months) was selected in the previous survey in order to maximize variation in diet and other characteristics. Further details of the sampling method are described elsewhere (Centers for Disease Control and Prevention, 2001). In order to develop a more complete picture of the usual diet, two dietary assessment methods were used: a 7-day FFQ and repeated, nonconsecutive, quantitative 24-hour recalls. Both used face-to-face interviews by trained interviewers from the local population who were familiar with the foods, customs, and language (Figure 1).

Of the 282 children participating in the 2000 dietary study (Englberger et al., 2001), there were 267 on the island at the time of the present study and along with their caretakers, all participated as subjects for the FFQ. All but one of the caretakers were female. The exception was the father of one child. For the 24-hour recall, a subsample (65 children and 65 female caretakers) was selected using the same sample list, which was organized by location (by the four municipalities of the island, also called villages). A coin was tossed as to whether the first or second person on the list would be selected, and then every fourth child was selected, providing a random and representative sample. Child dietary intakes were obtained from the caretakers.

The study was approved by the FSM National Health Research Committee, the Kosrae State Department of Health, and The University of Queensland Medical Research Ethics Committee. Verbal

Figure 1. A trained local Kosraean interviewer (right) conducts interview with a survey participant (left), using standard items to assist in estimating quantities of foods and drinks consumed.

informed consent was obtained from the families involved prior to their participation.

Ethnography and Food Sample Analysis

Ethnographic fieldwork, survey instrument development, and sample collection for nutrient analysis were carried out from September 2000 to February 2002 in Kosrae and Pohnpei. The study used observation, key informant interviews, informal focus group discussions, expert informant and literature reviews, market surveys, and photography, following methods described from guidelines developed for studies of this type (Blum et al., 1997; Fitzgerald, 1997; Miles and Huberman, 1994). The key informants included people from different ages (17 to 86 years), occupations (including students, farmers, housewives, nongovernmental and governmental officers), islands, and areas of the islands selected purposively for information-rich cases, in total, formally interviewing 91 male and 55 female informants. The interviews focused on description of the foods and food cultivars, coloration of the edible portion, stage of maturity that the foods were eaten, and differences in food consumption patterns between children and adults. As informants were interviewed other people often became interested and joined the discussion, resulting in informal focus group discussions.

The expert informant and literature reviews included contacting three Pacific e-mail networks—PACNUT (Pacific Nutrition Network), RootcropsNet, and PestNet, and the Food and Agriculture Organization (FAO)-based International Network of Food Data Systems (INFOODS) network for information on previous analysis of local foods, including different species of fish liver. The information was used for considering which foods to analyze and assess from the dietary intake data. Selected foods with potential for high nutrient content (i.e., using coloration of the edible portion as an indicator of carotenoid content) and no previous documentation of analysis were collected, prepared for analysis, and transported to two primary laboratories where the analyses were conducted (Englberger et al., 2003a, 2003b, 2003d). A focus was on carotenoid and retinol content.

Market surveys were conducted for documenting VA content from labels of commonly eaten imported foods and identifying VA-fortified shop foods. These data were used to develop the FFQ and assist in matching foods of the dietary intake with entries in the food composition database.

Food Frequency Questionnaire and 24-Hour Recall

Using the ethnographic data, the 7-day FFQ used in the 2000 dietary study, which had been modified from the HKI FFQ, was modified further (Englberger, 2003). For example, informants stressed that child diets differed from adult diets. Thus, the FFQ was changed to include data on caretaker intake. Separate food item categories were created for banana and breadfruit at different maturity stages. In all, the FFQ included 34 food items (recording number of days eaten) and 75 sub-items (whether eaten or not). Selected sub-items making up particular food item categories were listed,[4] including yellow banana cultivars. The intention was to include categories of foods containing about 100 RE per

[4]Types of dark green leafy vegetables, seafood egg/crab ovary, fish/seafood, tinned fish, tinned meat, non-yellow-fleshed and yellow-fleshed banana cultivars were listed as sub-items within the FFQ food item categories. Giant swamp taro and breadfruit cultivars were not listed as the ethnographic study showed them difficult to identify.

100 g according to the original HKI FFM, or as in the case of the non-yellow banana cultivars and different types of protein foods, to list the commonly eaten foods for that category. In pretesting the questionnaire, this was shown to assist interviewers in probing and standardization. Also, this allowed the collection of data on consumption of these sub-items. Interviewers recorded if the child was breastfed. Wheat flour, sugar-rich foods, and imported fats, such as shortening and oil, were not included in the FFQ in order to focus on VA-related items and avoid subject burden.

Data on local carbohydrate foods eaten at different maturity stages, such as green and ripe breadfruit, and green, half-ripe, and ripe banana, were recorded as separate items. Vitamin A-fortified margarine and butter were grouped (participants did not distinguish between the two). Ramen (instant noodles), which could be a possible vehicle for VA fortification, was included as a separate item in order to obtain information on its consumption. Through the market survey, one VA-fortified ramen brand was identified and interviewers showed samples to participants to inquire about its consumption.

In preparing for the 24-hour recall over 100 commonly eaten food items were measured in standard measures (cups, teaspoons, serving spoons, size in inches) and common portion sizes (large and small) and weighed, using a *Soehnle* digital kitchen scale (measuring in 1 g divisions). These results were itemized in a standard portion size list for use by interviewers. Recipes of common dishes were recorded. Food photographs were made for the interviewers for using as tools to help identify yellow-fleshed banana cultivars and other foods and identifying rare cultivars (Figure 2). Photographs were also made of common portion sizes of weighed foods for improving interviewer estimates of quantities of foods eaten (Figure 3).

During pretesting, informants indicated that the question on family income, which may be related to dietary intake, would not be culturally appropriate, may arouse suspicion among survey participants, and may not be known by the caretaker. Based on informant suggestions, this question was replaced with seven questions about items that might indicate family wealth and food supply. Also caretakers were asked about the number of years of schooling that they had had. Owning a car was the most important indicator of wealth among the items and was assigned a weight of three points. All other items were given a weight of one: the caretaker having 12 or more years of

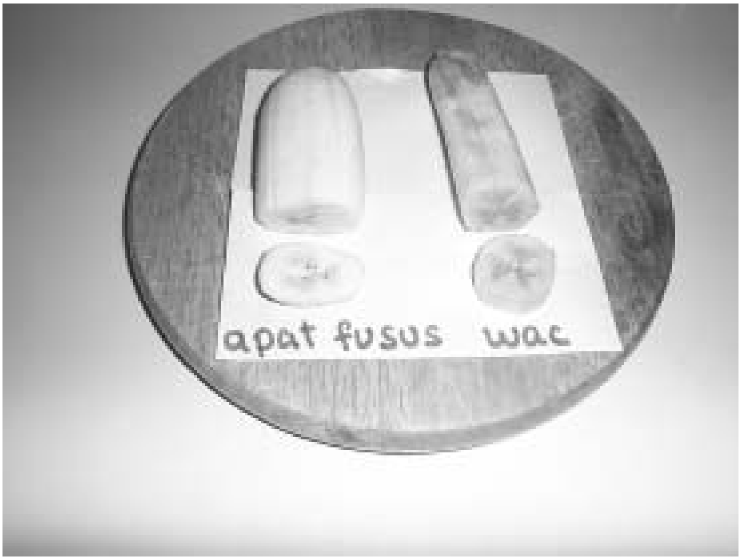

Figure 2. A peeled deep yellow-fleshed Kosrae banana, *Usr Wac*, (right) is compared to a light-fleshed banana, *Usr Apact Fusus* (left).

Figure 3. Common portion sizes of foods were weighed, measured, and photographed to assist interviewers in estimating the quantities of foods consumed.

schooling, the family having land, electricity, a freezer, refrigerator, electric stove, telephone, and a car. The maximum possible score was 10 points.

Draft survey instruments were pretested and revised before printing by reviewing questions with government officers and community people. The questions that provided the most relevant information and were culturally sensitive were selected and reworded if necessary. The interviewers interviewed one another to ensure that questions were understood, timing an interview to take 1 hour. Questions were presented in English on the forms but were asked in the local language. This was for three reasons: questions were more precise in English due to the limited vocabulary of the local languages, interviewers were fluent in English and the local languages, and there was more than one local language (Kosraean and Pohnpeian). Three days of interviewer training were provided on how to administer the questionnaires, estimate portion sizes, and probe for responses. Five practice interviews (not a part of the study) per interviewer were conducted.

The FFQ along with a structured questionnaire providing information on subject characteristics that might influence dietary intake, including education and occupation, was administered in a 2-week time period in March 2001. The three 24-hour recalls were conducted in May, July, and September 2001, to cover different seasons, in and out of the breadfruit season, excluding weekend days. Most survey participants came to the government health clinics for the interviews (Lelu, Malem, Tafunsak, and Utwe); some home interviews were conducted, including those in Walung, an area only accessible at the time by boat. A standard 24-hour recall protocol was followed, asking for the exact food and drink intake in the last 24 hours and recording time, place, description, and amounts of that which was consumed, including any food supplements (Gibson, 1993).

The primary author checked the forms before caretakers left the survey location. Interviewers were monitored throughout the survey to ensure standard interview methods. Form errors, omissions, and inconsistencies were corrected during the survey. Unusual results were verified with the interviewers and sometimes participants were again contacted. Inquiries were made to relatives and those with details on children's diets for details about foods and drinks that children consumed at times spent away from the primary caretaker.

Data Analysis

The field notes and other data from the ethnographic study were analyzed continually throughout the quantitative survey instrument development and collection and analysis of the quantitative data. Food items for both the 7-day FFQ and the repeated 24-hour recall were analyzed for the frequency (number of days) that items were consumed within the study period. Data were entered into Excel by the primary author and checked by rereading data entry, assisted by interviewers. The quantitative recall data were entered into FoodWorks 2.10.136 of Xyris Software (Australia). An appropriate database was chosen for matching with intake items (Dignan et al., 1994). A coding list was kept to record the match selected to standardize data entry. The focus was on measuring intake of total VA, retinol, β-carotene equivalents (directly relating to VA status), protein, energy, and fat (indirectly relating to VA status, absorption of VA-rich foods, VA metabolism, and overall energy). Twelve foods were entered into the database using content of μg β-carotene equivalents or μg retinol determined in the laboratory analyses associated with this study (different cultivars of banana, breadfruit, giant swamp taro, pandanus, and different species of fish liver) (Englberger, 2003). Sixteen recipes were entered. Imported foods labeled with high or negligible VA content were matched with a database item of similar VA content. Final statistical analysis was undertaken using SPSS version 10.0 statistical software. Differences in means were tested by the Student's *t*-test and paired sample *t*-test for two-group comparisons and by analysis of variance for multiple group comparisons. General linear modeling was used to adjust for the potential confounding variables of age and gender in comparison to means of dietary intake. Spearman's rank correlation coefficients were calculated to measure the strength of association between the rankings of frequency of consumption of individual foods from the 7-day FFQ and the three 24-hour recalls. Pearson's correlation coefficients were calculated to measure the strength of associations between continuous variables. The chi-squared test of association and Fisher exact test (for unexpected cell values less than five) measured the strength of associations between categorical variables. All *p* values were based on two-tailed tests.

RESULTS

Table 1 presents characteristics of the primary sample group and the subsample. There were no important differences between the two

Table 1. Characteristics of the study population

Characteristics	7-Day FFQ[1] Sample n (%)[3]	24-Hour Recall[2] Sub-Sample n (%)[3]
CHILD		
Gender: Male	136 (51)	36 (55)
Female	131 (49)	29 (45)
Age group		
29–47 months	87 (33)	17 (26)
48–59 months	91 (34)	23 (35)
60–78 months	89 (33)	25 (39)
Age in months, mean ± sd[4]	54 ± 10	55 ±10
CARETAKER		
Gender: Male	1 (0.4)	0 (0)
Female	266 (99.6)	65 (100)
Age group		
17–29 years	93 (35)	25 (38)
30–39 years	99 (37)	19 (29)
40–49 years	49 (18)	15 (23)
50–74 years	26 (10)	6 (9)
Age in years, mean ± sd	35 ± 10	35 ± 10
Level of education		
0–6 years	18 (7)	3 (5)
7–9 years	80 (30)	19 (29)
10–12 years	122 (46)	34 (52)
Over 12 years	47 (18)	9 (14)
Number of years of school, mean ± sd	10 ± 3	10 ± 3
Relationship to child		
Mother or adopted mother	212 (79)	49 (75)
Father	1 (0.4)	0 (0)
Other	54 (20)	16 (25)
Employed	88 (33)	22 (34)
Ethnicity		
Kosraean	258 (97)	63 (97)
Other (Pohnpeian, Marshallese)	9 (3)	2 (3)
Location of residence on the island[5]		
Utwe	41 (15)	8 (12)
Malem	50 (19)	13 (20)
Lelu	84 (32)	19 (29)
Tafunsak[6]	92 (35)	25 (39)
Most fresh produce from own land	252 (94)	60 (92)
Lives in own house	190 (71)	42 (65)
Has electricity	261 (98)	65 (100)
Has telephone	240 (90)	56 (86)
Has car	208 (78)	48 (74)

Table 1. Continued

Characteristics	7-Day FFQ[1] Sample n (%)[3]	24-Hour Recall[2] Sub-Sample n (%)[3]
Family kitchen equipment		
Has kerosene stove	247 (93)	61 (94)
Has rice cooker	193 (72)	49 (75)
Has electric stove	54 (20)	13 (20)
Has freezer	173 (65)	45 (69)
Has refrigerator	88 (33)	21 (32)
Family SES score, mean ± sd	6.51 ± 1.8	6.35 ± 1.8

[1]7-day FFQ in March 2001, n=267
[2]24-hour recall, May, July, Oct 2001. n=65 or 64/month
[3]Number and percentages, unless otherwise indicated.
[4]Standard deviation
[5]Grouped by municipality
[6]Tafunsak also includes Walung village

groups. None of the people approached refused to participate. Initially, some participants expressed concern as to why they had been selected and indicated that there was stigma associated with VA deficiency. However, after it was explained that they had been selected randomly, not on the basis of diet or health status, all were willing to participate.

The main dietary components reported in the two dietary assessments included imported products of rice, flour, chicken, other meats, and tinned fish, and local products of breadfruit, banana, taro, fish, and other seafood, with few fruits and vegetables. Caretakers reported no consumption of vitamin or mineral supplements and no alcohol (which is likely as Kosrae women do not commonly consume these), and they also reported no supplement intake by children (which is likely as supplements are not readily available and taking them is not a common cultural practice).[5]

7-Day Food Frequency Questionnaire

Rice (imported) was by far the most frequently eaten carbohydrate food (Table 2). A small percentage (33%) of children ate locally grown

[5]Since this study was done, a VA supplementation program has been initiated for preschool children through the Kosrae Department of Health, as supported by the FSM national government and the United Nations Children's Fund.

carbohydrate foods on 7 days, whereas 95% of the children consumed rice on 7 of these days. Caretakers consumed local carbohydrate foods somewhat more frequently, but still rice was eaten very frequently. Ramen was frequently eaten by children and caretakers, but only two

Table 2. Reported frequency of consumption of selected food items by children and caretakers in the 7-day FFQ

	Children[1]			Caretakers[1]		
Food Item[2]	0 days	1–2 days	3–7 days	0 days	1–2 days	3–7 days
Carbohydrate						
Rice	0	0	100	1	1	99
Local crops, as a group[3]	3	24	73	1	22	76
Breadfruit, green	13	54	33	10	54	36
Banana, ripe non-yellow	30	32	38	31	33	36
Ramen	25	46	29	26	45	29
Banana, half-ripe	57	23	20	56	24	20
Banana, green	62	23	16	57	27	17
Banana, ripe, yellow	62	12	11	78	12	10
Taro, giant swamp	60	37	4	51	43	5
Breadfruit, ripe	81	14	5	81	15	5
Cassava, yam, sweet potato[4]	80	18	2	88	20	2
Taro, common	77	23	1	72	28	1
Selected high-fat food						
Non-coconut, non-dairy[5]	7	18	75	7	17	76
Mature coconut[6]	6	45	50	6	44	51
Butter, margarine	64	16	21	63	16	21
Protein						
Meat, not tinned[7]	2	11	87	2	11	88
Fish, seafood, not tinned[8]	3	23	74	3	21	76
Milk[9]	15	21	64	17	21	62
Fish, tinned[10]	30	46	24	29	47	24
Egg of chicken with yolk	39	35	26	44	32	24
Meat, tinned[11]	42	44	14	42	45	13
Egg of fish, or crab ovary	77	16	8	69	23	8
Liver, fish	91	7	2	82	15	3
Liver, meat[12]	95	3	2	90	7	3
Fruit and vegetable						
Tangerine or orange	5	39	56	6	42	52
Dark green leafy vegetable[13]	52	31	18	50	32	18
Papaya, ripe	59	33	8	60	33	7
Pandanus	77	17	6	78	16	6

Table 2. Continued

	Children[1]			Caretakers[1]		
Mango, ripe	87	8	5	89	8	4
False durian (*Pangium edule*)	99	1	0	99	1	0
Pumpkin, fresh or tinned	99	1	0	99	1	0

[1]n= 267 in March 2001. Values are percentages.
[2]Fermented breadfruit, yellow sweet potato, and sea urchin were other items on the questionnaire, but these were not reported by any subject.
[3]Includes any breadfruit, banana, taro, and other root crops.
[4]Includes non-yellow fleshed sweet potato cultivars.
[5]Includes fried foods, gravy, curry, and turkey tail.
[6]Includes any food made with mature coconut or coconut cream.
[7]Includes chicken, pork, beef, dog.
[8]Includes reef and pelagic fish (including tuna), crab, turtle, lobster, eel, octopus, shellfish.
[9]Includes evaporated, condensed, heat-treated, powdered milk.
[10]Includes tinned mackerel, sardine, tuna.
[11]Includes corned beef, *spam*, beef stew, sausage.
[12]Includes liver of chicken, pork, or dog.
[13]Includes Chinese cabbage, pepper leaves, *kang kong, pele*, and a few reports of tinned mixed vegetable and carrots.

caretakers (0.7%) reported eating the fortified ramen. *Taiwang* (Figure 4) was found to be the most commonly consumed of the carotenoid-rich banana cultivars. However, many caretakers also revealed that they believed that eating *Taiwang* banana would cause a worm infection. Breadfruit (Figure 5) at the green mature stage was the most frequently eaten local carbohydrate food, but banana and giant swamp taro were also commonly eaten.

Foods providing fat, such as coconut products and imported oils, were frequently eaten, but butter and margarine, both VA-rich, were not. Most participants ate protein items each day, often at three or more meals. The most frequently consumed protein food was imported chicken (frozen), closely followed by local fish. Milk (an imported product in FSM), if consumed, was primarily diluted. Only three children (all over 24 months old) were still breastfed, and they were breastfed only once a day.

A significantly greater number of caretakers consumed liver on at least 1 day out of 7 days compared to the children, ($p < 0.01$ for fish liver

Figure 4. *Taiwang* banana (left), with its yellow edible flesh, compared to a common Kosrae light-fleshed banana (right).

and $p < 0.05$ for pork and chicken liver). Caretakers explained that they did not know that it was important to give liver to children. Informants also explained that a certain reef fish liver is (Figure 6) especially liked for its good taste and may be eaten raw by whoever is cleaning the fish. However, informants also explained that tuna fish liver is often not available as it is discarded before marketing. More caretakers, compared to children, consumed giant swamp taro (difference reaching significance), this was partly related to the hard texture.

24-Hour Recall

Table 3 presents the frequency of foods consumed in the 24-hour recalls, with foods grouped similarly as to the FFQ. The results showed a similar pattern as that seen in the results of the FFQ, but provided a fuller view of the diet. Marked differences were seen between the child and caretaker intake of local carbohydrates as a group, and individually for breadfruit, green banana, and giant swamp taro.

Table 3. Reported frequency of consumption of selected food items by children and caretakers in the three 24-hour recalls

	Children[1]				Caretakers[2]			
Food Item	0 days	1 day	2 days	3 days	0 days	1 day	2 days	3 days
Carbohydrate								
Rice	0	0	0	100	0	2	9	89
Sugar[3]	0	0	20	80	0	3	11	86
Local crops, as a group[4]	17	46	28	9	2	22	31	46
Flour, wheat[5]	5	15	29	51	9	22	26	43
Ramen	40	37	20	3	43	35	17	5
Banana, ripe non-yellow[6]	26	60	14	0	23	11	29	3
Banana, green	80	17	3	0	54	38	5	3
Breadfruit, any kind	65	34	2	0	20	75	5	0
Banana, ripe, yellow[7]	92	6	2	0	92	6	2	0
Taro, giant swamp	92	8	0	0	75	22	3	0
Taro, common	92	8	0	0	88	11	2	0
Cassava, yam, sweet potato[8]	94	6	0	0	92	8	0	0
Selected high-fat food								
Non-coconut, non-dairy[9]	0	2	9	89	0	0	11	89
Mature coconut[10]	62	31	6	2	40	35	22	3
Butter or margarine	94	6	0	0	86	14	0	0
Protein, any kind	0	0	5	95	0	0	2	99
Meat, not tinned[11]	3	17	40	40	2	22	42	35
Fish, seafood, not tinned[12]	20	32	32	15	6	29	49	15
Milk[13]	26	34	26	14	34	40	19	8
Egg of chicken with yolk	66	22	9	3	62	26	8	5
Fish, tinned[14]	37	46	12	5	34	46	19	2
Meat, tinned[15]	48	42	9	2	62	34	3	2
Cheese	94	6	0	0	94	6	0	0
Liver, fish	100	0	0	0	91	9	0	0
Egg of fish, or crab ovary	100	0	0	0	100	0	0	0
Fruits and vegetables								
Any fruit	15	37	35	12	29	31	23	17
Any vegetable	25	62	11	3	32	45	20	3
Tangerine or orange	55	34	9	2	71	14	12	3
Dark green leafy vegetable[16]	75	23	2	0	68	32	0	0
Tinned mixed vegetable	79	19	3	0	83	12	5	0
Lettuce, eggplant, other[17]	72	28	0	0	79	17	5	0

Table 3. Continued

	Children[1]				Caretakers[2]			
Mango, ripe	88	12	0	0	86	12	2	0
Papaya, ripe	91	9	0	0	91	9	0	0
Pandanus	95	3	2	0	99	11	0	0

Note: These foods consumed in the 24-hour recall (weekdays only) were grouped to match the categories of the 7-day FFQ in Table II for comparison purposes.

[1]n=65 in May, October 2001 and n=64 in July 2001. Values are percentages.

[2]n=65 in May, July 2001 and n=64 in October 2001. Values are percentages.

[3]Includes sugar, sweet drink, candy, ice cream, any food with sugar.

[4]Includes any breadfruit, banana, taro, or other root crops.

[5]Includes bun, doughnut, pancake, bread, all wheat products but ramen. All are from white refined flour.

[6]Includes *Usr Kufafa, Apat Fusus, Apat Regular, Fiji.*

[7]Includes *Usr Taiwang, Lakatan.*

[8]Includes nonyellow fleshed sweet potato.

[9]Includes fried food, gravy, curry, and turkey tail.

[10]Includes food made with mature coconut or coconut cream.

[11]Includes chicken, pork, beef.

[12]Includes reef and pelagic fish, crab, turtle, lobster, eel, shellfish.

[13]Includes evaporated, condensed, heat-treated, powdered milk.

[14]Includes mackerel, sardine, tuna.

[15]Includes corned beef, *spam*, beef stew, sausage.

[16]Includes Chinese cabbage, pepper leaves, *kang kong, pele.*

[17]Includes vegetables that are not VA-rich, such as white cabbage.

Although this study did not focus on flour products (all were from refined white flour, some brands fortified, some not), sugar-rich foods, and imported fats, the level of consumption of these foods was high (Table 3) and is a matter of concern. As in other parts of the Pacific, obesity, diabetes, and hypertension are now serious health problems in Kosrae, largely due to the shift in the diet to imported foods and to changing lifestyles (Englberger et al, 2003e; Shmulewitz et al, 2001). It is likely that there is a negative impact on the overall diet and health due to the high level of consumption of these foods, and they may also affect micronutrient utilization.

To assess the comparability of the two dietary assessment methods, the frequency of days (0–7) that a food item was consumed in the 7-day FFQ was correlated with the frequency eaten of the same item (or groups of items, grouped similarly in both methods) consumed in the 24-hour recalls (0 to 3 days) (Table 4). In this comparison, there were 10 food items consumed by caretakers that had a moderately strong correlation (correlation coefficients from 0.26 to 0.38). These included all the protein items except for fish liver, an infrequently consumed food. Seasonality affected

Table 4. Spearman's correlation coefficients between frequencies of consumption of selected foods by children and caretakers in the 7-day FFQ[1] and three 24-hour recalls[2]

Food Item	Child Intake		Caretaker Intake	
Carbohydrate				
Rice	–	–	0.26	p =0.04*
Local foods	0.15	p =0.24	0.21	p =0.09
Breadfruit, green	0.14	p =0.27	0.14	p =0.26
Banana, ripe non-yellow	–0.07	p =0.59	–0.00	p =0.98
Banana, yellow	0.03	p =0.80	–0.14	p =0.26
Banana, green	0.09	p =0.50	0.14	p =0.25
Taro, giant swamp	–0.10	p =0.43	0.17	p =0.18
Ramen	0.21	p =0.10	0.03	p =0.79
Selected high-fat food				
Butter	0.19	p =0.13	0.34	p =0.01*
Coconut	0.06	p =0.61	0.20	p =0.11
Protein				
Meat, untinned[3]	0.13	p =0.29	0.28	p =0.02*
Meat, tinned	0.17	p =0.18	0.38	p =0.00**
Fish and seafood	0.30	p =0.02*	0.27	p =0.03*
Fish, tinned	0.01	p =0.92	0.31	p =0.01*
Egg, chicken	0.25	p =0.05	0.32	p =0.01*
Egg, fish	-	-	-	-
Liver, fish	-	-	0.11	p =0.39
Milk, all kinds	0.37	p =0.00**	0.38	p =0.00**
Fruits and vegetables				
Tangerine and orange	0.12	p =0.33	0.34	p =0.01*
Dark green leafy vegetable	-0.26	p =0.04*	0.02	p =0.87
Papaya, ripe	0.33	p =0.01*	–0.02	p =0.89
Mango, ripe	-	-	0.25	p =0.04*

[1]n=267 children and 267 caretakers in March.

[2]n=65 children, 65 caretakers in May; 64 children, 65 caretakers in July; 65 children, 64 caretakers in October.

[3]Includes chicken as the most predominant food in the group of foods.

*Significance at p< 0.05.

**Significance at p< 0.01.

some items, which is likely to have been a factor resulting in the weak association between the local carbohydrate items of the two methods. The FFQ was administered during the breadfruit season and the 24-hour recalls were administered when little breadfruit was available; also fish egg, crab ovary, and mangoes were more available in May. Milk, an item not affected by seasonality, was the most strongly correlated of the food items.

Table 5 presents the mean daily nutrient intake estimated from the three 24-hour recalls. The mean daily intake of total VA for all children, regardless of age or gender, was less than half of the requirements estimated by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) (WHO/FAO, 2002).[6] However, the mean protein intake (54 g ± 10 sd) was well beyond estimated requirements [7] (Latham, 1997), and fat intake was well beyond the 5 g daily minimum estimated as necessary for VA metabolism (FAO/WHO, 1988). For caretakers, the findings were similar: the mean VA intake was low and protein and fat intakes were high, compared to estimated requirements (WHO/FAO, 2002).[8]

A comparison was made between selected foods eaten by children consuming low and high VA intake. The median total VA intake, 128 RE, was selected as the cut-off for grouping children into low and high levels of VA intake. A significantly greater number of children having high VA intake consumed various VA-rich foods (milk, liver, papaya, mango, and dark green leafy vegetables). However, papaya was among the important foods in the high VA intake group for children but not for caretakers, confirming informant reports that papaya is considered a children's food. Nevertheless, papaya consumption was still low.

Relationships between VA Intake and Factors Affecting Dietary Intake

The intakes of total VA, retinol, and ß-carotene equivalents were skewed for both children and caretakers,[9] whereas protein, fat, and

[6]The WHO/FAO Recommended Safe Intake of VA for children 1–3 years of age is 400 μg RE/day. For children 4–6 years of age, it is 450 μg RE/day.

[7]The FAO/WHO requirement is 16 g for a 3–5 year old child on a diet rich in complete proteins.

[8]The WHO/FAO Recommended Safe Intake of VA for non-pregnant, non-lactating women 19–65 years of age is 500 μg RE/day.

[9]Caretaker outliers had a high VA intake due to consumption of fish liver, whereas the child outliers had high VA intake due to consuming various foods.

Table 5. Mean daily intakes of selected nutrients by children and caretakers in three 24-hour recalls

Age Group	n	Total Vitamin A[1] µg RE[2]	Retinol µg	ß-Carotene Equivalents-µg	Protein g	Fat g	Energy kj
CHILDREN[2]	M = 7	122 ± 59	71 ± 44	304 ± 206	52 ± 10	51 ± 24	6080 ± 1551
29–47 mo	F = 10	147 ± 47	71 ± 32	455 ± 270	55 ± 10	43 ± 16	5585 ± 1040
		p=0.35	p=0.99	P=0.24	p=0.48	p=0.43	p=0.44
48–59 mo	M = 12	143 ± 68	81 ± 49	372 ± 273	51 ± 13	43 ± 9	5915 ± 943
	F = 11	175 ± 79	99 ± 46	456 ± 324	53 ± 8	46 ± 11	5740 ± 1089
		p=0.31	p=0.37	p=0.51	p=0.60	p=0.42	p=0.69
60–78 mo	M = 17	195 ± 92	108 ± 65	519 ± 380	54 ± 9	53 ± 12	6532 ± 697
	F = 8	173 ± 121	103 ± 70	422 ± 366	58 ± 14	56 ± 14	6289 ± 1123
		p=0.63	p=0.86	p=0.55	p=0.40	p=0.62	p=0.51
All ages	M = 36	163 ± 83	92 ± 57	429 ± 324	53 ± 10	49 ± 14	6239 ± 998
	F = 29	165 ± 82	91 ± 50	446 ± 308	55 ± 10	48 ± 15	5839 ± 1082
		p=0.94	p=0.92	p=0.82	p=0.30	p=0.70	p=0.13
Ages, genders combined	65	164 ± 82	91 ± 54	437 ± 314	54 ± 10	49 ± 14	6060 ± 1048
CARETAKERS[3]							
17–29 y	25	274 ± 204	141 ± 161	796 ± 647	80 ± 17	71 ± 19	9083 ± 1928
30–39 y	19	259 ± 208	138 ± 154	720 ± 493	78 ± 16	68 ± 19	8700 ± 1395
40–49 y	15	280 ± 186	140 ± 113	839 ± 731	73 ± 17	60 ± 25	8591 ± 2076
50–74 y	6	285 ± 163	157 ± 141	767 ± 506	74 ± 12	62 ± 14	8645 ± 1583
Significance		p=0.99	p=0.99	p=0.95	p=0.65	p=0.40	p=0.77
Ages combined		272 ± 197	141 ± 146	786 ± 617	77 ± 16	67 ± 20	8868 ± 1742

[1]Retinol Equivalents .

[2]Children, all ages, genders combined: n=65 in May and October; n=64 in July.

[3]Caretakers, all ages: n=65 in May and July, n=64 in October.

Note: Significance testing by analysis of variance.

energy intakes were more normally distributed. In examining for relationships, tests were done both with and without cases with extreme high values to ensure that relationships were not affected by the skewed values.

There were no significant gender differences in dietary intake among the children, which allowed for further relationships to be compared with genders combined. The caretaker education level was compared to the child and caretaker nutrient intake, grouping the number of years of schooling according to the education levels in Kosrae: 0–9 years (primary school), 10–12 years (high school), and over 12 years (tertiary schooling). There was a trend towards greater nutrient intake with greater educational level for all six nutrients for both child and caretaker, but the differences were not statistically significant.

Children of employed caretakers had a significantly greater intake of total VA, retinol, protein, and energy, which may be related to income or food accessibility differences (Table 6). Caretaker retinol intake was significantly greater among employed caretakers. However, there was no significant relationship between occupation and child total VA and caretaker retinol when outliers were excluded.

There was a moderately strong correlation between family SES scores and caretaker intake of total VA and ß-carotene equivalents, but only a weak correlation between SES and child intakes (Table 7). When outliers were excluded, the strength of the association was considerably weaker, indicating that there may not be a significant relationship in the larger population. Protein, fat, and energy intake were not correlated with the SES scores. Also the HKI FFQ scores were not strongly correlated with SES (Table 8).

There were significant differences between residence location and caretaker total VA and retinol intake, with the highest intake in Malem, a fishing village with poor soils and no access to the deep sea. Even with outliers excluded, the association of location with total VA intake remained significant. Informants said that Malem residents are known for eating a wider range of seafood, including small fish with liver intact (Englberger, 2003). Also less VA deficiency was found in Malem compared to the other three municipalities of Kosrae (Gonzaga, 2000). No clear seasonal differences were found after comparing VA intake of the three different days taken in different seasons.

Table 6. Mean daily intakes of selected nutrients by children and caretakers in three 24-hour recalls by caretaker occupation

	n[1]	Total Vitamin A µg RE[2]	Retinol µg	ß-carotene equivalents-µg	Protein g	Fat g	Energy kj
Child Intake							
Caretaker is housewife	43	146 ± 12	79 ± 8	401 ± 49	51 ± 1	46 ± 2	5833 ± 151
Caretaker is employed	22	193 ± 17	110 ± 11	498 ± 69	60 ± 2	52 ± 3	6384 ± 215
Significance[3]		p=0.03[4]*	p=0.03[5]*	p=0.26	p=0.00[6]**	p=0.13	p=0.04[6]*
Caretaker Intake							
Caretaker is housewife	43	242 ± 36	104 ± 26	825 ± 114	77 ± 3	65 ± 4	8848 ± 320
Caretaker is employed	22	323 ± 43	198 ± 31	745 ± 138	76 ± 3	66 ± 4	8810 ± 387
Significance[3]		p=0.14	p=0.02[4]*	p=0.65	p=0.73	p=0.90	p=0.78

[1]Children: n=65 in May and October; n=64 in July. Female caretakers: n=65 in May and July, n=64 in October.

[2]Retinol equivalents.

[3]Significant testing by univariate analysis of variance, controlled for age and gender.

[4]When the outliers were excluded from the analysis, there was no longer a significant difference.

[5]When the outliers were excluded from the analysis, there was still a significant difference.

[6]The data were normally distributed with no clear outliers.

Note: Numbers are the adjusted means ± standard error, unless otherwise indicated.

*Significance at p< 0.05.

**Significance at p< 0.01.

Table 7. Pearson correlation coefficients between mean daily intakes of selected nutrients by children and caretakers in three 24-hour recalls and SES scores

	n[1]	Total Vitamin A µg RE[2]	Retinol µg	ß-Carotene Equivalents-µg	Protein g	Fat g	Energy kj
Child Intake							
& Family SES score[3]	65	0.238	0.148	0.220	0.145	0.183	0.104
Caretaker Intake							
& Family SES score	65	0.327**	0.243	0.278*	-0.029	-0.005	-0.052

[1]Children: n=65 in May and October; n=64 in July. Female caretakers: n=65 in May and July, n=64 in October.
[2]Retinol Equivalents.
[3]Constructed of family ownership of items, land, and female caretaker educational level.
Note: When the 3 outliers were excluded for the analysis for caretaker intake of total VA, the Pearson correlation coefficient dropped to 0.225 and the association was much weaker.
*Significant at the 0.05 level.
**Significant at the 0.01 level.

Table 8. Pearson correlation coefficients between scores by children and caretakers in 7-day FFQ and SES scores

	n	7-Day FFQ Total Score[2]	7-day FFQ Animal Score[3]	n	7-Day FFQ Total Score	7-Day FFQ Animal Score
Child Intake & Family SES score[1]	267	0.083	0.085	65	0.129	0.139
Caretaker Intake & Family SES score	267	0.061	0.066	65	0.178	0.189

[1]Constructed of family ownership of items, land, and female caretaker educational level.
[2]The mean total VA scores (calculated by the HKI FFQ method) were 4.3 and 4.6, respectively, for children and caretakers, n=267.
[3]The mean animal scores (calculated by the HKI FFQ method) were 3.7 and 4.1, respectively, for children and caretakers, n=267.

Figure 5. Breadfruit, split in half and baked in the traditional earth oven (*um*), are presented in a traditional basket woven from coconut fronds.

DISCUSSION

The use of ethnographic formative research, two dietary assessment methods, intensive interviewer training, monitoring, and data verification, and the input of data to the food composition database contributed to a more precise assessment of the diets. Interviewers reported that caretakers appeared to have a good memory of the diets reported. Overall, the data suggest that we can be confident that the estimates of the dietary intake closely approximate the intake for those days studied and are probably indicative of the usual diet.

Dietary VA intakes for both children and women were very low. The child VA intakes were similar to intakes of other populations where VA deficiency is a public health problem (Calloway et al., 1993;

Figure 6. The liver of the parrotfish (shown above) is prized for its taste and is reported to be the largest sized liver of kosrae reef fish.

Ramakrishnan et al., 1999; Zeitlin et al., 1992). However, in contrast to populations in other developing countries where VA deficiency is endemic and protein intake is low (Adelekan et al., 1997; Faber and Benade, 1999), this population had a high protein intake and a relatively high proportion of VA from animal sources (52–53% for children and women).

Low income has been identified elsewhere as an important risk factor for low VA intake (Fawzi et al., 1997; Ramakrishnan et al., 1999). In this study, there was no clear association between family wealth and education (as indicated by the SES score), which may partly be explained by the subsistence nature of this island community. There were no clear trends relating gender, caretaker education, caretaker occupation, and socio-economic status with VA intake, indicating that a broad-based intervention over all segments of the population is needed to change dietary behavior.

The ethnographic approach was valuable in identifying the items of importance to include on the dietary instrument (both FFQ and 24-hour recall) and establishing the need for collection of both child and caretaker diets. This was important for detecting differences between children and women in the intake of VA-rich foods such as fish liver and caretaker perceptions on fish liver, *Taiwang* banana, and other local carbohydrate foods. An understanding of these beliefs is useful in developing a relevant food-based strategy for alleviating VA deficiency. The inclusion of subitems in the FFQ enhanced interviewer ability to probe and provided additional information. Although the consumption of yellow-fleshed carotenoid-rich banana cultivars is lower than the level of consumption of white-fleshed bananas low in carotenoid content, it is still likely that the precision added by specifying these two types of bananas contributed to a more accurate estimate of the dietary intake of VA. Also, the specification of banana maturity (if eaten green or ripe) was important in this community where bananas are an important part of the diet.

Again, as in other parts of the Pacific, chronic diseases such as diabetes, heart disease, and cancers, are now serious problems in Kosrae and are among the primary health risks that adult Kosraeans presently face. These chronic diseases are more recognized problems of the community, in comparison to VA deficiency. Epidemiological studies indicate that the consumption of carotenoid-rich foods may help protect against these chronic diseases (Bertram, 2002; Ford et al, 1999; World Cancer Research Fund, 1997). Foods rich in provitamin A-rich carotenoids protect against VA deficiency (McLaren and Frigg, 2001). Thus, a food-based public health intervention could be put into place in this community promoting foods and nutrients that would protect against both chronic disease and VA deficiency. Such an intervention is likely to have a greater acceptability and impact than an intervention promoting foods simply for protection against VA deficiency.

In conclusion, it is suggested that an ethnographic approach is critical to obtaining meaningful dietary assessment data that accurately reflects dietary intake, and provides information important for planning and implementing an effective food-based intervention. Culture-specific information is critical to the development of culturally competent, relevant, sensitive, and acceptable programs that address the wide array of nutrition needs in the community. Drawing on information provided by members of the community encourages a more collaborative approach that allows a greater sense of ownership of such programs. Aspects of this approach to dietary intake methodology are also likely to be relevant to other Pacific countries and countries where similar foods, including yellow-fleshed bananas, are eaten.

REFERENCES

Abdon, I. C., and I. F. del Rosario (1980). *Food Composition Tables: Recommended for use in the Philippines. Handbook 1 (5th Revision).* Food and Nutrition Research Institute, National Science Development Board, Manila.

Adelekan, D. A., A. O. Fatusi, J. B. Fakunle, C. T. Olotu, I. A. Olukoga, M. K. Jinadu, and E. O. Ojofeitimi (1997). Prevalence of malnutrition and vitamin A deficiency in Nigerian preschool children subsisting on high intakes of carotenes. *Nutrition and Health*, 12, 17–24.

Basiotis, P. P., S. O. Welsh, F. J. Cronin, J. L. Kelsay, and W. Mertz (1987). Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *Journal of Nutrition*, 117, 1638–1641.

Beaton, G. H., J. Milner, V. McGuire, T. E. Feather, and J. A. Little (1983). Source of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. Carbohydrate sources, vitamins, and minerals. *American Journal of Clinical Nutrition*, 37, 986–995.

Bertram, J. S. (Ed.) (2002). Lectures presented at the 13th International Symposium on Carotenoids Held in Honolulu, Hawaii, USA, 6–11 January, 2002, *Pure and Applied Chemistry*, 74(8) 1369–1487.

Blum, L., P. J. Pelto, G. H. Pelto, and H. V. Kuhnlein (1997). *Community Assessment of Natural Food Sources of Vitamin A: Guidelines for an Ethnographic Protocol.* Ottawa, Canada: International Development Research Centre.

Calloway, D. H., S. P. Murphy, G. H. Beaton, and D. Lein (1993). Estimated vitamin intakes of toddlers: predicted prevalence of inadequacy in village populations in Egypt, Kenya, and Mexico. *American Journal of Clinical Nutrition*, 58, 376–384.

Centers for Disease Control and Prevention (2001). Vitamin A deficiency among children–Federated States of Micronesia, 2000. *MMWR Morbidity Mortality Weekly Report*, June 22, 2001/50, 509–512.

de Pee, S., M. W. Bloem, J. Gorstein, M. Sari, Yip, R. Satoto, R. Shrimpton, and Muhilal (1998). Reappraisal of the role of vegetables in the vitamin A status of mothers in Central Java, Indonesia. *American Journal of Clinical Nutrition*, 68, 1068–1074.

Dignan, C. A., B. A. Burlingame, J. M. Arthur, R. J. Quigley, and G. C. Milligan (1994). *The Pacific Islands Food Composition Tables.* Noumea, New Caledonia: South Pacific Commission.

Englberger, L. (2003). *A community and laboratory-based assessment of the natural food sources of vitamin A in the Federated States of Micronesia. PhD Thesis.* University of Queensland, Brisbane, Australia.

Englberger, L., W. Aalbersberg, M. H. Fitzgerald, G. C. Marks, and K. Chand (2003a). Provitamin A carotenoid content and cultivar differences in edible pandanus fruit *Pandanus tectorius*. *Journal of Food Composition and Analysis*, 16, 237–247.

Englberger, L., W. Aalbersberg, P. Ravi, E. Bonnin, G. C. Marks, M. H. Fitzgerald, and J. Elymore (2003b). Further analyses on Micronesian banana, taro, breadfruit and other foods for provitamin A carotenoids and minerals. *Journal of Food Composition and Analysis*, 16, 219–236.

Englberger, L., I. Darnton-Hill, M. H. Fitzgerald, T. Coyne, and G. C. Marks (2003c). Carotenoid-rich bananas: a potential food source for alleviating vitamin A deficiency. *Food and Nutrition Bulletin*, 24, 303–318.

Englberger, L., J. Schierle, G. C. Marks, and M. H. Fitzgerald (2003d). Micronesian banana, taro, and other foods: newly recognized sources of provitamin A and other carotenoids. *Journal of Food Composition and Analysis*, 16, 3–19.

Englberger, L., G. C. Marks, and M. H. Fitzgerald (2003e). Insights on food and nutrition in the Federated States of Micronesia: a review of the literature. *Public Health Nutrition*, 6, 5–17.

Englberger, L., J. Elymore, A. Sowell, P. S. Gonzaga, and D. Huff (2001). Dietary intake of vitamin A in preschool children in Yap and Kosrae States, Micronesia. Abstract. In *XX International Vitamin A Consultative Group Meeting, February 12–15, 2001, Hanoi, Vietnam*. (Ed. ILSI Research Foundation, Washington DC, p. 39).

Faber, M., and A. J. Benade (1999). Nutritional status and dietary practices of 4-24-month-old children from a rural South African community. *Public Health Nutrition*, 2, 179–185.

FAO/WHO (1988). Requirements of vitamin A, iron, folate and vitamin B12. *Report of a Joint FAO/WHO Expert Consultation. FAO Food and Nutrition Series no. 23.* Rome: Food and Agriculture Organization.

Fawzi, W. W., M. G. Herrera, W. C. Willett, P. Nestel, A. El Amin, and K. A. Mohamed (1997). Dietary vitamin A intake in relation to child growth. *Epidemiology*, 8, 402–407.

Fitzgerald, M. H. (1997). Ethnography. In *Qualitative Research: Discourse on Methodologies.* (Ed. Higgs, J.) Sydney: Hampden Press, pp. 48–60.

Ford, E. S., J. C. Will, B. A. Bowman, and K. M. Narayan (1999). Diabetes millitus and serum carotenoids: findings from the Third National Health and Nutrition Examination Survey. *American Journal of Epidemiology*, 149, 168–76.

Gibson, R. S. (1993). *Nutritional Assessment: A Laboratory Manual.* New York: Oxford University Press.

Gonzaga, P. C. (2000). Results of vitamin A, anemia, and blood lead survey among 2–4 year old children and reproductive-aged women in Yap proper and Kosrae state, Federated States of Micronesia (January and February 2000). Centers for Disease Control and Prevention, Atlanta, GA.

Humphrey, J., D. Friedman, G. Natadisastra, and Muhilal (2000). 24-hour history is more closely associated with vitamin A status and provides a better estimate of dietary vitamin A intake of deficient Indonesian preschool children than a food frequency method. *Journal of American Dietetics Association*, 100, 1501–1510.

Institute of Medicine (2001). Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. A report of the Panel on Micronutrients, Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Use of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Washington, DC: Food and Nutrition Board, National Academy Press.

International Network for the Improvement of Banana and Plantain (INIBAP) (2003). *The Musa Germplasm Information System (MGIS): an international database on Musa genetic resources.* Montpellier, France: INIBAP.

Kuhnlein, H. V., and G. H. Pelto (Eds.) (1997). *Culture, Environment, and Food to Prevent Vitamin A Deficiency.* Boston, MA: International Nutrition Foundation for Developing Countries.

Latham, M. C. (1997). *Human Nutrition in the Developing World.* Rome: Food and Agriculture Organization of the United Nations.

McLaren, D. S., and M. Frigg (2001). *Sight and Life Manual on Vitamin A Deficiency Disorders (VADD), Second Edition.* Basel, Switzerland: Task Force Sight and Life.

Mele, L., K. P. West, Jr., P. A. Kusdiono, H. Nendrawati, R. L. Tilden, and I. Tarwotjo (1991). Nutritional and household risk factors for xerophthalmia in Aceh, Indonesia: a case-control study. The Aceh Study Group. *American Journal of Clinical Nutrition*, 53, 1460–1465.

Miles, M. B., and A. M. Huberman (1994). *Qualitative Data Analysis Second Edition.* Thousand Oaks, CA: Sage Publications.

Nelson, M., A. E. Black, J. A. Morris, and T. J. Cole (1989). Between- and within-subject variation in nutrient intake from infancy to old age: estimating the number of days required to rank dietary intakes with desired precision. *American Journal of Clinical Nutrition*, 50, 155–167.

Nimsakul, S., M. Collumbien, V. Likit-Ekaraj, D. Suwanarach, A. Tansuhaj, and G. J. Fuchs (1994). Simplified dietary assessment to detect vitamin A deficiency. *Nutritional Research*, 14, 325–336.

Persson, V., T. Greiner, I. P. Bhagwat, and M. Gebre-Medhin (1999). The Helen Keller International food frequency method may underestimate vitamin A intake where milk is a normal part of the young child diet. *Ecology of Food and Nutrition*, 38, 57–69.

Persson, V., T. Greiner, S. Islam, and M. Gebre-Medhin (1998). The Helen Keller International food-frequency method underestimates vitamin A intake where sustained breastfeeding is common. *Food and Nutrition Bulletin*, 19(4), 343–346.

Puwastien, P., M. Raroengwichit, P. Sungpuag, and K. Judprasong (1999). *Thai Food Composition Tables.* Institute of Nutrition, Mahidol University.

Ramakrishnan, U., R. Martorell, M. C. Latham, and R. Abel (1999). Dietary vitamin A intakes of preschool-age children in South India. *Journal of Nutrition*, 129(11), 2021–7.

Rodriguez-Amaya, D. B. (1997). *Carotenoids and Food Preparation: The Retention of Provitamin A Carotenoids in Prepared, Processed, and Stored Foods. USAID OMNI Project.* John Snow, Inc./OMNI Project, Arlington, Virginia.

Rosen, D. S., N. J. Haselow, and N. L. Sloan (1993). *How to Use the HKI Food Frequency Method to Assess Community Risk of Vitamin A Deficiency.* Helen Keller International: New York, NY.

Shmulewitz, D., S. B. Auerbach, T. Lehner, M. L. Blundell, J. D. Winick, L. D. Youngman, V. Skilling, S. C. Heath, J. Ott, M. Stoffel, J. L. Breslow, and J. M. Friedman (2001). Epidemiology and factor analysis of obesity, Type II diabetes, hypertension, and dyslipidemia (syndrome X) on the island of Kosrae, Federated States of Micronesia. *Human Heredity*, 51, 8–19.

Siong, T. E. (1985). *Nutrient Composition of Malaysian Foods - A Preliminary Table (First Up-Date).* Division of Human Nutrition, Institute for Medical Research and Asean Protein Project, National Sub-committee Malaysia, Kuala Lumpur.

Sloan, N. L., D. Rosen, T. de la Paz, M. Arita, C. Temalilwa, and N. W. Solomons (1997). Identifying areas with vitamin A deficiency: the validity of a semiquantitative food frequency method. *American Journal of Public Health*, 87, 186–191.

Solon, F. S., B. M. Popkin, T. L. Fernandez, and M. C. Latham (1978). Vitamin A deficiency in the Philippines: a study of xerophthalmia in Cebu. *American Journal of Clinical Nutrition*, 31, 360–368.

Sowell, A., P. S. Gonzaga, L. Englberger, D. Schendel, J. Elymore, and D. Huff (2000). Vitamin A deficiency and anemia among preschool children and their mothers or female caregivers in Yap and Kosrae States, Federated States of Micronesia. Abstract. XX International Vitamin A Consultative Group Meeting, February 12–15, 2001. *XX International Vitamin A Consultative Group Meeting, February 12–15, 2001, Hanoi, Vietnam*, 38.

Tarwotjo, I., A. Sommer, T. Soegiharto, D. Susanto, and Muhilal (1982). Dietary practices and xerophthalmia among Indonesian children. *American Journal of Clinical Nutrition*, 35, 574–581.

WHO (1995). *Global Prevalence of Vitamin A Deficiency. MDIS Working Paper #2. Micronutrient Deficiency Information System, WHO/NUT/95.3.* Geneva: World Health Organization.

WHO/FAO (2002). Vitamin A (Chapter 7). In *Human Vitamin and Mineral Requirements. Report of a joint FAO/WHO expert consultation, Bangkok, Thailand.* Rome: FAO and WHO.

World Cancer Research Fund (1997). Food, nutrition and the prevention of cancer: a global perspective Washington, D. C., American Institute for Cancer Research.

Zeitlin, M. F., R. Megawangi, E. M. Kramer, and H. C. Armstrong (1992). Mothers' and children's intake of vitamin A in rural Bangladesh. *American Journal of Clinical Nutrition*, 56, 136–147.