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NUTRITIVE VALUE OF LEAFY GREEN VEGETABLES

IN SELECTED LOCATIONS IN BELIZE

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Nutritive Value of Leafy Vegetables Grown in Belize

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Summary

A research project to provide information about the availability and utilization of food plants that can improve the nutritional quality of diets was started in the fall of 1985 in Belize. Samples of leaves and stalks were collected on a number of plants that are used as leafy greens. All of the plants analyzed compared well to spinach in food value on the basis of published data and laboratory analyses.

A survey of children 1-14 years old living in rural areas of Cayo and Toledo of Belize was conducted to provide data on food intake and nutritional status. Analyses of 171 24-hour food recalls showed marginal to deficient intakes of energy, vitamins A and C, riboflavin, calcium, iron and zinc. Signs of nutrition-related problems most frequently observed from clinical examinations were inflamation and bleeding of gums and papillae (45%), conjunctival injection (39%), dental caries (35%), thyroid enlargement (24%), hypertrophy of the tongue (16%), clubbed fingers (16%) and Bitot's spots (11%). These findings suggest deficiencies of vitamins A and C, riboflavin, fluoride and iodine. Enlarged thyroid or goiter was found primarily in Mayan children living in

Cayo near the Guatemalan border. Little evidence was found for anemia from either iron or folic acid deficiency.

Retarded growth was common in children 4-13 years old. Most children were below the 25th percentile of the growth charts from the U.S. National Center for Health Statistics. Mayan children in Toledo had the poorest growth records, over 50% were below the 5th percentile of height for age. Eating more fruits and vegetables that grow in Belize could help prevent vitamin and mineral deficiencies that may contribute to retarded growth in children. Leafy green plants growing wild that are known as food sources by rural Belizeans are a potential source of important nutrients.

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Final Report

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INTRODUCTION

Belize has 8,866 square miles of land area with a population reported by the 1980 census (1) of about 145,000. It has a relatively low population density and considerable potential for agricultural development since only 10% of the arable land is cultivated or under pasture. However, at the present time, food production is inadequate and food imports amount to about a quarter of all imports (2, 3). To help deal with this problem, new lands that appear to have great promise for food production are being opened to cultivation (4).

Although the data are limited, it appears that nutrient deficiencies are likely among the population, including dietary shortages for energy, protein, iron, calcium, B vitamins, vitamins A and C (2, 3, 5-7). Home gardening has been encouraged as a way to increase intake of nutrients and to lower expenditures for food, estimated at 40-55% of family income (2, 3).

Green, leafy vegetables are a prime choice for the home garden since they require little space, can be harvested repeatedly and supply many of the nutrients that are deficient in diets. Many

leafy greens considered as food plants grow wild in yards, field borders, and roadsides and are already utilized to some degree. However, information on nutrient content and availability is lacking for many plants of potential food value. Such data will be helpful for encouraging the selection and harvesting of specific plants for maximum nutritional impact.

Methodology

A basic goal of this study was to provide nutrition information helpful to health and nutrition education programs for the general public in Belize, and especially for education programs directed at the growing number of children in elementary schools (7).

To supplement the limited data available on nutritional status of Belize citizens, a nutrition survey was conducted in two rural agricultural districts, Cayo and Toledo. Six adult females employed as full or part-time teachers in the different communities involved in this survey were trained to interview main food preparers in their homes. Teachers collected household information, 24-hour food recalls and anthropometric data.

Because of the limitations of funds and personnel for this project, data analyses and reporting were for children 1-14 years only.

A random sample of school children was selected from six community schools, one each located in Blackman Eddy, San Jose Succotz, Benque Viejo and San Antonio in the Cayo District, and San

Antonio in the Toledo District. Only one school-age child from a household was included in the sample. If a child of pre-school age was in the family, he/she was also included in the sample. In addition, dietary data was taken on the main food preparer in each household.

A consent form approved by the human subjects review committee at Lincoln University was required for each subject, signed by the subject and his/her guardian.

Dietary interviewers obtained a 24-hour food recall from the main food preparer (usually the mother) on each child in the sample, as well as on each main food preparer. Interviews in the homes usually occurred from 3-6 pm after school on week days, and were conducted during February to June, 1986. Additional data were obtained on the number, ages and occupations of household members. However, for reasons stated above, data are only reported for children in this manuscript.

Blood samples, measurements for height and weight, and examinations for signs of nutritional problems were taken in November, 1987. Only three schools were included in this part of the survey (in Blackman Eddy, Unitedville and San Antonio, all in Cayo District). Although attempts were made to include children previously surveyed in these schools in 1986, only 20 were located and 66 additional students were enrolled.

Signed consent forms were obtained for each subject for this part of the survey, also. Subjects who were to provide blood samples were asked (verbally and by letter to parents) to provide

fasting blood samples [no food was to be consumed after the regular evening meal on the day preceeding the clinic or during the morning before blood samples were taken].

Height was recorded to the nearest 1/2 inch with the aid of a carpenter's rule taped to a wall and a small carpenter's square to provide a horizontal plane from the top of the child's head to the rule. Weight was measured on a portable platform scale previously checked against a beam balance scale for accuracy. Children removed their shoes before height and weight were measured. Growth charts prepared by a task force from the National Center for Health Statistics (NCHS) were used to evaluate growth status of the children measured in Belize (8).

A medical intern (Dr. Mary Bess Kohrs) with extensive training in nutrition (R.D. and Ph.D.) and considerable experience in nutrition research examined children for signs of nutritional problems. Examination forms from the 10-state Nutrition Survey were used to record observations (9).

Venous blood samples were drawn into 10-ml vacutainers by a medical technician from the Belize Pathology Laboratory in Belize City. The same lab measured hemoglobin, hematocrit, and mean corpuscular volume (using a Hematology Analyzer, Clay Adams, Division of Becton, Dickinson and Company, Parsippany, New Jersey). About 5 ml of serum was obtained from each subject for analyses of vitamin A and trace minerals. However, these analyses are not complete at this time.

Plant leaf and stalk samples were taken at several locations

in the Cayo District. Fresh specimens were identified and collected with the help of L. Quiroz, a laboratory technician at Central Farms experiment station in Cayo. Further identification was by John Link of the C.A.R.E. office in Belize City.

Drying, grinding and initial analyses for moisture, protein and ash were carried out by the Central Farms forage laboratory in Cayo, Belize. Further analyses for protein was by kjeldahl method in our nutrition laboratory at Lincoln University. Mineral analyses were done by the Environmental Trace Substances Research Center at the University of Missouri, Columbia, using wet ashing and with an inductively - coupled argon plasma spectrometer (Thermal-Jarrel-Ash Corporation, Waltham, Massachusetts).

Data Analyses

Daily nutrient intakes were calculated using a computer program from the University of Missouri modified at Lincoln University for its Human Nutrition Research Program. The modified program uses a nutrient file based on Agriculture Handbook No. 8 with about 2,000 additional foods (10). Food items on the 24-hour recalls were coded as similar foods in Handbook No. 8 when the food was not listed in the program. In addition, about 40 new food items found on the food recalls from Belize were added to the dietary program after their nutrient composition was determined from published sources (11,12). Statistical analyses were performed using the University of Missouri computer system and portions of the Statistical Analysis System (SAS) programs (13).

Analysis of variance using General Linear Models with least-square means (LSM), which are means adjusted for all covariates, were used for unbalanced data. Differences between the different age and ethnic groups for mean intakes of nutrients, RDA percentages, hematology indices and clinical indications of nutrient deficiencies were tested by chi-square analyses. Height and weight percentiles were calculated according to anthropometric data from the National Center for Health Statistics (8).

Results

Mean height and weight of 25 Belize children of both sexes aged 8 years are shown in Table 1, along with heights and weights reported by Meredith (14) for children from Guatemala, Jamaica and the United States. The stature and weight of Belize children appear to be similar to that found for children in neighboring Guatemala.

Data in table 1 were measured in 1986-87, and pooled for the three ethnic groups. Data in Tables 2-4 were measured in the same years and are listed by sex and ethnic group with Mayans in the Cayo and Toledo areas listed separately.

The Mayan children tended to be shorter than the Creole and Mestizo children. While it is apparent that the rural Belize children were smaller in stature than their American counterparts, it appears that the Mayans and Mestizos tended to be of stockier build, based on the weight for height data

(Table 4).

Mean values for hemoglobin (Hb), hematocrit (Hct) and mean corpuscular volume (MCV) are shown for the different ethnic groups in Table 5. The estimated mean values for Caucasions 6-11 years old were derived from the United States Health and Nutrition Examination Survey (HANES), 1976-80, reported by Dallman and Reeves (15). Hemoglobin values for Creoles tend to be lower than for the other ethnic groups, in keeping with observations by Dallman et al (16) that norms for Blacks should be about 0.5 g/dl lower for hemoglobin. Only two of the 78 children tested had a hemoglobin value below 11 g/dl, the minimum normal range for 2-11 year olds indicated from HANES data (16). However, seven children had hematocrit values below the "lower limit" of 32%, and 22 had low readings for MCV (below 75 fL).

Clinical signs of nutrition-related problems were prevalent in the Belize school children that were examined (Table 6). Clinical findings most frequently observed were inflamation (redness, swelling) and bleeding of the gums and papillae (45%), conjunctival injection (39%), dental caries (35%), thyroid enlargement (24%), mild fungiform hyperthrophy of the tongue (16%), clubbed fingers (16%), and Bitot's spots (11%) (Table 6). These findings suggest deficiencies of vitamins A and C, riboflavin, fluoride and iodine (17, 18).

Clinical signs involving the gums (inflamation, bleeding) suggest ascorbic acid deficiency. Dietary shortage of vitamin A is indicated by Bitot's spots, xerosis conjunctivae and thickened

opaque bulbar conjunctivae. Goiter, suggesting iodine deficiency, was evident in about one fourth of the children surveyed. Thyroid enlargement was found largely in Mayan children living in San Antonio Village, in the Cayo district.

The incidence of dental caries could be related to poor dental hygiene, high intakes of carbohydrates and/or fluoride deficiency (18). The only evidence for deficiency of B vitamins was in the conjunctival injection observed in the eyes and the mild fungiform hypertrophy of the tongue, both suggesting riboflavin deficiency.

Clubbed fingers were found primarily in Creole children (37%). Clubbed fingers are often observed in children who lack oxygen secondary to chronic cardiac or respiratory disorders (19).

Although no significant differences were found for incidence of clinical symptoms by sex or age, differences between ethnic groups for clinical signs were significant (Table 7). Mayan and Mestizo children showed more deficiency signs for riboflavin (conjunctival injection). Thyroid enlargement or goiter was most evident in Mayan children. Creoles had more signs for deficiency of ascorbic acid (inflamation of gums and papillae). The small numbers of children in the different deficiency categories detract from the validity of the statistical analysis.

Mean intakes from one-day food recalls for energy and nutrients of 171 rural Belize children 1-10 years old are shown in Table 8. The children are grouped according to ethnic background in age categories given for the United States Recommended Dietary Allowances (USRDA) (20). Allowances published jointly by the Food

and Agriculture Organization (FAO) of the United Nations and the World Health Organization (WHO) are also shown in Table 8, although the statistical analysis was done using the USRDA (21).

Increased food consumption with age was reflected by significant increases in intakes of energy, protein, fat, carbohydrate, thiamine, niacin, folacin and iron. In general, estimated average intakes indicate marginal to deficient consumption of energy and most of the nutrients by one or more of the ethnic groups. Protein and niacin intakes appear to be more adequate. Although the allowances given by FAO/WHO tend to be lower than for the USRDA, consumption of total energy, vitamins A and C, riboflavin and calcium are often inadequate by these standards, also. Allowances suggested for the Caribbean by the Caribbean Food and Nutrition Institute (22) are similar to those from FAO/WHO.

A significant interraction between age and ethnic group was found for riboflavin and calcium (Table 8). Mestizo children, aged 1-3 years, consumed significantly more of these nutrients than the other ethnic groups of this age. Toledo Mayans, ages 7-10, ate more calcium than either Mayans or Mestizos of the same age from the Cayo district.

Comparisons based on percentages of the USRDA consumed are shown in Table 9 for energy and selected nutrients. Significant ($P<0.05$) differences between ethnic groups were found for vitamins A and C, riboflavin, calcium, iron and zinc.

The small number of children tested limit the interpretation

of these results. However, it appears that the Mestizo children had more adequate intakes of vitamin C, especially compared to the Mayans from the Toledo district. Also, more of the Mestizos met the USRDA for riboflavin. The Toledo Mayans tended to meet more of their calcium needs, while Mayans from the Cayo district more often fell into the lower intake (<67%) group. More of the Creoles consumed less than 67% of the USRDA for iron, while more Toledo Mayans ate adequate amounts. Mayans from the Cayo area tended to eat more zinc.

The frequency of fruit and vegetable consumption for 196 children 1-14 years of age is shown in Table 10. Although fruits and vegetables were often missing from food records, good sources of vitamin C were consumed more frequently than good sources of vitamin A. Data on starchy roots, including Irish potatoes, white yams and taro, were not included in Table 10.

Nutrients measured in leafy greens collected in the Cayo area of Belize are shown in Table 11. It is apparent that all of the greens compare quite favorably to spinach according to values published in U.S.D.A. Handbook No. 8-11 (23).

Discussion

Growth

A child cannot reach his/her genetic potential for growth without adequate nutrition. The question can be debated about the limitations that genetics may place on growth of children from different ethnic backgrounds. However, the remarkable increases

in stature with nutritional improvement observed in studies in Japan, Taiwan and other countries in recent years (24,25) indicates that malnutrition may account for much of the differences in growth that are observed among children from countries in different stages of economic development. Similarly, children from lower socioeconomic families are often found to have retarded physical growth when compared to children of higher income families with similar ethnic heritage in the same country (24, 26).

Data on growth status of children 8 years old in Table 1 indicates that growth patterns of Belize children are similar to those of children from neighboring Guatemala. The fact that many of the children in the Cayo area of Belize are from families who emigrated to Belize from Guatemala helps account for this similarity.

The NCHS growth charts are based on accurate measurements on a large, nationally representive sample of United States children. They have been recommended for clinical appraisal of growth and nutritional status for children around the world (26, 27).

Measurements between the 25th and 75th percentiles are considered to represent normal growth (26). Using this standard, the growth of rural Belize children should be a major concern, since most of the children measured below the 25th percentile. In fact, from 73 to 88% of the Mayan children fell below the 25th percentile, and over 50% of the Mayans in the Toledo district were below the 5th percentile of height for age.

Distributions of weight for height were more normal (Table 4).

The data indicate that the Mayan and Mestizo children tended to be heavier for their height than American children. Although height and weight data for Belize children in this report are based on a small number of subjects, they are similar to results reported for school-aged Columbian boys in 1983 (27). Limited data on heights and weights of Belize children previously published (5, 28) also showed growth retardation.

Anemia

Anemia was not indicated to be a generally serious problem in the children that were tested since only two of the 78 involved had low values (<11.0 g/dl) for hemoglobin. Data for hematocrit and mean cell volume showed more evidence for marginal anemia.

A report on "Food and Nutrition Statistics" dated October, 1984, lists anemia as a problem in school children in the Toledo district, although no data are given (2). In the same report, values for percent of Belize women receiving ante-natal services indicate that 43% had hemoglobin levels below 11 g/dl.

Values found for MCV do not indicate macrocytic anemia in this population due to deficiency of either folic acid or vitamin B12. In fact, average MCV values suggest microcytic anemia characteristic of iron deficiency (29).

Although the dietary intake of iron was often low or marginal by USRDA standards, it was more adequate for the lower requirements set by FAO/WHO (Table 8). Red meat and/or poultry were frequently consumed, which should have increased iron bioavailability in

diets. Intestinal parasites may be a primary factor when anemia is observed (2, 30).

Clinical Signs of Nutritional Deficiency

We were fortunate to have Dr. Mary Bess Kohrs examine children in this survey for signs of nutritional deficiency. Dr. Kohrs has considerable experience in nutrition surveys, backed by training in nutrition science (Ph.D, University of Wisconsin) and medical practice (M.D., University of Illinois). However, clinical examination for signs of nutritional deficiencies have recognized limitations. These include a non-specificity of most clinical signs and the lack of agreement between different examiners. On the other hand, physical examinations may find evidence of certain deficiencies which will not be detected by dietary or laboratory methods (31).

The clinical signs observed most frequently in the Belize children, inflamation and bleeding of the gums and papillae, suggest ascorbic acid deficiency. Poor dental hygiene may also contribute to inflamation of gum tissues. However, low intakes of vitamin C (<67% of the USRDA) were estimated for 36-86% of the different ethnic groups of children (Table 9).

Vitamin A deficiency was suggested for 10% or more of the children by eye examinations. Xerosis of conjunctival tissues and Bitot's spots are considered signs of vitamin A lack. Food records indicated that over half of the children consumed less than two-thirds of the USRDA for vitamin A.

Redness of eye membranes (conjunctival injection, 39%) a ring of fine blood vessels in the corner of the eye (circumcorneal injection, 10%) and mild hypertrophy of the fungiform papillae of the tongue (16%), are signs of riboflavin deficiency (31) observed in the children. With limited intake of dairy products, riboflavin was indicated to be inadequate in most diets based on the one-day food records (Tables 8 and 9).

Enlarged thyroid (goiter) was noted for about one-fourth of the children, primarily in Mayans living in San Antonio village in the foothills of the Mayan mountains. Goiter due to soils deficient in iodine has been reported to be endemic in certain areas of neighboring Guatemala. Addition of iodine to salt has been effective in decreasing the incidence of simple goiter in populations (32). If iodine is indeed lacking in areas of Belize it could account for some of the reduced growth rate in children (33).

Goitrogens found naturally in food and water may also contribute to thyroid enlargement. In fact, goitrogens in combination with iodine deficiency are often the cause of endemic goiter. Important goitrogens include cassava, cabbage, disulfides of hydrocarbons in drinking water, and bacterial products of Escherichia coli in drinking water (34).

Significant differences of deficiency signs between ethnic groups may be related to dietary habits, hygenic practices and/or geographic location. The Mayans in this survey lived in a relatively isolated village and to a greater degree than the other

groups, probably grew most of the food they ate and lacked centralized water and sewage facilities. They exhibited more goiter, more signs of riboflavin deficiency (conjunctival injection) and showed evidence of less care of gums and teeth than was observed in the Creole and Mestizo children (Table 7).. The Creoles may have had more vitamin C deficiency, based on incidence of inflamed gums and papillae. More clubbing of the fingers, a condition probably related to chronic lack of oxygen secondary to cardiac or respiratory disorders, was also observed in Creoles. The Creole children were primarily found in two adjacent villages, Blackman Eddy and Unitedville.

Dietary Intake

Estimated dietary intakes summarized in table 8 indicate that energy and several nutrients were often marginal or deficient for the children surveyed. In fact, protein and niacin (conversion from tryptophan was assumed, based on total protein intake) were the only nutrients consistently adequate in diets. Mean iron intakes were also sufficient by FAO/WHO standards, but were sometimes deficient based on the USRDA.

Table 9 shows the percentages of children consuming >100, 67-100 or <67% of the USRDA. Over one-half of the Creole children were estimated to consume <67% of the USRDA for iron. However, the fact that only two of 78 children tested had low hemoglobin values indicates that iron - deficiency anemia was not common.

Clinical signs (Table 6) were more in evidence for

deficiencies of vitamin A, riboflavin, and vitamin C, in agreement with the low dietary intakes estimated for these nutrients from the food records.

Food sources of vitamins A and C abound in Belize, in the leafy greens, fruits and vegetables that are grown. However, vitamin deficiencies are not uncommon in the tropics, inspite of their apparent availability in local foods.

Deficiency of vitamin A has been reported in children in several countries of Central and South America, including Brazil (35), El Salvador (36) and Guatemala (37). Early signs of vitamin A deficiency include poor appetite, growth failure and impaired immune response with decreased resistance to infection. As the deficiency progresses, degenerative changes in the eye collectively termed xerophthalmia, can lead to blindness. Over the entire world, at least 250,000 children are estimated to become blind each year due to inadequate intakes of vitamin A (38).

Low intakes of riboflavin were probably linked to limited consumption of dairy products, a prime source of this nutrient. Riboflavin deficiency leads to lesions of the eyes and lips, as noted in Table 6. Other features of riboflavin deficiency include a dermatitis, soreness and burning of the lips, mouth and tongue, glossitis, anemia and neuropathy. Retarded intellectual development has been reported in children with riboflavin deficiency (39).

Evidence for low intakes of vitamin C indicated by the data in Table 9 was supported by the large portion of children

exhibiting signs of deficiency (inflamation and bleeding of gums Table 6). Significantly more Mayan children living in the Toledo area consumed less than two-thirds of the USRDA for vitamin C, while the Mestizo children appeared to have a more satisfactory intake (Table 9). However, because we were unable to arrange air transportation into the Toledo area for our clinic team, physical examinations were not made for clinical signs of deficiency in Mayans living there. Of the children examined in the Cayo region, the Creoles showed more signs of vitamin C deficiency than either the Mayans or Mestizos (Table 7).

Folacin intake was indicated to be marginal to deficient for many of the children (Table 8). However, no hematological evidence was found for folacin deficiency. The fact that prime food sources of folates (leafy green vegetables, organ meats and nuts) were only infrequently found on food records accounts for the low intakes of folacin recorded.

The amounts of calcium eaten each day were generally low by USRDA standards but more adequate by FAO/WHO requirements (Table 8). Estimated consumption data suggest that Mayans in Toledo had better intakes of calcium while Mayans living in Cayo (about 60 miles to the northwest) had the lowest intakes. More frequent consumption of tortillas from lime-soaked corn appears to account for the extra calcium intake of the Toledo Mayans. The availability of calcium is affected by many factors, including exposure to ultraviolet light and vitamin D intake, the sex and age of the individual, the food source, and the bioavailabililty of

calcium.

Children with active skeletal growth absorb calcium well. Another positive influence on calcium utilization for Belize children is their exposure to sunlight. Factors that tend to decrease calcium utilization in the Belize environment include high temperatures and the consumption of foods high in oxalates, phytates and fiber (40).

Few of the children met more than 2/3 of the USRDA for zinc (Table 9). Growth failure is a principal feature of zinc deficiency (41). A lack of zinc in the diet may have contributed to the retarded growth observed in these children but biochemical measurements have not been completed on plasma samples to provide additional evidence for zinc deficiency. Factors other than dietary supply of this mineral that may contribute to a zinc deficiency include inflammation and stress, parasitic diseases, protein-energy malnutrition, high dietary fiber and phytate, and pica (41). All of these affect children to varying degrees in Belize.

Fruit and Vegetable Consumption

The number of times that fruits and vegetables appeared on one-day food recalls indicate that Belize children need to eat more of these foods. Dietary recalls of 24-hour food consumption are an estimate of the foods actually eaten, and it is entirely possible that individual foods are omitted. However, signs of deficiency found in the clinical examinations support the dietary recall indications that vitamins A and C were lacking in diets.

Visits to the roadside markets in Belize showed the abundance of fruits and vegetables that were available during the months that most food recalls were taken (January - March). Gardens and farm plots also grew a wide variety of these foods. Educational campaigns to increase the use of nutritious fruits and vegetables - especially the richer sources of vitamins A and C - are therefore in order.

Leafy Greens in Belize

The green, leafy plants listed in table 11 are well known by rural people in the Cayo area of Belize. The data indicate they compare well to spinach in the nutrients they were analyzed for and probably are also good sources of vitamins A, C and other vitamins. Unfortunately, none of these plants occurred in great frequency on the food recall forms.

All of these were growing "wild" on the edges of gardens and field plots, roadsides and pastures. Perhaps the best known green listed and the one showing up most frequently on food recalls (four of the 196 food recalls) was "Callaloo". This may have been the result of educational programs to increase the eating of greens (2, 7).

The availability of nutrients in different plants along with toxic factors that may be present, are important considerations in food plants, especially in those that are less well known. Research on the safety and availability of nutrients of potential food plants are in order before educational campaigns to increase

their use in diets.

Conclusions

1. Retarded growth in Belize children is evidence for malnutrition, probably due to several dietary factors with complications from various disease conditions.

2. Examinations for clinical signs of malnutrition indicated deficiencies for vitamins A and C, riboflavin and iodine. Poor dental hygiene and dental caries were common. Anemia was not found to be a generally serious problem.

3. Dietary intake data from 24-hour food recalls provided evidence for inadequate consumption of energy and several nutrients including vitamins A and C, riboflavin, calcium and zinc. Although iron intake was sometimes marginal, protein consumption was generally adequate.

4. Infrequent eating of fruits and vegetables by Belize children accounts for their low intakes of vitamins A and C.

5. Leafy green plants growing wild that are known as food sources by rural Belizeans are a potential source of nutrients that appear to be deficient in children's diets.

Recommendations

1. Encourage eating more fruits and vegetables to help prevent vitamin and mineral deficiencies. Greater consumption of foods grown in Belize will help improve diets and decrease outlay for imported foods.

2. Promote milk drinking for pre- and school-aged children. Milk and other dairy products can supply the calcium needed for proper growth.

3. Promote the use of iodized salt, especially for people living in the Mayan mountains and foothills.

4. Encourage the increased dietary use of leafy greens that are well known, such as spinach and callaloo (Amaranthus sp.). Further testing of a number of leafy green plants, both wild and domesticated, is needed to determine their suitability in Belizean diets.

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TABLE 1. MEAN HEIGHTS AND WEIGHTS OF CHILDREN 8 YEARS OF AGE FROM BELIZE AND FROM OTHER COUNTRIES (14)

LOCATION	N	HEIGHT (CM)	WEIGHT (KG)
BELIZE	25	119.9	22.0
GUATEMALA (MAYAN)	55	111.8	19.9
GUATEMALA (MESTIZO)	500	117.2	21.2
JAMAICA (BLACK)	1,891	121.8	22.4
U.S. (WHITE)	2,323	127.5	26.6
U.S. (BLACK)	337	128.1	26.1

TABLE 2. DISTRIBUTION OF HEIGHT FOR AGE OF BELIZE CHILDREN (4-13 YEARS)

ETHNIC GROUP/LOCATION	SEX	HEIGHT FOR AGE (NCHS PERCENTILES) 5<	5-25	26-50	>50
CREOLE (CAYO)	M	3*	7	6	2
	F	3	5	1	4
MAYAN (CAYO)	M	12	15	5	0
	F	14	11	2	4
MAYAN (TOLEDO)	M	19	5	3	6
	F	16	7	3	0
MESTIZO (CAYO)	M	3	7	7	1
	F	7	8	8	4

*NUMBER OF CHILDREN

TABLE 3. DISTRIBUTION OF WEIGHT FOR AGE OF BELIZE CHILDREN (4-13 YEARS)

ETHNIC GROUP/LOCATION	SEX	WEIGHT FOR AGE (NCHS PERCENTILES) 5<	5-25	26-50	>50
CREOLE (CAYO)	M	5*	5	5	3
	F	3	4	2	4
MAYAN (CAYO)	M	10	8	11	3
	F	5	11	8	7
MAYAN (TOLEDO)	M	9	18	3	4
	F	7	10	5	4
MESTIZO (CAYO)	M	2	5	6	5
	F	3	8	10	6

*NUMBER OF CHILDREN

TABLE 4. DISTRIBUTION OF WEIGHT FOR HEIGHT
PREPUBESCENT PHYSICAL
GROWTH - NCHS PERCENTILES

ETHNIC GROUP/LOCATION	SEX	WEIGHT FOR HEIGHT (NCHS PERCENTILES) 5<	5-50	>50
CREOLE (CAYO)	M	1*	11	6
	F	1	5	4
MAYAN (CAYO)	M	0	7	16
	F	2	7	21
MAYAN (TOLEDO)	M	5	7	19
	F	1	5	19
MESTIZO (CAYO)	M	0	5	13
	F	1	7	12

*NUMBER OF CHILDREN

TABLE 5. MEAN DISTRIBUTION OF HEMOGLOBIN, HEMATOCRIT AND MEAN CORPUSCULAR VOLUME OF BELIZE SCHOOL CHILDREN*

ETHNIC GEOGRAPHIC GROUP	SEX	N	MEAN AGE, YEARS	HB G/DL (13)**	HCT % (38)	MCV FL (81-83)
CREOLE	M	14	8.5	12.8 ± 1.09	37.0 ± 2.53	75.7 ± 4.07
	F	11	9.5	12.5 ± 3.50	34.8 ± 4.17	78.4 ± 6.62
MAYAN	M	12	7.3	13.1 ± 0.58	37.2 ± 3.98	76.0 ± 5.19
	F	16	8.6	13.4 ± 0.53	38.9 ± 2.92	81.2 ± 3.11
MESTIZO	M	11	12.3	13.5 ± 0.58	38.5 ± 2.64	78.1 ± 3.81
	F	14	11.2	12.9 ± 2.88	36.3 ± 7.79	76.8 ± 7.77

*±STANDARD DEVIATION

**ESTIMATED MEAN VALUES FOR CAUCASIONS 6-11 YEARS OLD (15)

TABLE 6. INCIDENCE OF CLINICAL SYMPTOMS INDICATIVE OF NUTRITIONAL PROBLEMS IN BELIZE CHILDREN*

CLINICAL SYMPTOMS	%
1. HAIR	
A. DRY, STARING	5.0
2. EYES	
A. THICKENED OPAQUE BULBAR CONJUNCTAVAE	1.2
B. CONJUNCTIVAL INJECTION, BILATERAL	39.0
C. CIRCUMCORNEAL INJECTION, BILATERAL	9.6
D. XEROSIS CONJUNCTIVAE	4.8
E. BITOT'S SPOTS	11.0
3. LIPS	
A. ANGULAR LESIONS	1.2
B. ANGULAR SCARS	1.2
4. TEETH	
A. VISIBLE CARIES	35.4
B. 1. DEBRIS	9.7
2. CALCULUS + DEBRIS	7.3
C. FLUOROSIS	2.4
5. GUMS	
A. ATROPHY, RECESSION, INFLAMATION	
1. LOCAL	3.7
B. MARGINAL REDNESS OR SWELLING	
1. LOCAL	25.6
2. DIFFUSE	20.0
C. SWOLLEN, RED PAPILLAE	
1. LOCAL	11.0
2. DIFFUSE	4.9
D. BLEEDING GUMS	
1. LOCAL	6.1
6. TONGUE	
A. FUNGIFORM PAPILLARY HYPERTROPHY	
1. MILD	15.9
B. GEOGRAPHIC	1.2
C. SERRATION/ SWELLING	1.2
7. FACE & NECK	
A. NASOLABIAL SEBORRHEA	2.4
B. THYROID ENLARGEMENT	24.3
8. FINGERS & NAILS	
1. CLUBBED FINGERS	15.7
2. COMBINATION (CLUBBED FINGERS; SPOONED, RIDGED NAILS)	1.2
9. SKIN	
A. PELLAGROUS DERMATITIS	2.4
B. DRY OR SCALING (XEROSIS)	1.2
C. HYPER-PIGMENTATION, FACE OR HANDS	4.8
D. THICKENED PRESSURE POINTS	7.2
E. CRACKED SKIN	1.2

*DATA COMPILED ON THE NATIONAL NUTRITION SURVEY GENERAL CLINICAL EXAMINATION FORM NCCD-3-5 (D.C.) FROM THE DEPARTMENT OF HEALTH EDUCATION AND WELFARE - UNITED STATES PUBLIC HEALTH SERVICE.

TABLE 7. DISTRIBUTION OF CLINICAL SYMPTOMS BY ETHNIC GROUP IN BELIZE SCHOOL CHILDREN

CLINICAL SYMPTOMS	ETHNIC GROUP CREOLE (27)*	MAYAN (29)	MESTIZO (25)	P**
1. EYES				
CONJUNCTIVAL INJECTION BILATERAL	5	19	14	.001
BITOT'S SPOTS	2	4	1	.447
2. TEETH				
DEBRIS, CALCULUS	4	9	0	.029
VISIBLE CARIES	9	13	6	.278
3. GUMS				
MARGINAL REDNESS, SWELLING	17	6	4	.001
SWOLLEN RED PAPILLAE	11	0	1	.001
4. TONGUE				
FUNGIFORM PAPILLARY HYPERTROPHY	2	6	5	.354
5. FINGERS, NAILS				
CLUBBED FINGERS, SPOONED, RIDGED NAILS	10	1	3	.016
6. NECK				
THYROID ENLARGEMENT	3	16	3	.001

*TOTAL NUMBER OF CHILDREN EXAMINED
**P>CHI-SQUARE VALUE

Table 8. Mean intakes of energy and nutrients for children in two rural Belize districts[1]

District, Ethnic Group	Age yrs.	N[2]	Energy Kcals	Protein g	Fat g	Vitamin A IU	Vitamin C mg	Thiamine mg	Ribo-flavin mg	Niacin (equiv) mg	Folacin ug	Calcium mg	Iron mg
1. A. Cayo, Creole	1-3	4	726 ± 3273	30.6 ± 13.8	29.6 ± 16.2	1304 ±1101	17.3 ± 19.6	0.44 ± 0.23	0.71[A4] ± 0.57	10.2 ± 4.97	64.5 ± 34.6	357[A] ± 343	5.39 ± 1.67
B. Cayo, Mayan	1-3	7	741 ± 304	27.9 ± 12.8	27.0 ± 11.9	514 ± 537	6.7 ± 8.5	0.61 ± 0.53	0.34[A] ± 0.17	9.07 ± 4.15	103 ± 63.6	274[A] ± 167	8.13 ± 4.47
C. Cayo, Mestizo	1-3	11	1221 ± 471	44.7 ± 18.8	38.3 ± 20.4	2332 ±1737	85.6 ± 89.9	0.90 ± 0.41	1.48[B] ± 1.08	15.4 ± 6.03	139 ±106	880[B] ± 668	8.10 ± 3.59
D. Toledo, Mayan	1-3	20	1105 ± 356	42.5 ± 17.7	35.2 ± 16.3	1317 ±1661	12.6 ± 20.6	0.73 ± 0.30	0.63[A] ± 0.28	14.2 ± 6.58	139 ± 65.2	514[A] ± 227	11.97 ± 4.52
USRDA	1-3		1300[5] (900-1800)	23		1320	45	0.7	0.8	9	100	800	15
FAO/WHO	1-3		1360[6]	16		825	20	0.5	0.8	9	100	400-500	5-10
2. A. Cayo, Creole	4-6	7	948 ± 699	34.3 ± 27.5	29.2 ± 31.6	1195 ± 923	24.6 ± 24.9	0.63 ± 0.37	0.84 ± 0.78	11.66 ± 10.47	81.4 ± 28.9	434 ± 389	7.22 ± 3.40
B. Cayo, Mayan	4-6	13	1253 ± 665	49.2 ± 31.5	44.9 ± 29.5	2527 ±3049	52.5 ±104.5	0.82 ± 0.52	1.02 ± 1.36	14.98 ± 8.41	177 ±130	661 ± 864	10.98 ± 4.67
C. Cayo, Mestizo	4-6	12	1025 ± 352	36.1 ± 21.5	30.7 ± 18.7	2136 ±1530	72.6 ± 84.4	0.78 ± 0.45	0.86 ± 0.53	14.8 ± 9.52	134 ± 96.4	447 ± 264	7.65 ± 2.84
D. Toledo, Mayan	4-6	22	1324 ± 482	48.5 ± 20.3	33.8 ± 16.6	2588 ±5588	20.5 ± 48.3	0.96 ± 0.40	0.67 ± 0.35	18.3 ± 9.36	150 ± 90.3	607 ± 280	14.4 ± 5.97
USRDA	4-6		1300-2300	30		1650	45	0.9	1.0	11	200	800	10
FAO/WHO	4-6		1830	20		990	20	0.7	1.1	12.1	100	400-500	5-10

Table 8. (continued) Mean intakes of energy and nutrients for children in two rural Belize districts[1]

District, Ethnic Group	Age yrs.	N[2]	Energy Kcals	Protein g	Fat g	Vitamin A IU	Vitamin C mg	Thiamine mg	Ribo-flavin mg	Niacin (equiv) mg	Folacin ug	Calcium mg	Iron mg
3. A. Cayo, Creole	7-10	6	1368 ± 348	54.5 ± 15.7	52.5 ± 27.3	2185 ±1634	44.4 ± 48.5	1.20 ± 0.40	1.04 ± 0.45	20.25 ± 6.10	129 ± 38.0	518 ± 234	11.8 ± 2.75
B. Cayo, Mayan	7-10	12	1437 ± 698	50.7 ± 23.5	48.8 ± 29.8	3044 ±5280	57.2 ±144	1.01 ± 0.53	0.58 ± 0.35	17.73 ± 9.58	217 ±139	411[A] ± 186	15.59 ± 6.97
C. Cayo, Mestizo	7-10	24	1417 ± 546	51.7 ± 28.9	39.9 ± 24.7	1940 ±1344	59.7 ± 56.5	1.03 ± 0.46	0.90 ± 0.56	21.53 ± 12.81	152 ± 98.1	514[A] ± 325	11.85 ± 6.24
D. Toledo, Mayan	7-10	33	1482 ± 471	50.3 ± 18.8	36.5 ± 20.6	2964 ±5962	22.9 ± 48.2	1.02 ± 0.35	0.71 ± 0.32	17.91 ± 6.72	171 ± 90	747[B] ± 297	16.4 ± 5.32
USRDA	7-10		1650-3300	34		2310	45	1.2	1.4	16	300	800	10
FAO/WHO	7-9		2190	25		1320	20	0.9	1.3	14.5	100	400-500 500	5-10

1. Based on 24-hour food recalls
2. Number of subjects
3. ± standard deviation
4. Means within columns with different superscript letters (A,B) are significantly ($P<0.05$) different for age group
5. For children of medium height and weight in each age group: 1-3 yrs (90 cm, 20 kg); 7-10 yrs (132 cm, 28 kg), respectively
6. For children of medium weight for each age group: 1-3 yrs, 13.4 kg; 4-6 yrs, 20.2 kg; 7-9 yrs, 28.1 kg.

TABLE 9. PERCENTAGE OF BELIZE CHILDREN IN EACH ETHNIC GROUP WHO CONSUMED OVER 100%, 67-100%, OR LESS THAN 67% OF THE USRDA FOR DIFFERENT NUTRIENTS

		PERCENTAGE OF THE USRDA CONSUMED		
LOCATION/ETHNIC GROUP		<67	67-100	>100
		ENERGY		
CAYO CREOLE	(17)[A]	70.6	23.5	5.9
CAYO MAYAN	(32)	68.7	21.9	9.4
CAYO MESTIZO	(47)	68.3	23.4	12.8
TOLEDO MAYAN	(75)	53.3	34.7	12.0
		PROTEIN		
CAYO CREOLE		17.6	5.9	76.5
CAYO MAYAN		9.4	25.0	65.6
CAYO MESTIZO		10.6	17.0	72.3
TOLEDO MAYAN		6.7	10.7	82.6
		VITAMIN A		
CAYO CREOLE		52.9	23.5[B]	23.5
CAYO MAYAN		75.0	3.1	21.9
CAYO MESTIZO		51.1	14.9	34.0
TOLEDO MAYAN		77.3	4.0	18.7
		VITAMIN C		
CAYO CREOLE		64.7	17.6	17.6
CAYO MAYAN		78.1	9.4	12.5
CAYO MESTIZO		36.2[B]	21.3[B]	42.5[B]
TOLEDO MAYAN		86.7[B]	0.0[B]	13.3

TABLE 9. (CONTINUED) PERCENTAGE OF BELIZE CHILDREN IN EACH ETHNIC GROUP WHO CONSUMED OVER 100%, 67-100%, OR LESS THAN 67% OF THE USRDA FOR DIFFERENT NUTRIENTS

	PERCENTAGE OF THE USRDA CONSUMED		
LOCATION/ETHNIC GROUP	<67	67-100	>100
	RIBOFLAVIN		
CAYO CREOLE	58.8	11.8	29.4
CAYO MAYAN	81.2	6.3	12.5
CAYO MESTIZO	44.7	14.9	40.4[B]
TOLEDO MAYAN	60.0	25.3	14.7
	CALCIUM		
CAYO CREOLE	58.8	17.7	23.5
CAYO MAYAN	84.4[B]	6.2[B]	9.4
CAYO MESTIZO	59.6	19.1	21.3
TOLEDO MAYAN	38.7[B]	33.3[B]	28.0
	IRON		
CAYO CREOLE	52.9[B]	17.7	29.4
CAYO MAYAN	21.9	37.5	40.6
CAYO MESTIZO	29.8	34.0	36.2
TOLEDO MAYAN	13.3	17.3	69.3[B]
	ZINC		
CAYO CREOLE	88.2	11.8	0.0
CAYO MAYAN	65.6	28.1[B]	6.3
CAYO MESTIZO	85.1	6.4	8.5
TOLEDO MAYAN	88.0	9.3	2.7

[A]NUMBER OF CHILDREN 1-10 YEARS OLD

[B]VALUE IS SIGNIFICANTLY ($P<0.05$) DIFFERENT FROM EXPECTED FREQUENCY BY CHI SQUARE TEST.

TABLE 10. FREQUENCY OF FRUIT AND VEGETABLE CONSUMPTION FOR CHILDREN 1-14 YEARS IN BELIZE*

	NUMBER OF TIMES FOOD APPEARED ON 196 ONE-DAY FOOD RECORDS
ONION	109
TOMATO	50
BANANA	33
CABBAGE	19
LEMONADE	17
ORANGES	17
ORANGE JUICE	10
PALM HEART	6
OKRA	5
PLAINTAIN	5
CALLALOO	4
CARROT	3
CUCUMBER	3
LIME	3
GREEN PEPPER	2
PINEAPPLE JUICE	2
LETTUCE	2
MANGO	2

APPLE JUICE, "CHIB" (IMMATURE PALM FLOWER), COCONUT MILK, OLIVES, TURNIP AND VEGETABLE SOUP EACH APPEARED ONE TIME.

*STARCHY ROOTS AND TUBERS NOT INCLUDED ON LIST.

Table 11. Nutrients measured in leafy greens collected in Belize

Item	Amounts in 100 gms, edible portion								
	Water	Protein NX 6.25	Calcium	Copper	Iron	Potassium	Magnesium	Phosphorus	Zinc
	g	g	mg	mg	mg	mg	mg	mg	mg
Spinach (23)	91.6	2.86	99	0.13	2.71	558	79	49	0.53
"Calaloo" Amaranthus sp.	91.5	2.43	236	0.12	2.86	594	61.8	48.0	0.73
"Mt Cow Leaf" Amplocera hottlei	84.4	4.16	292	0.17	3.62	588	52.6	54.9	0.67
"Chaya" Cnidoscolus chayamansa	84.2	4.72	186	0.15	2.56	630	58.3	81.4	1.20
"Coco" Colocasia esculenta	92.8	1.43	110	0.09	1.00	359	20.2	32.0	0.30
"Cassava" Manihot aesculenta	79.0	5.1	452	0.14	1.18	412	95.8	45.8	1.16
"Jokoto" Solanum quitoense	83.6	4.06	253	0.14	2.20	554	33.9	55.4	0.77
"Purslane" Portulaca oleracea	88.2	1.56	184	0.11	3.15	738	68.9	30.6	0.65