

Estimated intake and food sources of vitamin A, folate, vitamin C, vitamin E, calcium, iron, and zinc for Guamanian children aged 9 to 12

Abstract: This study describes the nutrient intake and food sources of select vitamins and minerals for children on Guam. Food records (n = 954) from public school students aged nine to twelve of all regions on Guam were analyzed for nutrient content and compared to Recommended Dietary Allowances (RDA). Individual foods were condensed into 194 food aggregates and food lists representing 84% to 91% of the major vitamins and minerals in the diet of the children were developed by frequency analysis. Median intake of calcium, vitamin E, folate were less than 50% of the Recommended Dietary Allowance (RDA) and mean intake of these nutrients was 60% RDA or less. Mean and median vitamin A intake was 107% and 76% RDA, respectively. Both mean and median intake of Vitamin C, iron and zinc were present at levels above 100% RDA. Rice, meat, fruit drink from powder, milk, and fortified cereals are foods that provide substantial contributions to the vitamin and mineral content of the diets. Traditional, nutrient dense foods, such as fish, yams, papaya, and mango had minor contributions because of low frequency of consumption. Information from this study can be used to develop specific diet assessment instruments and culturally appropriate nutrition education. Key words: Guamanian, vitamin, mineral, diet assessment, children

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Introduction

Vitamin and mineral intake during childhood has a well-known relationship to health and affects susceptibility for chronic disease later in life^{1,2}. Early assessment, education, and intervention can have a positive effect by reducing nutritional risk factors and encouraging healthy behaviors¹, especially if culturally relevant materials are used³. Nutrition education materials and diet assessment instruments utilized in the United States are less useful on Guam because of cultural differences. Guam is an island with a multicultural population comprised of the native Chamorros, Filipinos, other Pacific Islanders, Caucasians, Chinese, Japanese, Korean, and other ethnic groups⁴. Currently there are no diet assessment instruments and few nutrition education materials developed specifically for children in this population. A necessary prerequisite is quantitative informa-

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tion on the contribution of specific foods to the nutrient intake of the group⁵.

Stable isotopic analysis shows the prehistoric diet in the Marianas Islands to include marine proteins and plants such as sugar cane and seaweed⁶. In the last few centuries, the Guamanian diet was predominantly vegetarian and included rice, taro, yams, breadfruit, cassava, bananas, and coconut⁷. Now, the diet on Guam is more similar to Western societies with meat and rice as staples⁸ with some similarities to Hispanic cultures because of historical Spanish influences⁷. Recent research on Guam indicates that many of the foods in children's diets are not traditional choices, lack nutrient density, and are high in energy, fat, and sugar⁹. Rice is consumed more than twice as frequently as any other food item. The major contributors of energy, fat, cholesterol, and protein are meat dishes, fried chicken, canned meats, and whole milk. Sweetened fruit flavored drinks and carbonated beverages contribute substantially to energy and total carbohydrate intake¹⁰. However, other than a report published by the South Pacific Commission in 1958¹¹ there are no studies describing the vitamin and mineral intake of children on Guam despite the recognized need for more dietary information on Pacific Islanders¹²⁻¹⁴.

The objectives of the present study are to quantify intake and identify foods contributing the highest amount of vitamin A, folate, vitamin C, vitamin E, calcium, iron, and zinc in the diets of fifth grade children on Guam. The Human Subjects Research Committee at the University of Guam, Mangilao, Guam and the Government of Guam Department of Education granted approval for this research.

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Table 1. Vitamin and mineral content in the diets of Guamanian children

Nutrient	Mean \pm SD ¹	Mean
Vitamin A, RE		
% RDA ²	107.2 \pm 109.6	76.4
Density	407.6 \pm 430.1	291.6
Vitamin C, mg		
% RDA	214.8 \pm 252.9	139.6
Density	59.8 \pm 67.4	36.2
Folate, mcg		
% RDA	60.0 \pm 52.0	46.9
Density	109.0 \pm 79.7	82.8
Vitamin E, AE		
% RDA	56.3 \pm 89.2	41.0
Density	3.4 \pm 2.5	3.0
Calcium, mg		
% RDA	42.0 \pm 28.8	36.0
Density	329.9 \pm 190.0	292.4
Iron, mg		
% RDA	132.7 \pm 72.00	117.6
Density	6.4 \pm 2.2	6.0
Zinc, mg		
% RDA	115.5 \pm 67.8	101.0
Density	5.5 \pm 2.1	5.2

1. SD = Standard deviation

2. RDA = Recommended Dietary Allowances (reference # 15. Trumbo P, Yates, AA, Schlicker S, et al. Dietary reference intakes: Vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. *J Am Diet Assoc*, 2001: 101,294-301.)

Methods

Design

Food records were collected from fifth grade children, aged nine to twelve, attending public schools on Guam as previously described^{9,10}. Briefly, one-day food records were collect by teachers who were trained by a registered dietitian. Two-dimensional food models from the Food Intake Analysis System^Ó (FIAS) version 2.3, 1993, (University of Texas Health Science Center, Houston, TX) were used as quantification aids. A total of 954 food records from students of all regions on Guam were analyzed for nutrient content.

Data analysis

The food records were entered into the FIAS, which was supplemented with recipes for 67 traditional local recipes and Calrose[®] rice, for nutrient analysis. Nutrient summaries and percentages of the most recent Recommended Dietary Allowances (RDA) were calculated¹⁵.

A second database was created that included one line of data (nutrient content) for each food item from each subject for a total of 9,036 lines of data consisting of 1,006 individual foods. Grouping similar food items¹⁶ condensed the individual food items in this subset into 194 food aggregates. In most cases specific fruits and vegetables were grouped separately but with different forms of the same item combined, i.e., orange juice included fresh, frozen, and canned juices grouped together. Other groups were formed on the basis of food type and nutrient content, such as fried rice with meat and vegetables, which was grouped with pancit (fried noodles with vegetables and meat), egg rolls, chow mein with noodles, and empanada (meat and vegetables wrapped in dough and fried). Each group name was based on the item in the group that was consumed the most frequently.

Statistical analysis

Data were analyzed for descriptive statistics and frequency using the Statistical Analysis System, SAS for Windows Version 6.09 (SAS Institute, Cary, NC). The contribution of each food aggregate to the total intake of each nutrient consumed by the sample was estimated by calculating the weighted average consumed for each aggregated food group. Summing the amount of the nutrient provided by each food aggregate and dividing by the total intake of that nutrient from all foods and multiplying by 100 accomplished this. Once the percentage of total nutrient contributed by a specific food item was determined, the cumulative percent contributed to the diet for each nutrient was tabulated.

Results

Vitamins

Dietary vitamin E and folate with mean intake at or below 60% RDA, and median levels less than 47% RDA are well below recommendations (Table 1). Although vitamin E is widespread in foods, the number one contributor of vitamin E in the diet of Guamanian children is potato chips, providing 9.3% of their total vitamin E (Table 2). White or red rice (which is cooked with fat) and fried rice contribute 11%, followed by tortilla chips, which provide 3.9% of the vitamin E. Two beverages including fruit drink from powder and orange juice provide 18.9% of the total folate in the diet (Table 3). Fruit-flavored, sweetened cereal and corn flakes are also important contributors of folate for these children.

Table 3. Major food sources of folate in the diets of children on Guam

Rank	Food description	% of total folate	Cumulative % of folate
1	Fruit drink from powder	12.77	12.77
2	Fruit-flavored, sweetened cereal	6.94	19.71
3	Orange juice	6.17	25.89
4	Corn flakes	5.57	31.45
5	Potato chips, regular or flavored	3.30	34.75
6	Whole milk	2.85	37.60
7	White or red rice	2.40	40.00
8	Fried rice	2.33	42.33
9	Chili con carne with beans	2.20	44.53
10	Lowfat (2% fat) milk	2.08	46.61
11	Yellow corn, canned	2.00	48.61
12	Tortilla chips	1.69	50.30
13	Cheeseburger on a bun	1.64	51.95
14	Shredded wheat cereal	1.60	53.55
15	Frankfurter on a bun	1.51	55.06
16	White bread	1.34	56.40
17	Orange, raw	1.30	57.70
18	Crisped rice cereal (e.g. Rice Krispies)	1.29	58.99
19	Pizza with cheese and meat	1.27	60.26
20	Egg, fried	1.19	61.46
21	Chicken adobo	1.18	62.64
22	Hamburger on a bun	1.15	63.79
23	Peanut butter and jelly sandwich	1.12	64.91
24	Apple juice	1.11	66.02
25	Chicken, white or dark meat, fried	1.09	67.11
26	Spaghetti with tomato and meat sauce	1.09	68.20
27	Fruit drink, canned	1.03	69.23
28	Oatmeal	1.02	70.25
29	Granola cereal bar	1.01	71.26
30	Oat ring cereal (e.g., Cheerios)	0.99	72.25
31	Egg sandwich, fried	0.93	73.18
32	Pizza with cheese	0.87	74.05
33	French fries	0.86	74.91
34	Tuna salad sandwich	0.85	75.76
35	Noodle soup	0.82	76.58
36	Breakfast tart	0.79	77.38
37	Beef stew with potatoes and vegetables	0.77	78.14
38	Green beans, cooked	0.74	78.88
39	Corned beef, canned	0.72	79.61
40	Wheat cereal	0.70	80.30
41	Lettuce salad with assorted vegetables	0.67	80.97
42	Mixed vegetables, canned	0.67	81.64
43	Pineapple juice	0.62	82.26
44	Chocolate milk	0.60	82.86
45	Chicken, white or dark meat, roasted	0.58	83.44
46	Egg, boiled	0.58	84.01
47	Egg omelet or scrambled egg	0.57	84.58
48	Pork and beans, canned	0.57	85.15
49	Beef steak	0.53	85.68
50	Milk chocolate candy bar	0.50	86.18

Table 5. Major food sources of calcium in the diets of children on Guam

Rank	Food description	Percentage of total calcium	Cumulative percentage of calcium
1	Whole milk	22.26	22.26
2	Lowfat (2% fat) milk	16.44	38.70
3	Chocolate milk	4.54	43.24
4	Ice cream	3.40	46.65
5	Cheeseburger on a bun	3.03	49.68
6	Pizza with cheese and meat	2.98	52.66
7	White or red rice	2.70	55.36
8	Fruit drink from powder	2.60	57.97
9	Grilled cheese sandwich	2.15	60.12
10	Pizza with cheese	2.09	62.21
11	Frankfurter on a bun	1.99	64.20
12	Tortilla chips	1.53	65.73
13	Spaghetti with tomato and meat sauce	1.52	67.25
14	Pancakes from a mix	1.50	68.75
15	Fried rice	1.22	69.97
16	Fruit drink, canned	1.10	71.07
17	American, processed cheese	1.04	72.11
18	Milk chocolate candy bar	1.04	73.15
19	White bread	1.02	74.17
20	Hamburger on a bun	0.86	75.03
21	Egg sandwich, fried	0.85	75.89
22	Tuna salad sandwich	0.78	76.67
23	Chicken, white or dark meat, fried	0.76	77.43
24	Peanut butter and jelly sandwich	0.68	78.11
25	Noodle soup	0.68	78.79
26	Potato chips, regular or flavored	0.64	79.43
27	Corned beef, canned	0.61	80.04
28	Breakfast tart	0.61	80.65
29	Egg, fried	0.56	81.21
30	Orange, raw	0.54	81.75
31	Chicken adobo	0.53	82.28
32	Egg omelet or scrambled egg	0.49	82.77
33	Skim milk	0.48	83.25
34	Champulado	0.48	83.73
35	Meatloaf	0.48	84.20
36	Lemonade flavored drink	0.45	84.65
37	Orange juice	0.45	85.10
38	Taco or burrito	0.42	85.52
39	Chicken, white or dark meat, roasted	0.41	85.93
40	Chocolate milk shake	0.41	86.34
41	Fish, fried	0.38	86.71
42	Shrimp, fried	0.37	87.09
43	Green beans, cooked	0.37	87.46
44	Muffin, fruit and or nuts	0.35	87.81
45	Oatmeal	0.35	88.16
46	Pork and beans, canned	0.33	88.49
47	Pork chop, fried	0.32	88.81
48	Apple juice	0.32	89.14
49	Cola, carbonated beverage	0.32	89.46
50	Butter-type crackers	0.29	89.75

Mean vitamin A is 107.2% of the RDA, but median intake is low, 76.4% RDA. The top five aggregated groups contributing to vitamin A content in the diet include fruit drink from powder, cooked or raw carrots, whole milk, low fat (2% fat) milk, and corn flakes (Table 4). These five contributors provide 42.4% of the total vitamin A in the diet. Although only 63 respondents reported carrots, their high vitamin A content makes them an important contributor of the nutrient. Other good sources of vitamin A included in the children's diet are canned mixed vegetables, eggs, and spaghetti with tomato and meat sauce. Mangos, a fruit high in vitamin A, was eaten infrequently and provided less than one-half of one percent of vitamin A in the diet.

Both mean and median vitamin C intake are high at 215% RDA and 140% RDA, respectively (Table 1). The top three contributors of vitamin C in the children's diet are beverages, including, powdered fruit drink, canned fruit drink, and orange juice, providing 54.6% of the total vitamin C. Oranges are reported by about 15% of the population surveyed but because this fruit is high in vitamin C it contributes 4.2% of the total vitamin C. Since this vitamin is abundant in the children's diets, a food source table is not presented in this paper.

Minerals

Dietary calcium with mean intake at 42% RDA and median levels at 36% RDA is extremely low (Table 1). Milk and milk products are not the traditional sources of calcium on Guam, yet milk, including whole, low fat, and chocolate versions, contribute 43.2% of the total dietary calcium (Table 5). Ice cream, cheeseburgers and pizza are other important contributors of calcium. Fried fish, shrimp and green vegetables each account for only 0.4% or less of the dietary calcium.

Both mean and median of iron and zinc intake are at or above 100% of the RDA (Table 1). White, red rice, and fried rice contribute 17.6% of the total iron in the children's diet, making enriched rice the number one contributor of iron. Enriched cereals, including fruit-flavored, sweetened cereal and corn flakes, are also important contributors of iron, supplying 7.2% of the total. Meats and eggs were frequently consumed and were contributors of both iron and zinc. The major contributors of zinc in the diet of Guamanian children include canned corned beef, supplying 8.7% of the total dietary zinc, followed by white or red rice, which contribute 7.0%. Fried or roasted chicken, including both white and dark meat, contributed 10.9%. Since both iron and zinc are abundant in the children's diets, food source tables for these minerals are not presented in this paper.

Discussion

The dissimilarity of the foods reported by the fifth grade children in this study to foods historically consumed on Guam is striking and not only highlights the departure from traditional foods previously noted^{9, 10} but also is in line with the lifestyle changes being made in the nations of Asia and the Pacific in what is called the most rapid area of epidemiological transition in the world¹⁷. Dietary changes of this nature appear to be associated with the high levels of chronic disease found in the Pacific Islanders¹⁷⁻¹⁹.

Foods that are not "traditional" are not necessarily poor dietary choices. For example, ready-to-eat cereals, including corn flakes, crisped rice cereals, and fruit-flavored sweetened cereals are important contributors of vitamins A, vitamin C, folate, iron and zinc in the diet of children on Guam. In the United States, children consuming ready-to-eat cereals have higher intakes of vitamin A, thiamin, riboflavin, niacin, vitamins B6 and B12, and folate than children who do not consume these cereals²⁰. Furthermore, milk is an important food in the diets of the children

on Guam contributing 43% of their calcium and 13% of their vitamin A even though milk is not a traditional food in the Pacific presumably because of factors related to culture, preference¹⁴, or lactose intolerance. Lactose intolerance can result in an unnecessary reduction in milk consumption

and an insufficient dietary calcium intake²¹. On Guam milk is provided as part of the United States Department of Agriculture School Lunch Program, which was taken by approximately 51% of the children enrolled in the public schools during the year this study was conducted. However, there is cause for concern because the shift toward a western diet which resulted in low micronutrient density in a Samoan population¹⁸ is also noted in the present study as evidenced by low median intakes of calcium, vitamin E, folate (less than 1/2 of the RDA) and vitamin A (less than 2/3 of the RDA) with the observation that many of the most commonly consumed foods are not nutrient dense.

The fact that potato chips are the number one contributor of vitamin E and ranks fifth for vitamin C in the diet of the Guamanian children is an indication of the excessive intake of a food with low nutrient density (chips) relative to more nourishing food choices. Because of importance of vitamin E to heart health²², foods that are accepted on Guam such as red rice or chicken adobo (chicken cooked in a soy and vinegar sauce) can be encouraged along with traditional fruits such as papaya which is not included on the food lists because of a low frequency of consumption.

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Mangos contribute only 0.29 percent of the children's vitamin C and are not on the vitamin E list even though one ripe mango would provide a child with 21% of the RDA for vitamin E while contributing other vitamins and minerals as well.

Most of the folate came from fruit drink from powder and orange juice. The frequent consumption of these drinks resulted in adequate folate intake although the best sources of folate are fresh, vegetables and fruits, such as spinach and cantaloupe, along with orange juice, legumes, and eggs. Adequate folate is related to reductions in birth defects²³, and to decreased risk for heart disease and cancer because of the effects on plasma homocysteine levels²⁴. Although the low intake of folate noted in this study has serious public health implications, the current folate intake on the island presumably is higher because of a U.S. law for fortification of grains with folate which was enacted subsequent to data collection for this study²⁵.

Fruit drink from powder is the number one contributor of vitamin A, and combined with canned fruit drink provides 43% of the total vitamin C. These fortified and unfortified fruit drinks are the second highest contributor of vitamin C in the diet of Hispanic children in the United States as well, providing about 18% of the total vitamin C⁵. Although orange juice and raw oranges are the next major contributors of vitamin C, they were only reported on 9% and 6% of the food records collected, respectively. Carrots are a major source of vitamin A, although they are only consumed by 7% of the population. The prevalence of xerophthalmia, occurring from a vitamin A deficiency, is approximately 14% in some areas of the Pacific Islands²⁶ and this study shows limited intake of vitamin A rich foods and low levels of vitamin A in the diet.

To reach peak bone density, it is important for children to consume adequate amounts of calcium. The children in this study consume limited amounts of milk, ice cream, cheeseburgers, and pizza. Milk consumption is low for most adolescents, yet it is still one of the best ways to obtain adequate calcium²⁷. Although Asians tend to obtain calcium from food sources other than dairy¹⁴ not many of the soy or vegetable sources of calcium were observed in the Guamanian sample. For example, the only dark green vegetable identified in this study was green beans, which contributed just 0.37% of the dietary calcium. Fish is another calcium source expected in a Pacific Islander population but fish and shrimp together provided only 0.74% of the calcium in the children's diets. Fish production has become an export-oriented industry in the Pacific with a negative nutritional impact¹⁹. A diet study

conducted on another Pacific Island, Palau, showed a lower amount of fish in the diets of children than women²⁸. It is unclear if the low fish intake is because the children are being offered different food than adults but will adopt a broader diet as they age, or if children are moving even farther from the traditional food sources than adults.

Important strengths of the children's diet on Guam are the iron and zinc intake despite the fact that these are common deficiencies in children and adolescents worldwide^{29, 30}. Rice, fortified cereal, and meat (chicken, beef, canned meat, and mixed dishes with meat) provide more than half of the dietary iron and zinc for these children. In contrast, dried beans and bread products are the primary contributors of iron in the diet of Hispanic children in the United States, and the combined meat groups provide about 30% of the total iron⁵. Although plant and animal products supply iron, the mineral is more readily absorbed from animal sources. Approximately 28% of the total iron and 44% of the zinc in the diet of children on Guam is contributed by meat and mixed dishes containing meat.

A return to the traditional diets of the Pacific is being promoted as a model for the prevention and reversal of coronary heart disease³¹. The traditional foods may improve vitamin and mineral intake as well. In the past, coconut juice, which is the liquid from a young coconut and has 70 mg of calcium per cup³², was a drink that was consumed frequently and thus provided a sizeable amount of calcium. Data from the present study indicate that today coconut juice is so

rarely consumed by children that it is not included in the top 90% of food contributions to calcium in the diet. Reasons may be due to lack of convenience or promotion of other Western drinks, such as carbonated beverages and sweetened fruit-flavored drinks¹⁹. Using this information, we can help children return to more nutritious cultural foods. For example, in a nutrition education project conducted on Yap, another Micronesian island, grocery store owners agreed to sell fresh coconut juice, and to promote this drink by displaying posters with the advertisements for carbonated beverages. Imports of soft drinks decreased by half in one year³³. This type of outcome is especially beneficial in light of the negative nutritional consequences of soft drink consumption³⁴.

The information from this study includes lists that capture adequately, 80% or more, the foods needed to develop dietary assessment instruments for a specific population⁵. Food frequency questionnaires are often used for large cohort research studies, and development of an appropriate food list for this type of questionnaire is critical. On a questionnaire to assess calcium status of this population, it would be effective to include com-

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monly consumed sources of calcium, along with food items that are not usually considered rich sources of calcium but are major contributors in the diet, such as mixed dishes with cheese and rice. The Health Habits and History Questionnaire was developed at the National Cancer Institute from similar food lists³⁵. This questionnaire was based on the most commonly consumed foods and the most frequently reported food items in the United States, and has proven to be a useful tool for assessing dietary intake. Diet history questionnaires for large studies in Hawaii, California, and Asia were developed based on information from a food record relaying the most important foods contributing to the consumption of each nutrient. To obtain cultural relevance, different questionnaires were computed for each ethnic group including foods important to each specific culture, as well as seasonal produce, depending on the availability³⁶. Local dietitians and other public health planners can develop culturally relevant dietary assessment surveys using information provided by food lists.

This study is limited by bias commonly associated with obtaining dietary information including underreporting³⁷, social acceptability³⁸, and cognitive issues related to children³⁹. Other limitations possibly result from the generalizations used in creating aggregate food groups or over-emphasis on school lunch^{9, 10}. Furthermore, in this study we used a convenience sample and did not collect data from students attending private schools on Guam or from the children whose food records were illegible or incomplete. However, the fact that a large proportion of students living on the island were included in the survey helps mitigate this bias^{9, 10}.

Summary and conclusions

This descriptive dietary intake study provides detailed information concerning the nutrient content and major food sources of selected vitamins and minerals in the diet of fifth grade children on Guam that will help fill gaps in our knowledge of these Pacific Islanders. The food lists established in this study are important for the development of culturally relevant dietary assessment instruments. Inasmuch as dietary guidance directed toward children should focus more on foods than nutrients¹, these food lists will help nutrition education efforts and direct public health interventions as well. Traditional foods, such as fish, bananas, yams, papaya and other local produce are consumed at low levels and would provide a nutrient dense source of many vitamins and minerals if eaten more frequently. Rice, meat, fruit drink from powder, milk, and fortified cereals are foods that provide substantial contributions to the vitamin and mineral content of the diet.

Traditional foods, such as fish, bananas, yams, papaya and other local produce are consumed at low levels and would provide a nutrient dense source of many vitamins and minerals if eaten more frequently.

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