

Investigation of the nutrition problems of Central America and Panama

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Abstract

From its earliest years, INCAP gave a high priority to a multidisciplinary effort to learn as much as possible about the dietary habits, nutritional status, and their consequences in the populations of Central America and Panama. Most of the papers in this Special Issue contain some of this information. The first studies were in school-children but were soon extended to preschool children, pregnant and lactating women, and other adults.

This paper describes the principal findings of the initial dietary, biochemical, and clinical community-based studies. From 1965–67, very extensive studies were carried out in all six countries including dietary, biochemical, clinical, and anthropological studies were carried out in all six countries, the results of which are summarized.

Key words: Central America, nutrition surveys, nutritional deficiencies, vitamin deficiencies, mineral deficiencies, iron deficiency, vitamin nutrition

Introduction

It was to be expected that the highest-priority effort of the Institute of Nutrition of Central America and Panama (INCAP) after its inauguration in September 1949 would be to determine the nature and scope of the nutritional deficiencies and problems affecting the populations of its member countries. At the time, knowledge of the food and nutrition situation was largely

lacking. In some of the countries, there was not even official consensus as to whether significant nutritional problems existed. With relatively limited resources, assessment of nutritional status was launched as the highest priority of INCAP's initial research.

Staff were recruited for dietary, clinical, and nutritional biochemistry units during the first few months of operation. A nutritional biochemistry laboratory was equipped with the most modern instrumentation available at that time to determine in fingertip blood samples the levels of those nutrients suspected to be most relevant to the health of the populations of Central America and Panama. Ultra-micro methods only recently developed in the United States were set up and standardized. The capability to carry out analytical work in the smallest possible aliquots of biologic specimens was important for the feasibility of these studies in small children, who were the most nutritionally vulnerable. This type of laboratory at the time was unique in Latin America and other developing regions in the world.

Early studies

Dietary surveys

Investigations of dietary habits and food consumption are presented in expanded detail in another article in this issue [1]. Data on nutrient intake will be referred to only when considered pertinent for the interpretation of biochemical and clinical findings.

Biochemical observations

As early as 1955, INCAP published the first scientific reports of studies conducted during 1952–55 in children from some “typical” low-socioeconomic communities [2–4]. Findings suggesting protein and vitamin A deficiencies were very consistent [5]. Although the average levels of serum riboflavin appeared normal, the large standard deviation indicated that a significant

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number of children fell below acceptable levels. On the other hand, ascorbic acid values were always found to be either adequate or high. The finding of low serum riboflavin in some individuals was consistent with a high prevalence of low intakes of this vitamin, as found in food consumption surveys [1].

Additional biochemical studies similar to the ones already cited [1–5] were carried out in other small communities of the countries, but their results were reported directly to the health sectors as internal documents and were not published. The findings of these studies, however, were generally in good agreement with those discussed above, as well as with a later study published in 1960 [6].

Two specific investigations of the riboflavin status of poor urban pregnant women were carried out in Guatemala. In the first study [7], a tissue saturation test showed that approximately 20% of the women had marked unsaturation, indicative of insufficient intake. In the second study [8], a sample of pregnant women from a low socioeconomic level was found to have somewhat lower red blood cell riboflavin levels than a comparable group of pregnant women from a high socioeconomic level. These data suggested that the riboflavin status of these women was less than adequate, although not as serious as that in children.

In 1961, INCAP published an extensive report on blood serum values selected as indicators of vitamin nutrition among Central American schoolchildren [9]. In a sample of more than 850 public schoolchildren (7 to 12 years of age), serum levels of riboflavin, ascorbic acid, vitamin E, vitamin A, carotene, and alkaline phosphatase (indicators of vitamin D nutrition) were measured over a period of 2½ years in 18 public schools from urban and rural communities in Costa Rica, El Salvador, Guatemala, Honduras, and Panama.

The most important conclusions reached by the authors are summarized as follows: “All the average values in the present study were within the limits of values for population groups considered well nourished. Since the standard deviations are large, however, levels suggestive of deficiencies for some of the nutrients were found in many children” [9]. In view of the consistently inadequate levels riboflavin intakes found in similar population groups, the investigators expected a higher prevalence of reduced serum riboflavin levels. Ascorbic acid values were higher than those found in US schoolchildren, but these findings are compatible with the more than adequate intakes reported in food consumption surveys. On the other hand, in the case of vitamin A, individual serum values below 20 mg/dL were observed in approximately 15% of the children.

Clinical studies

In essentially all of the above-mentioned studies, physical examinations of the subjects showed a consistent

pattern that can be summarized as follows:

Alterations associated with protein and iodine deficiencies were quite frequent. Eye lesions attributable to vitamin A deficiency were rare, despite evidence of deficiency revealed by biochemical studies. These three nutrients are discussed in detail in other articles in this issue [5, 10, 11].

Eye signs suggestive of riboflavin deficiency were common among rural preschool children. The consensus of the investigators was that environmental factors, rather than nutrition, were most likely responsible. A cause–effect relationship between the changes observed with low riboflavin intakes and biochemical levels could not be established. Other signs suggestive of riboflavin deficiency (cheilitis, angular stomatitis, and nasolabial seborrhea) were rare.

Finally, no clinical manifestations of other micronutrient deficiencies were found, including deficiencies of ascorbic acid, thiamine, and niacin.

Comprehensive regional assessment: The Central American Nutrition Survey

Bases and organization

A large amount of information was gathered during the first decade. Initial surveys, described above, were carried out either to enable INCAP to identify the most salient food and nutrition problems affecting population groups, particularly those most vulnerable, or to respond to the member countries' requests for preliminary information required to introduce a nutrition component into their local health activities in specific communities. Thus, these studies were not components of a coherent plan and, therefore, were not sufficiently representative to permit generalization of the results to a regional or national level. Nevertheless, the information made available provided a preliminary view of the most salient nutritional deficiencies and the need for more representative documentation.

In the early 1960s, it became clear that food and nutrition problems found in regions and countries could not be solved in a country by isolated, narrowly-targeted interventions. A consensus formed that these immense challenges could be better served if actions were planned within a broader and more integrated context. INCAP became aware that this ambitious approach would demand more complete knowledge of the magnitude and extent of existing problems in the Central American region, including their geographic and socioeconomic differences levels. Therefore, it was imperative that a comprehensive national assessment be implemented for all countries in the region. An ambitious plan for national nutrition surveys in all six member countries was submitted to the meeting of the Directing Council of the Ministers of Health in

November 1964 and received unanimous approval.

These surveys were made possible by the technical and financial support of the Interdepartmental Committee of Nutrition for National Development (ICNND) of the United States and were carried out during 1965–67. Individual reports for each of the six countries were published in Spanish shortly after the surveys were completed [12–17], and a 165-page regional summary was published in English in 1972 [18].

The study population was statistically selected by a random procedure to ensure adequate representation. The household was taken as the study unit, and all members were included. A breakdown and the actual size of the rural sample is presented in **table 1**. The characteristics investigated, categorized in terms of the classical epidemiologic approach, were as follows:

Host characteristics

Clinical

- Clinical nutritional examination
- Dental examination
- Anthropometric measurements
- Ancillary studies
 - Mortality rates
 - Prevalence of diabetes and cardiovascular disease
 - Bone maturation (wrist–hand x-rays)

Biochemical and hematologic

Agent characteristics

Dietary studies

Environmental characteristics

- Socioeconomic
- Agricultural food production
- Food industry
- Microbiologic and parasitologic

This paper focuses mainly on the clinical and biochemical aspects of the survey. The clinical survey recorded all signs of potential nutritional significance in the 21,521 subjects. Approximately one-fourth of these constituted the sample for the biochemical studies, for which the following analyses were performed:

- Blood serum or plasma
 - Proteins and electrophoretic fractions
 - Nonessential to essential amino acid ratio
 - Vitamin A
 - Ascorbic acid
 - Folic acid
 - Vitamin B₂
 - Iron and iron-binding capacity
- Red blood cells
 - Riboflavin
- Whole blood
 - Hemoglobin and hematocrit
- Urine
 - Riboflavin
 - Thiamine
 - N-Methyl nicotinamide
 - Iodine
 - Creatinine
 - Urea

Survey findings

Nutrient deficiencies

The following is a summary of the main biochemical and clinical findings in relation to dietary intake. Information on all nutrients investigated is included in order to convey the completeness and comprehensiveness of the regional survey. However, problems of protein–energy and vitamin A deficiencies, nutritional anemias, and endemic goiter are covered more extensively elsewhere in this issue [5, 10, 11, 19].

Hematopoietic nutrients. In general, a high prevalence of anemia was found indicating that nutritional deficiencies affecting erythropoiesis constituted a health problem in the countries.

Iron deficiency. A high proportion of the low income populations in Central America and Panama are iron deficient as judged by low dietary iron intakes and very low transferring saturation values. The low iron bioavailability of the predominantly vegetable diets of the rural and urban poor families is the most important causative factor. INCAP studies of iron deficiency and

TABLE 1. Survey sample of the rural population

Country	No. of communities	No. of families	No. of individuals		Total
			Male	Female	
Costa Rica	30	600	1,804	2,261	4,065
El Salvador	30	600	1,506	1,725	3,231
Guatemala	40	800	2,006	2,017	4,023
Honduras	30	600	1,560	2,094	3,654
Nicaragua	30	600	1,389	2,088	3,477
Panama	30	600	1,337	1,734	3,071
Total	190	3,800 ^a	9,602	11,919	21,521

a. One-fourth were selected at random for biochemical studies.

TABLE 2. Plasma ratio of nonessential to essential amino acids

Country	% of children with ratio ≥ 3				No. of children with ratio $\geq 3^a$
	Rural		Urban		
	0-4 yr	5-9 yr	0-4 yr	5-9 yr	
Guatemala	8	6	—	—	90,000
El Salvador	6	11	9	10	80,000
Honduras	24	29	0	17	158,000
Nicaragua	25	16	11	12	115,000
Costa Rica	18	13	6	3	86,000
Panama	18	15	6	0	41,000

a. The number is derived by multiplying the percentage of children between 0 and 9 years of age with a plasma ratio of nonessential to essential amino acids of 3.0 or higher by the total number of children in this age group in the respective countries, estimated from census figures.

iron deficiency anemia are discussed in detail in the paper by Viteri in this Special Issue [19].

Folate. A high prevalence of low and deficient serum levels of folic acid was also found in both rural and urban populations. Although microcytic-hypochromic type (iron deficiency) anemia was generally found, it could be concluded that a large percentage of anemic subjects were also deficient in folate and that therefore preventive and curative measures should consider both nutrients.

Vitamin B₁₂. Contrary to the other two hematopoietic nutrients, vitamin B₁₂ deficiency appeared very rarely.*

Protein-calorie nutrition. Table 2 shows the percentages of children with abnormally elevated plasma ratios of nonessential to essential amino acids. The differences among countries are considerable, and the situation in urban areas is more favorable than that in rural areas. When these data were related to the families' socioeconomic status the highest prevalence rates of abnormally elevated plasma ratios of nonessential to essential amino acids were found among the lower-socioeconomic groups [20, 21].

Plasma albumin data also indicated a severe protein problem. This biochemical parameter does not decrease gradually with a progressive degree of protein deficiency but drops rather abruptly in the severe acute stages. Therefore, children with these low and deficient values (table 3) must have had protein-energy malnutrition severe enough to alter plasma protein.

Although the average daily per capita intake of total proteins appeared to be adequate for each population as a whole, the distribution of the protein supply, both in quantity and in quality, was shown to be inequitable. Rural and urban children of the lowest socioeconomic levels were found to be receiving the poorest share of protein available. Calorie deficiency was also shown to affect very significant portions of the population, and,

* It is now recognized that the assay available at that time gave falsely high values.

as in the case of proteins, the intrafamilial distribution was most unfavorable to small children.

Anthropometric measurements showing marked retardation in height and weight were considered strong further evidence that protein-energy malnutrition was a serious problem among young children.

Vitamin A nutrition. Biochemical data showed higher prevalence rates of deficient and low serum levels of vitamin A in rural areas than in urban areas in all the countries (table 4). When the data were analyzed according to low, medium, and high socioeconomic index, vitamin A serum levels were shown to decrease progressively as socioeconomic status became lower [20, 21]. The average vitamin A intake at the family level was grossly inadequate in all rural areas and considerably below the intakes for the corresponding

TABLE 3. Prevalence (%) of deficient and low plasma albumin values

Country	Rural		Urban	
	Deficient	Low	Deficient	Low
Guatemala	0.3	3.1	0.0	0.3
El Salvador	0.7	5.2	0.0	3.0
Honduras	0.6	2.7	0.0	4.1
Nicaragua	0.1	4.9	0.0	3.9
Costa Rica	1.3	18.4	0.0	4.1
Panama	0.3	12.1	0.0	12.0

TABLE 4. Prevalence (%) of low and deficient serum vitamin A levels

Country	Rural		Urban	
	Low	Deficient	Low	Deficient
Guatemala	11.7	2.2	4.1	0.3
El Salvador	21.3	1.4	13.8	1.0
Honduras	18.8	3.6	14.9	2.5
Nicaragua	9.5	0.5	10.3	0.5
Costa Rica	15.2	1.8	3.0	0.0
Panama	7.1	0.3	5.0	0.0

urban sectors. Children under 10 years of age had the lowest levels, with preschool children more affected. This finding reinforced dietary survey evidence that within the family, small children do not receive their share of vitamin A. Despite the vitamin A deficiency detected by biochemical and dietary studies, specific clinical signs were rarely seen.

Riboflavin status. Inadequate riboflavin intakes in the rural population were confirmed by the prevalence of low urinary excretion of riboflavin. These inadequate intakes resulted in a significant reduction of red blood cell riboflavin concentration in a large portion of the sample (table 5). According to the same indicators, the situation in urban areas was much better. Clinical signs suggestive of riboflavin deficiency were observed. However, their erratic distribution among the population casts doubts on their specificity and health significance.

Thiamine. No clinical abnormalities suggestive of thiamine deficiency were observed in any of the countries. Furthermore, the overall intake of this vitamin was adequate in virtually all the population groups surveyed. Only in Costa Rica were intakes of thiamine found to be somewhat lower than the recommended allowances.

Despite these favorable clinical and dietary data, urinary excretion of thiamine was low in a significant proportion of individuals, particularly in Panama. It was speculated that cooking losses of thiamine from enriched rice, the principal staple and main potential source of thiamine, could be the reason for the discrepancy. But since no other evidence of thiamine deficiency was found, the question was investigated no further.

Niacin status. Urinary excretion of *N*-methyl nicotinamide was adequate or high in most rural and urban populations, indicating ample niacin intakes, despite the relatively high corn diets in most of the countries. Dietary studies reported intakes ranging from 75% to more than 100% of the recommended allowances, without taking into account the contribution of dietary tryptophan and coffee consumption, even by children. These niacin precursors would have ensured that there would be no niacin deficiency [22].

TABLE 5. Prevalence (%) of low and deficient red blood cell riboflavin

Country	Rural		Urban	
	Low	Deficient	Low	Deficient
Guatemala	2.0	29.6	2.3	36.4
El Salvador	4.7	50.0	0.0	5.0
Honduras	1.5	13.0	0.0	7.4
Nicaragua	0.3	9.4	0.0	2.5
Costa Rica	1.1	15.0	0.0	3.0
Panama	0.7	17.8	2.0	10.2

Ascorbic acid. Blood plasma levels of ascorbic acid in all populations fell within the acceptable and high ranges, consistent with the absence of clinical signs of deficiency. Dietary studies indicated that ascorbic acid intakes were adequate and in many instances were well above the recommended allowances, even though consumption of food outside the household was usually not reported in dietary survey interviews because it was not known to the informant.

Calcium. No physiological or clinical evidence of calcium deficiency was found, even in Panama where average intakes of this mineral were lower than the recommended allowances. The wrist and hand x-ray studies carried out jointly with the clinical examination indicated that osteoporotic bone loss with age suggested no abnormal pattern that could be attributed to a calcium intake deficit in relation to the requirements.

In most of the countries, the treatment of corn with lime in making tortillas would add significant calcium to the diet. However, in Costa Rica, part of the corn is processed with wood ash instead of lime, and in Panama, wood ash is commonly used for this purpose.

Iodine status. At the time of the survey, endemic goiter represented a serious problem in all countries except Guatemala. In 1956, a national salt iodization program was implemented in Guatemala, which reduced goiter prevalence from 38% to 5%, well below the 10% maximum considered acceptable by the World Health Organization [10]. Urinary iodine excretion levels were confirmatory, as they showed the average levels to be around or below 25 µg per day for most investigated localities, whereas in Guatemala City they averaged 155 µg per day.

Socioeconomic status and nutrition

In addition to the dietary and nutritional studies already described, a sociocultural team conducted a parallel investigation on all the rural families in the sample. This allowed for the calculation of a "socio-economic index" for each family, using criteria such as property, housing conditions, income, education, home food production, and exposure to mass-media communications. On the basis of a numerical grading according to these criteria, families could be grouped into low, medium, and high socioeconomic levels. Nutritional data were then reanalyzed for each of these subgroups, and the results showed a consistent association between socioeconomic index and nutritional status. In all of the countries, families in the low socioeconomic level were at a great disadvantage in both dietary intake and nutritional parameters. The largest gaps between the high and the low socioeconomic levels were for vitamin A, riboflavin, and protein nutrition indicators. The best food sources for these nutrients are animal products, which because of their high price are consumed only in very small amounts by the rural poor population.

Ascorbic acid, on the other hand, showed little difference between the low and high socioeconomic levels. This may be explained by the fact that food sources rich in this nutrient are abundant and inexpensive in all rural areas of the region.

The results of this study provided valuable insights regarding the magnitude of the gaps in nutritional status among different socioeconomic groups in the countries. The data gathered were used as the basis for program planning and for establishing program priorities for the different population sectors. This investigation documented, for the first time, the dramatic socioeconomic dimension of the nutrition problems affecting the region.

Concluding remarks

This regional survey still stands as one of the most extensive and in-depth assessments of the nutritional status and related health problems in any country or region in the developing world. It is a patent example of an integrated institutional effort for which essentially all scientific and technical disciplines joined forces. This is reflected in the concluding remarks published in the Regional Summary [18]:

“The situation described in this report is due to a combination of interrelated social, economic, cultural, and health factors which act on production, distribution, intake and utilization of food and nutrients by the people of Central America and Panama. All these factors must

be corrected if a definitive and permanent solution is to be given to the nutritional problems of the area. This will require long-term multidisciplinary actions. The mutual relationship between these factors, however, is such that correcting the major ones will help to reduce the effect of many of the others. There exists, therefore, an optimal combination of programs which would yield a fast and effective improvement through the best use of resources. Definition of national food and nutrition priorities, selection of programs, and allocation of resources are the privilege and responsibility of Governments.

This position statement clearly conveys INCAP's vision at the time (1972). With many variations and adaptations, the philosophy expressed is being repeated at all levels by nutritional communities as the accepted thing to do. In fact, it is now being carried out or at least attempted in most parts of the world.

Based on the richness of the collected data, INCAP offered its member countries the technical assistance and staff training needed for the design and implementation of their food and nutrition strategies. Nevertheless, the need for investigating and defining present and emerging nutrition problems and the quest for answers and solutions will never cease. At that time, INCAP's scientists had the scientific and technological capability to plan and implement nutritional assessments. They were “on call” to assist governments in identifying their public health nutritional problems and potential interventions as well as in program surveillance, monitoring, and evaluation.

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