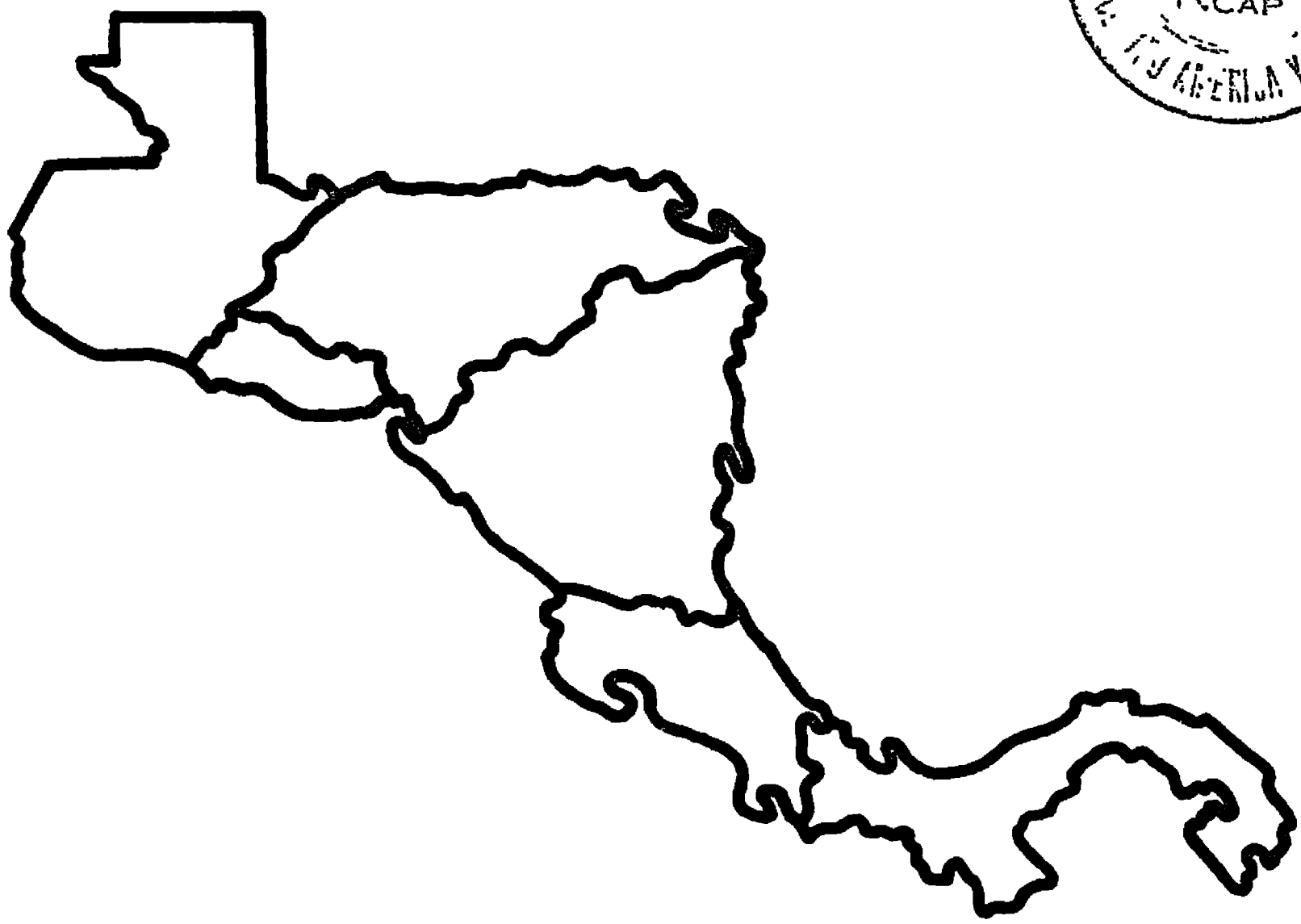
NUTRITIONAL EVALUATION OF THE POPULATION OF CENTRAL AMERICA AND PANAMA

Regional Summary



INSTITUTE OF NUTRITION OF CENTRAL AMERICA AND PANAMA

NUTRITION PROGRAM, CENTER FOR DISEASE CONTROL

(Formerly, Interdepartmental Committee on Nutrition for National Development)

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NUTRITIONAL EVALUATION OF THE POPULATION OF CENTRAL AMERICA AND PANAMA

1965 - 1967

Institute of Nutrition of Central America and Panama (INCAP) and

The Interdepartmental Committee on Nutrition for National Development (ICNND)

DHEW Publication No. (HSM) 72-8120

INSTITUTO DE NUTRICION DE CENTRO AMERICA Y PANAMA

OFICINA SANITARIA PANAMERICANA

OFICINA REGIONAL DE LA
ORGANIZACION MUNDIAL DE LA SALUD

COSTA RICA
EL SALVADOR
GUATEMALA

HONDURAS
NICARAGUA
PANAMÁ

APARTADO POSTAL 1188

CARRETERA ROOSEVELT ZONA 11
GUATEMALA, C. A.

TELEFONOS 43762 AL 43767

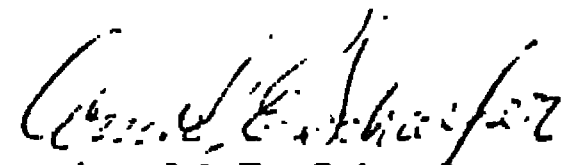
CABLE: INCAP

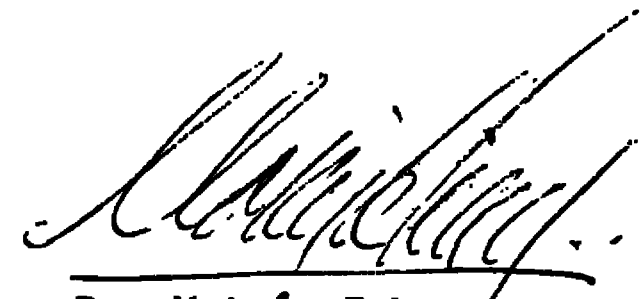
Guatemala, 10 November 1971

It is our pleasure to present this summary report of the Nutrition Surveys of Central America and Panama. Individual country reports were published in Spanish in 1969. These reports are being used for planning and implementing remedial and preventive programs to combat the problems of malnutrition defined by the surveys. This summary report enables one to view the findings in reference to similarity or differences in problems and resources for the region.

The surveys were indeed a joint cooperative effort of teams of multidisciplinary scientists, and specialists in health, agriculture, biochemistry, anthropometry, dentistry, dietetics, hematology, sociology, parasitology, statistics, government and politics.

The cooperation of the over 23,000 participants was tremendous. We have not included in this report the survey team personnel since there were over 100 members on each country team. The directors of the survey were Dr. Guillermo Arroyave and Dr. Werner Ascoli of INCAP; Dr. William McGanity and Dr. Walter Unglaub,* consultants to the Nutrition Section, of the office of International Research, National Institute of Health, U. S. A.





** Dr. Arnold E. Schaefer,
former chief, Nutrition Section,
Office of International Research,
National Institute of Health,
HEW, Washington, D.C. U.S.A.

Dr. Moisés Behar,
Director, Institute of
Nutrition for Central
America and Panama
INCAP, Guatemala

* Deceased

** Currently, Nutrition Consultant,
PAHO, Washington, D.C.

The nutrition surveys of Central America and Panama 1965-1967[a/] were supported by the Advanced Research Projects Agency (Project AGILE) and was monitored by the ICNND, presently the Nutrition Program, Center for Disease Control, HSMHA, DHEW, under ARPA Order No. 580, Program Plan No. 298.

(In 1965 the International Committee on Nutrition for National Development became the Nutrition Section, Office of International Research, National Institutes of Health, PHS, DHEW. In 1967 it became the Nutrition Program, National Center for Chronic Disease Control, PHS, DHEW. In 1970 it became the Nutrition Program, Center for Disease Control, HSMHA, PHS, DHEW.)

Publication of this report was supported by the U.S. Agency for International Development.

[a/] INCAP V-25, INCAP V-26, INCAP V-27, INCAP V-28, INCAP V-29, INCAP V-3C

Acknowledgments

The field collection of data for this nutrition survey was made possible by the active support and cooperation of many agencies. Special appreciation is expressed to:

The Ministries of Health, Agriculture, Defense, Education and Transport in the participating countries.

Pan American Health Organization

International Center for Medical Research and Training, Costa Rica

Middle America Research Unit, (MARU), Panama

Tuberculosis Hospital, Costa Rica

School of Dentistry, University of San Carlos, Guatemala

National Bureau of Statistics, Guatemala

Red Cross, Guatemala

Bank of Guatemala

Air Forces of Guatemala, El Salvador, Honduras, Nicaragua, Panama and the United States

National Guard of Nicaragua.

RECOMMENDATIONS

A. Definition of National Food and Nutrition Policies

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 action. 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, and this needs to be determined. Definition of national priorities, selection of programs, and allocation of resources are the privilege - and responsibility - of Governments, which should define national food and nutrition policies.

To the extent possible, the national policies should be defined with a view to Central American integration, in order to make the best use of the mutual complementarity of the countries with relation to food production.

Taking into account the specific needs and problems of the countries surveyed by INCAP and OIR/NIH at this particular moment of their social and economic history, the following aspects should be included in the national policies in the immediate future:

(1) Definition of national priorities in terms of: nutrition problems, groups to be reached, and methods to be used.

(2) Study and inventory of human resources.

(3) Selection of specific programs for each sector.

(4) Definition of norms and targets.

(5) Definition of the role of external food aid.

(6) Legislation on food standards and implementation of rules and controls.

(7) Definition of a national policy to increase the purchasing power of low socio-economic groups (policy on employment, food price control, wages, etc.).

(8) Establishment of a system for monitoring changes in food supply and in nutritional status.

While these long-term actions are being studied and put into practice, some immediate problems can be significantly ameliorated through short-term action.

B. Short-Term Recommendations

1. Iodization of salt

Endemic goiter has been erradicated in Guatemala by an effective program of salt iodization. This spectacular result can be achieved in a few years in the other five countries through application of the same measure. It is recommended that existing legislation be actually enforced - or that the present iodization be more effectively practiced - in four of the other countries, with appropriate laws and regulations, and that iodization be put into practice without delay in the fifth country, which is not yet iodizing. Systems for control (collecting of samples, analyzing of salt, and enforcing regulations) need to be reassessed and strengthened in some countries.

2. Fortification of sugar

Elimination of hypovitaminosis A as a public health problem could eventually be achieved in a short time through the vitamin A fortification of a staple food, such as sugar produced for domestic use in those countries where a significant coverage of the population at risk could be obtained. The magnitude and seriousness of the problem and its cost to society justify immediate preventive measures.

3. Distribution of iron to pregnant women

While further studies are needed to assess the possible importance of folate deficiency in anemia in pregnancy, and to design practical ways of increasing the intake of iron through enrichment or distribution of iron among large population groups, the systematic administration of iron to pregnant women is recommended as a public health measure of great significance on the short range.

4. Strengthening of nutrition activities in the health services

The widening and strengthening of the role of the health services in nutritional rehabilitation, protection against malnutrition, and prevention should be considered a national priority in the six countries. Improving detection of malnourished children; hospital and/or ambulatory treatment of those children; establishment of nutritional rehabilitation centers; organizing supervised supplementary feeding; educating the parents;

and providing medical attention, even minimal, are essential aspects of an effective attack on malnutrition considered as a disease in itself. Supervision should be improved, and the health services should be increasingly staffed with qualified personnel.

5. In-service training of personnel

The integration of nutrition activities in the health services, as referred to in the section above, implies intensive training of personnel at all levels, from auxiliary nurses to physicians, from school teachers to supervisors, through short courses, preferably at the regional or district level.

6. Increased production and consumption of basic foodstuffs by low socio-economic groups

Evidence has been provided that low calorie and protein intake is characteristic of low income groups. This situation will be partly corrected through energetic action to increase local production and consumption of (a) corn and/or rice; (b) beans; (c) small animals. Basic food projects now being implemented by the ministries of agriculture of most of the countries should receive considerably more financial and technical support.

7. School lunches

School lunch programs exist in each country. They should be developed to reach more children. The meals should be redesigned in some countries and diversified in all, in order to carry more educational value and to decrease their dependence on donated food. Nutrition education, school health and whenever possible school gardens, should be combined with school lunches in a single consolidated educational program.

8. Priority in the use of milk for the very young child

It is not always fully appreciated that it is difficult for the very young child to meet his protein requirements without milk, either his mother's milk or cow's milk. It is therefore recommended that, since milk is scarce, it be reserved in priority for infants and children in the early preschool age. The possibility of developing a national milk industry, partly as a nutritional measure, deserves much more consideration. Furthermore, increase in milk availability would augment the intake of calcium, vitamin A, and riboflavin among the consumers.

9. Incaparina

It is recommended that the obstacles to a better and wider use of incaparina be studied and overcome.

C. Long-Term Recommendations

1. Nutrition education in the school is well organized in some countries and should be generalized in all primary schools in the area, as well as taught in all teachers' colleges.

2. Teaching of nutrition in the medical schools is progressing. Still, its effective implementation in all schools of medicine in Central America and Panama ought to be achieved.

3. Increase in number and level of qualified professionals specialized in nutrition: doctors, nutritionists, food technologists, biochemists.

4. Use of mass media for nutrition education. Educational programs using appropriate media and messages, and adjusted to the population to which they are directed, should be designed.

5. Development of food technology, with special emphasis on meeting nutritional needs. The development of food technology should be encouraged not only with a view to economic goals, or wholesomeness of foods, but also with regard to nutritional value as related to present nutrient deficits in low income groups and children in general.

The following aspects should receive particular attention:

a. food fortification (vitamin A, riboflavin, iron, amino acids, protein concentrates)

b. protein-rich foods

c. study of the obstacles to a greater development of food industries

d. use of by-products of cash crops

6. Investigation of better genetic varieties of cereals and legumes and their production not only by large farms, but also by medium-size and small holdings.

7. Increase of milk production because of the importance of milk in the diet of the very young child.

8. Improvement of dietary services of hospitals. Both the special diets and the regular food services in hospitals can be improved and the latter made more efficient through the use of specialized personnel and equipment.

9. Environmental sanitation is already a significant part of the programs of the six governments. However, improvement of nutrition (essentially through reduction of diarrheal disease and intestinal parasites) will depend to a large extent on successful improvement of the health conditions of the environment, which should therefore receive priority.

CONTENTS

TABLES

APPENDIX TABLES

FIGURES

I

INTRODUCTION

The assessment of the nutritional conditions of the populations of Central America and Panama has been one of the main objectives of the Institute of Nutrition of Central America and Panama (INCAP) since its foundation. In its early years, INCAP made a series of dietary, clinical and biochemical studies throughout the area, providing initial information on nutrition problems. These studies were however limited in scope and could not provide information on the magnitude of nutritional problems in the area. The governments of the countries, at a meeting of the Directing Council of INCAP in Managua, Nicaragua, in November, 1964, approved the planning of nutrition surveys on a national scale in all the countries, as a cooperative project between INCAP and the Interdepartmental Committee on Nutrition for National Development (ICNND)[1/] of the United States.

These surveys were carried out between 1965 and 1967 on representative random samples of the populations in each country and covered most of the factors thought to influence nutritional health. They can provide data necessary for the development of national health plans and broad baselines for the evaluation of applied nutrition programs.

The surveys were made possible only by the active cooperation of the governments, and especially the ministries responsible for health and the sections concerned with nutrition. The Ministries of Agriculture, the National Guards, the Air Forces, and others provided valuable assistance. Finally, the generous cooperation of the families selected in the population samples studied provided all the data necessary for the successful completion of the surveys.

In addition to the civilian population, studies were made in groups of soldiers at different military installations and a unit of police in the city of San Jose, Costa Rica. These sectors of the population represented young healthy males living under presumably better than average rural conditions. The results obtained from these special groups are the subject of a separate report.

1/ Later designated the Nutrition Program, National Center for Disease Control, Health Services and Mental Health Administration of the U. S. Department of Health, Education, and Welfare.

Sampling

In determining the survey samples, the population, area and political or other subdivisions of each country were taken into consideration (Table 1).

TABLE 1. POPULATION, AREA, AND SUBDIVISIONS OF THE COUNTRIES

Country	Total Population	Rural Population %	Area, Km^2	Persons per Km^2	Major Subdivisions	Districts	Townships
Guatemala	4,437,871[a]	82.0	108,889	40.7	6[e]	22	325
El Salvador	2,918,600[a]	74.8	21,393	136.4	6[f]	14	261
Honduras	2,100,000[b]	76.8	141,521	14.8	--	18	279
Nicaragua	1,535,000[a]	80.0	148,300	10.4	3[g]	16	126
Costa Rica	1,454,360[c]	80.2	50,900	28.6	7	68	339
Panama	1,075,541[d]	64.7	75,474	14.3	9	64	440

[a] 1965
[b] 1966
[c] 1963
[d] 1960
[e] Regions of economic development.
[f] Arbitrary geographic areas.
[g] Public health regions.

El Salvador, with the smallest area, has the greatest population density, 136 persons per square kilometer, while Nicaragua with the largest area is the most thinly populated. Guatemala is the most rural of the six countries, with 82 percent of the population so classified, but is followed closely by Nicaragua and Costa Rica. While these data were based on population figures which have since changed, the relative orders are probably similar.

It was planned that 40 localities with populations under 25,000 in Guatemala and 30 in each of the five other countries would be chosen to represent the rural population. The large majority of the 190 places thus selected actually had populations far smaller than 25,000. In Guatemala, for example, 70 percent of the localities chosen had less than 2,000 inhabitants and nearly 40 percent less than 1,000. The situation was similar, in general, in the other countries.

The localities were selected by a systematic random sampling

method and the number of localities in each major region into which a country was divided was determined by the population of that region. In Guatemala, El Salvador, Honduras and Nicaragua, the communities selected were cabeceras municipales, county seats. In Costa Rica and Panama they were centers of districts or smaller communities within those districts. In each locality, a primary sample of 20 dwellings was selected from a census map by a random sampling method, and five others to serve as alternates if necessary.

A team of two public health nurses, social workers, education supervisors or other field workers visited each locality in advance to identify the 25 dwellings and to make necessary random changes if a dwelling did not exist or had been abandoned, or if a family failed to cooperate. A complete family roster, by name, age, sex and occupation of household head and spouse, was prepared by these workers.

In each country, a rapidly developing urban center was selected to represent an urban population. These centers were: Guatemala City, Guatemala; San Salvador, El Salvador; San Pedro Sula, Honduras; Managua, Nicaragua; San Jose, Costa Rica; and Panama City, Panama. A random sample of 100 households was selected in each city.

The total number of families and localities selected in each country, as well as the proportion of the total population which the sample represented, are given in Table 2.

TABLE 2. NUMBER OF FAMILIES AND LOCALITIES SELECTED AND RATIO OF THE SAMPLE TO THE TOTAL POPULATION

Country	No. of Families Selected	No. of Localities Selected	Ratio of the Sample to Total Population
Guatemala	800	40	1.0 per 1000
El Salvador	600	30	1.5 per 1000
Honduras	600	30	2.5 per 1000
Nicaragua	600	30	3.5 per 1000
Costa Rica	600	30	4.0 per 1000
Panama	600	30	4.0 per 1000
TOTALS	3,800	190	

Because of roads impassable for vehicles, some of the communities selected could not be surveyed and in those cases alternate communities were selected in the same area. Because of bad roads, 11 communities were replaced in Honduras and from one to six in the other countries. Four of the 190 places in the six countries were ultimately not surveyed. Figure 1 shows the distribution of the survey sites in the entire area.

Figure 1
MAP OF CENTRAL AMERICA AND PANAMA SHOWING GEOGRAPHICAL AREAS AND RURAL LOCALITIES SURVEYED

Because of the random process used, the geographical concentration of the communities on the map follows population density.

Methodology

The family or household was used in all cases as the unit of observation. Much of the survey data can best be obtained at the family level. Moreover, most nutritional problems do not originate solely within the individual but are the result of his participation in the family environment and the interaction of its members.

The various characteristics investigated were described in the reports prepared in Spanish by INCAP for each of the six countries in terms of the classical epidemiological approach:

I. Host Characteristics

  A. Clinical

    1. Clinical nutritional examinations
    2. Oral examinations
    3. Anthropometric measurements
    4. Ancillary studies

       a. Mortality rates
       b. Prevalence of diabetes and cardiovascular disease
       c. Bone maturation
       d. Physical fitness

  B. Biochemical and hematological

II. Agent Characteristics

  A. Dietary studies

III. Environmental Characteristics

  A. Socioeconomic
  B. Agricultural
  C. Food Industry
  D. Immunological and parasitological

To determine the host characteristics, the clinical examination, the oral examination and the anthropometric measurements were performed on 21,611 subjects. The clinical examination to determine the prevalence of signs indicative or suggestive of nutritional disease was performed by experienced physicians. It specifically included lesions of the scalp, eyes, mouth and skin, as well as a search for gross neurological and skeletal abnormalities, and edema. The oral examination was performed

by two dentists and included abnormalities of the lips, gums, tongue, teeth and mucous membranes. A total of 17 anthropometric measurements including weight, total body length and two partial lengths, five circumferences, five diameters and three skinfold thicknesses were taken. In this report, results of only five (weight, total body length, leg length, head circumference and tricipital skinfold thickness) are presented.

Ancillary studies were performed on sub-samples. The prevalence of diabetes was determined by a modified glucose tolerance test on 2,250 persons over 35 years of age and the occurrence of cardiovascular disease was measured by means of an electrocardiogram on a similar number of persons.

A right wrist and hand X-ray to determine bone age in children and bone density in all age groups was taken on 12,885 individuals. The films were taken with a prototype portable X-ray unit supplied by the U.S. Army.

The physical fitness of over 1,735 men between 15 and 40 years of age was studied by means of the Harvard Step Test.[1/] In Guatemala, in 35 locations included in the sample, deaths by age, sex and cause, for the years 1958-1964, were investigated through the civil register kept in each county seat. It was possible to obtain adequate data on over 40,000 deaths. This report covers only the deaths of children under 5 years of age.

Nonfasting blood and urine samples were collected from all members of five of the 20 families studied in each location. These five families were previously selected at random and were among those included in dietary and sociocultural studies. The blood sample for each individual consisted of 20 ml distributed in three tubes for the preparation of serum, plasma and red blood cells. Heparin was used as an anticoagulant. One of the clotted samples was collected in a sterile acid-washed tube for the microbiological determination of vitamin B_{12} and folic acid and of iron and iron-binding capacity. The samples were kept refrigerated. Sixty milliliter aliquots of urine acidified with 1 N HCL to pH 2-3 were also kept under refrigeration.

The blood and urine samples collected in each location were shipped refrigerated to a Public Health Service laboratory in the capital city. The samples always arrived in the laboratory before midnight of the day of collection and initial processing was immediately begun. This included separation of blood plasma, preparation of plasma and red blood cell aliquots and stabilization of samples for ascorbic

---

1/ Brouha L., et al. The Step Test. A Simple Method of Measuring Physical Fitness for Hard Muscular Work in Adult Man. Rev. Canad. Biol., 2:86-91, 1943.

acid. The urine samples were adjusted for the correct pH and aliquots prepared. All samples were then frozen and the next day shipped in dry ice by commercial airlines to the central laboratory at INCAP.

The following analyses were carried out:

In blood serum or plasma:	
Total protein	Refractometric method, using a Goldberg Refractometer (TS meter) American Optical Co., Buffalo 15 N. Y. Interdepartmental Committee on Nutrition for National Defense, Manual for Nutrition Surveys, Second Edition-1963, Bethesda, Md. (ICNND Manual).
Electrophoretic fractions	Microzome Electrophoresis Cell, Beckman Manual RM-IM-2, August 1963.
Non-essential/essential amino acid ratio	Lancet, February 1, 1964, p.250.
Vitamin A and carotene	J. Biol. Chem., 166: 177, 1946.
Ascorbic acid	J. Biol. Chem., 168: 197, 1947.
Iron and iron-binding capacity	Advances in Clin. Chem., 1:1, 1958.
Cholesterol	J. Biol. Chem., 195: 357, 1952.
Vitamin B_{12}	J. Clin. Path., 17:14, 1964.
Folic acid	J. Clin. Inv., 40:81, 1961.
In whole blood:	
Hemoglobin	ICNND Manual
Hematocrit	ICNND Manual
In red blood cells:	
Riboflavin	J. Biol. Chem., 175:457, 1948.

In urine:

Creatinine	Anal. Chem., 21:1218, 1949.
Urea	J. Biol. Chem., 140:595, 1942. J. Biol. Chem., 152:453, 1944.
Thiamine	ICNND Manual
Riboflavin	ICNND Manual
N'-Methylnicotinamide	ICNND Manual
Iodine	Determined by Boston Medical Research Laboratories.

Dietary studies were made on the same sample of families on which detailed biochemical and hematological investigations were also carried out. Generally, two methods of obtaining quantitative data on family food consumption were used: one, by means of a 24-hour recall, using the housewife's own account of the previous day's meals; the other, a 3-day record consisting of the actual recording in the home of the foods prepared and consumed during 3 days. The 3-day record method was applied to a random portion of the families surveyed by the 24-hour technique. The results of the 24-hour method, which covered a larger number of families, are used in this report. The results of the 3-day studies will be the subject of INCAP reports on the relative value of the two techniques.

The calorie and nutrient content of the foods consumed by each family was calculated by use of food composition tables[1/]. The nutritional recommended allowances for the families were estimated by scales of calorie and nutrient intake levels recommended by expert committees of the Food and Agriculture Organization of the United Nations and the World Health Organization and based on the most recent knowledge in nutrition

---

1/a. Food Composition Table for Use in Latin America, Institute of Nutrition of Central America and Panama, Guatemala City, C.A., and the Interdepartmental Committee on Nutrition for National Defense, National Institutes of Health, Bethesda, Maryland, U.S.A., June 1961.

b. Composition of Foods, Agriculture Handbook No. 8, Consumer and Food Economics Research Division, Agricultural Research Service, United States Department of Agriculture, Washington, D. C., December 1963.

c. Tabla de Composicion de Alimentos de Centro America y Panama. Cuarta Edicion. Instituto de Nutricion de Centro America y Panama, INCAP, Guatemala, 1960.

science. These international scales, adapted by INCAP to the populations and environments of Central America, are presented in Appendix I. The calorie and nutrient content of the diets, compared to the recommended allowances for the families, indicated the adequacy of the diets.

At the end of the survey in each location, typical family diets were calculated and food composites were locally prepared for subsequent detailed chemical analysis. Other information collected included the food intake of preschool children in the various countries. Local marketing conditions and food prices were also reported and observations made on a number of environmental conditions which might bear on the nutritional health of the people.

In each location, a socioeconomic survey was carried out on 10 of the 20 families previously selected at random and including the five undergoing the dietary, biochemical, and hematological studies. The socioeconomic study included family food production, housing, income, education, food beliefs, and exposure to mass communication media. Information on intra- and extra-community exchange was also collected.

A food resources study was conducted in each country at the national level, covering an assessment of food production and potential per capita availability, as well as future estimated projections for 5-year periods until 1980. Aspects of food technology, including production, processing, storage and marketing were also investigated at the national level.

Over 17,500 stool samples were obtained for use in determining the prevalence of intestinal parasites. The day before the visit of the clinical group, 2-ounce metal boxes were distributed in each location with instructions for the collection of the sample. Stool samples were initially processed in the field to insure preservation.

More than 16,000 whole blood samples for pertinent serological and immunological studies were obtained from members of families not included in the biochemical and hematological studies in the six countries. The field handling and shipping of these blood samples was the same as for the others. The resulting sera were equally divided between INCAP and the Middle America Research Unit (MARU) in the Panama Canal Zone. The two organizations handled different aspects of the antibody determinations. Other institutes or research organizations are invited to collaborate in the long-range studies of this serum bank.

II

REGIONAL SUMMARY OF RESULTS

Foreword

The nutrition surveys in Central America and Panama were carried out by the Institute of Nutrition of Central America and Panama (INCAP) with the cooperation and assistance of the Nutrition Program[1/] of the United States Public Health Service. The results for each country were published in a Spanish edition. Because of the uniformity in format and content, it was possible to combine these reports into a single volume in the English language. Some reduction in the amount of data included was, however, made. For full details the reader should consult the original Spanish reports: INCAP V-25 to INCAP V-30.

Since the countries of Central America and Panama differ widely among themselves, comparisons on a regional basis are made in this report in order to search for differences in dietary customs which might suggest practical solutions to the problems of malnutrition throughout the region.

Emphasis was also given to the conclusions and recommendations in the individual country reports and relative priorities of programs for nutritional improvement are discussed.

The Salient Features of the Malnutrition Problem

The results of clinical observations, biochemical analyses and dietary studies indicate widespread inadequacies in the following principal nutrients: calories, protein, vitamin A, riboflavin, folacin, iron and iodine. The incidence of clinical symptoms specifically related to nutrient deficiencies was not as high as the occurrence of biochemical values in the "deficient" range.

Dietary studies revealed an even higher incidence of inadequate nutrient intakes than was evident from the biochemical and clinical studies. Since the ill effects on health generally result from multiple deficiencies, it is not possible nor relevant to assign a comparative importance to the deficiencies of individual nutrients.

1/Formerly the Interdepartmental Committee on Nutrition for National Development.

The results of biochemical analyses and dietary studies (with some exceptions) indicate that the average consumption of essential nutrients in each country would have been enough if the distribution of the foods had been equitable. However, maldistribution brought about inadequate consumption by important segments of the population. Families low in the socioeconomic scale were low on the nutritional status scale. There was also maldistribution of foods within the family and children between 1 and 4 years of age were the members most deprived.

The serious effects of malnutrition in infants and small children are shown by child mortality rates and growth measurements in Guatemala. Infectious diseases as well as malnutrition contribute to high mortality and inhibit growth. Malnutrition and infection interact so that each condition re-enforces the effects of the other: malnutrition reduces resistance to infectious diseases which in turn intensify the degree of malnutrition. The problem of malnutrition in small children can only be solved by controlling infectious diseases as well as improving diets.

Summary of Dietary Results:

Table 3 shows the average consumption of selected foods per person per day in families of rural areas, and Table 4, the contribution of the foods to the total calories in the diet. Important differences between the countries can be seen. In Guatemala and El Salvador, 65 and 62 percent of the total calories come from cereals, which are largely corn. Both corn and the total calories from cereals decrease until, in Costa Rica, only 39 percent of the total calories come from cereals and the principal grain is no longer corn but rice. In neighboring Panama rice consumption was still greater and cereals, principally rice, provide 47 percent of the calories. All rural areas consume wheat bread but in small amounts.

In the urban centers, not shown in these tables, the picture is somewhat similar. The per capita consumption of corn, however, is less in the urban than in the rural areas and that of wheat bread and rice generally higher. In Guatemala City, 50 percent of the total calories in the diet come from cereals. This proportion decreases to 37 percent in San Jose, Costa Rica, rising again to 41 percent in Panama City.

TABLE 3. CONSUMPTION OF SELECTED FOODS PER PERSON PER DAY IN RURAL AREAS
(grams, edible portion)

FOODS	Guatemala[3]	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
Milk products[1]	84	190	194	243	193	73
Eggs	13	10	13	12	15	11
Meat, poultry & fish	44	37	41	58	40	90
Beans & oily seeds	54	59	56	72	57	20
Vegetables	66	53	51	27	66	25
Fruits	14	17	40	41	7	50
Bananas & plantains	20	16	43	72	47	99
Starchy roots & tubers	14	13	22	33	46	82
Cereal products						
rice	16	27	29	54	100	186
corn tortillas etc.[2]	359	352	224	139	41	32
wheat bread	36	26	12	28	54	37
wheat flour & pastes	4	0	8	7	12	10
others	2	6	5	16	0	0
Sugar	52	41	39	58	89	51
Fats & oil	4	15	16	19	19	26
Number of families	203	293	331	355	456	361

[1] In terms of liquid milk.

[2] In terms of grain.

[3] In the report on Guatemala (INCAP V-25) the figures for food consumption were those obtained by the three-day record method. In order to conform to the data in the reports for the other five countries, the dietary data for Guatemala used throughout this report are based on the 24-hour recall method.

TABLE 4. PERCENT CONTRIBUTION OF SELECTED FOODS TO CALORIE INTAKE OF RURAL FAMILIES

FOODS	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
	(Percentages)					
Milk products	2.8	5.6	6.9	7.3	7.3	2.7
Eggs	1.0	.7	1.1	.9	1.3	.8
Meat, poultry & fish	3.9	3.3	5.0	5.4	3.8	7.2
Beans & oily seeds	9.5	9.7	10.7	13.0	10.7	3.9
Vegetables	1.4	.9	1.4	.6	2.2	1.1
Fruits	.6	.6	1.8	1.5	.4	4.1
Bananas & plantains	1.1	1.0	2.9	4.8	3.2	5.9
Starchy roots & tubers	.6	.7	1.8	2.2	2.6	4.9
Cereal products	65.1	61.8	49.5	41.5	39.3	47.4
Sugar	9.4	7.4	8.2	11.5	17.9	8.8
Fats & oil	2.6	6.9	8.8	9.3	9.8	11.7

As the total calorie intake from cereal products decreases from Guatemala and Salvador south to Costa Rica and Panama, the use of bananas and plantains, and starchy roots and tubers, increases. These two groups of foods provide about 10 percent of the calories in rural Panama compared to 2 percent in Guatemala.

Sugar provides from 7 to 18 percent of the calorie intake in rural families, with the highest consumption in Costa Rica. Fats and oil supply from 3 to 12 percent of the calorie intake in rural areas. The lowest percentage is in Guatemala and the highest in Panama. Urban families use significantly more fats and oil than the rural.

The data show marked differences between the countries with respect to the consumption of protein-rich foods. Table 5 indicates the percent contribution which the major sources make to the total protein intake among the rural families. Protein of animal origin ranges from 23 percent of the total in Guatemala to 44 percent in Panama. Meat (including poultry and fish) is the major animal protein source. Protein from dried beans varies from 9 percent of the total in Panama to 27 percent in Nicaragua. In contrast, the intake of animal protein among the urban families was considerably higher, and that of protein from cereals and dried beans lower, as shown in the full report.

TABLE 5. PERCENT CONTRIBUTION OF SELECTED FOODS TO PROTEIN INTAKE IN RURAL FAMILIES

Country	Protein from Animal Sources				Beans and oily seeds	Cereal products
	Milk products	Eggs	Meat, poultry, fish	All animal sources		
			(Percentages)			
Guatemala	5.5	2.3	14.8	22.6	19.4	50.8
El Salvador	10.9	1.8	12.8	25.5	20.5	50.1
Honduras	13.2	2.6	16.1	31.9	22.8	39.2
Nicaragua	13.7	2.2	20.7	36.6	26.8	30.9
Costa Rica	13.5	3.4	17.7	34.6	25.2	32.7
Panama	4.8	2.2	37.3	44.3	8.8	37.8

Table 6 shows the average intake of calories and specific nutrients per person per day among the rural families. These quantities are evaluated in Table 7 by comparison with the recommended allowances of calories and nutrients. The standards of comparison used are given in Appendix I. The average calorie intake is adequate for all the countries except Honduras and Costa Rica, where it is marginal. The average protein intake appears adequate in all the countries, but without consideration of the biological value of

the proteins. It is seen in Table 6 that the average animal protein intake in rural families ranges from 15 grams in Guatemala to 27 grams in Panama.

TABLE 6. AVERAGE INTAKE OF CALORIES AND SPECIFIC NUTRIENTS PER PERSON PER DAY IN RURAL FAMILIES

		Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
Calories		2117	2146	1832	1986	1894	2089
Total protein	g	68.0	67.9	58.0	64.4	53.6	60.1
Animal protein	g	15.4	17.3	18.5	23.4	18.5	26.6
Vitamin A	I.U.	2420	900	1280	1700	1800	1830
Riboflavin	mg	.80	.78	.79	.93	.84	.69
Iron	mg	17.9	11.6	15.5	18.2	15.4	14.3

TABLE 7. PERCENT ADEQUACY OF AVERAGE INTAKE OF CALORIES AND SPECIFIC NUTRIENTS IN RURAL FAMILIES

	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			(Percentages)			
Calories	109	109	89	96	91	104
Protein	133	128	108	115	98	112
Vitamin A	68	24	34	44	49	49
Riboflavin	70	66	64	75	68	58
Iron	178	114	152	175	150	141

Average figures however do not indicate the real situation in the population. Tables 8 to 11 show the distribution of the rural families by level of adequacy of calories and of the same nutrients which are evaluated in Table 7. Although the average caloric intakes appeared satisfactory in all but two countries, it is revealed in Table 8 that significant numbers of families in all the countries failed to meet their calorie needs. This signifies maldistribution of the foods which might otherwise have been adequate.

The problem seems less severe in the case of protein, as seen in Table 9. Larger proportions of the families in the several countries attained 100 percent or more of the recommended amounts. Nevertheless the protein intakes of substantial numbers of the families were low, even when the quantity alone was considered. Animal proteins are the more expensive and less available to many families.

The intake of vitamin A and that of riboflavin reveal a dramatic deficit when compared to the recommended levels. Table 10 indicates that families meeting the recommended levels of vitamin A intake range from 2 percent in El Salvador to 17 percent in Guatemala. From 66 to 88 percent of the families in the various countries obtain less than half the recommended amounts. Moreover, much of the vitamin A in the rural areas comes from vegetable sources and may not be wholly utilized. Vitamin A from animal sources in these diets varied from 19 to 50 percent. As in the case of protein, animal sources of vitamin A are the more expensive.

Table 11 shows that families receiving the recommended amounts of riboflavin ranged from 14 percent in Guatemala to 25 percent in Nicaragua. A large proportion of the families obtained less than half the recommended amounts.

TABLE 8. PERCENT DISTRIBUTION OF RURAL FAMILIES BY ADEQUACY OF CALORIE INTAKE

Country	No. of families	Percent Adequacy				
		<25	25-49	50-74	75-99	≥100
		Percent of Families				
Guatemala	200	0	2	12	28	58
El Salvador	278	0	4	16	23	57
Honduras	323	1	6	27	33	33
Nicaragua	331	0	6	22	31	41
Costa Rica	414	0	6	26	28	40
Panama	352	0	3	16	28	53

TABLE 9. PERCENT DISTRIBUTION OF RURAL FAMILIES BY ADEQUACY OF PROTEIN INTAKE[1/]

Country	No. of families	Percent Adequacy				
		<25	25-49	50-74	75-99	≥100
		Percent of Families				
Guatemala	200	0	1	7	19	73
El Salvador	278	0	0	12	19	69
Honduras	323	1	3	14	25	57
Nicaragua	331	0	3	17	21	59
Costa Rica	414	1	8	21	25	45
Panama	352	1	5	15	21	58

1/Biological value of protein not taken into consideration.

TABLE 10. PERCENT DISTRIBUTION OF RURAL FAMILIES BY ADEQUACY OF VITAMIN A INTAKE

Country	No. of families	Percent Adequacy				
		<25	25-49	50-74	75-99	≥100
		Percent of Families				
Guatemala	200	44	22	10	6	17
El Salvador	278	69	19	7	3	2
Honduras	323	57	26	9	2	6
Nicaragua	331	45	23	13	8	11
Costa Rica	414	44	26	11	7	12
Panama	352	42	32	13	5	8

TABLE 11. PERCENT DISTRIBUTION OF RURAL FAMILIES BY ADEQUACY OF RIBOFLAVIN INTAKE

Country	No. of families	Percent Adequacy				
		<25	25-49	50-74	75-99	≥100
		Percent of Families				
Guatemala	200	2	30	37	18	14
El Salvador	278	5	29	30	16	20
Honduras	323	8	34	28	14	16
Nicaragua	331	8	24	24	19	25
Costa Rica	414	13	30	22	13	22
Panama	352	9	38	26	14	13

Summary of Biochemical Results

The biochemical data generally confirm the results of the dietary surveys in showing widespread inadequacies in the consumption of nutrients. The average values for vitamin A in blood plasma are shown in Table 12 to range from 15 to 46 mcg/100ml and to vary markedly with socioeconomic levels. With the exception of the lowest socioeconomic group in Honduras, the average values for plasma vitamin A and urinary riboflavin in all the countries were satisfactory.

Similar results were obtained in measurements of the ratio of nonessential to essential amino acids in blood plasma. Table 13 shows a marked correlation with socioeconomic levels, the "low" socioeconomic groups in general having abnormally elevated ratios.

Average values, however, do not adequately describe the magnitude or nature of the problem. The distribution of the biochemical values

TABLE 12. AVERAGE VALUES FOR VITAMIN A IN BLOOD PLASMA IN RELATION TO SOCIOECONOMIC LEVELS OF RURAL FAMILIES
(mcg per 100 ml)

	Socioeconomic Levels					
	Low		Medium		High	
	male	female	male	female	male	female
Guatemala	30	28	31	33	34	35
El Salvador	24	25	26	29	27	35
Honduras	15	16	30	31	35	36
Nicaragua	28	29	31	32	39	35
Costa Rica	24	25	33	32	42	39
Panama	37	35	37	39	42	46

TABLE 13. SERUM NON-ESSENTIAL/ESSENTIAL AMINO ACID RATIO IN RELATION TO SOCIOECONOMIC LEVELS OF RURAL FAMILIES

	Socioeconomic Levels					
	Low		Medium		High	
	male	female	male	female	male	female
Guatemala	2.2	2.3	2.1	2.1	1.9	1.8
El Salvador	2.7	2.4	2.5	2.4	2.3	2.1
Honduras	2.8	3.0	2.7	2.6	2.5	2.6
Nicaragua	2.5	2.5	2.3	2.4	2.1	2.3
Costa Rica	2.4	2.5	2.4	2.3	2.1	2.2
Panama	2.6	2.2	2.4	2.3	1.9	1.7

reveals the proportion of persons who are not meeting their needs for specific nutrients. Table 14 shows the percentage of persons studied who fall into a combined "low" and "deficient" classification (Appendix II) in analyses for plasma albumin, plasma vitamin A, urinary riboflavin, hemoglobin, transferin saturation, serum folate, vitamin B_{12} and serum nonessential/essential amino acid ratio. Levels in the "low" range are considered to be "at risk" from a public health/nutrition point of view.

Table 15 shows the percentages of persons who exhibit "low" and "deficient" levels of riboflavin in red blood cells and in the urine. Although differences in magnitude of the figures are observed, both parameters indicate a widespread riboflavin problem.

TABLE 14. PERCENTAGE OF "LOW" AND "DEFICIENT" BIOCHEMICAL PARAMETERS IN THE RURAL POPULATION

Parameters	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
Plasma albumin	3	5	3	5	20	12
Plasma vitamin A (male)	17	31	22	13	16	11
Plasma vitamin A (female)	8	14	20	11	16	6
Urinary riboflavin (male)	39	26	33	30	18	48
Urinary riboflavin (female)	31	24	23	29	15	39
Hemoglobin, low & deficient	8	12	16	10	9	22
Hemoglobin, deficient	6	4	6	3	3	8
Transferrin saturation, low & defic.	31	30	35	17	29	36
Transferrin saturation, deficient	17	17	17	7	18	20
Serum folate, low & deficient	38	49	48	63	59	62
Serum folate, deficient	17	23	13	35	20	18
Serum vitamin B_{12}	15	20	7	--	3	--
Serum amino acid ratio (non-essential/essential)	8	6	24	25	18	18

TABLE 15. PERCENTAGE OF "LOW" AND "DEFICIENT" LEVELS OF RIBOFLAVIN IN RED BLOOD CELLS AND IN THE URINE IN THE RURAL POPULATIONS

	In Red Cells		In Urine	
	Low	Deficient	Low	Deficient
Guatemala	30	2.0	33	4.2
El Salvador	50	5.0	25	3.0
Honduras	13	1.5	27	5.4
Nicaragua	94	0.3	28	4.9
Costa Rica	16	1.2	15	1.1
Panama	18	0.7	43	12.0

Some of the biochemical results in Table 14 can be related to dietary patterns. The very low consumption of milk in Panama is reflected by a high proportion of persons with "low" and "deficient" values for urinary riboflavin. Costa Rica and Honduras had the lowest total protein consumption. In Honduras, this was reflected in the least favorable ratios of non-essential to essential amino acids. In Costa Rica, 20 percent of the individuals studied had either "low" or "deficient" plasma albumin. Both of these countries also had a low calorie intake and the energy needed may have resulted in the use of protein primarily for energy.

Growth Rates

Retardation of growth rate during infancy and the preschool age period is perhaps the most convincing evidence of inadequate nutrition in these age groups.

TABLE 16. HEIGHT DEFICIT IN MALES IN RURAL AREAS
(centimeters below standard)

Country	At 6 years (cm)	At 18 years (cm)
Guatemala	15	15
El Salvador	15	16[a]
Honduras	13	13
Nicaragua	11	10
Costa Rica	10	12
Panama	9	10

[a] At 16 years.

TABLE 17. HEIGHT AND WEIGHT OF BOYS IN RURAL AREAS

Country	Age 4 years		Age 18 years	
	height (cm)	weight (kg)	height (cm)	weight (kg)
Guatemala	90	13.7	160	52
El Salvador	92	15.4	160	53
Honduras	92	14.8	160	52
Nicaragua	95	14.8	164	55
Costa Rica	96	14.6	164	52
Panama	96	15.0	162	52

Table 16 shows the average deficit in the height of boys in the rural areas measured at 6 years and again at 18 years of age to be about 12 centimeters below the standard for normal growth. The boys are normal in size at birth, lose an average of 12 centimeters before the age of 6 and then grow at a normal rate until the age of 18, neither regaining the growth lost nor losing any more.

Table 17 shows the height and weight of boys in rural areas at the age of 4 and 18 years. The heights were lowest in those countries

consuming the highest proportion of corn. This would suggest a need for supplemental protein.

Child Mortality Rates

Data on child mortality were recorded only for Guatemala. Table 18 gives the mortality for all causes and convincingly shows the high degree of stress to which the children are exposed. Most of the deaths result from infectious diseases which occur earlier in life and with more severity than in more advanced countries. In Guatemala, the mortality rate peaks in the first year and falls off rapidly in the third and fourth years. The mortality for causes other than infectious diseases is also shown in Table 18. High child mortality in developing countries is truly disastrous and measures for the improvement of this situation should be given the highest priority.

TABLE 18. CHILD MORTALITY RATES IN GUATEMALA
Deaths per 1,000 Live Births
(Rural Areas)

Causes	0-28 days	1-11 months	Second year	Third year	Fourth year
All causes	36	58	51	37	26
Excluding infectious diseases	15	10	8	6	3

Clinical Symptoms of Malnutrition

Except for the diminished growth rates in small children, there were only rare occurrences of serious clinical symptoms of nutritional deficiencies. Only one or two isolated cases of kwashiorkor and marasmus in a country, or none at all, were found in the sample to provide clinical evidence of protein-calorie malnutrition. No cases of xerophthalmia were observed.

In the case of riboflavin, the prevalence of clinical symptoms was much lower than the percent of the population that was found to be "deficient" by biochemical analyses. Table 19 shows the percentage of persons with clinical symptoms attributable to riboflavin deficiency.

It is known that in the presence of multiple deficiencies the specific overt clinical manifestations of individual nutrient deficiency are rarely found. Malnutrition resulting in diminished growth and high mortality rates, due to multiple deficiencies, is much more frequent than would be indicated by the prevalence of the acute classical lesions for any of the deficient essential nutrients.

TABLE 19. PERCENTAGES OF THE RURAL POPULATIONS SHOWING CLINICAL SYMPTOMS OF RIBOFLAVIN DEFICIENCIES

Clinical Symptoms	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
Angular lesions of the eye	2.9	1.4	0	.8		0
Angular stomatitis	.3	2.6	.8	.4	.2	.8
Nasolabial seborrhea			0	.8		0
Filiform atrophy of papilla[1/]	2.9	2.4	4.0	3.3	1.7	5.7
Fungiform atrophy of papilla[1/]	14	1.7	3.0	3.3	.8	22

[1/] Partly attributable to chronic iron deficiency

Nutritional Anemia

The point has been made that the most important effects of malnutrition have been due to multiple deficiencies for which the classical symptoms of specific nutritional diseases are not observed. Anemia and goiter are two nutritional diseases which are exceptions. Both conditions are widespread public health problems.

The reduction of hemoglobin concentrations in the blood in cases of nutritional anemia is generally attributed to dietary deficiencies in one or more of the hematopoietic factors (iron, folate and vitamin B_{12}). In the surveys in Central America and Panama great efforts were made to determine the principal causes of anemia, its variation between cities and rural areas, and at different altitudes. Studies were also made on population groups of differing age and sex. Biochemical analyses were carried out on hemoglobin and on the saturation of transferrin as well as on serum folate and vitamin B_{12}.

The prevalence of anemia in each of the countries is shown in Table 14 by the percentage of subjects with "deficient" values for hemoglobin. Table 7 shows that the average iron intakes are well over 100 percent of the level usually considered ample to meet requirements. However, the distribution of the rural families by level of iron intake shows that from 33 to 59 percent of the rural families in the six countries fall short of the desired level. In all but two countries, smaller proportions of the urban families have comparably low intakes.

The results from all the countries generally show that the prevalence of anemia is higher in rural areas than in urban centers and that the prevalence of anemia is diminished at higher altitudes. One of the complications contributing to the severity of anemia is infection with intestinal parasites, chiefly those which, like hookworm and trichuris,

result in loss of blood. In an extensive study of parasitism it was shown that infections with the above organisms were fewer in the cities than in rural areas and less intense at higher altitudes than near sea level.

Since the amounts of dietary iron and other hematopoietic factors are not increased at higher altitudes, the evidence strongly suggests that intestinal parasites are a determinative factor in the occurrence of anemia. The fact that there is less anemia in the cities than in rural areas may be due as much to the better dietary intakes in the cities as to the lower frequency of intestinal parasitism.

Efforts to establish the age groups and population segments most affected by anemia were not entirely successful due to the wide variations in prevalence that were observed in all countries.

The evidence on the prevalence of anemia in pregnant women was conflicting primarily because of the small number of pregnant women studied. However, from the results obtained, it would appear that the widely held belief that anemia is most apt to be found in women of child-bearing age is not supported by the findings of this survey. It was found, instead, that adolescent boys are the most apt to be anemic and adolescent girls, the least.

Goiter

Endemic goiter is a nutritional disease usually caused by iodine deficiency. Table 20 shows the occurrence of goiter in Central America and Panama.

TABLE 20. PERCENT PREVALENCE OF GOITER, 1965-1967

Country	Total prevalence	Prevalence among all women	Prevalence among women age 15-20
Guatemala	5	2.6	7.3
El Salvador	48	54	75
Honduras	17	21	35
Nicaragua	32	37	55
Costa Rica	18	23	45
Panama	16	24	38

Prior to the iodization of salt in Guatemala in 1956, the prevalence of goiter was 38 percent. El Salvador began iodizing salt in 1967 and Honduras in 1968. Similar programs are obviously needed in the other three countries.

III

BIOCHEMICAL AND CLINICAL FINDINGS IN RELATION TO DIETARY INTAKE

1. Anemia studies

The presence of anemia, defined as hemoglobin concentration, packed red cell volume (hematocrit) and/or red blood cell count below expected limits in normal population groups under the same conditions of age, sex, physiological state and altitude, reflects the final results of one or more nutritional deficiencies of erithropoietic substances. The deficiency of these elements must be severe and of long duration for anemia to develop, except for cases of acute blood loss or hemolysis. Since acute blood loss or hemolysis was not found in the populations studied, the anemias detected during the survey are assumed to reflect a nutritional deficiency state.

The deficiencies could result from inadequate intake or absorption of nutrients or from other situations affecting erithropoiesis by increasing individual requirements of hematinics. In tropical populations, greater importance should be placed on chronic blood loss occasioned by parasitic infections, particularly hookworm, and to the loss of nutrients through sweat, as possible determinants of increased requirements for certain nutrients, especially iron and folates.

Protein-calorie malnutrition reduces the requirements for hematinics either through a decrease in growth or through a loss of body tissues. Thus, deficiencies of iron, folates and vitamin B_{12} can exist in a population without inducing obvious anemias. Furthermore, multiple deficiencies of hematinic substances may alter the classical picture of iron deficiency anemia (microcytic-hypochromic) and the anemia produced by folate or vitamin B_{12} deficiencies (macrocytic-normochromic).

Because of these variables, in addition to hemoglobin concentration, hematocrit, red blood cell counts and the hematological indices, a special effort was made to determine iron, folate and vitamin B_{12} nutrition by means of biochemical methods.

Iron nutrition was evaluated by the determination of serum iron, total iron-binding capacity and percent saturation of transferrin by Ramsey's method. Serum folate and vitamin B12 were determined by microbiological procedures, using L. casei and E. gracillis, respectively. The interpretation of the usual hematological data was based on guidelines published in the ICNND Manual for Nutrition Surveys, making special allowances for age, sex, and altitude above sea level. (Appendix II shows the "normal", "low" and "deficient" levels obtained from values published in the literature for serum iron, total iron binding capacity, percent transferin saturation, folates and vitamin B12.)

The following determinations were made and were analyzed by age group, sex and altitude: hemoglobin, hematocrit, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, serum iron, total iron binding capacity and percent saturation of transferrin. In addition serum folates and vitamin B_{12} were determined in all countries on a subsample. This subsample was selected as follows: all children under 5 years of age and pregnant women in the sample were studied; the other subjects were subdivided according to altitude above sea level. Each one of these groups was divided into quartiles based on the hemoglobin concentration. One third of the subsample was drawn from the first quartile, another third from the two middle quartiles and the last from the fourth quartile.

Hemoglobin and hematocrit levels

Hemoglobin and hematocrit levels, expressed as percent of cases with "low" and "deficient" levels, grouped by age and by altitude above sea level in the rural and urban areas, are given in Figures 2,3,4 and 5. 1/

In general, the high prevalence of anemia indicates that nutritional deficiencies affecting erithropoiesis constitute a health problem in the countries of Central America and Panama. With some exceptions, the prevalence of anemia is greatest in rural areas at altitudes below 2,500 feet above sea level and is less of a problem in urban areas at corresponding altitudes.

The detailed interpretation of the data for the region is made difficult by marked variations among age and sex groups and by conflicting results in the different countries. The average prevalence of "deficient" findings for hemoglobin concentrations generally varied between 25 and 5 percent of the sample for most of the age groups in all of the countries. The number of pregnant women studied was too small to permit valid conclusions for this subgroup.

The discrepancy between hemoglobin concentration and hematocrit suggests a greater frequency of microcytic hypochromic anemia. This situation could arise from a predominant iron deficiency resulting from increased requirements during growth and losses of iron in sweat in the hot environment and in hookworm infection.

Iron deficiency

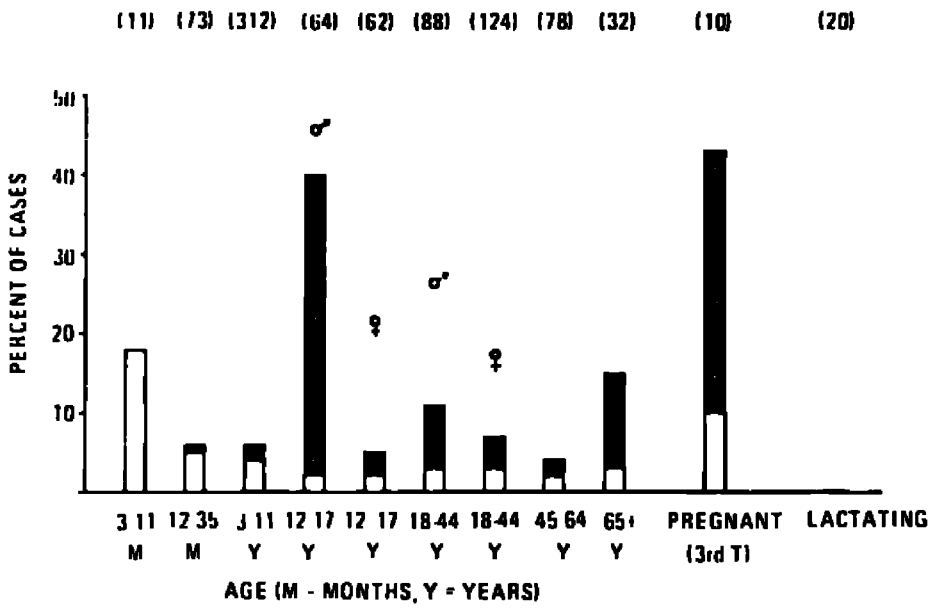
Table 21 gives the percent of rural and urban families whose intake of iron is less than 12 and 10 mg per capita per day. Judged by this and the percent of serum samples with transferrin saturation under 20 and 15 percent, also shown in the table, the prevalence of iron deficiency is very high.

1/ Hematological values by altitude are omitted for Panama - 96.5 percent of the rural population lives at an altitude of less than 2500 feet.

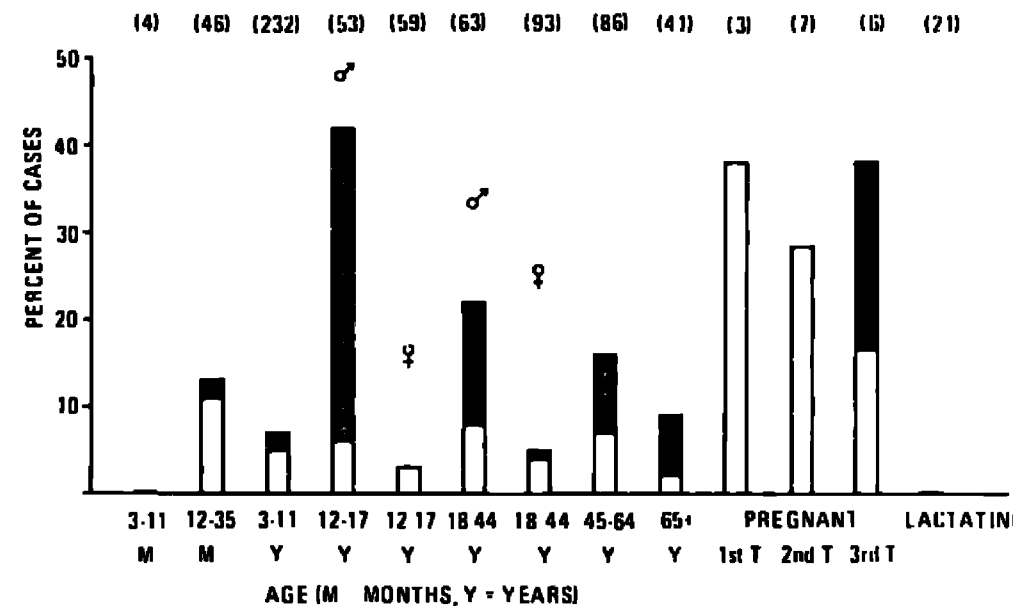
FIGURE 2

HEMOGLOBIN: PREVALENCE OF "LOW" AND "DEFICIENT" LEVELS ACCORDING TO AGE AND SEX

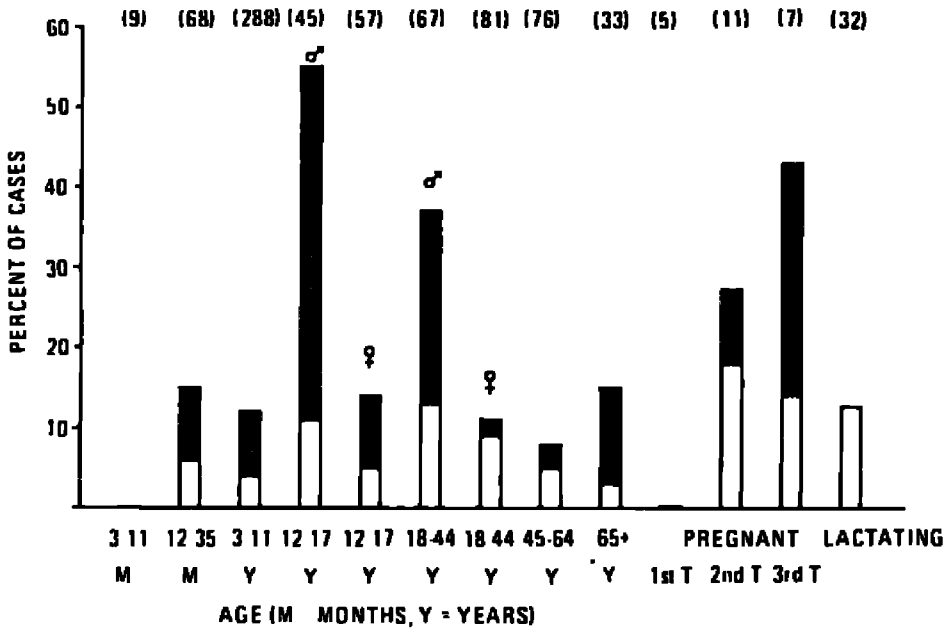
COSTA RICA



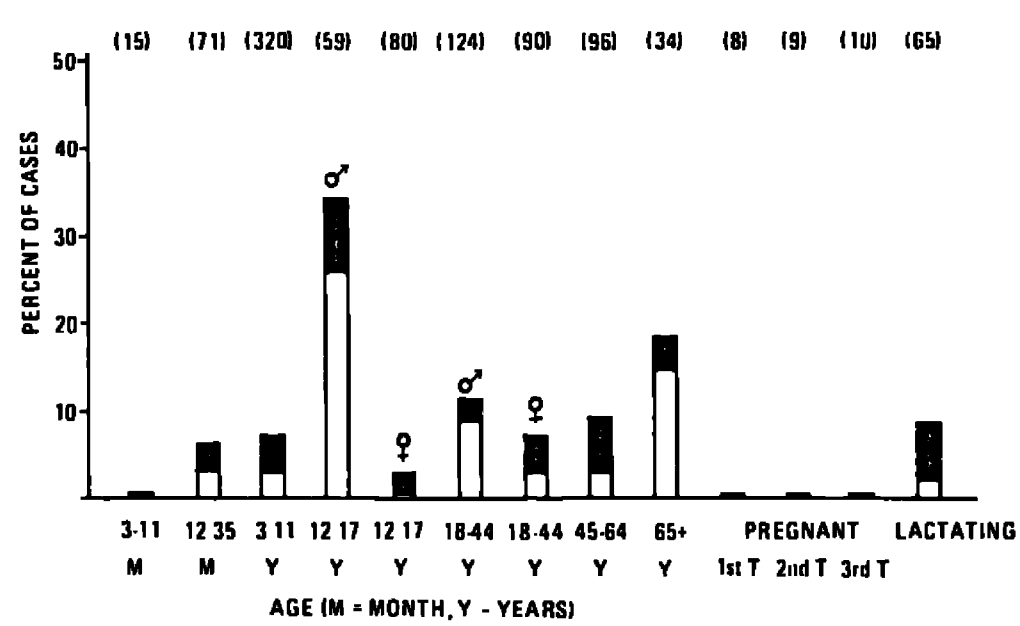
EL SALVADOR



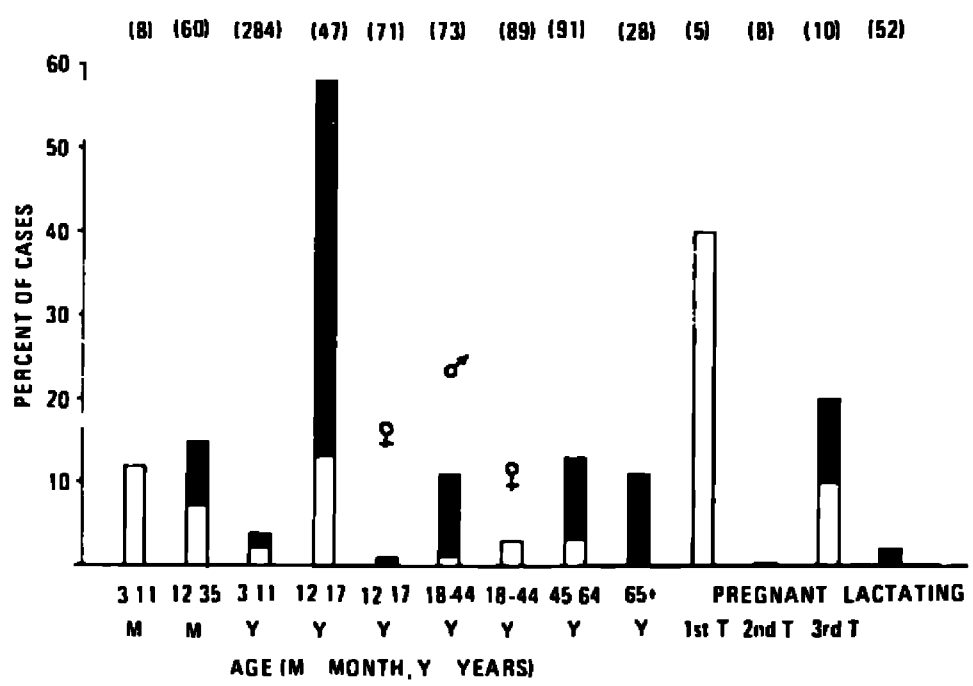
HONDURAS



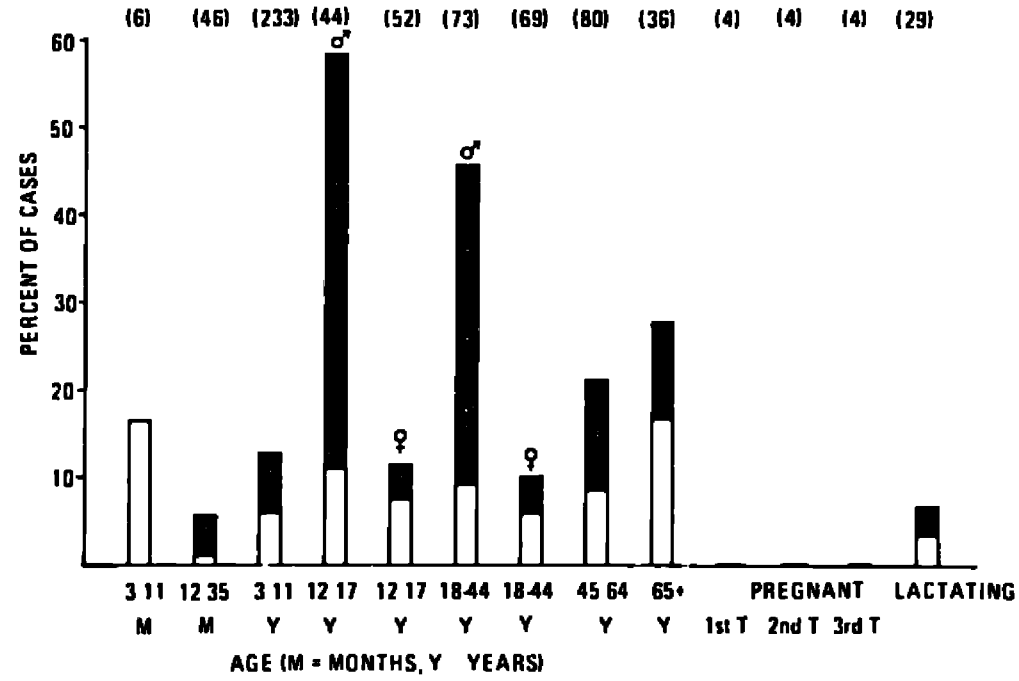
GUATEMALA



NICARAGUA



PANAMA

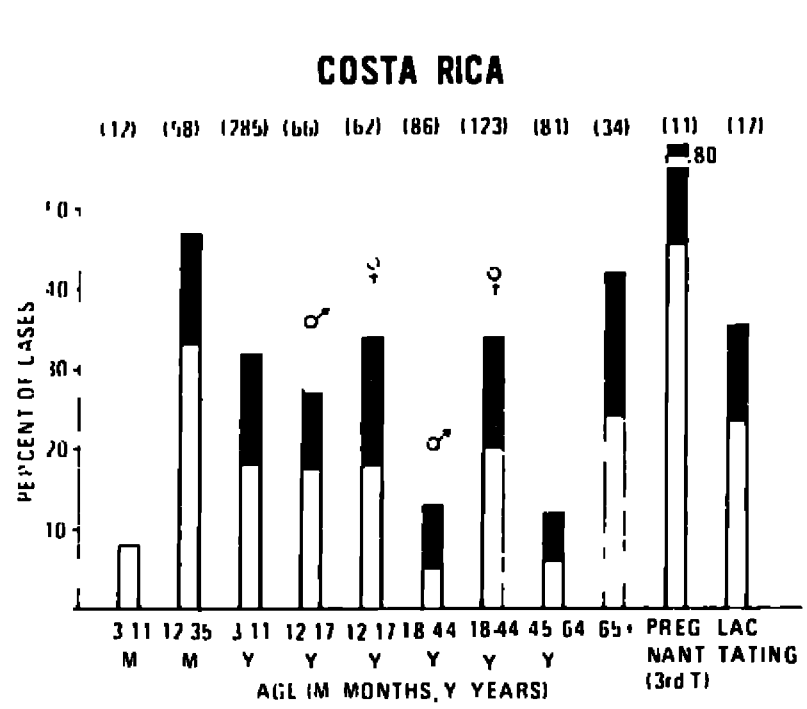


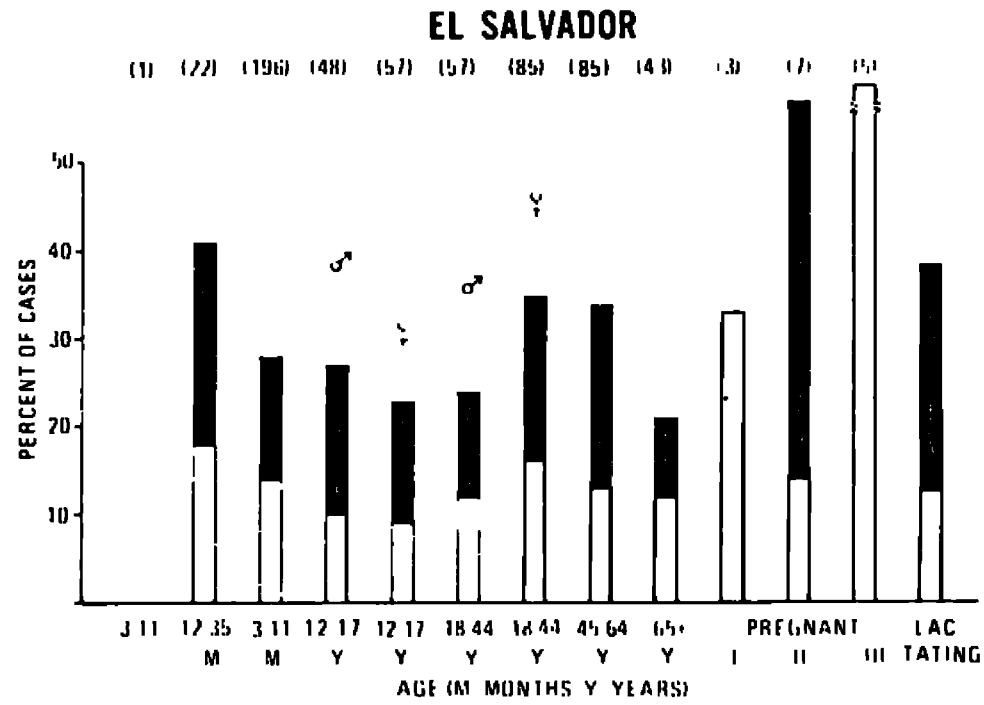
NUMBERS IN PARENTHESES INDICATE NUMBER OF CASES

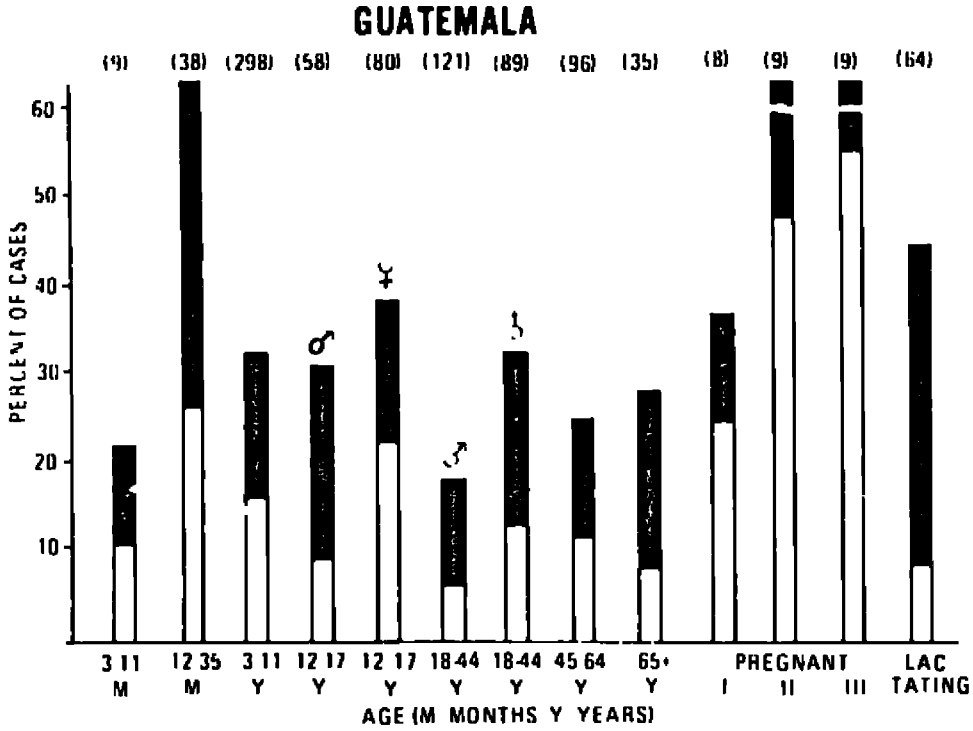
LEGEND ■ LOW □ DEFICIENT

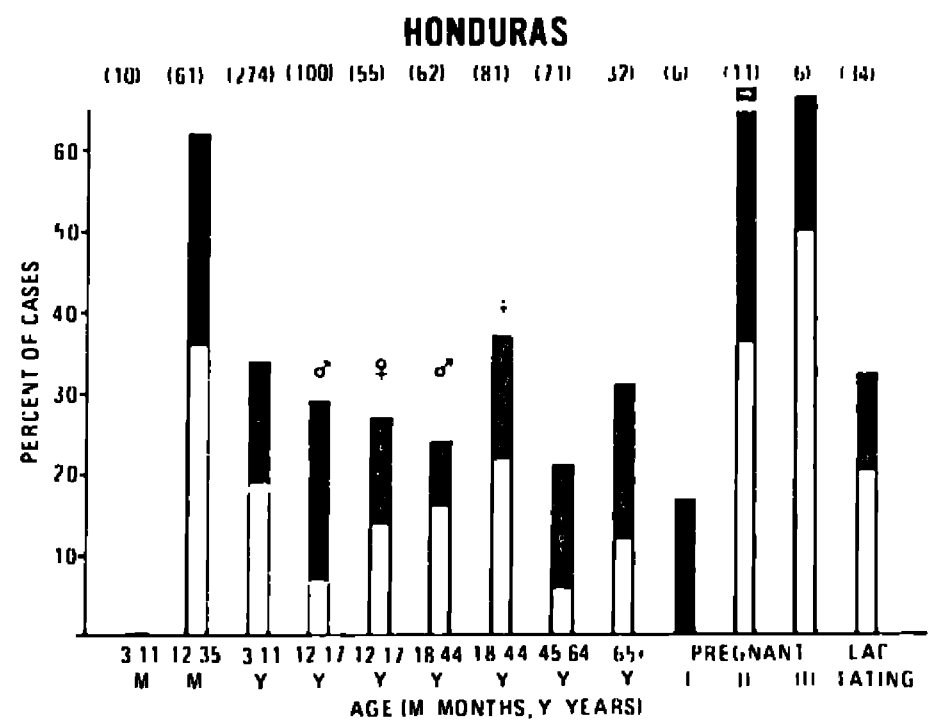
FIGURE 3

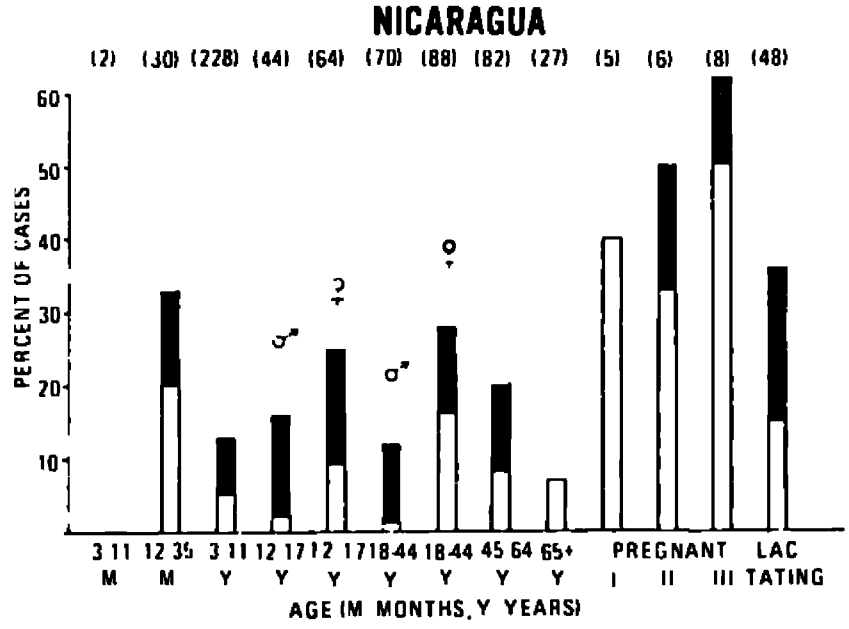
TRANSFERRIN SATURATION: PREVALENCE OF "LOW" AND "DEFICIENT" LEVELS ACCORDING TO AGE AND SEX

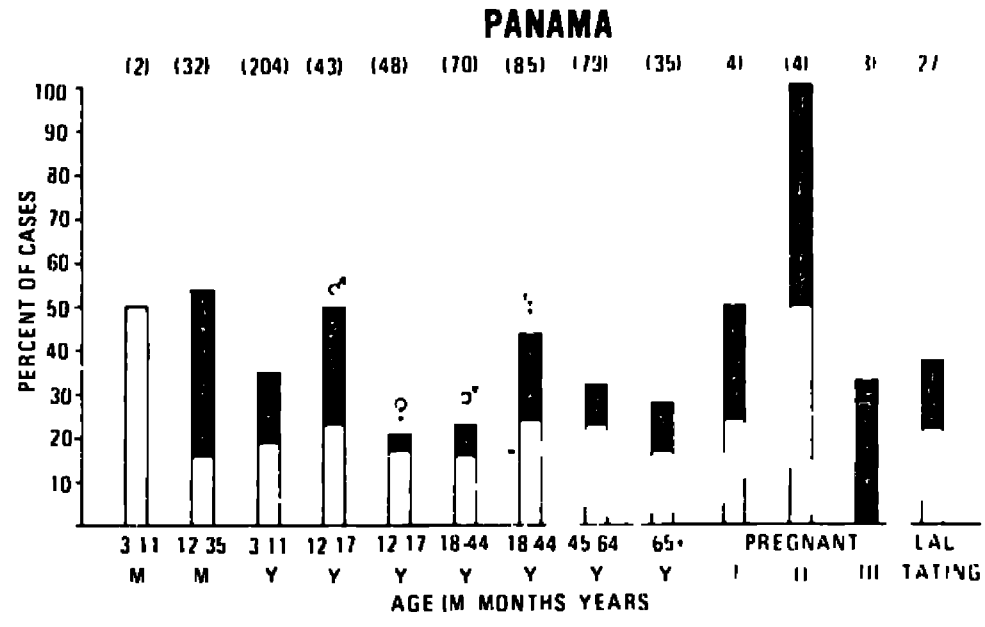










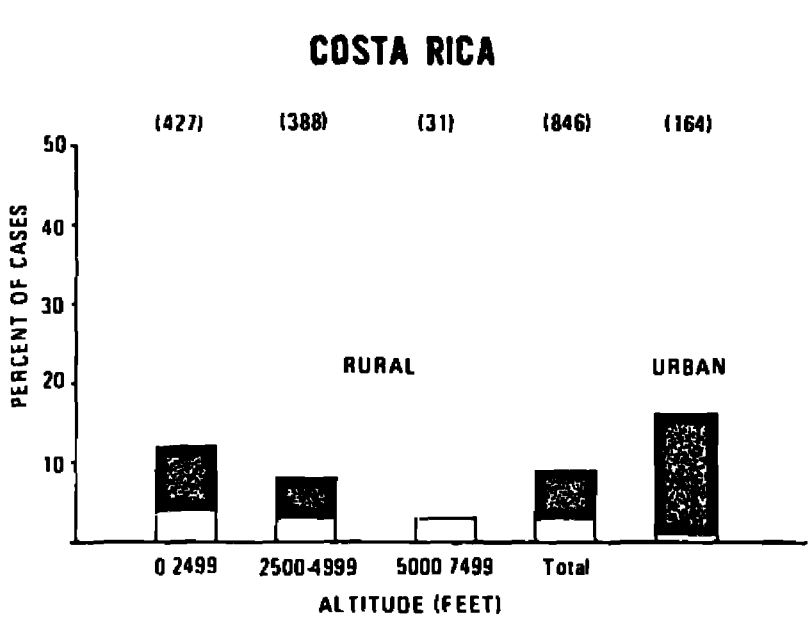


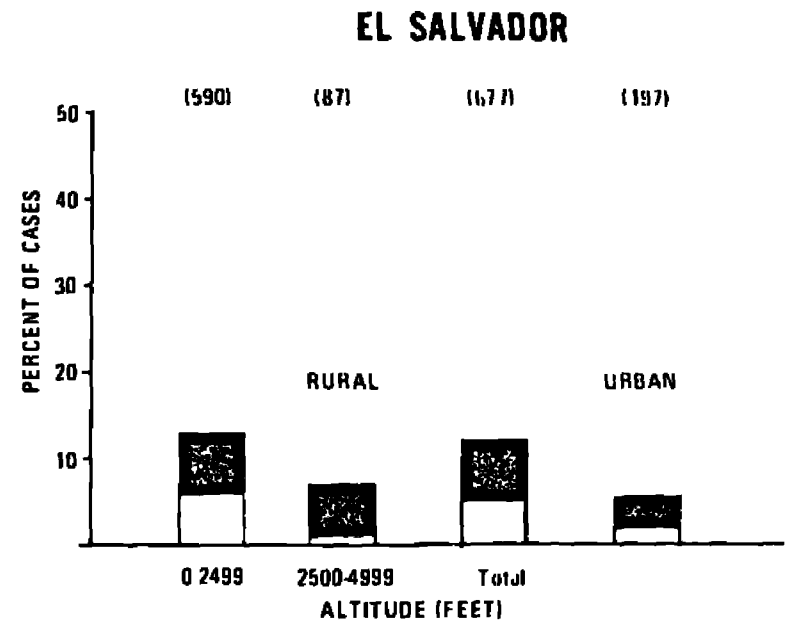
LEGEND
LOW
DEFICIENT

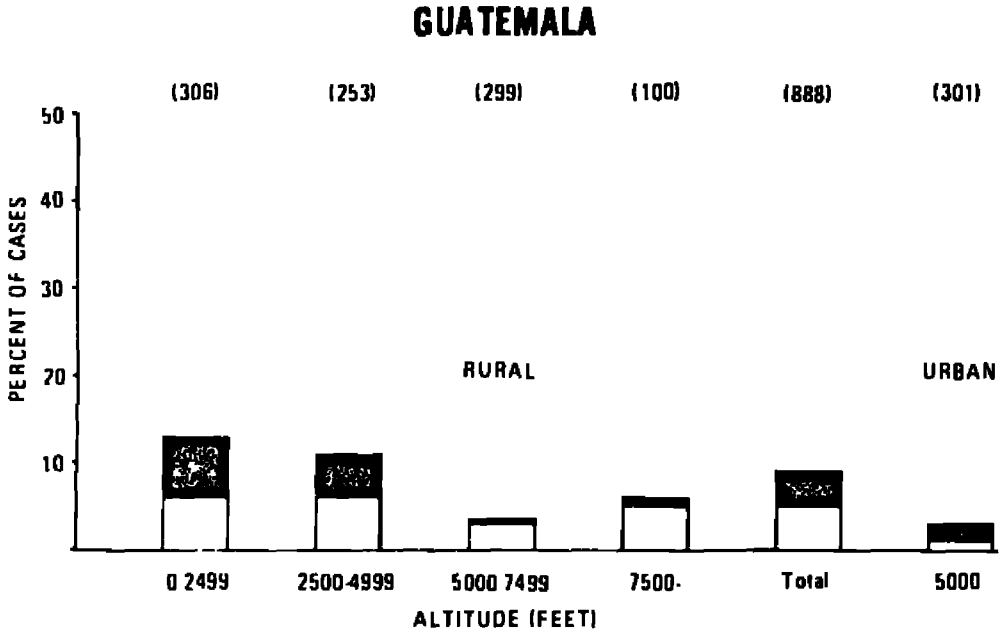
NUMBERS IN PARENTHESES INDICATE NUMBER OF CASES

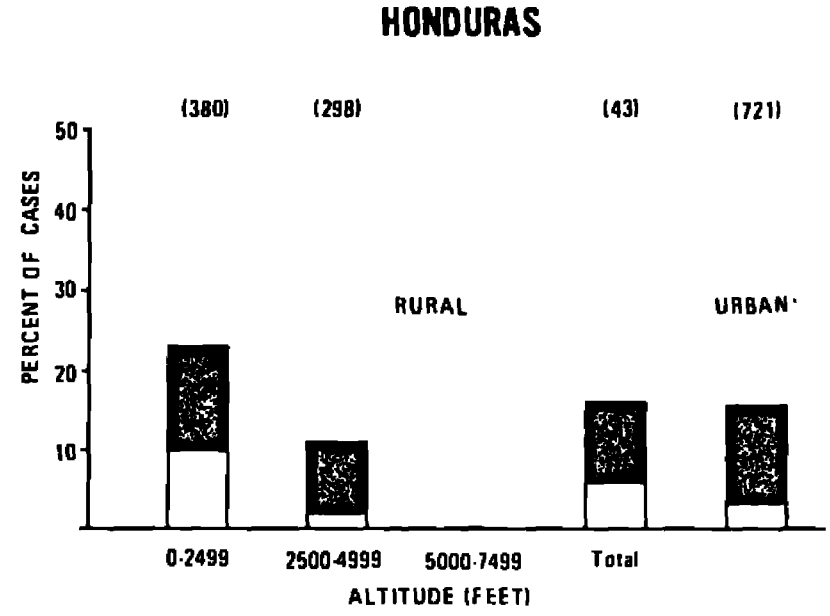
FIGURE 4

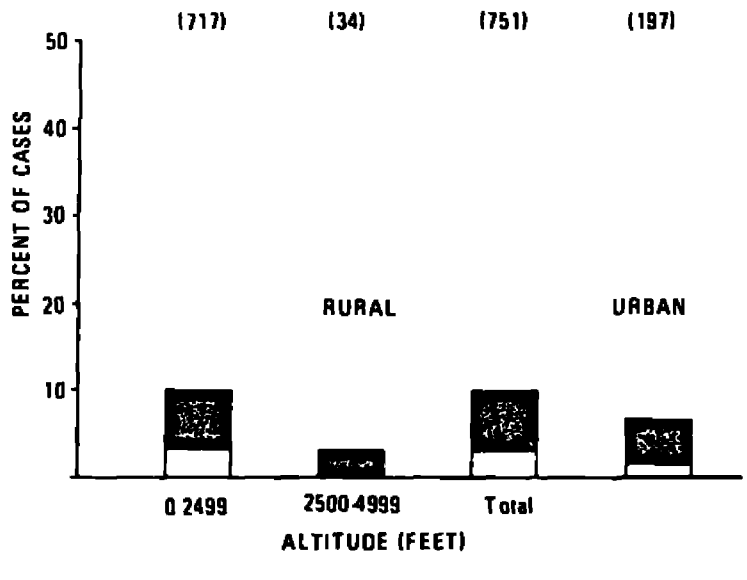
HEMOGLOBIN: PREVALENCE OF "LOW" AND "DEFICIENT" VALUES ACCORDING TO ALTITUDE

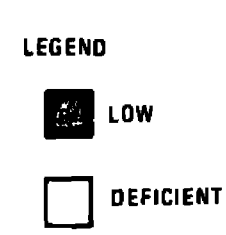








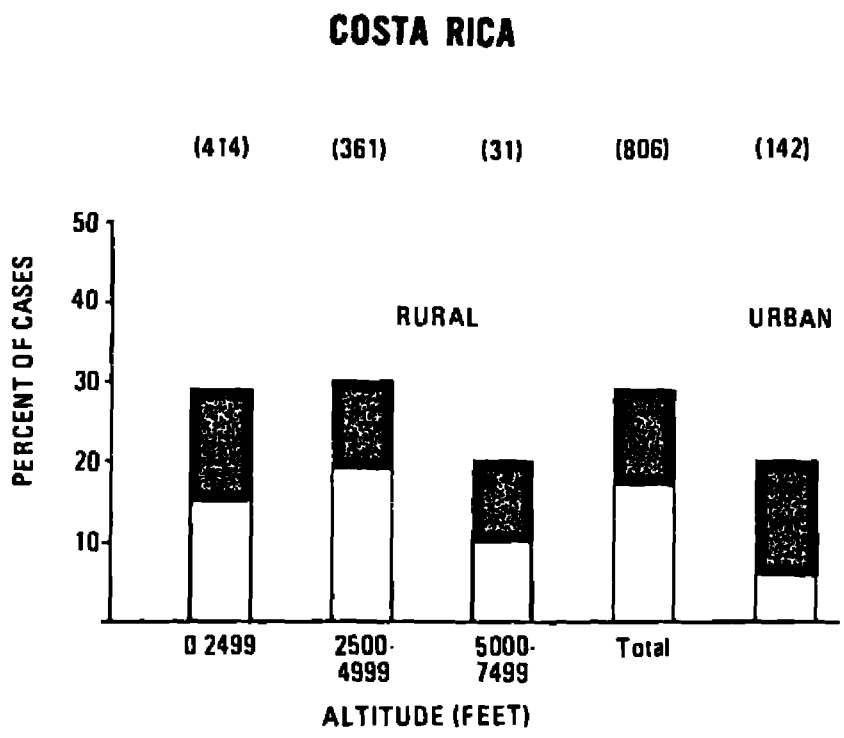


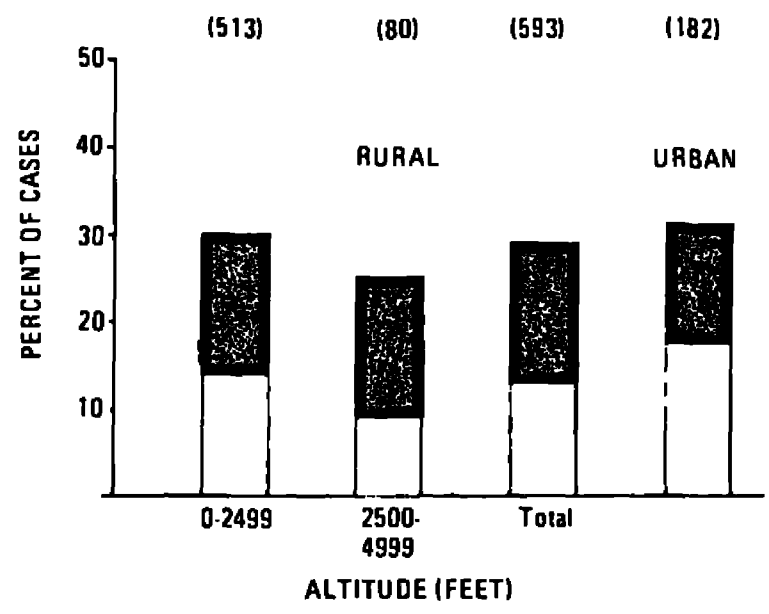


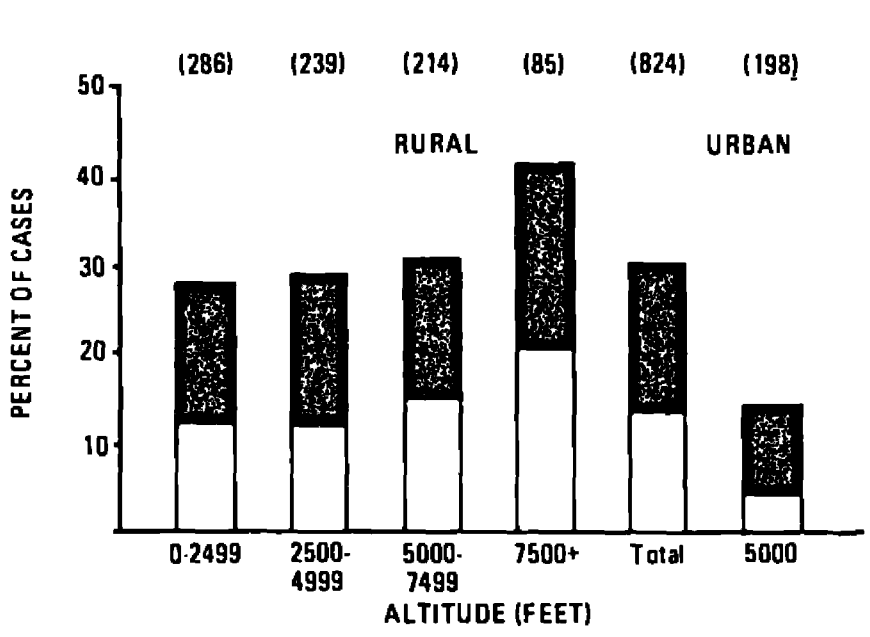
NUMBERS IN PARENTHESES INDICATE NUMBER OF CASES

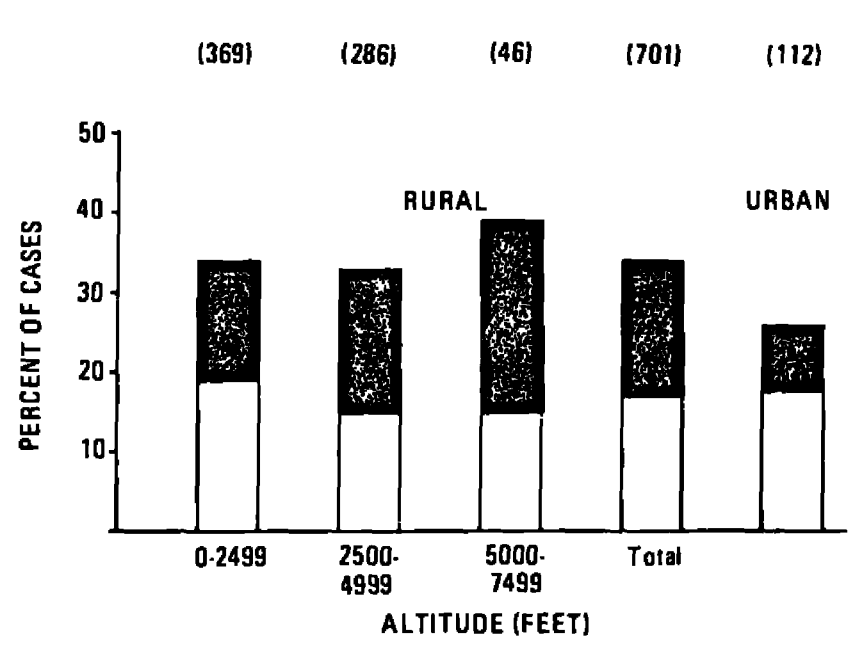
FIGURE 5

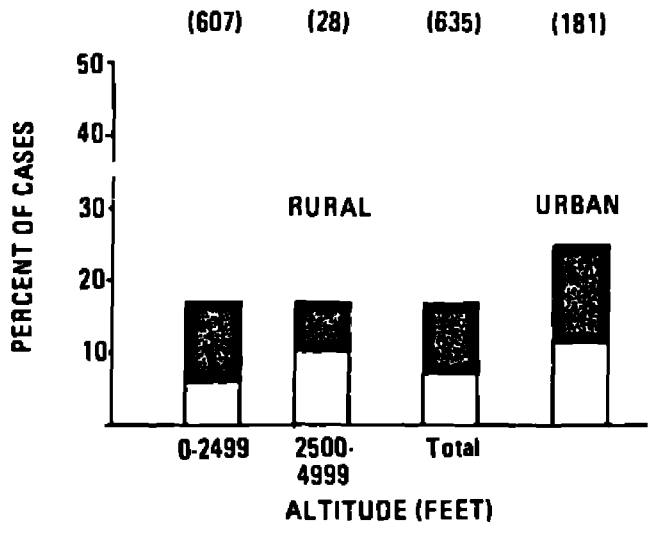
TRANSFERRIN SATURATION: PREVALENCE OF "LOW" AND "DEFICIENT" LEVELS ACCORDING TO ALTITUDE











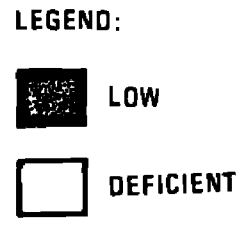


TABLE 21. PERCENT DISTRIBUTION OF POPULATION BY IRON INTAKE LEVEL AND PERCENT TRANSFERRIN SATURATION

Country		Iron Intake Per Person Per Day		Percent Transferrin Saturation	
		<12mg	<10mg	<20%	<15%
		Percent of Families			
Guatemala,	rural	42	25	31	17
	urban	11	6	15	10
El Salvador,	rural	59	42	29	13
	urban	42	25	31	18
Honduras,	rural	43	32	32	17
	urban	41	26	26	18
Nicaragua,	rural	43	32	32	17
	urban	37	18	25	12
Costa Rica,	rural	33	20	29	17
	urban	24	12	26	20
Panama,	rural	36	23	40	20
	urban	42	25	24	12

The high prevalence of iron deficiency in the rural population is a direct result of the low availability of dietary iron for satisfying a requirement potentially increased because of chronic blood loss and losses in perspiration. Most of the iron in the rural diet comes from cereals and vegetables. In many families only small quantities of animal protein are consumed. Iron absorption under these circumstances is less than 10 percent, even in the presence of iron deficiency.

Folate nutrition

A high prevalence of low to deficient serum levels of folic acid was found in both rural and urban populations. The anemias noted, although primarily iron deficiency, are also complicated in a large percentage of the anemic individuals with folic acid deficiency. Thus preventive and curative measures must consider both nutrients. In cases where the anemia is due to both nutrients, the supply of only one will not effect a cure or prevent the anemia.

Folate deficiency can be explained on the basis of inadequate dietary intake, malabsorption and increased metabolic loss of folic acid.

Vitamin B_{12} nutrition

Contrary to iron and folate deficiency, vitamin B_{12} deficiency anemia is rare in Central American and Panamanian populations.

2. Protein and calorie nutrition

While the average protein intake per person per day in the countries surveyed appeared to be adequate for each population as a whole, the distribution of the protein supply, in quantity as in quality, varied considerably among the countries, as well as among the families in each country. The distribution of the protein supply within the family itself is also often inequitable. Earlier surveys in the region have shown that children of the rural areas and of the lower socioeconomic levels receive the poorest share of the family protein supply, even though children need more protein per unit body weight than adults and an inadequate intake of essential amino acids is particularly detrimental to them.

The countries vary in their protein source. Corn is the major protein source in the northernmost countries, Guatemala, El Salvador, Honduras and Nicaragua, while rice has this role in Costa Rica and Panama. Corn protein is poor in certain essential amino acids, principally lysine and tryptophan, while the better quality of the rice protein is offset by the smaller quantity in which it occurs in the grain.

Table 22 shows the percentage of children in rural and urban areas having an abnormally high nonessential/essential amino acid ratio of 3.0 or more. The differences between countries are considerable, and the situation in the urban areas is more favorable than that in the rural.

TABLE 22. PLASMA NON-ESSENTIAL/ESSENTIAL AMINO ACID RATIO

Country	Percent Children Having 3.0 or Higher				Total No. Children Having Unfavorable Ratio[1/]
	Rural		Urban		
	0-4 yrs.	5-9 yrs.	0-4 yrs.	5-9 yrs.	
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

[1/] Derived by multiplying the percentage of children between 0 and 9 years of age having a plasma nonessential/essential amino acid ratio of 3.0 or higher by the total number of children in this age group in the respective countries, estimated from census figures.

When these data are related to the socioeconomic level of the families (see "Socioeconomic Studies") it is seen, in Figure 6 that the lower the socioeconomic level, the more abnormally elevated the amino acid ratio in the children.

The plasma albumin values also indicate a severe problem. The highest prevalence of "low" and "deficient" values was found in rural areas and in children 0-9 years of age. This biochemical parameter does not decrease gradually with a progressively greater degree of protein malnutrition, but rather drops abruptly in the acute severe stage. Therefore, the subjects with these "low" and "deficient" values must be cases of protein deficiency severe enough to alter this plasma protein (Table 23).

TABLE 23. PERCENT OVERALL "DEFICIENT" AND "LOW" PLASMA ALBUMIN VALUES IN THE POPULATION

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

Although clinical signs suggestive of protein deficiency had a relatively low prevalence, their presence in this population group cannot be overlooked since they are not expected to occur in a well-nourished group. Except for a few isolated cases, Guatemala was the only country in which marasmus or kwashiorkor was observed. In the Guatemalan survey sample, 1.9 percent of the children under 5 years were suffering from either kwashiorkor or marasmus. Table 24 presents a summary of clinical symptoms suggestive of protein deficiency.

A limitation in protein-calorie intake is one of the principal causes of growth retardation in countries with the socioeconomic, agricultural and dietary characteristics of underdevelopment typical of the Central American countries.

Caloric deficiency affects a significant portion of the rural population. From previous studies, it is known that, as in the case of protein, the small child gets the poorest share in the distribution of calories within the family. In this light, the anthropometric

FIGURE 6

RATIO OF NONESSENTIAL TO ESSENTIAL AMINO ACIDS IN SERUM ACCORDING TO THE SOCIO-ECONOMIC INDEX OF RURAL FAMILIES

TABLE 24. PERCENT OF CHILDREN UNDER 5 SHOWING CLINICAL SIGNS SUGGESTIVE OF PROTEIN DEFICIENCY

Country	Hair changes	Ankle edema	Tongue edema	Kwashiorkor or marasmus
Guatemala	1.5	0.7	-	1.9
El Salvador	1.7	0.3	0.2	0.0
Honduras	21.4	0.2	-	- a/
Nicaragua	5.5	0.1	1.9	- a/
Costa Rica	3.5	0.1	-	0.0
Panama	8.1	-	8.1	- b/

a/one case of marasmus.
b/two cases of marasmus.

measurements in Figures 11,12,15 & 16 (Chapter IV) may be further evidence of protein-calorie malnutrition. A retardation in both weight and height is evident by the age of 4-6 months, as compared with standards for well-nourished children.

The development of leg length and head circumference is similarly retarded. There are observations suggesting that malnutrition in early ages results in retardation in mental development. It is true that no relationship has been found between skull size and intelligence, but this conclusion may apply only within the limits found in normal populations. It is also true that head circumference alone does not permit estimation of intracranial volume. Further studies are needed to determine the significance of the observation reported here.

The overall picture is compatible with epidemiological evidence indicating that the protein intake is drastically reduced as the supply of breast milk diminishes and the growing child begins to receive carbohydrate-rich, protein-poor foods. The cross-sectional data reported here indicate that the retardation which occurs during the preschool age, a critical rapid growth period, is not regained.

Using the Gomez classification of degrees of malnutrition based on weight by age, a projection of the sample to the total population of children under 5 years of age can be made for all countries (Table 25).

The information obtained from all studies points to a serious protein-calorie malnutrition problem, particularly among children.

TABLE 25. CASES OF PROTEIN-CALORIE UNDERNUTRITION IN CHILDREN LESS THAN 5 YEARS, PROJECTED TO THE 1965 POPULATION

Country		Total population less than 5 years	Level of Undernutrition			
			1st degree	2nd degree	3rd degree	Total 1st, 2nd, & 3rd degree
Guatemala,	No.	833,400	408,366	220,851	49,170	678,387
	%		49.0	26.5	5.9	81.4
El Salvador,	No.	554,400	268,884	126,958	17,186	413,028
	%		48.5	22.9	3.1	74.5
Honduras,	No.	346,900	149,167	94,357	7,979	251,503
	%		43.0	27.2	2.3	72.5
Nicaragua,	No.	287,500	120,175	37,950	5,175	163,300
	%		41.8	13.2	1.8	56.8
Costa Rica,	No.	294,300	128,609	35,904	4,415	168,928
	%		43.7	12.2	1.5	57.4
Panama,	No.	207,900	101,455	22,453	2,287	126,195
	%		48.8	10.8	1.1	60.7
TOTAL:		2,524,400	1,176,656	538,473	86,212	1,801,341
		100.0	46.6	21.3	3.4	71.4

Vitamin A nutrition

The dietary study indicated that the average vitamin A intake at the family level in the rural areas was grossly inadequate and considerably below the intake in the corresponding urban sections. This situation was confirmed by the biochemical data which showed average serum vitamin A levels in rural areas lower than in corresponding urban areas.

When the biochemical data were classified as "deficient" (less than 10mg per 100 ml), "low" (from 10 to 19mg per 100 ml) and "satisfactory" (over 20 mg per 100 ml), a much greater prevalence of "deficient" and "low" values was found in the rural than in the urban population (Table 26).

TABLE 26. 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

When the data for the rural area were analyzed by "low", "medium" and "high" socioeconomic index or level, the serum vitamin A concentration was seen to decrease in almost all groups by socioeconomic level (Figure 7).

The data, tabulated by age groups and summarized in Figure 8, show that children, particularly those under 10 years, have lower serum vitamin A levels than adults. Apparently within the family the small child receives a portion poorer in relation to his requirements than do adults. This is a matter of great importance for nutrition education.

Despite the relatively severe deficiency of vitamin A detected by the dietary and biochemical studies, the clinical signs indicative or suggestive of this deficiency were rare (Table 27).

TABLE 27. PREVALENCE OF CLINICAL SIGNS OF VITAMIN A DEFICIENCY[1/]

Country	Bitot's Spots	Follicular hyperkeratosis	Non-purulent conjunctivitis
	No. of cases	% incidence	% incidence
Guatemala	2	2.2	0
El Salvador	0	0.4	0.4
Honduras	0	1.7	0
Nicaragua	3	5.1	3.7
Costa Rica	2	1.0	0.3
Panama	0	0.6	0

[1/] No cases of keratomalacia or xerophthalmia were noted.

This lack of agreement could be because the concomitant occurrence

FIGURE 7

SERUM VITAMIN A IN RELATION TO THE SOCIO-ECONOMIC INDEX OF RURAL FAMILIES

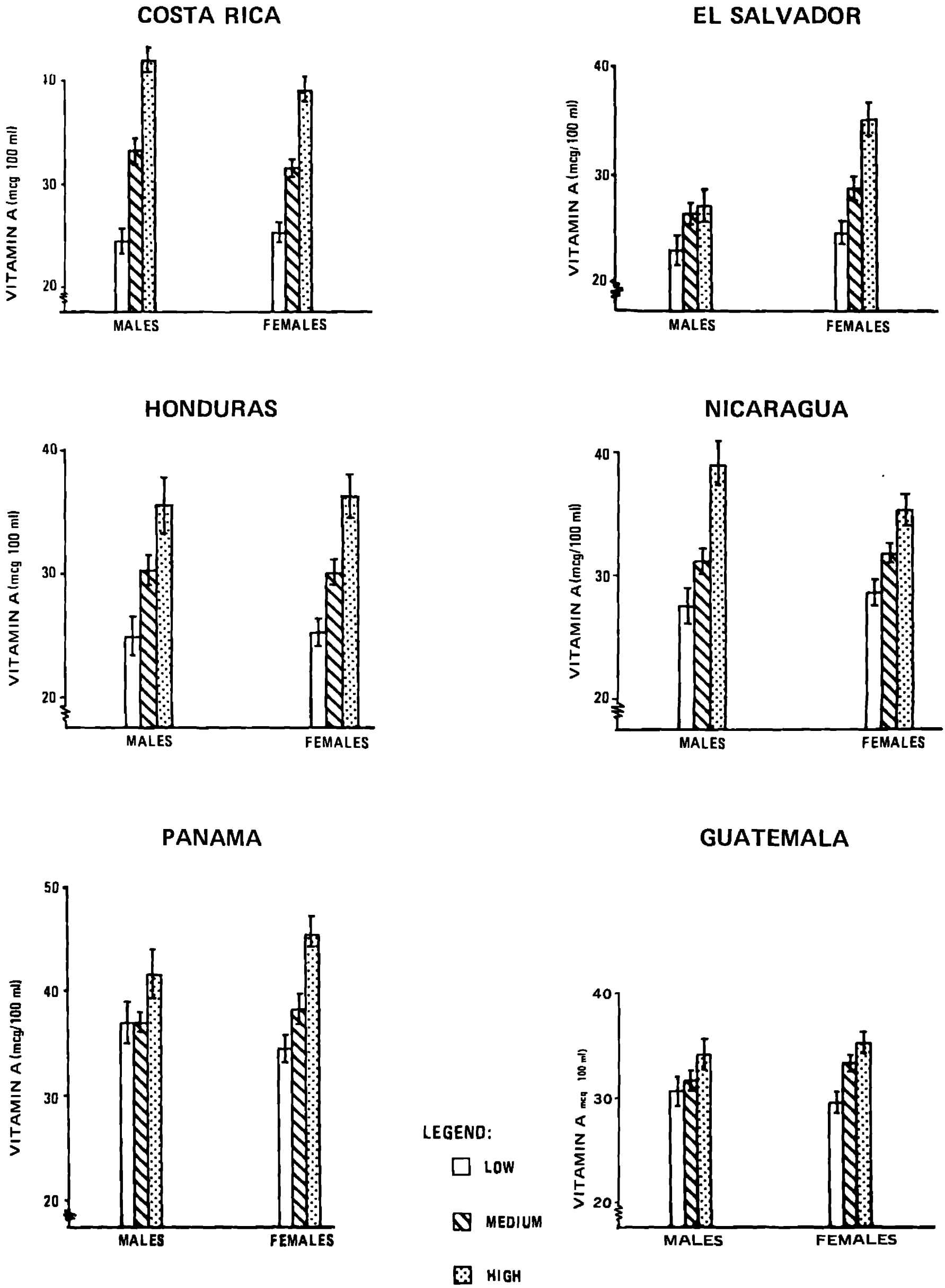
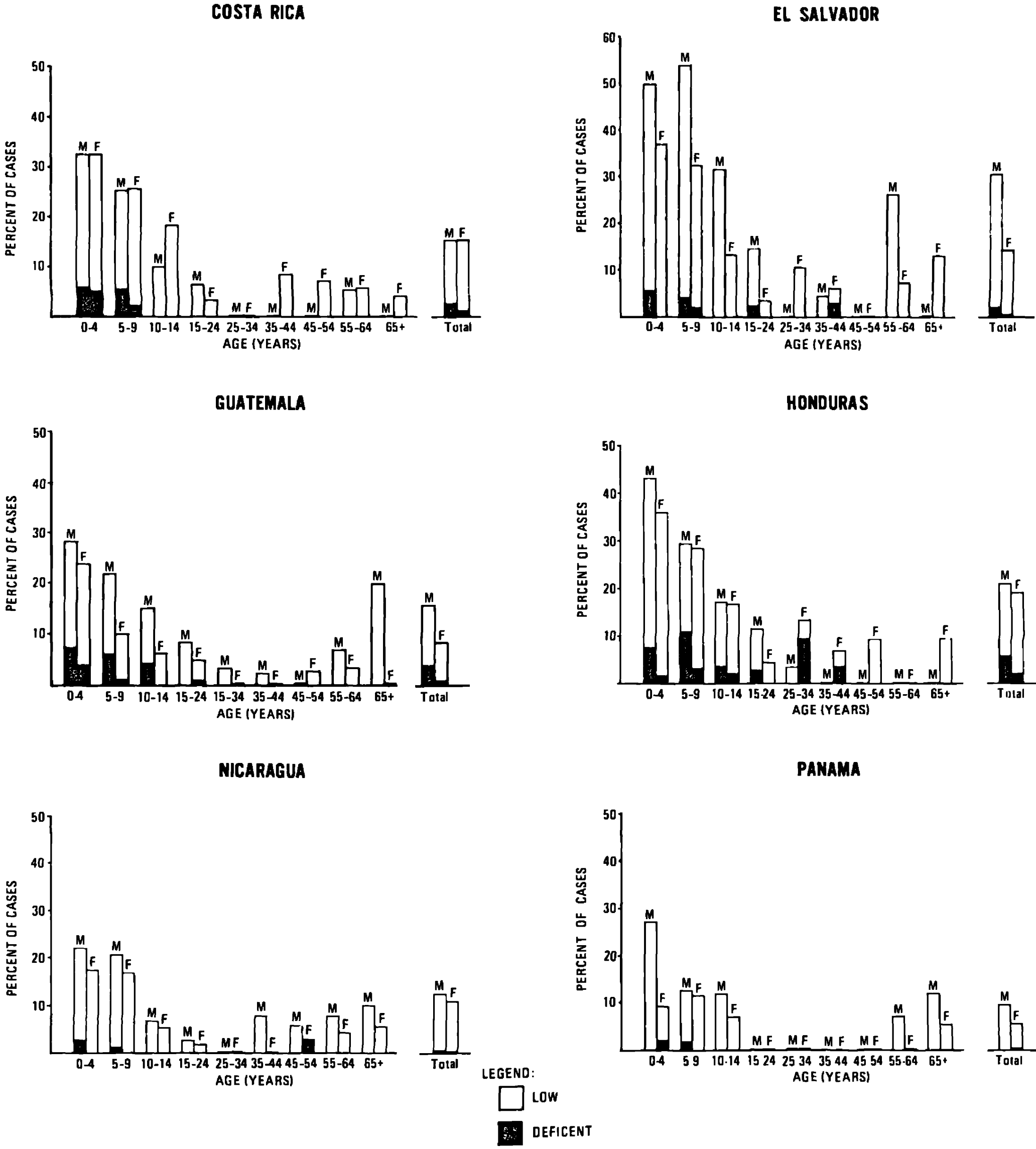


FIGURE 8

SERUM VITAMIN A: PREVALENCE OF "LOW" AND "DEFICIENT" VALUES IN RURAL AREAS



of other deficiencies which limit growth may result in a lesser tissue demand for vitamin A, preventing gross clinical lesions in spite of an actual intake inadequacy. It is also possible that at the time of the surveys, availability of vitamin A sources was seasonally low but that it had been higher in the preceding season, allowing for some reserves of this vitamin.

The data point to vitamin A deficiency as an obvious public health nutrition problem in the six surveyed countries, affecting particularly the small child in the rural areas. Since adequate vitamin A nutrition is essential for normal growth and development, one cannot overemphasize the need for improvement in this area. That the ultimate solution lies at the national level is indicated by the food and agricultural study which reveals the scarce production and availability of sources of vitamin A, particularly those of animal origin.

Riboflavin

The average riboflavin intake in the rural population was inadequate in all six countries, although to a lesser degree than in the case of the vitamin A intake. In contrast, the riboflavin intake of the corresponding urban populations was in most cases adequate or marginally so. When the individual rural families were ranged by percent of adequacy, a third or more in all the countries were found to have less than half the amount of riboflavin considered desirable (Table 11). These results are in agreement with the urinary excretion data (Table 28).

TABLE 28. PERCENT PREVALENCE OF "DEFICIENT" AND "LOW" LEVELS OF URINARY RIBOFLAVIN

Country	Rural		Urban	
	deficient	low	deficient	low
Guatemala	4.2	32.8	2.4	14.2
El Salvador	3.0	25.1	0.6	8.1
Honduras	5.4	27.0	3.5	16.7
Nicaragua	4.9	27.8	1.6	13.4
Costa Rica	1.2	15.6	0.6	12.7
Panama	10.8	41.9	5.3	14.7

The inequitable distribution of the supply among the different age groups is illustrated by the much higher prevalence of "low" and "deficient" urinary excretions in children than in adults, as shown in Figure 9. This deficient intake is severe enough to result in a significant reduction of red blood cell riboflavin concentration in a

FIGURE 9

URINARY RIBOFLAVIN: PREVALENCE OF "LOW" AND "DEFICIENT" VALUES IN RURAL LOCALITIES

large portion of the total population (Table 29).

TABLE 29. PERCENT PREVALENCE OF "DEFICIENT" AND "LOW" RED BLOOD CELL RIBOFLAVIN IN THE TOTAL POPULATION

Country	Rural		Urban	
	deficient	low	deficient	low
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

The clinical examination likewise confirmed the deficiency of riboflavin, although not to the same degree. The biochemical and clinical characteristics of the subjects indicate a general and serious problem of riboflavin deficiency, which is in agreement with the large proportion of the sample whose intake of the vitamin is grossly inadequate. Data on predominant food patterns and on the food and agricultural characteristics at the national level provide the logical explanation for the situation since they reveal the meager availability and consumption of food sources of riboflavin.

Thiamine

The average intake of thiamine at the family level was adequate in both rural and urban populations of virtually all six countries, by the standards applied.[1/] Only in the rural population of Costa Rica was the intake somewhat below the estimated requirements. Nevertheless, among the individual persons studied, a significant proportion showed "deficient" and "low" urinary thiamine excretions (Table 30).

Although the average thiamine intakes were relatively comparable in both rural and urban populations in all the countries, the prevalence of "deficient" urinary thiamine excretions was less in the urban than in the rural groups in most of the countries. The explanation of this situation is not clear but the finding suggests a better distribution of the available thiamine supply in some of the urban populations.

1/ Requirements of Vitamin A, Thiamine, Riboflavin and Niacin: Report of a Joint FAO/WHO Expert Group, FAO Report Series No. 41, World Health Organization Technical Report Series No. 362, 1967.

TABLE 30. PERCENT PREVALENCE OF "DEFICIENT" AND "LOW" URINARY THIAMINE EXCRETIONS

Country	Percent "Deficient"		Percent "Low"	
	Rural	Urban	Rural	Urban
Guatemala	13.9	8.7	13.0	9.0
El Salvador	0.3	1.8	2.3	6.6
Honduras	5.6	4.5	10.8	23.6
Nicaragua	13.8	3.3	15.3	16.8
Costa Rica	24.2	4.3	18.0	12.3
Panama	24.2	26.6	25.4	25.5

The possibility that thiamine was generally destroyed or lost during the preparation and cooking of food was not supported. Dietary intakes of thiamine estimated on the basis of the chemical analyses of composite meal samples were even higher than results based on food intake data analyzed by use of food composition tables and were not significantly different. In Panama, however, composite analyses showed thiamine values less than half those derived by use of food composition tables. There, rice is the principal food in the diet and also the major source of thiamine. In the preparation of rice in the home, it is thoroughly washed two or three times and the water discarded. The rice is boiled in water until completely dry. This washing and cooking of rice could then be the reason for the exceptional loss of a large portion of the thiamine. No clinical signs of thiamine deficiency were found, however, in either the rural or urban populations.

Niacin

The urinary excretion of N'Methylnicotinamide was used to assess biochemically the adequacy of niacin intake. The results show that most of the rural and urban populations have "acceptable" and "high" excretions, indicating an ample niacin intake (Table 31).

The intake of pre-formed niacin averaged from 75 to over 100 percent of the recommended allowances in the rural and urban populations. This does not take into account the contribution of tryptophan, precursor of niacin, which would increase all the levels. No clinical signs of niacin deficiency, or pellagra, were found.

TABLE 31. PREVALENCE OF "ACCEPTABLE"-AND-"HIGH" URINARY NIACIN EXCRETION LEVELS

Country	Percent "Acceptable"-and-"High"	
	Rural	Urban
Guatemala	98.7	99.0
El Salvador	92.5	100.
Honduras	96.8	97.3
Nicaragua	98.8	100.
Costa Rica	100.	100.
Panama	99.4	100.

Ascorbic Acid

The average ascorbic acid levels in the blood plasma of the rural population fell in the "high" range. The prevalence of "acceptable" and "high" values is shown in Table 32.

TABLE 32. PREVALENCE OF "ACCEPTABLE"-AND-"HIGH" LEVELS OF PLASMA ASCORBIC ACID

Country	Percent Acceptable-plus-High Values	
	Rural	Urban
Guatemala	95.0	94.7
El Salvador	94.4	99.5
Honduras	98.1	93.3
Nicaragua	98.7	96.6
Costa Rica	98.8	98.9
Panama	95.4	95.0

This conforms with the absence of clinical signs among the subjects. Pregnant women showed no increased prevalence of values in the "low" range. Although the average value for lactating women was somewhat lower, it still was in the "acceptable" range. The dietary study showed that the average ascorbic acid intake in both rural and urban populations in most of the six countries was well above the recommended allowances for this vitamin. Exceptions were the rural areas of Guatemala and El Salvador, where the average ascorbic acid intake was only marginal or low. In these two populations the per capita consumption of plantains, bananas, other fruits, and starchy roots and tubers, important sources of ascorbic acid in the diet, was substantially lower than in the other areas. The average intakes of ascorbic acid were in general higher in the urban than in the rural areas.

Iodine

Endemic goiter due to iodine deficiency represents a serious health problem in all the Central American countries except Guatemala (Figure 10). Since the introduction of salt iodization in Guatemala in 1956, the prevalence of this condition in this country has decreased from 38 percent to 5.2 percent, which places it well below the 10 percent limit set by the World Health Organization to classify goiter as a public health problem (Table 33).

TABLE 33. PERCENT PREVALENCE OF ENDEMIC GOITER

Country	Males and Females	Males	Females
Guatemala	5.0	2.6	7.3
El Salvador	48.0	40.0	54.0
Honduras	17.0	8.9	21.0
Nicaragua	32.0	25.0	37.0
Costa Rica	18.0	11.5	23.3
Panama	16.5	7.5	24.0

As in other goitrous areas, the highest prevalence was found in adolescents and young adults and even more so in females. Grades II and III goiters were also more frequent in females, excluding small children (Table 34).

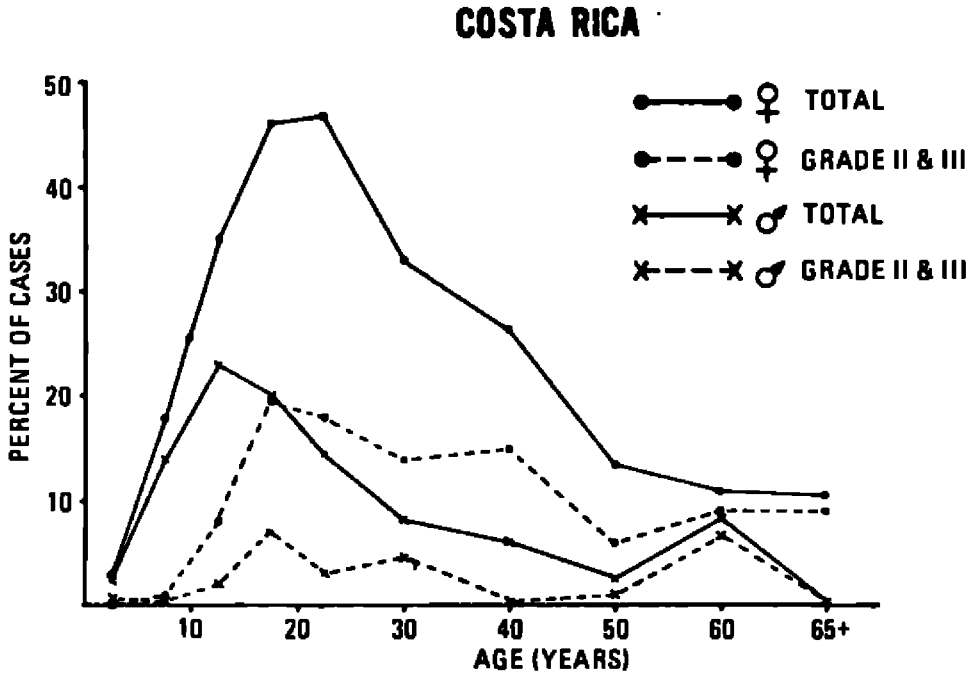
TABLE 34. PERCENT PREVALENCE OF GOITER, GRADES II AND III

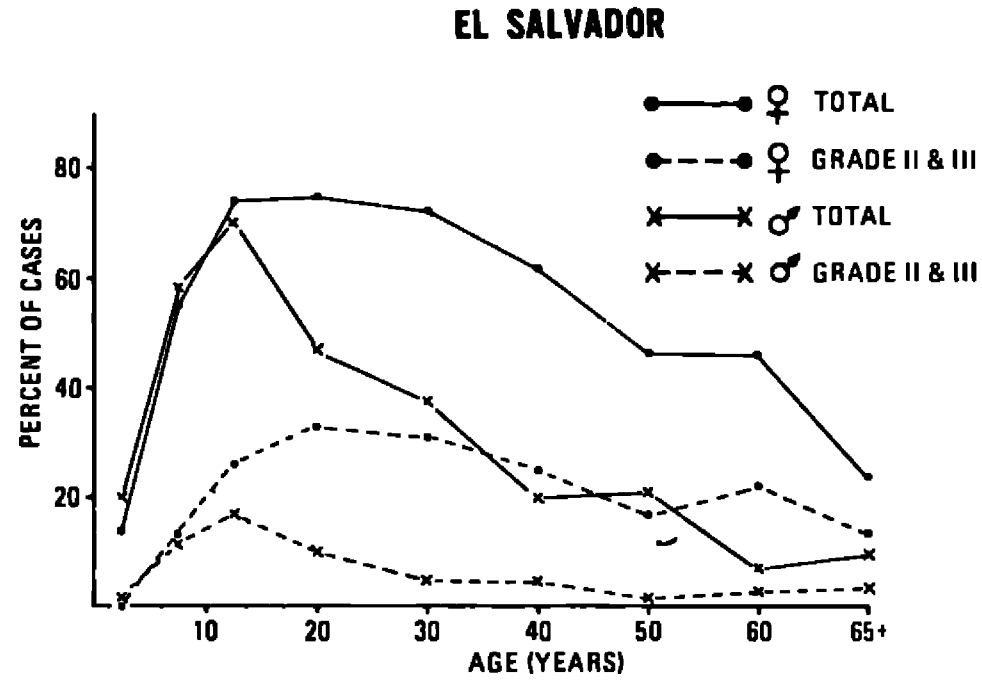
Country	Males	Females
Guatemala	0.5	2.7
El Salvador	8.0	20.0
Honduras	3.2	11.9
Nicaragua	6.2	16.6
Costa Rica	2.0	8.0
Panama	2.0	13.0

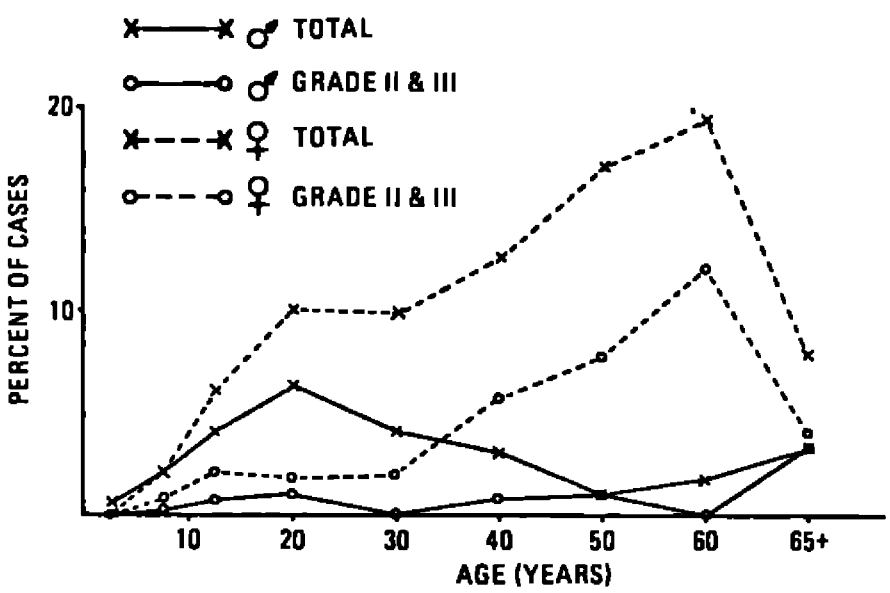
The urinary iodine data confirm the problem by showing that the average excretion for most locations surveyed is below 25 micrograms per person per day and above that figure in only a few locations (Table 35). Population studies have shown that urinary iodine excretions below 25 micrograms per day are compatible with a deficient

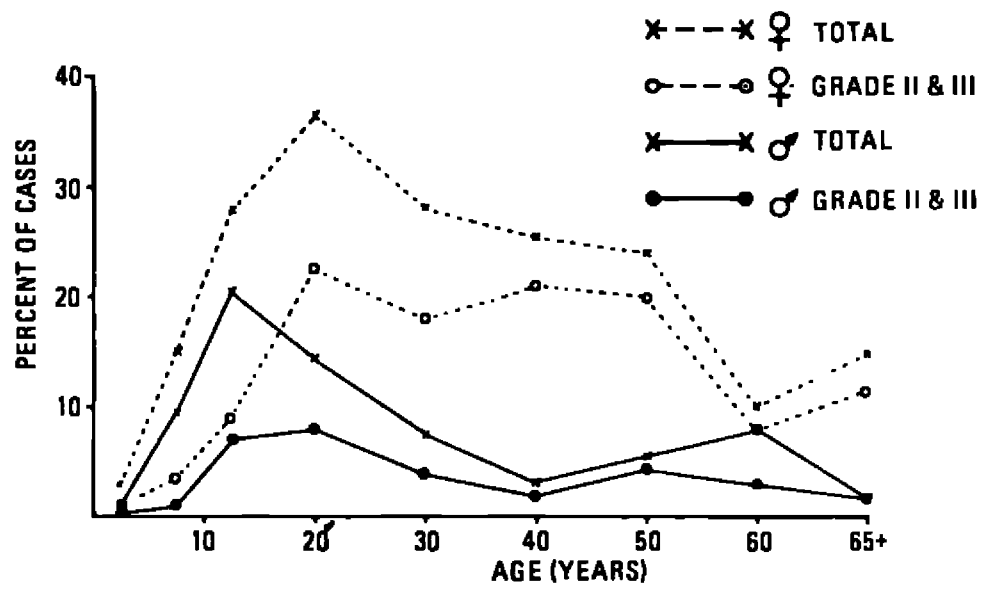
Figure 10

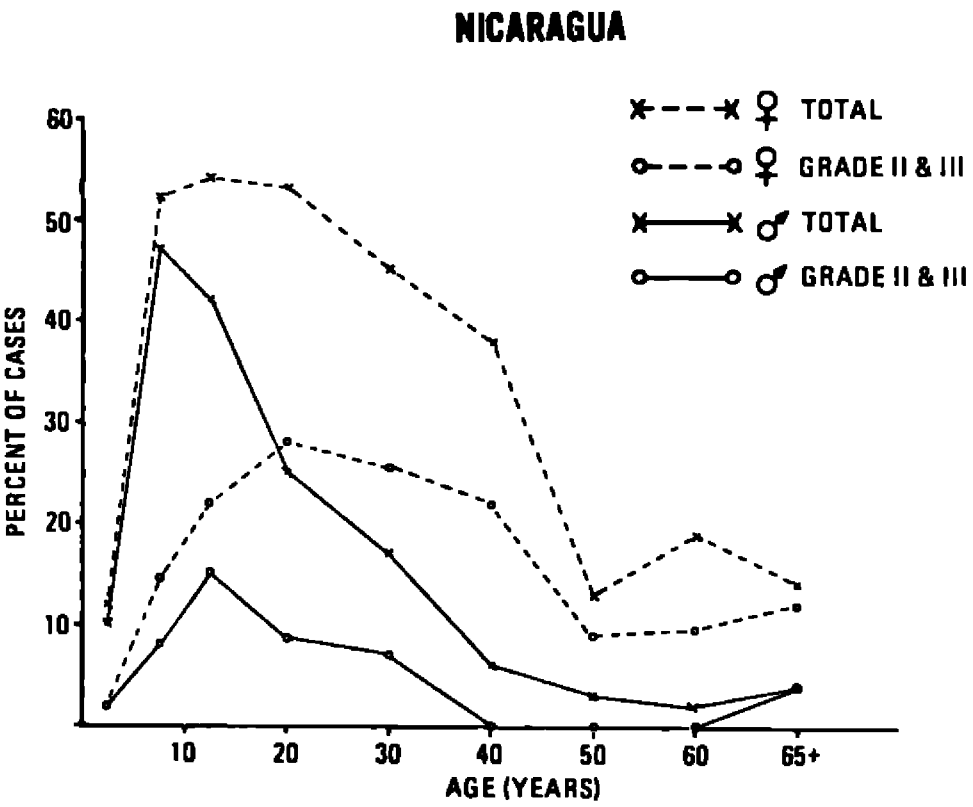
PREVALENCE OF ENDEMIC GOITER IN RURAL AREAS

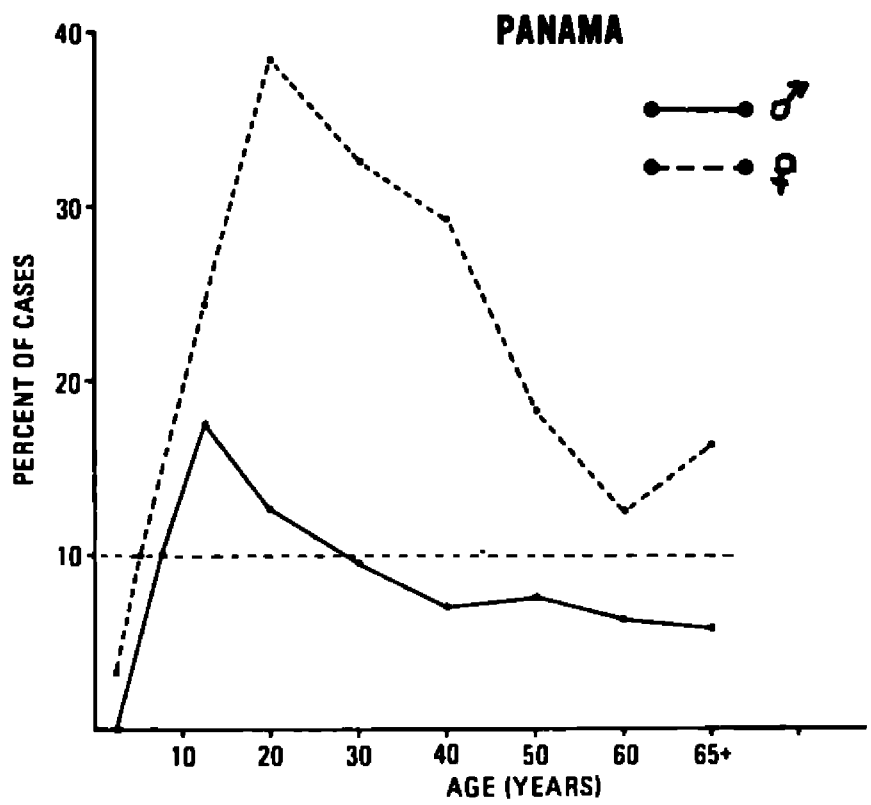












intake of this mineral.

TABLE 35. MEDIAN IODINE EXCRETION LEVELS

Country	Mcg per Person per Day
Guatemala	155
El Salvador	22
Honduras	21
Nicaragua	28
Costa Rica	21
Panama	26

TABLE 36. ENDEMIC GOITER IN GUATEMALA, BY DEPARTMENTS[1/]

Department	1954		1965	
	Locations surveyed	Percent Prevalence	Locations surveyed	Percent Prevalence
San Marcos	1	54	4	5
Quetzaltenango	1	31	3	4
Totonicapan	4	46	1	3
Retalhuleu	1	39	1	1
Huehuetenango	13	38	2	3
Quiche	3	44	3	5
Guatemala	12	28	2	2
Sacatepequez	8	57	1	2
Chimaltenango	6	60	2	1
Solola	4	38	2	3
Suchitepequez	1	37	2	4
Escuintla	10	34	2	3
Alta Verapaz	7	42	3	4
Baja Verapaz	4	65	1	6
El Progreso	11	31	1	4
Santa Rosa	7	40	2	12
Jutiapa	1	37	2	14
Jalapa	1	22	1	7
Chiquimula	2	34	2	10
Izabal	1	21	1	5
Zacapa	1	22	1	8
Peten	6	7	-	-

[1/]Munoz, J. A., Perez, C., and Scrimshaw, N. S. "Distribucion del Bocio Endemico en Guatemala." Rev. Colegio Medico de Guatemala, 6:36-43, 1955.

Table 36 gives the prevalence of endemic goiter in Guatemala by departments. In all departments except Santa Rosa, Jutiapa and Chiquimula, the prevalence of goiter had fallen to less than 10 percent by 1965. A single locality in each of those three subdivisions accounted for the higher figures. In Guazacapan (Department of Santa Rosa) the salt used came from several small producers who did not iodize their product. In Jerez de la Frontera (Department of Jutiapa) the people bought their salt from neighboring El Salvador which was not iodizing its salt in 1965. San Juan Ermita (Department of Chiquimula) obtained uniodized salt from neighboring Honduras and only recently, after the introduction of a new road, obtained iodized salt. The effectiveness of salt iodization was further proved by the values of urinary iodine excretion which in all locations except Guazacapan and Jerez de la Frontera was above 40 mg/day in 1965.

In Guatemalan males a 10 percent prevalence of endemic goiter is not reached in any age group, while in females over 20 years of age it reaches that limit and increases with age up to 19 percent. However, most of the goiters in the older groups are of grades II and III, which are not affected by the iodine supplement. The data indicate that before the age of 20 years the iodization has been very effective in reducing already-existing small goiters and preventing the appearance of new ones.

In September, 1967 and June, 1968, El Salvador and Honduras, respectively, began similar salt iodization programs. The prevalence in these countries is expected to decrease rapidly.

Calcium

The dietary study indicates the following calcium intake in the six countries:

TABLE 37. AVERAGE CALCIUM INTAKE, ADEQUACY, AND SOURCE

Country	Intake, Rural		Intake, Urban		Main Calcium Source
	Per Person Per Day, mg	Percent Adequacy	Per Person Per Day, mg	Percent Adequacy	
Guatemala	1100	207	961	192	corn[1/]
El Salvador	1092	207	865	170	corn[1/]
Honduras	883	166	864	168	corn[1/]
Nicaragua	763	144	901	173	milk products
Costa Rica	580	112	855	165	milk products
Panama	301	59	419	80	milk products

1/Lime treated corn.

The distribution of calcium intake among the families surveyed showed that most had an adequate amount. (Panama and Costa Rica are exceptions. Reference: Table 121)

No clinical evidence of calcium deficiency was encountered, even in Panama. The wrist and hand X-ray studies showed that osteoporotic bone loss with age does not suggest any abnormal pattern which could be attributed to a deficit in calcium intake.

Fats

Requirements of fat in the diet are still unknown. In technically developed countries, where food is abundant, diets providing 40 percent or more calories from fat are suspected of contributing to several chronic diseases. It is considered that diets sufficient in other nutrients supplying approximately 20% of total calories from fat are adequate. Table 38 shows the average intake of fat and percent of total calories from this source.

TABLE 38. AVERAGE FAT CONSUMPTION PER PERSON PER DAY

Country	Rural		Urban	
	Grams Fat	% of Total Calories	Grams Fat	% of Total Calories
Guatemala	31	13	63	22
El Salvador	39	16	69	28
Honduras	44	22	60	26
Nicaragua	48	22	60	26
Costa Rica	44	21	67	26
Panama	50	22	59	25

Biochemical analyses showed serum cholesterol levels typical of developing countries (Table 39).

TABLE 39. AVERAGE SERUM CHOLESTEROL LEVELS
(mg per 100 ml)

Country	Rural		Urban	
	Males	Females	Males	Females
Guatemala	143	156	166	178
El Salvador	131	158	203	203
Honduras	173	187	207	213
Nicaragua	168	174	180	199
Costa Rica	176	186	199	230
Panama	180	198	185	201

Levels of 230 mg/100 ml are common in technically advanced populations where nutritional disorders tend to be from oversupply and imbalance of calories and nutrients. The usual findings of higher levels during pregnancy, lower levels during lactation, and general increase with age were observed in the six countries as well.

The percentage distribution of values in the rural population is shown in Table 40.

TABLE 40. PERCENT DISTRIBUTION OF SERUM CHOLESTEROL VALUES IN THE RURAL POPULATION

Country	<120mg/100ml		120-159mg/100ml		160-199mg/100ml		≥200mg/100ml	
	M	F	M	F	M	F	M	F
Guatemala	29	16	40	38	22	33	8	13
El Salvador	36	17	47	40	14	26	3	17
Honduras	7	6	36	24	34	33	24	37
Nicaragua	7	3	45	36	27	36	21	24
Costa Rica	4	1	28	23	47	42	22	34
Panama	4	2	28	19	39	34	29	45

IV

ANTHROPOMETRIC MEASUREMENTS

Introduction

A number of anthropometric measurements, either by themselves or in combination, have been used for some time in determining the nutritional status of population groups.

In this survey a total of 17 anthropometric measurements were taken on all subjects. In this report, only five (height, weight, leg-length, head circumference, and tricipital skinfold thickness) are presented. The remaining measurements will be analyzed and presented separately.

The standards used for comparison have been taken primarily from the United States because Central American standard measurements are not yet available. A basic premise is that these standards are a mark toward which the Central American populations should strive as their environment improves and their genetic potential is fully attained.

Materials and Methods

Preparation of the subjects. Upon arrival at the anthropometry examining room, the subjects were prepared for measurement as follows: For children up to 5 years of age, shoes and all clothes above the waist were removed. Babies below one year of age kept only diapers, but in cold climates the undershirt or shirt was also left on. In the case of adults and children older than 5 years, the males were prepared in the same way as children up to 5 years of age. The females were asked to remove shoes and all clothing except the dress or skirt and blouse and underwear. This plan was necessitated by the general resistance of the older girls and adult females to undress any further in the presence of the investigators.

Standardization of technical personnel. The measurements were taken by 11 physicians who were instructed in the techniques and underwent a process of standard training to minimize inter-investigator differences.

Measurements of body weight. Infants (children who could not stand by themselves) were weighed on an infant scale ("SECA," Vogel, Germany). The weight of older children and adults was taken with "Detecto" scales (Detecto International, Brooklyn, N. Y.).

The unit of measurement was the kilogram, recorded to 0.1 kg. Weights reported here include minimum clothing which never exceeded 2 percent of total weight.

Measurement of body height. Infants were measured for body length stretched in a supine position in a wooden infantometer. The measurement was taken from the bottom of the heels to the top of the head. Older children and adults were measured against a measuring tape attached to the wall in a vertical position with the aid of a right angle wooden device. Care was taken that the subject was standing straight with head, back, buttocks, and heels touching the wall, and heels touching each other. The unit of measurement was the centimeter with an approximation to one millimeter.

Measurement of leg length. This measurement was, in effect, the heel-knee distance taken on the right leg, bent to a right angle position at the knee by placing the foot on a bench 50 cm high against a measuring tape attached to the wall whose zero was aligned with the surface of the bench. The height of the segment was measured by pressing the wooden right angle against the horizontal surface of the bent knee. The unit was the centimeter, approximated to one millimeter.

Measurement of head circumference. Head circumference was measured with a flexible metal tape placed over the frontal and occipital protuberances to obtain the maximum circumference of the head. In women, all hair adornments and interfering hairdos were avoided and enough pressure was applied to press down abundant hair. The measurement was recorded in centimeters and approximated to one millimeter.

Measurement of skinfold thickness. With the aid of a Lange skinfold caliper, the thickness of a fold of skin pulled parallel to the longitudinal axis of the arm at the mid-distance between the acromion and the olecranon on the posterior surface of the arm (over the triceps) was determined. The pressure surfaces of the caliper were placed about one centimeter from the top of the fold. The measurements were rounded to the nearest millimeter.

Recording of results. Auxiliary nonprofessionals were employed and trained to write clearly the numbers dictated by the investigators.

Results

Weight. Figures 11 and 12 show the weight curves for males and females respectively from 0 to 5 years of age with the Iowa standard as reference. In the case of the standard, the deviations from the average are shown for the 16th and 84th percentiles, while for the Central American curves they represent one standard deviation above and below the average.

In both sexes, at the age of 3 months the Central American average equals the standard average, but at the age of 6 months the Central

Figure 11

WEIGHT OF MALES 0-5 YEARS OF AGE IN RURAL AREAS

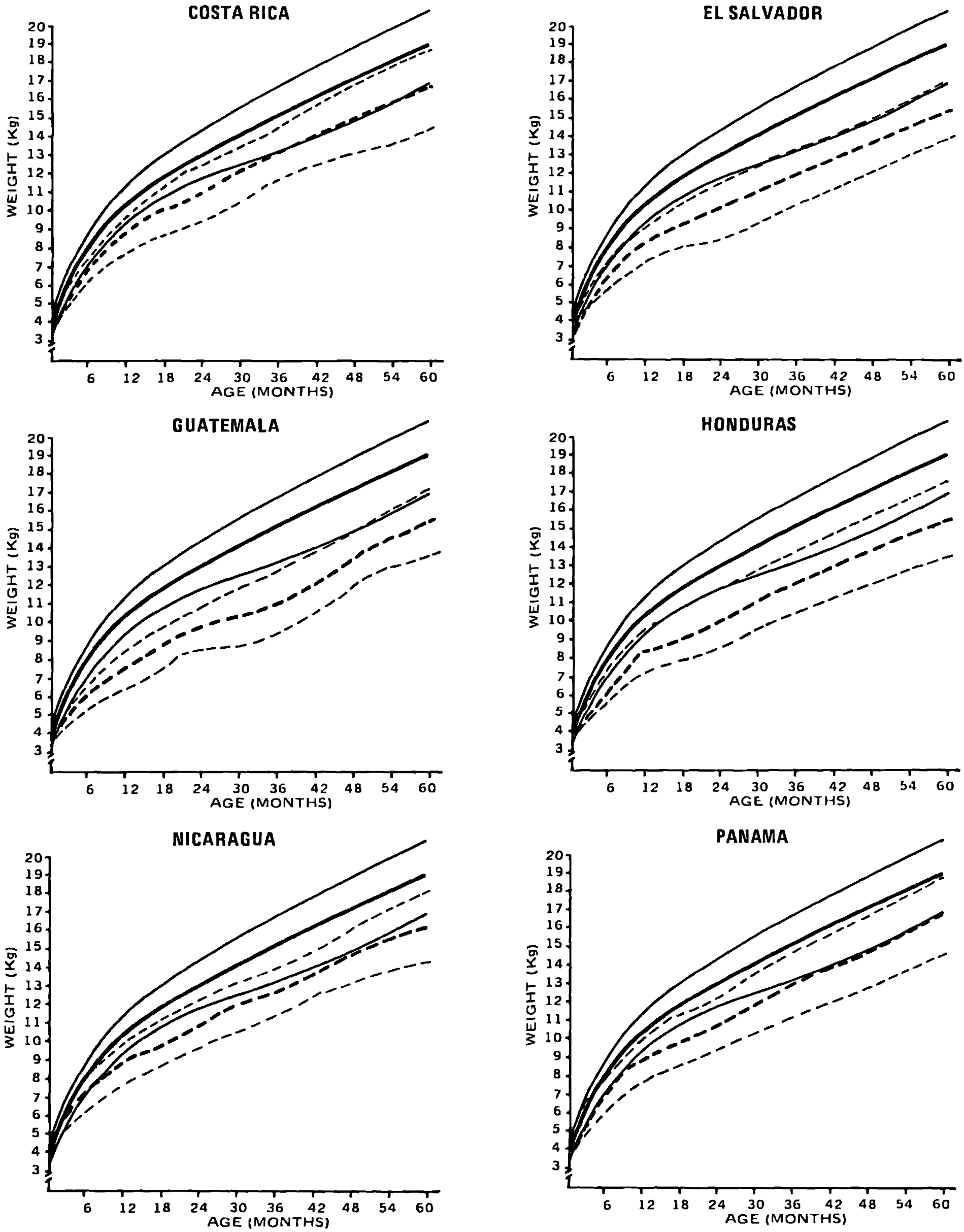
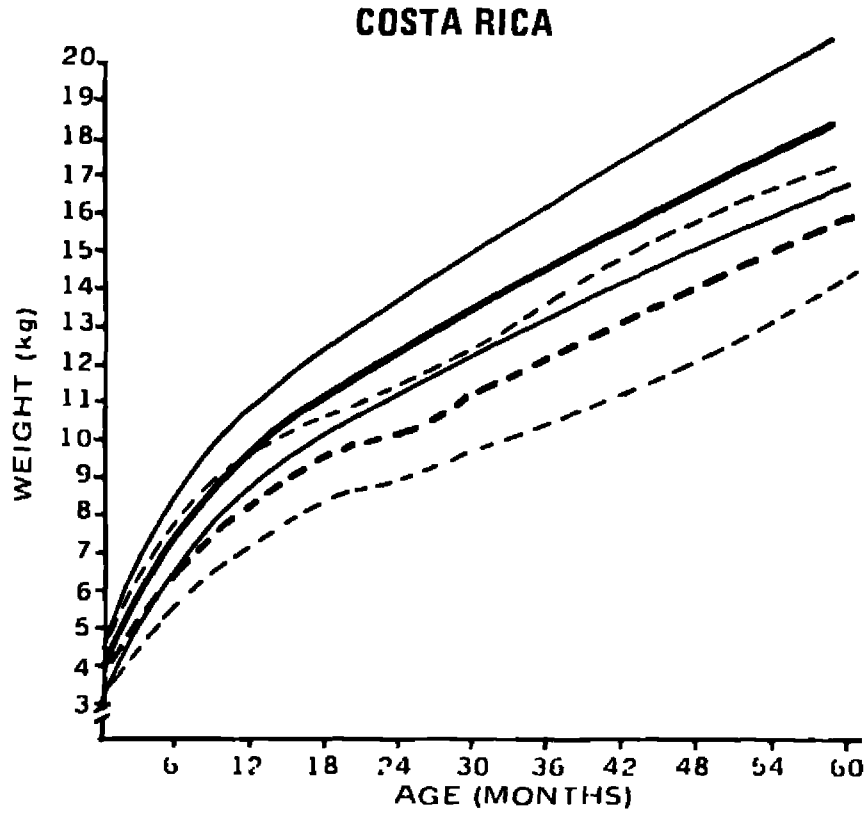
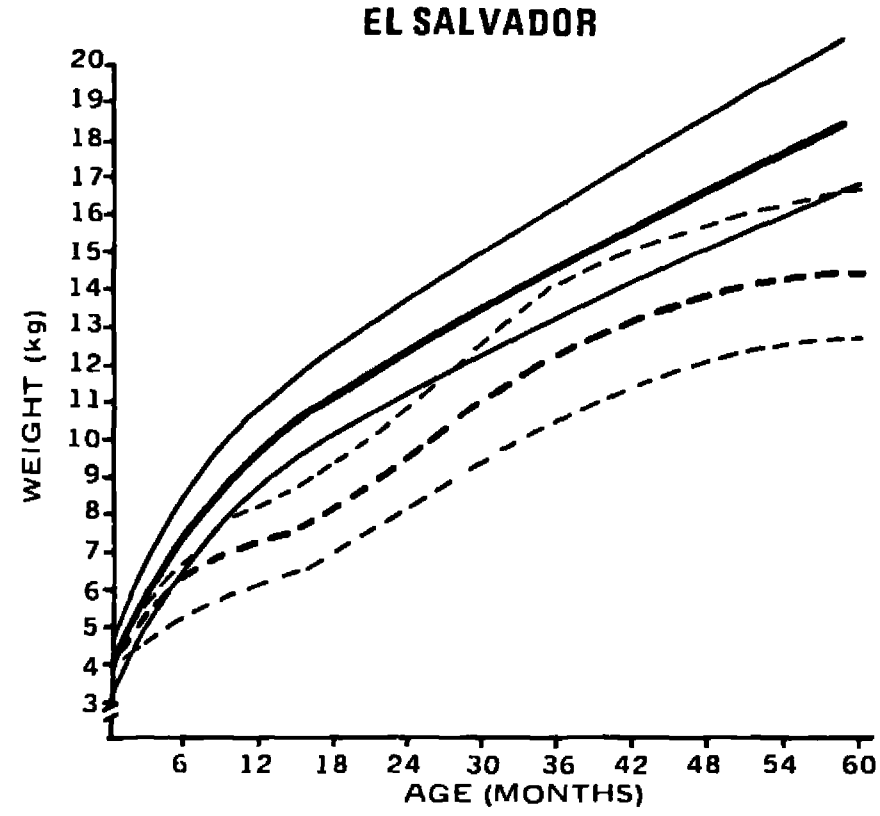
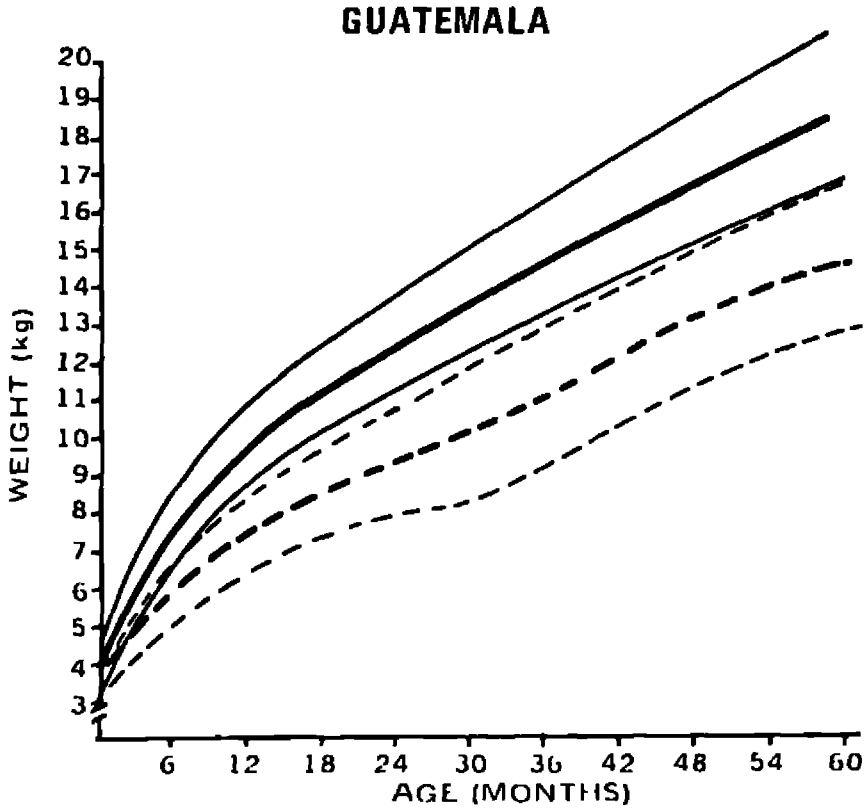


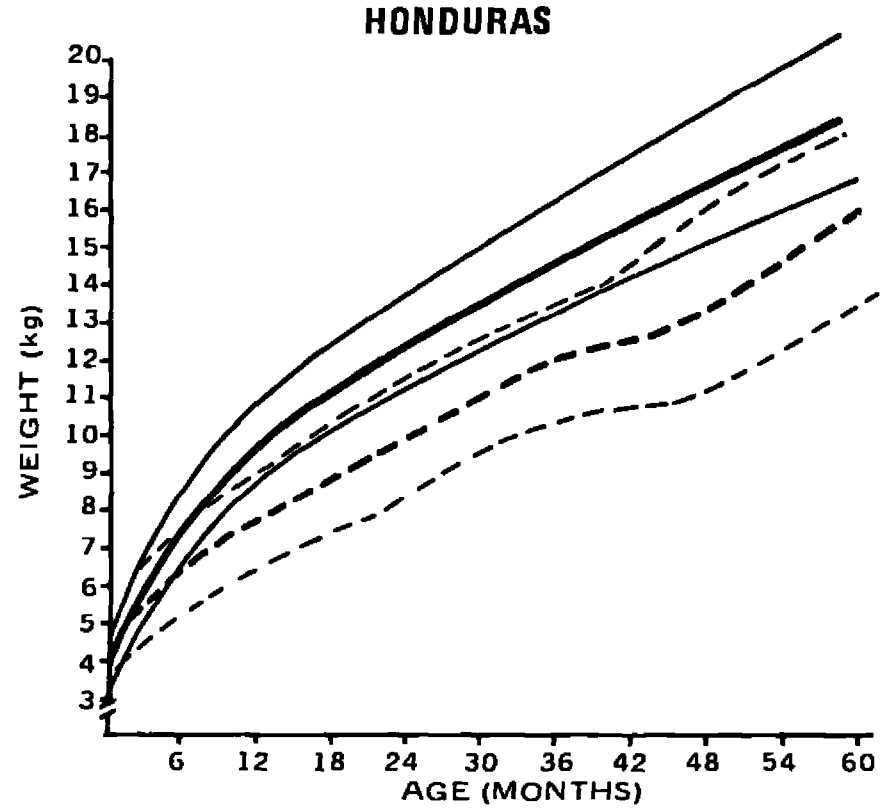
Figure 12

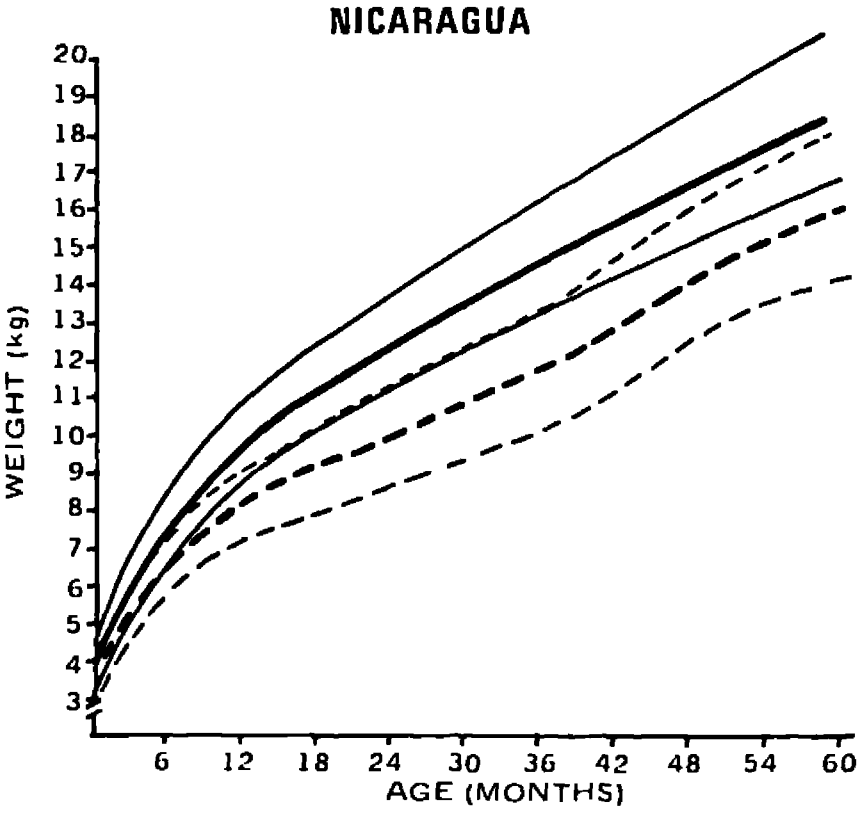
WEIGHT OF FEMALES 0-5 YEARS OF AGE IN RURAL AREAS

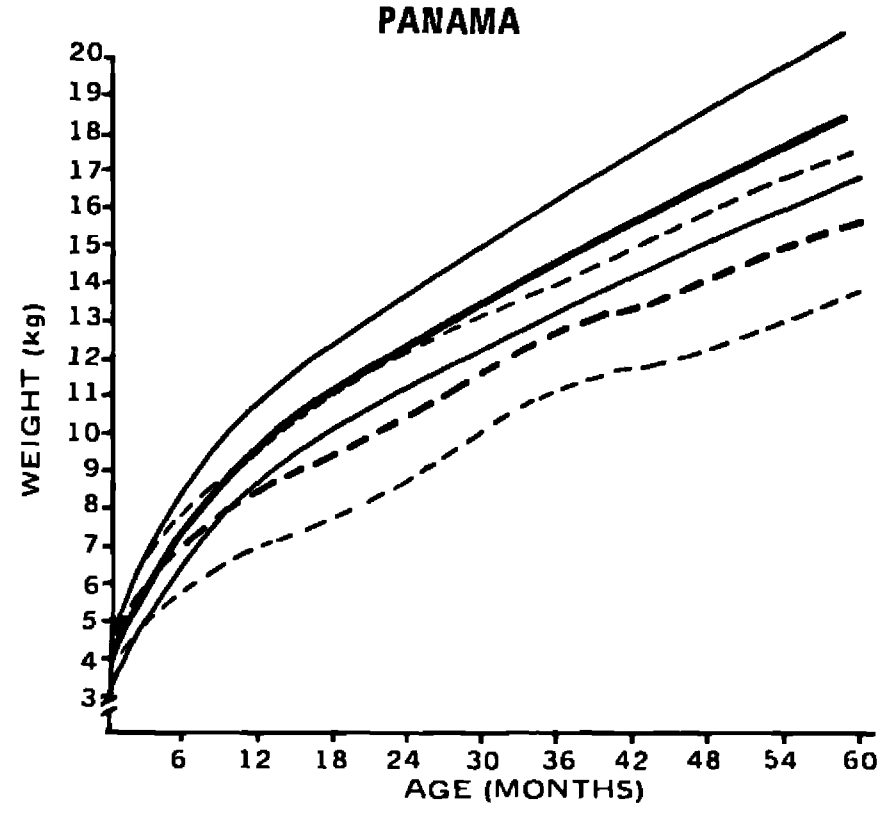












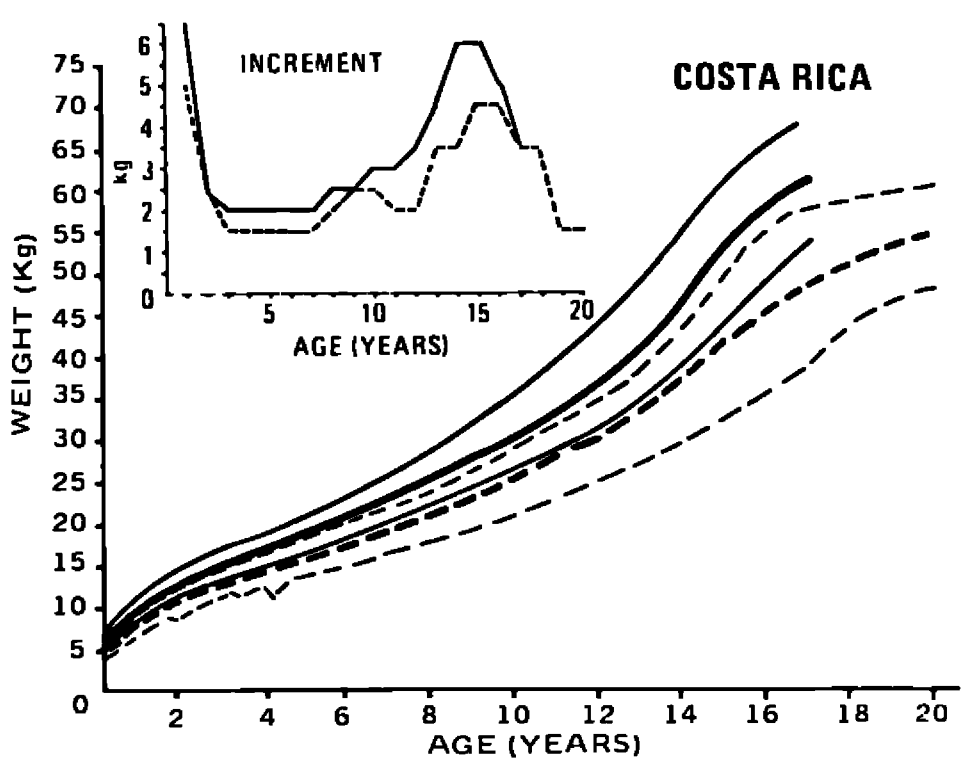
LEGEND:

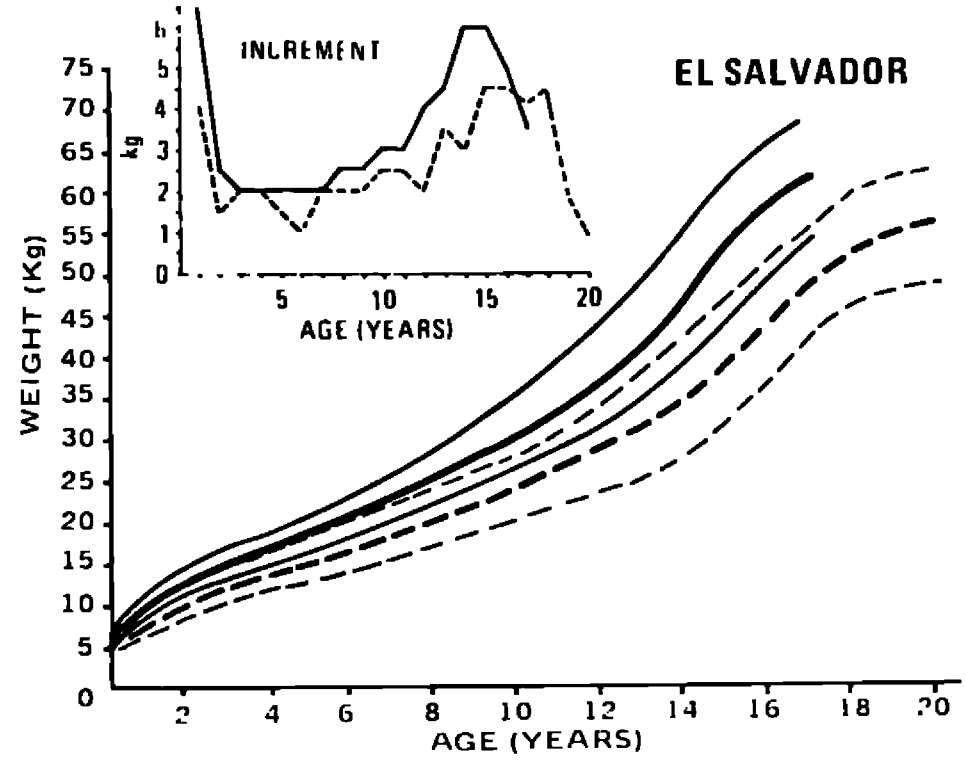
INCAP STANDARD (PERCENTILES 16 AND 84)

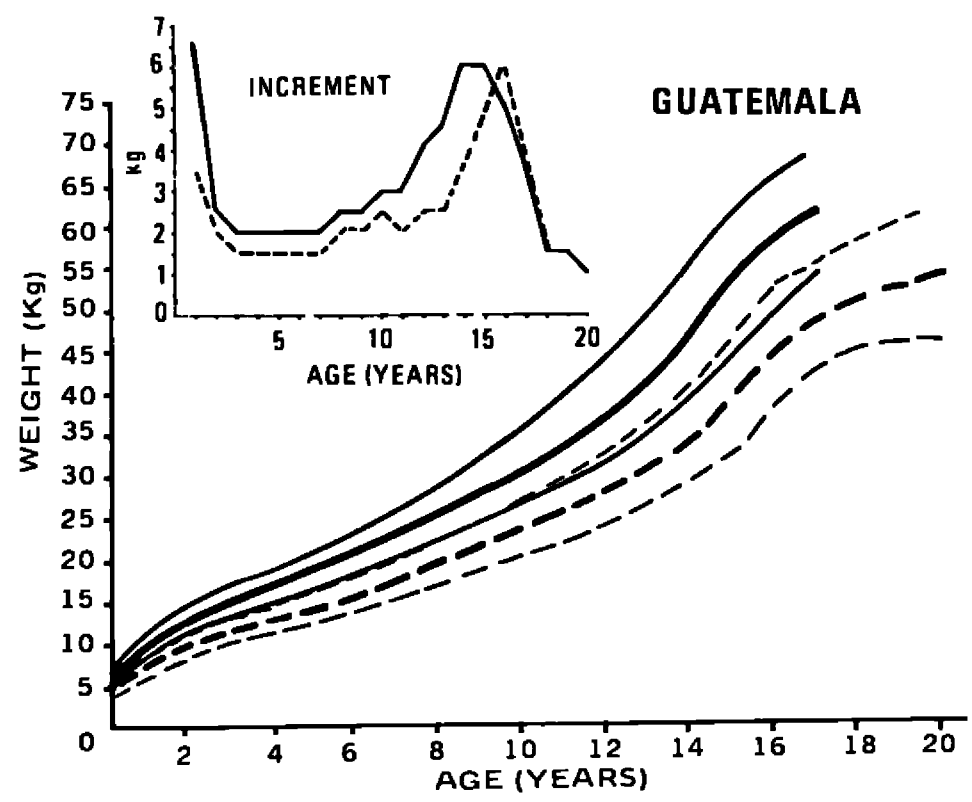
RURAL AVERAGE ± STANDARD DEVIATION (S.D.)

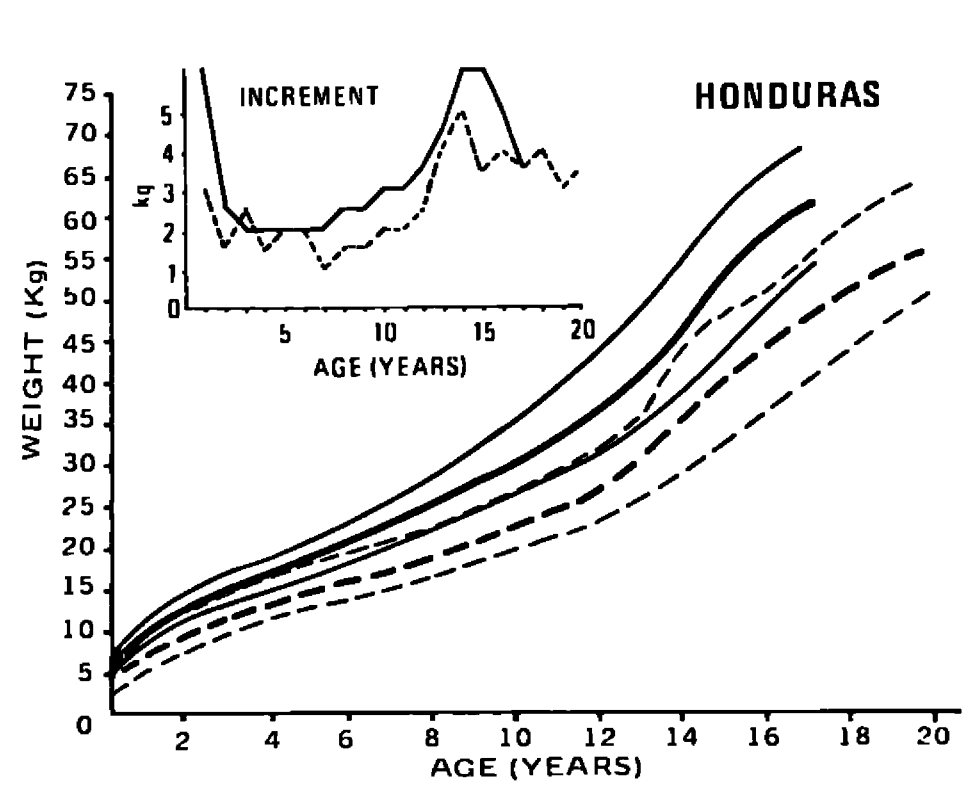
Figure 13

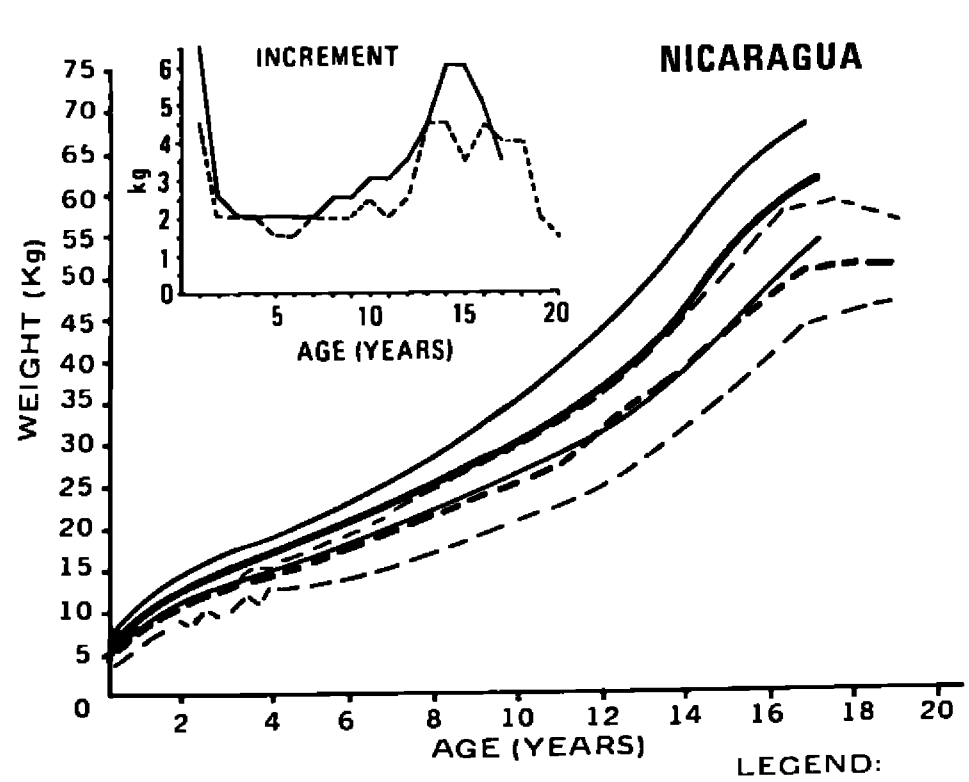
WEIGHT OF MALES 0–20 YEARS OF AGE IN RURAL AREAS

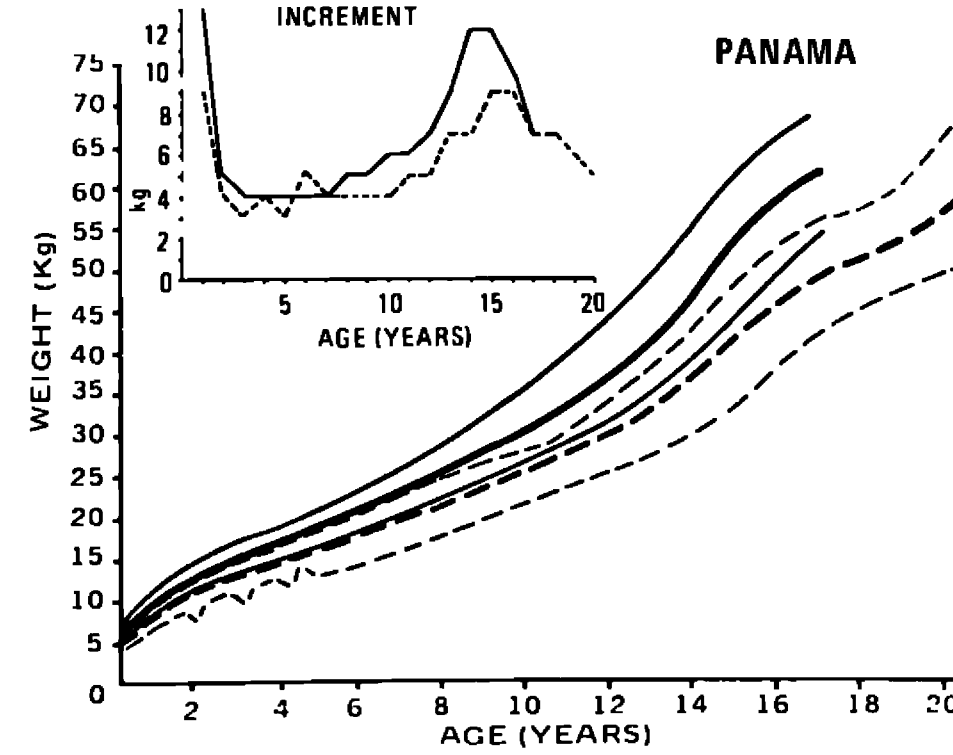












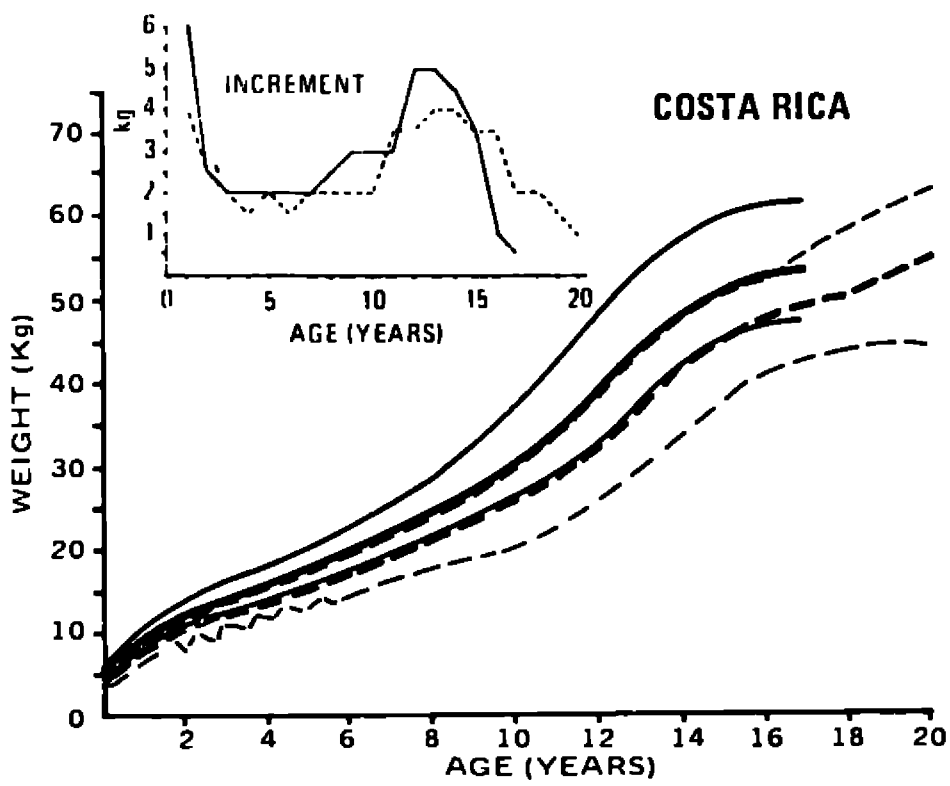
LEGEND:

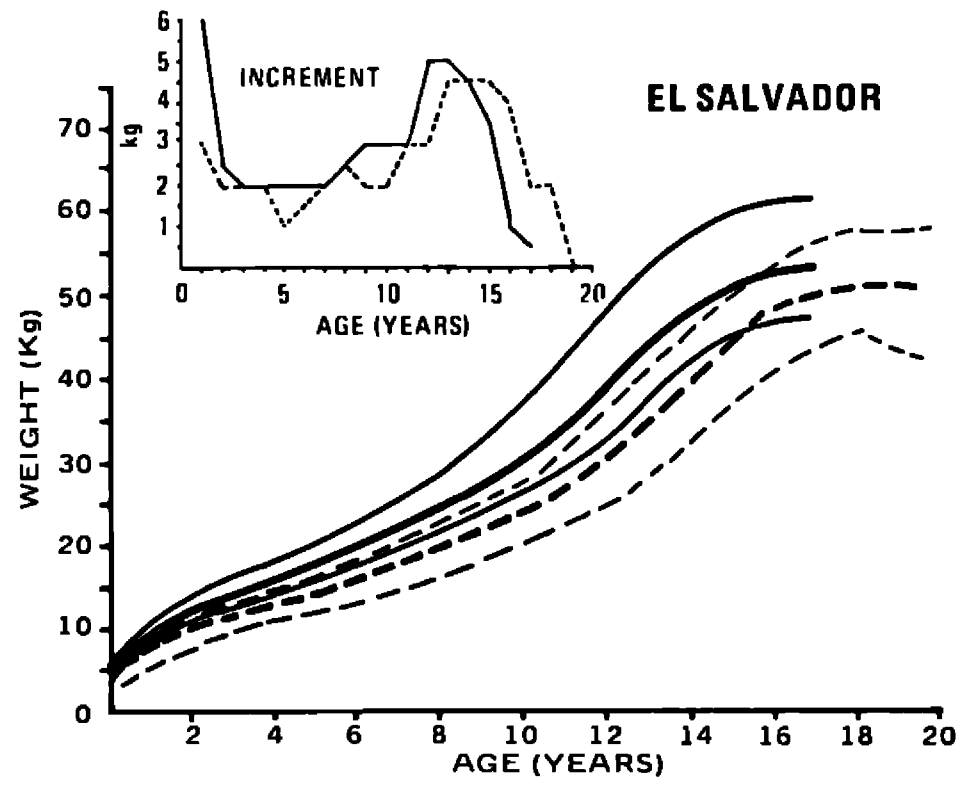
INCAP STANDARD (16th AND 18th PERCENTILES)

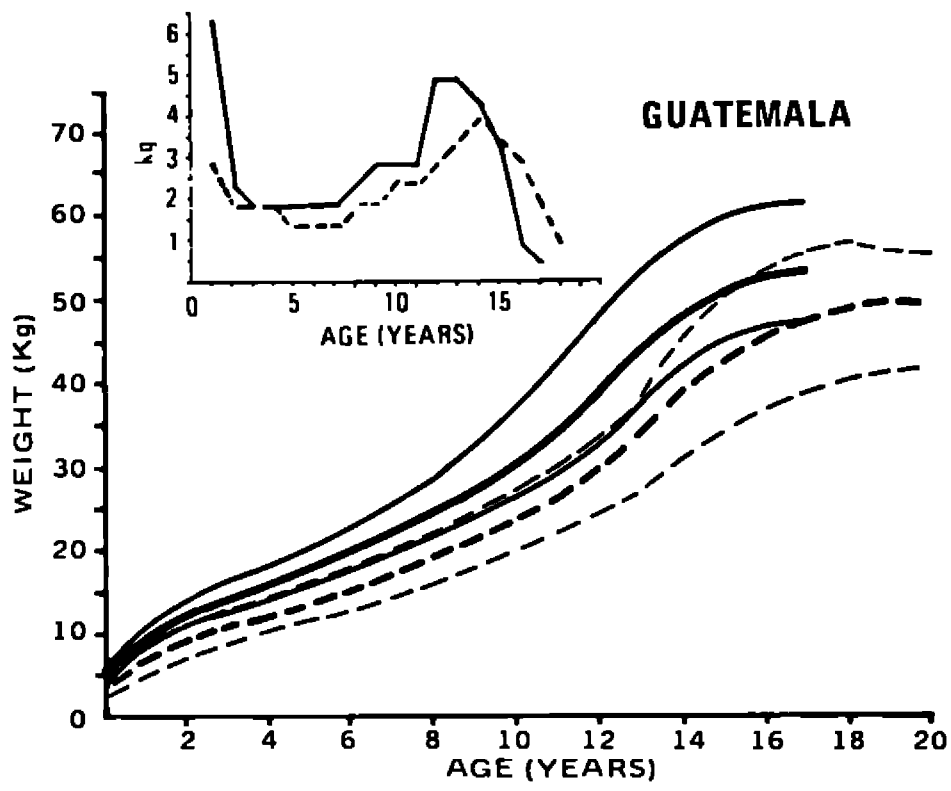
RURAL MEDIAN ±S.D.

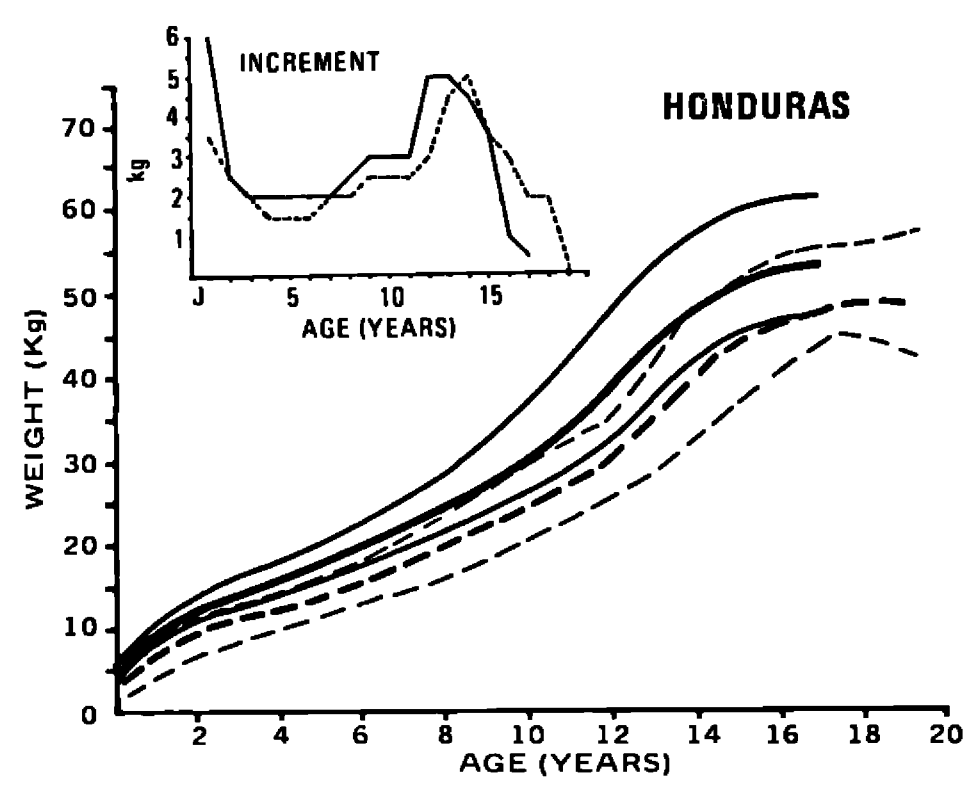
Figure 14

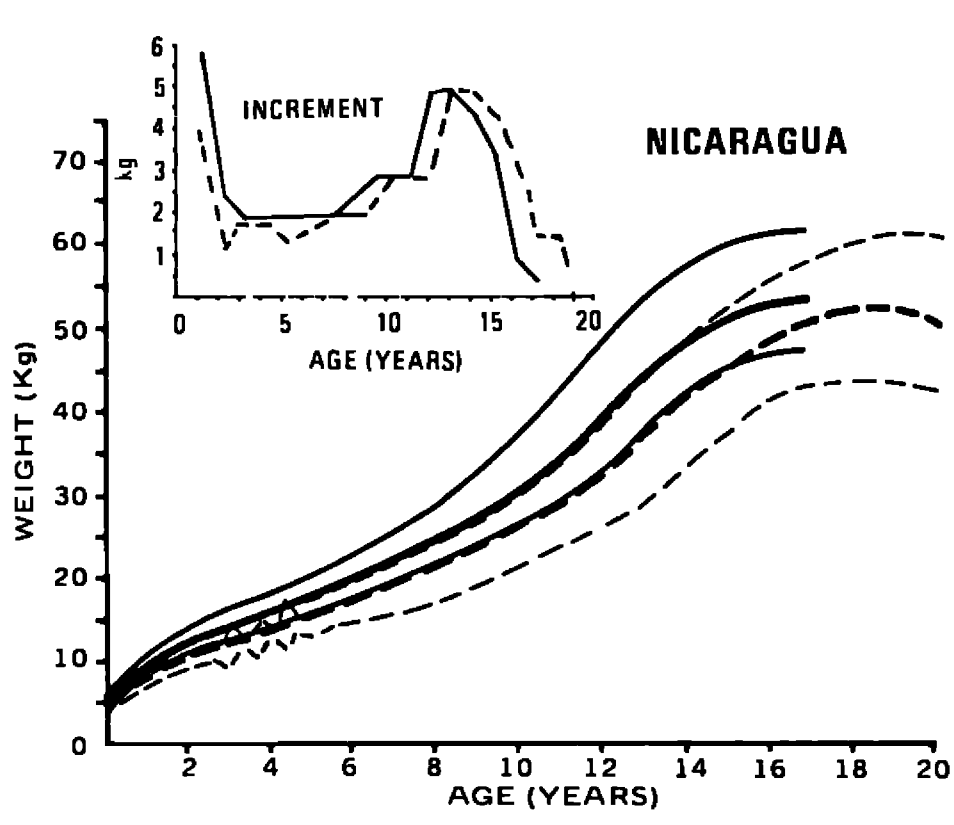
WEIGHT OF FEMALES 0-20 YEARS OF AGE IN RURAL AREAS

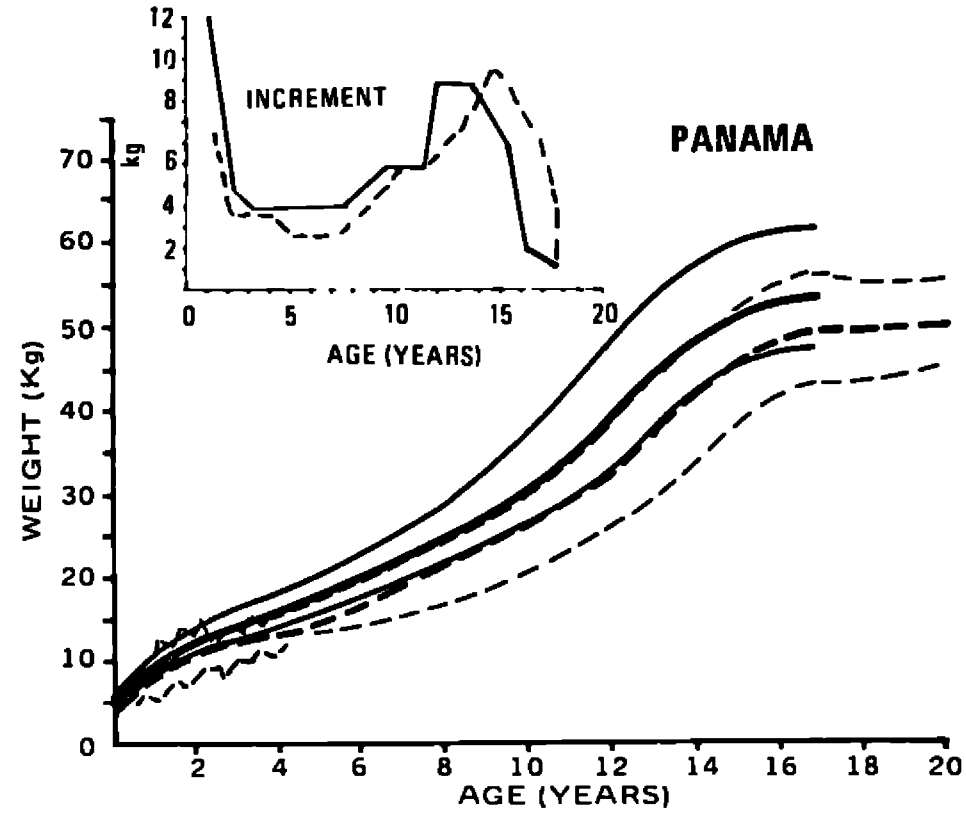










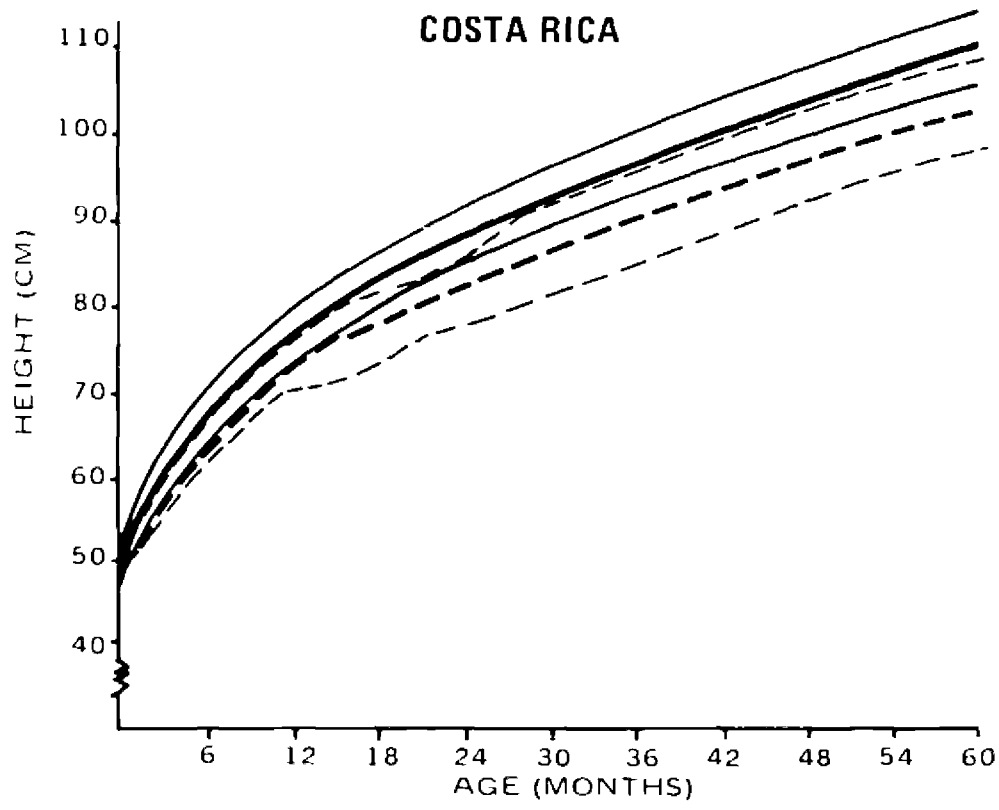


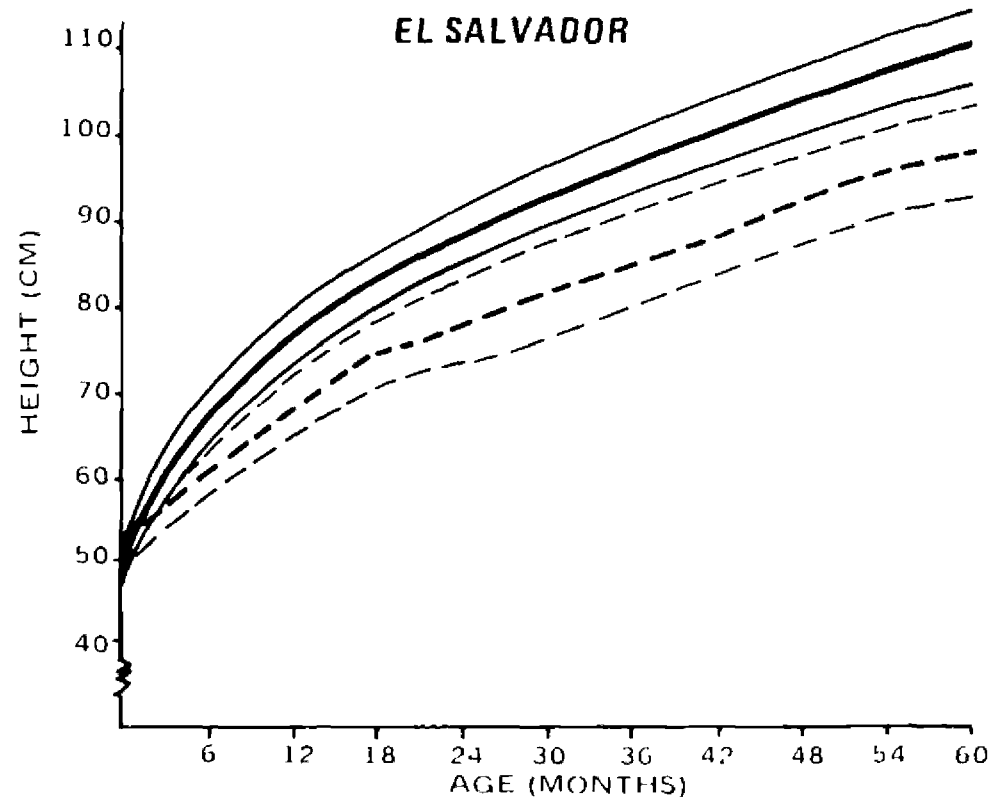
LEGEND:

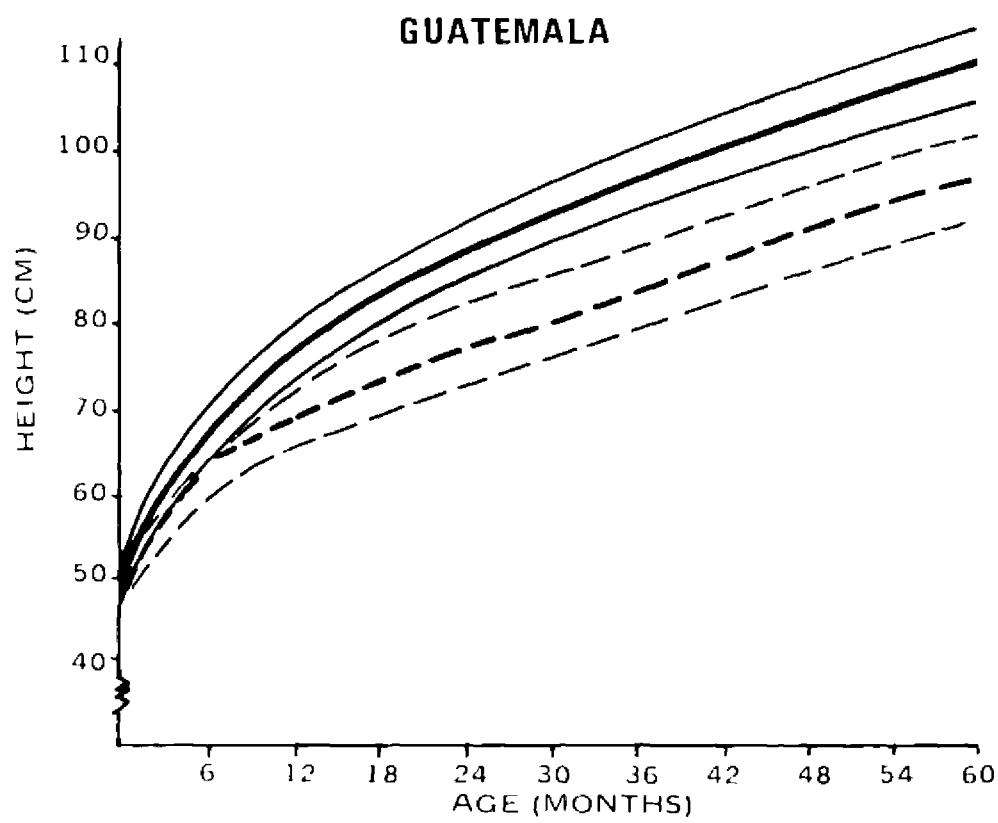
INCAP STANDARD (PERCENTILES 16 AND 84)

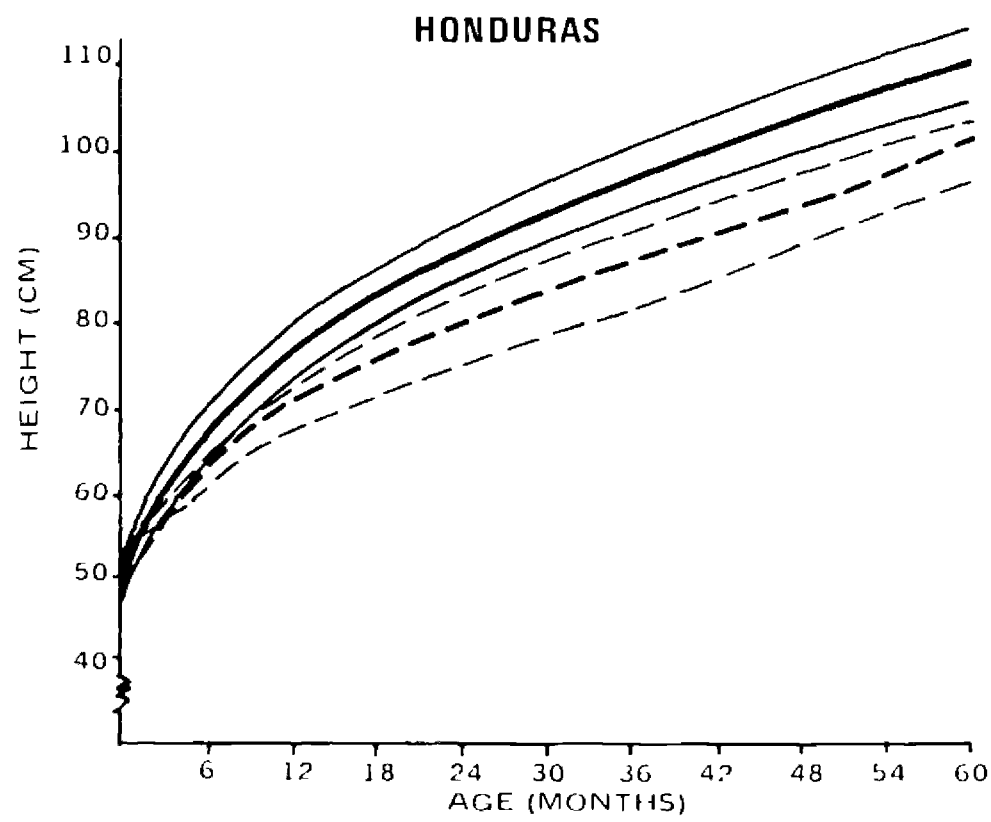
RURAL AVERAGE ± STANDARD DEVIATION (S.D.)

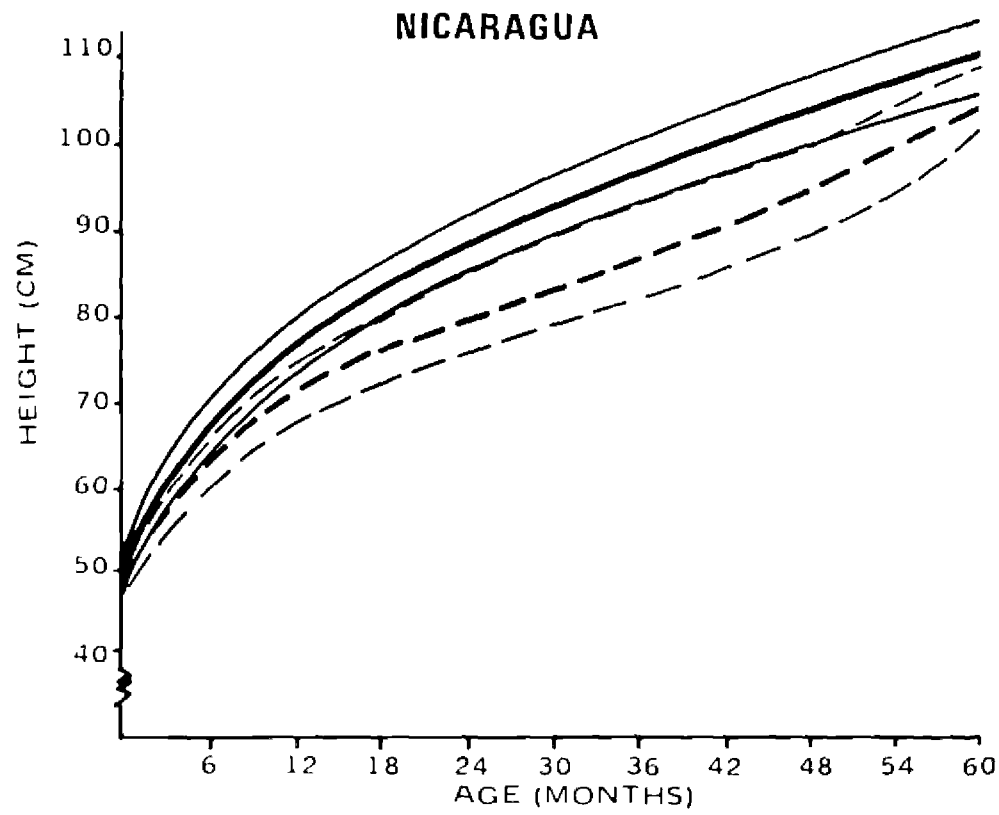
Figure 15
HEIGHT OF MALES 0-5 YEARS OF AGE IN RURAL AREAS

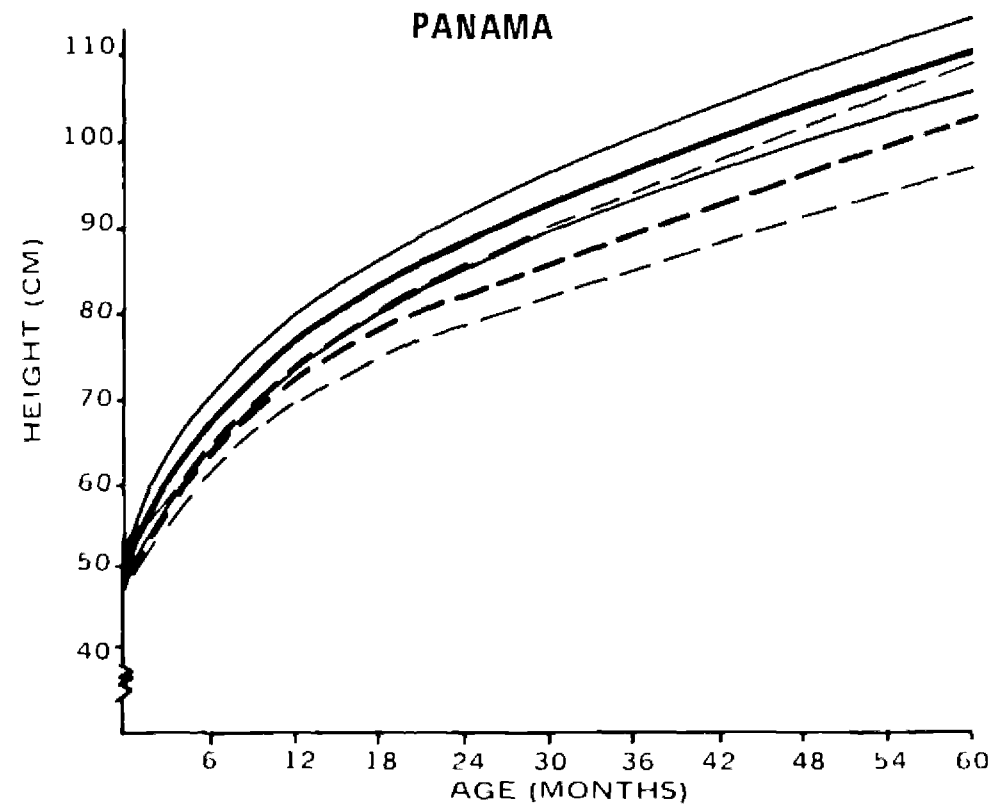












LEGEND:

INCAP STANDARD ± S.D.

RURAL MEDIAN ± S.D.

Figure 16
HEIGHT OF FEMALES 0-5 YEARS OF AGE IN RURAL AREAS

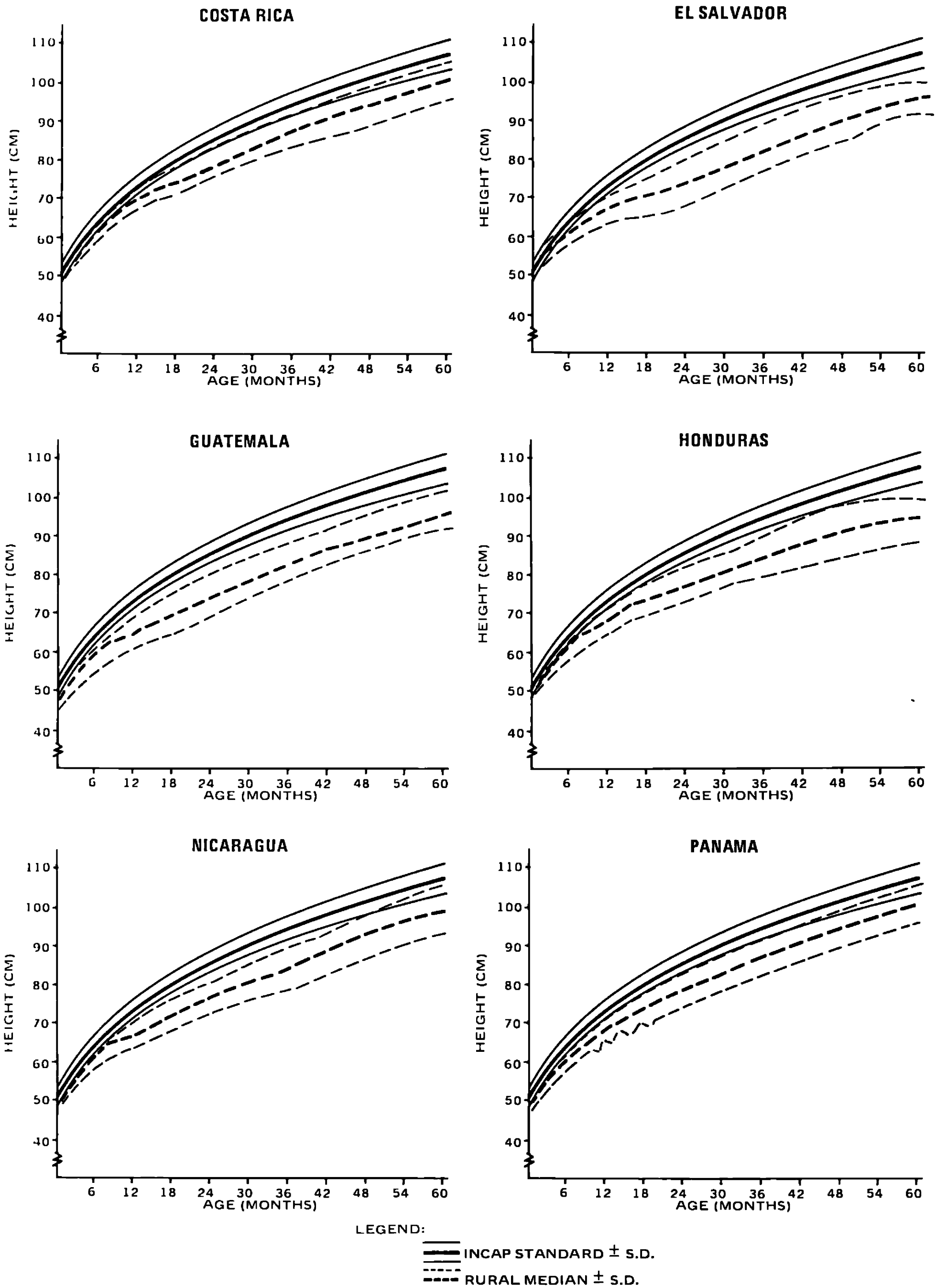
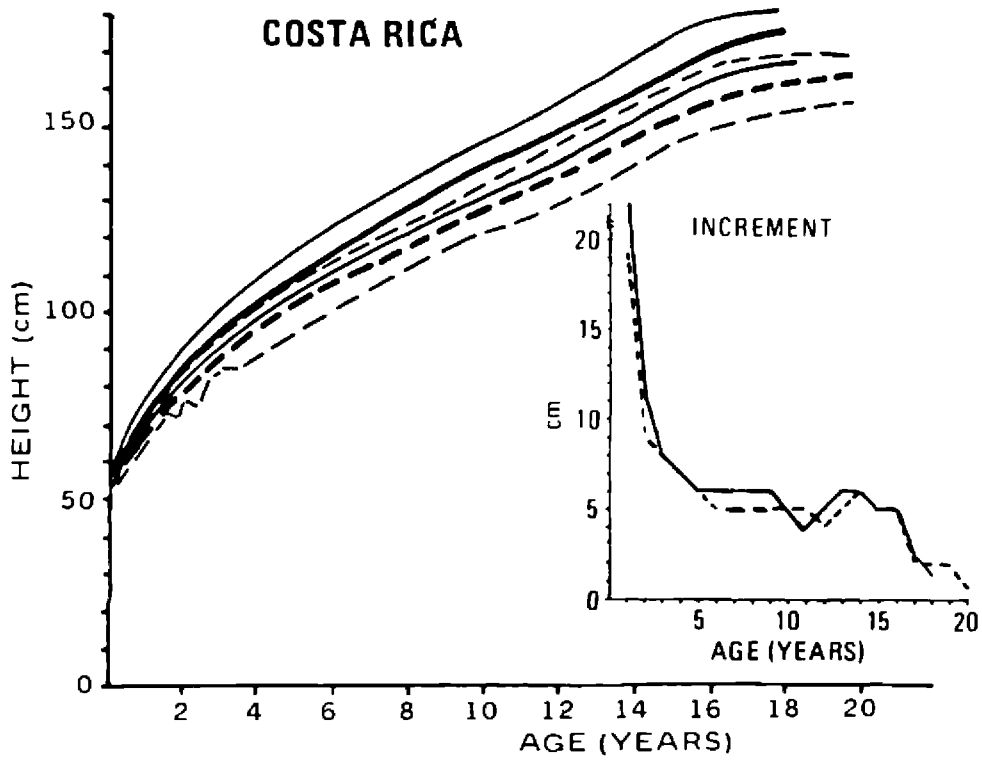
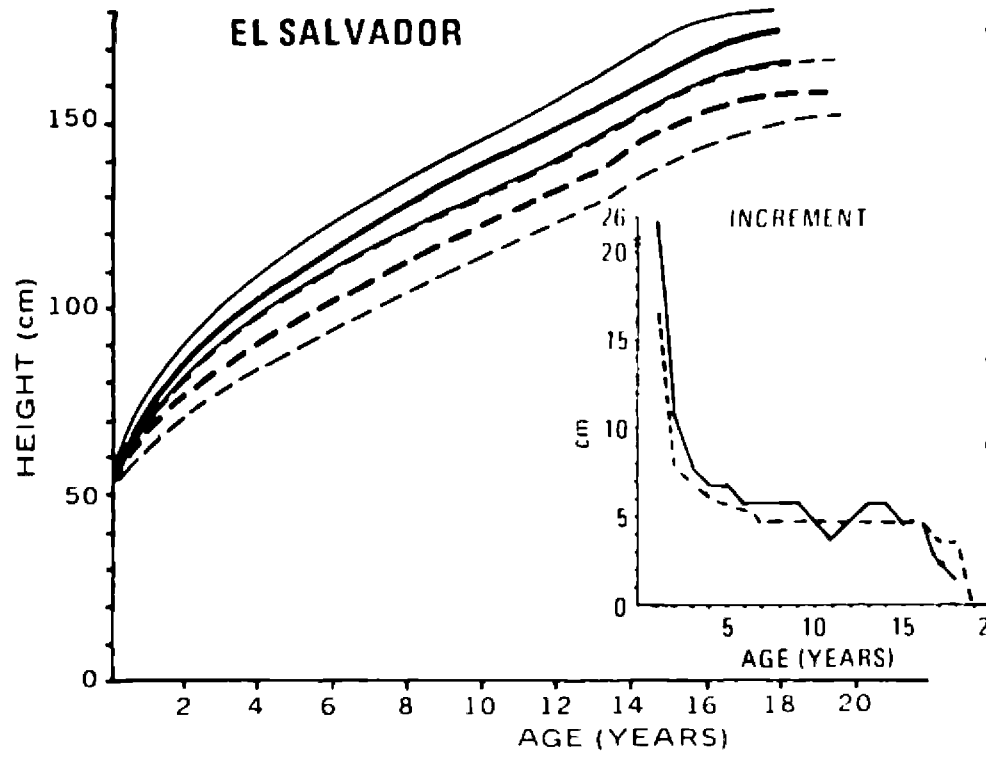
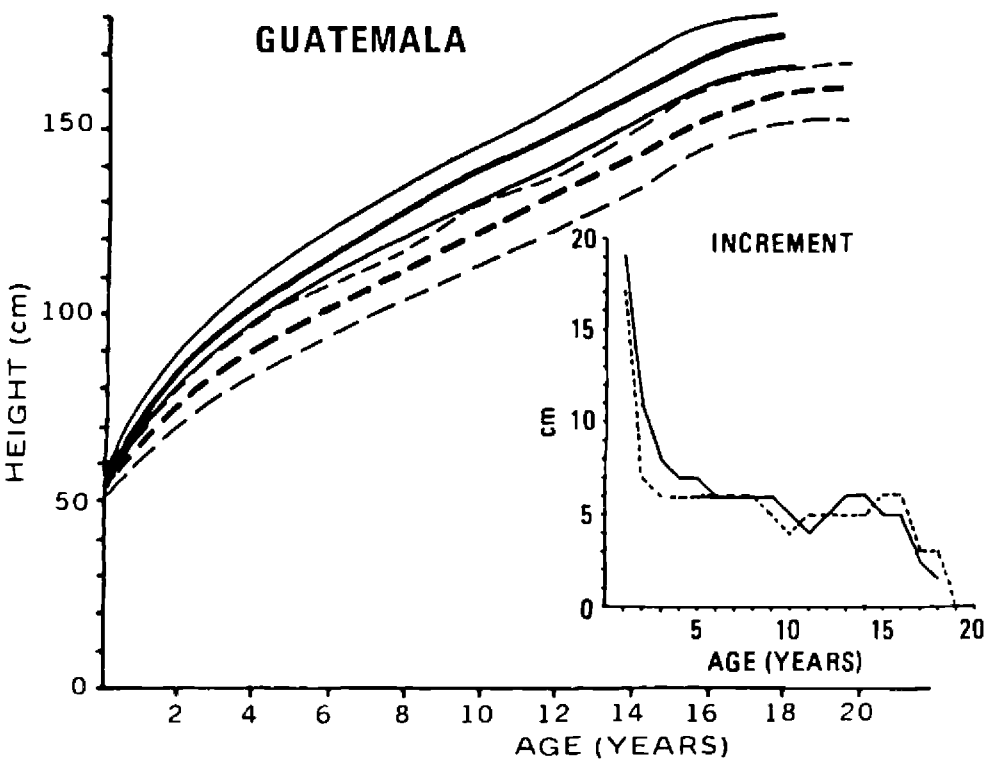
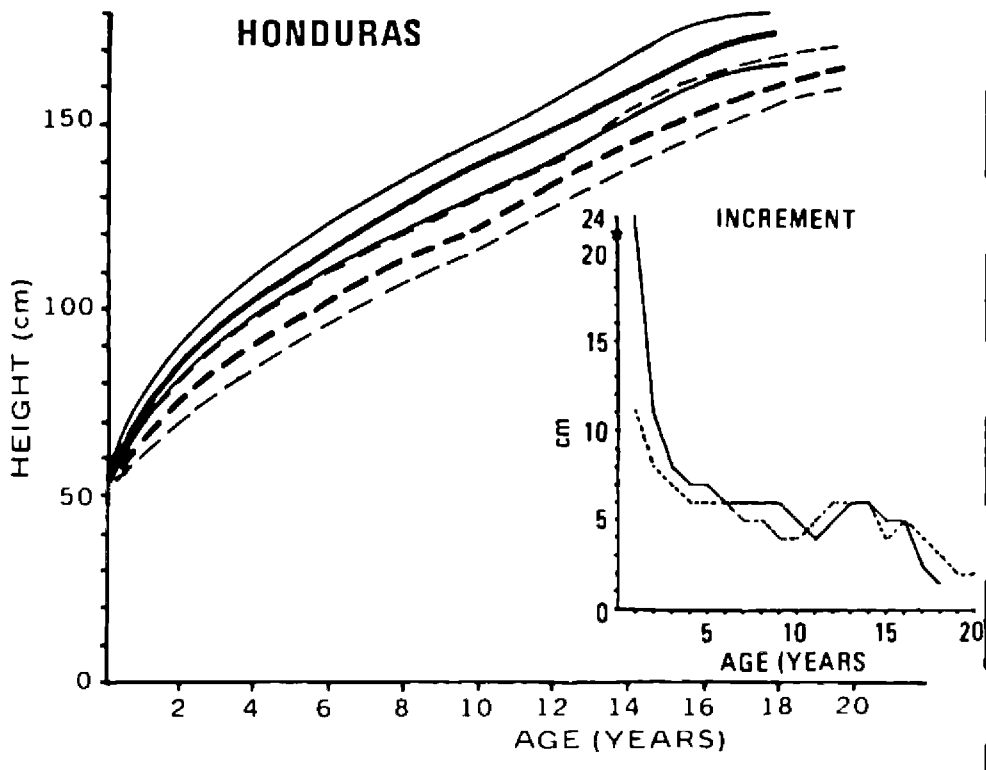


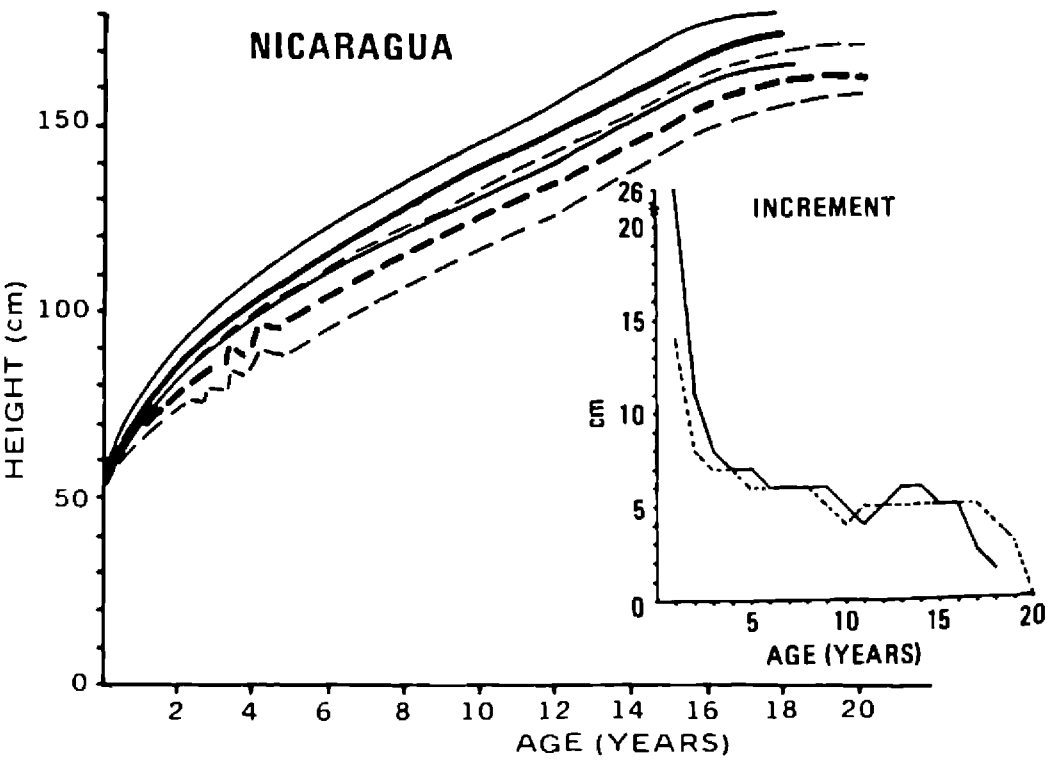
Figure 17
HEIGHT OF MALES 0-20 YEARS OF AGE IN RURAL AREAS

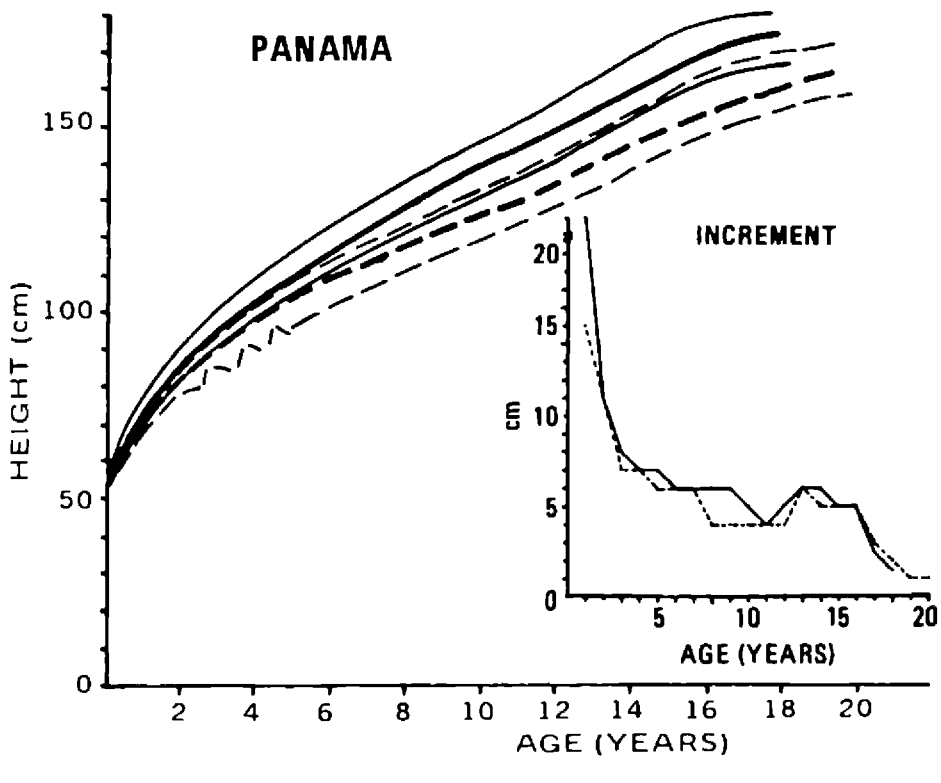












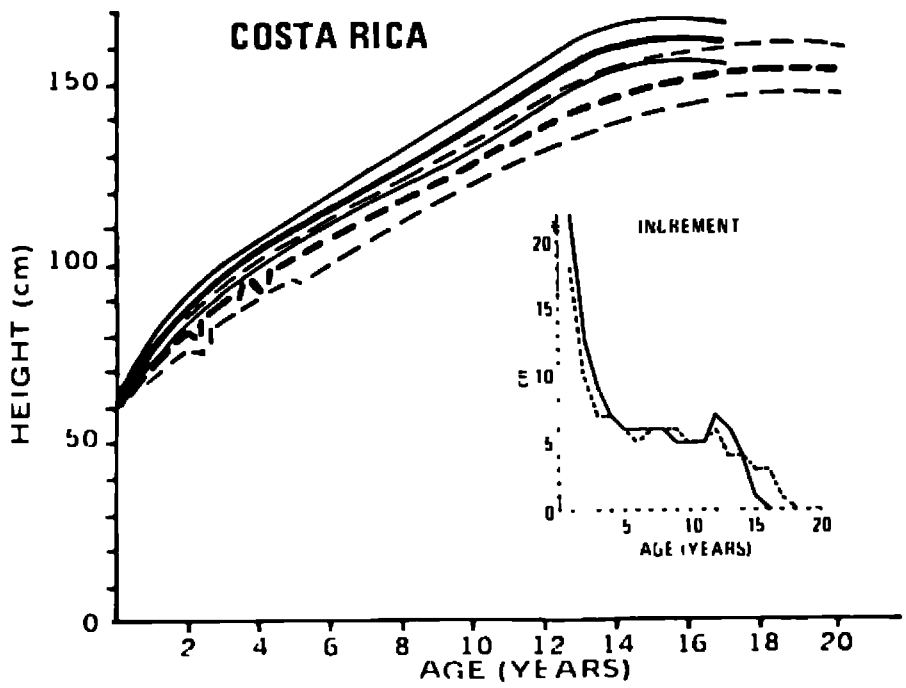
LEGEND:

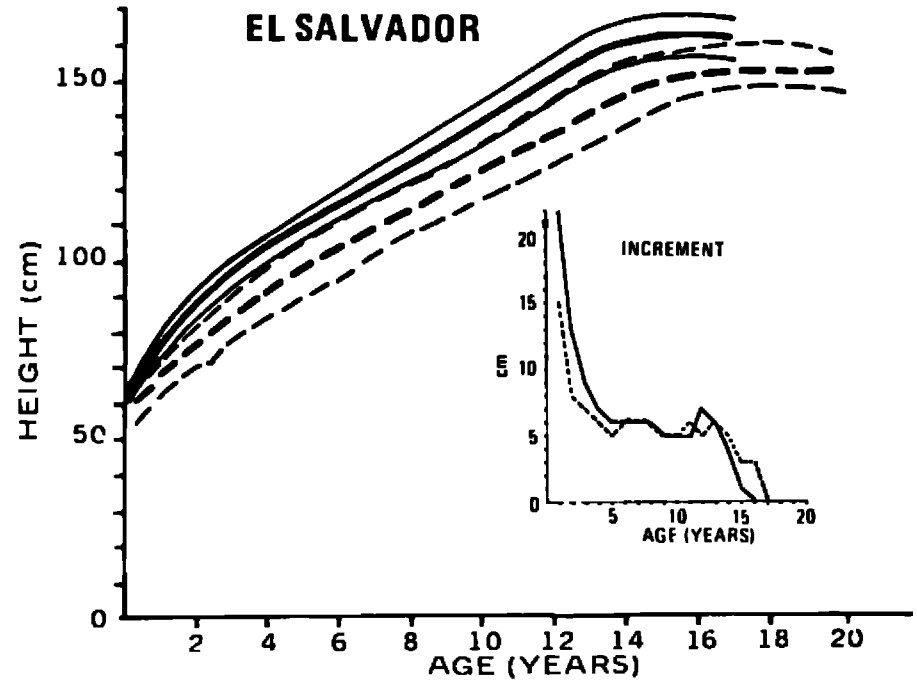
INCAP STANDARD ±S.D.

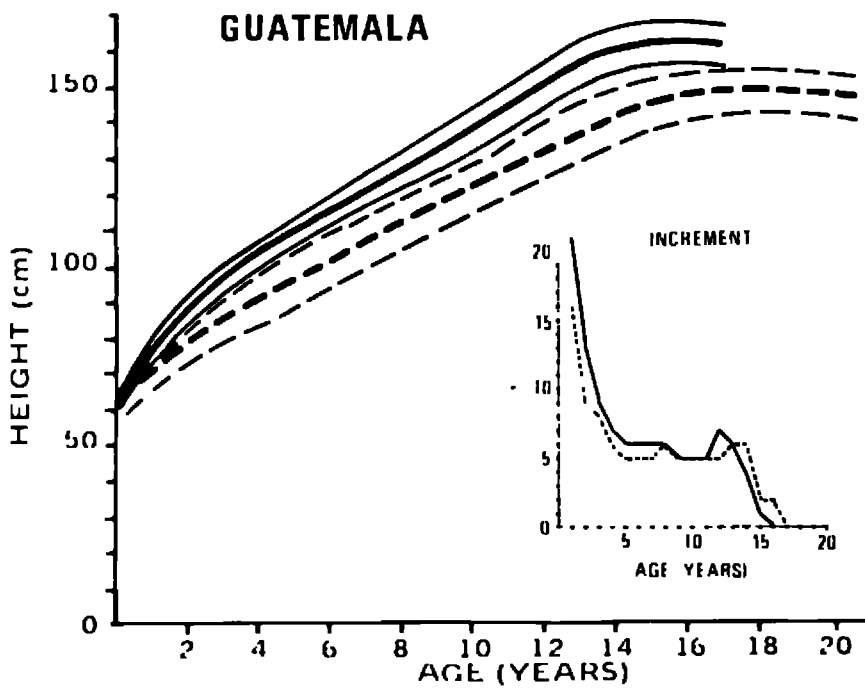
RURAL MEDIAN ±S.D.

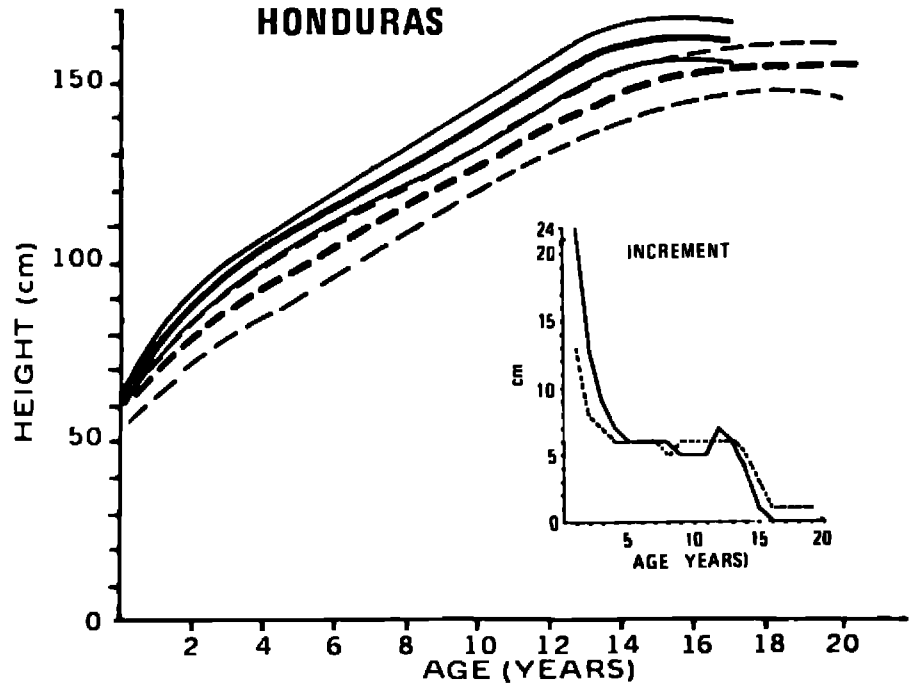
Figure 18

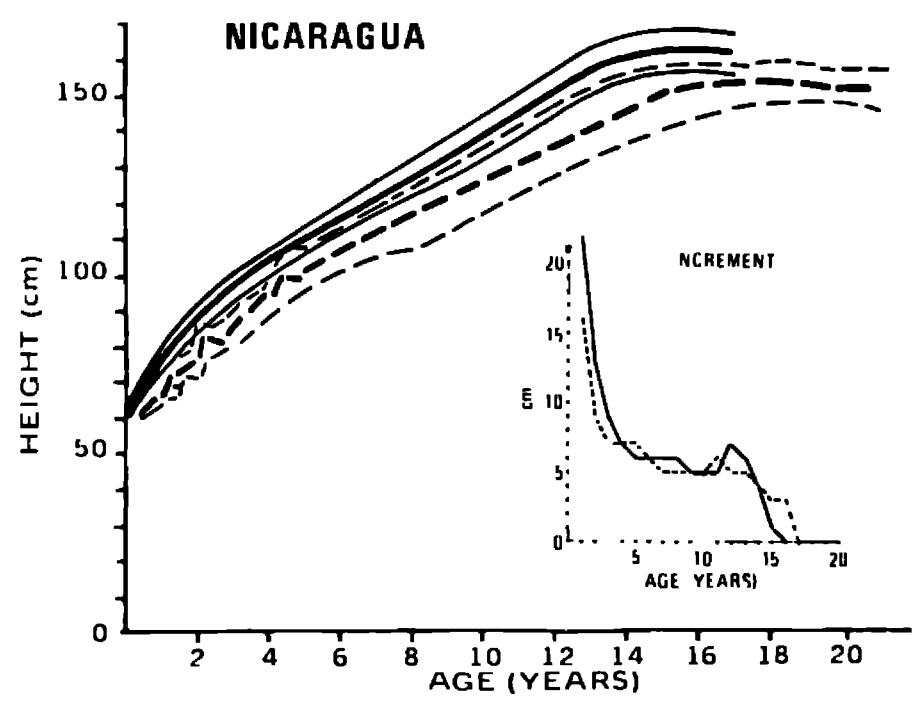
HEIGHT OF FEMALES 0-20 YEARS OF AGE IN RURAL AREAS

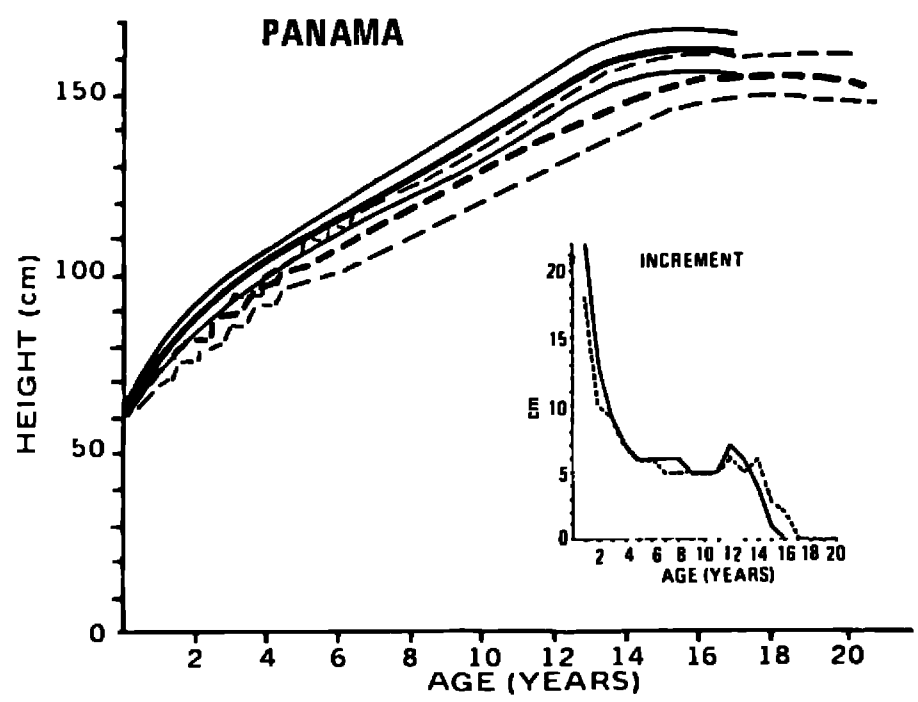












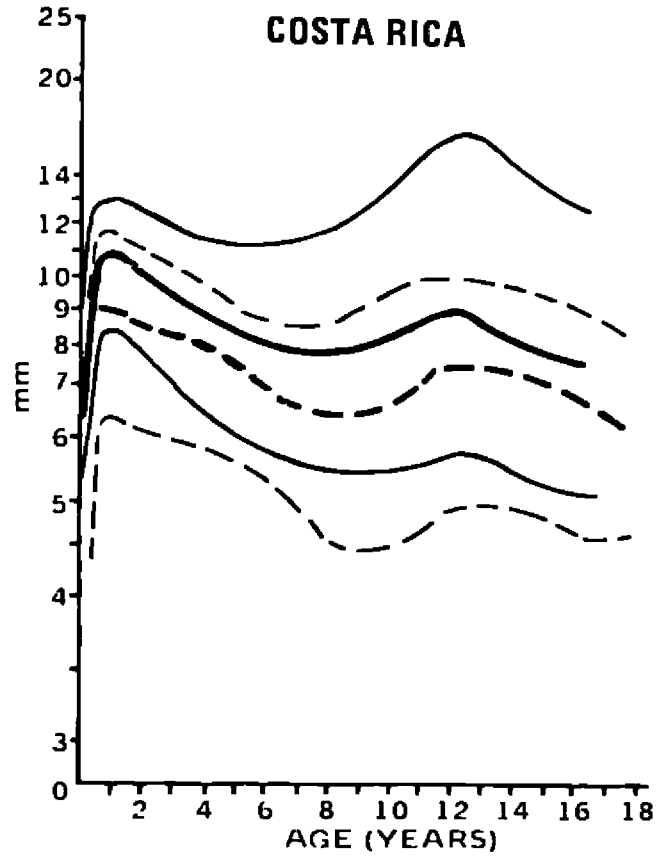
LEGEND:

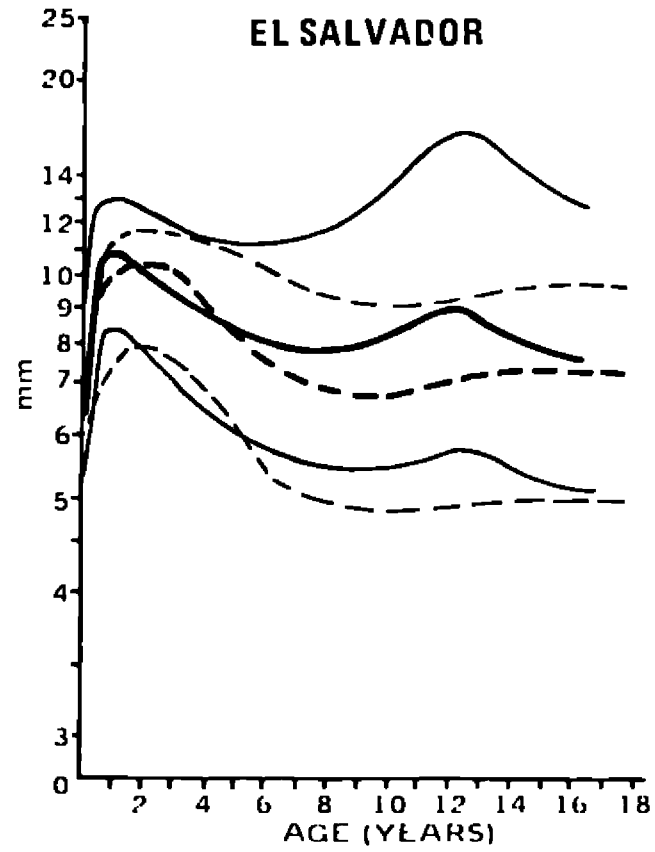
INCAP STANDARD ±S.D.

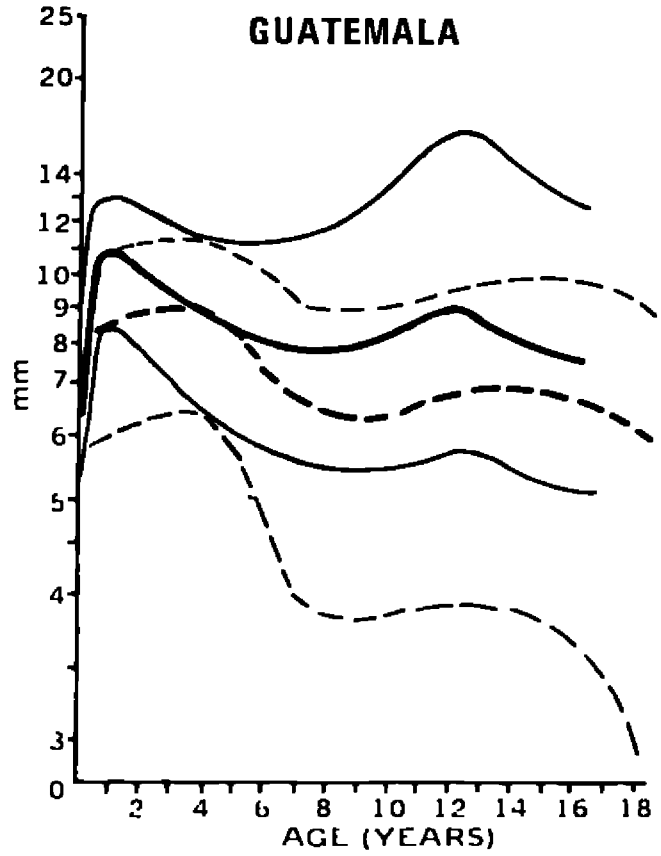
RURAL MEDIAN ±S.D.

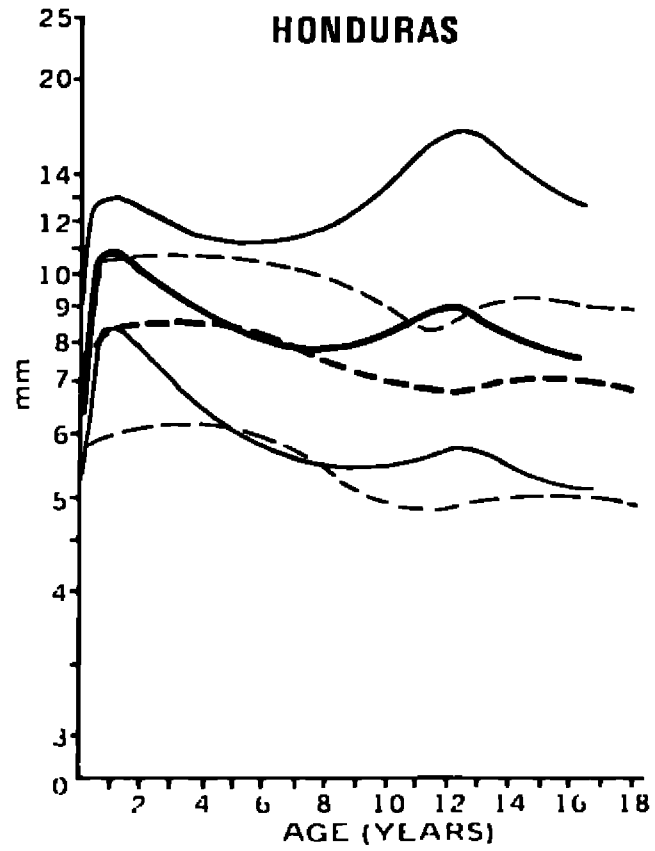
Figure 19

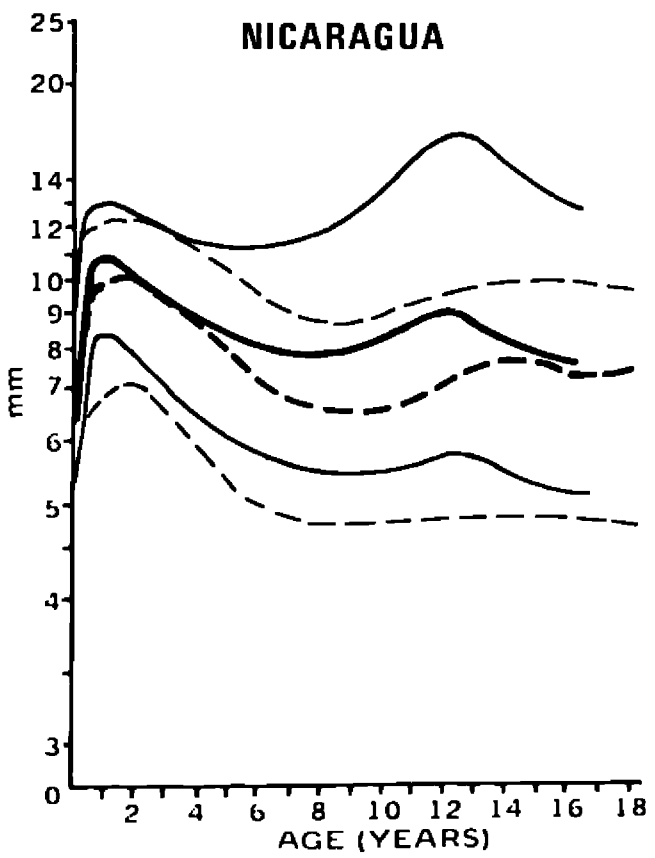
SKINFOLD THICKNESS IN MALES 0-18 YEARS OF AGE IN RURAL AREAS

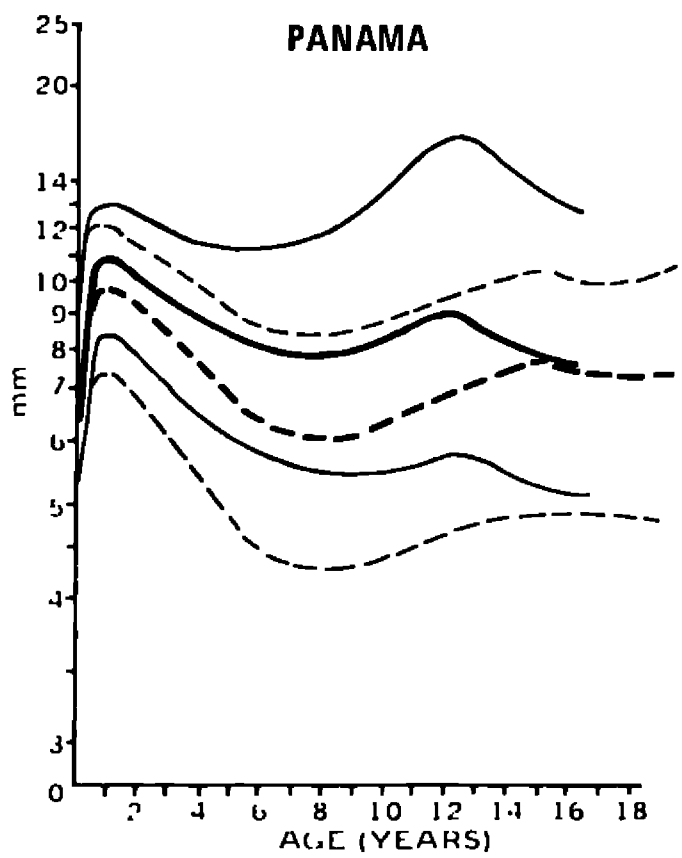












LEGEND:

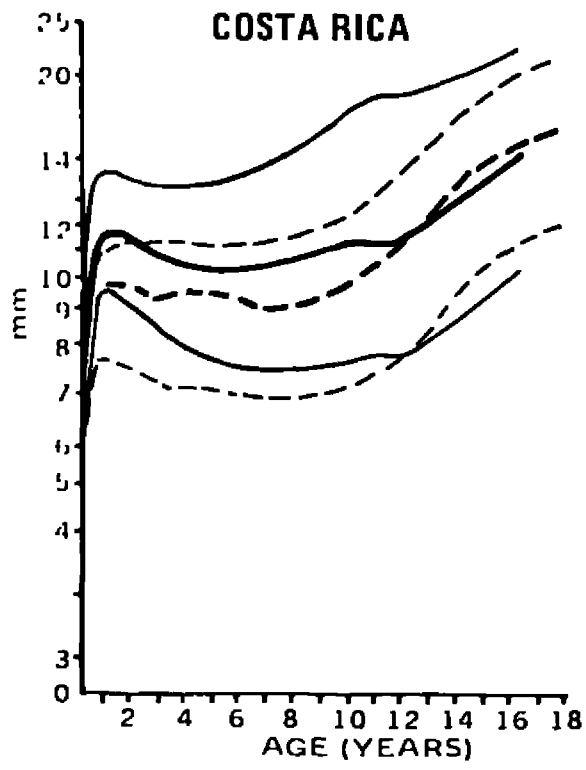
STANDARD [1]PERCENTILES 10, 15, + 90

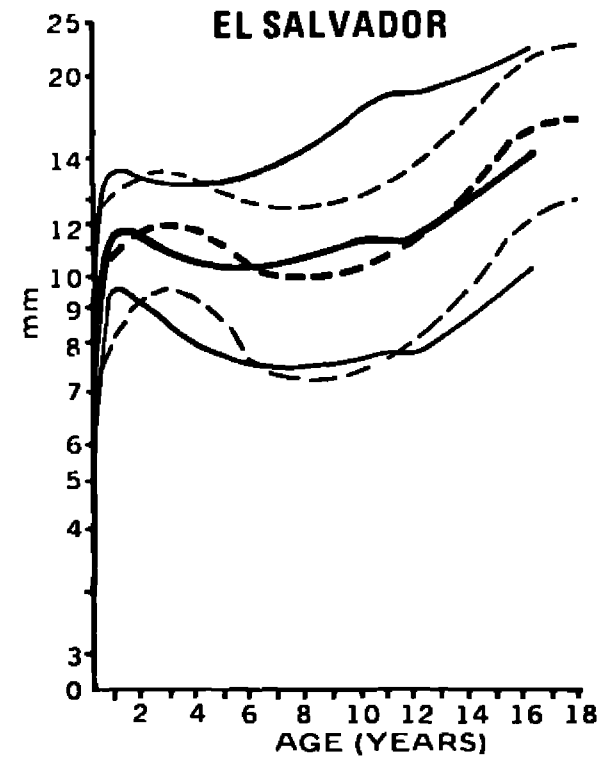
RURAL MEDIAN ± S.D.

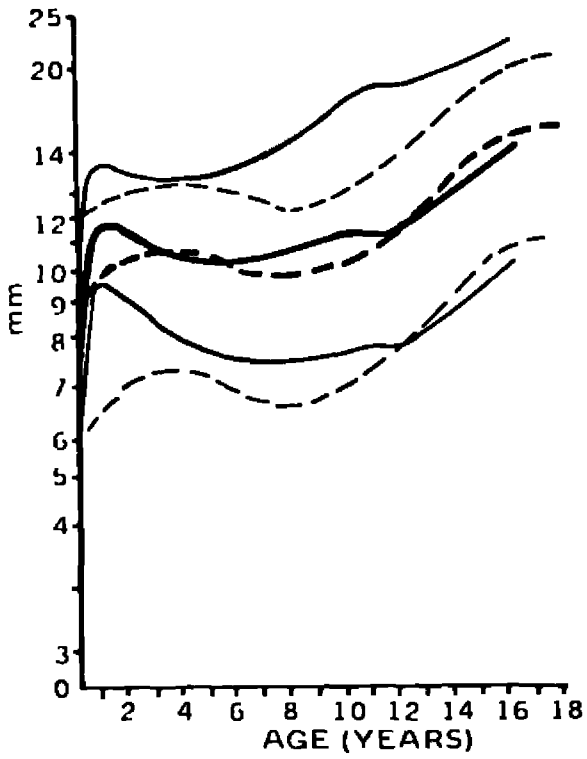
[1]TANNER, J. M., WHITEHOUSE, R. H., BRIT. MED. J., 1:446, 1962

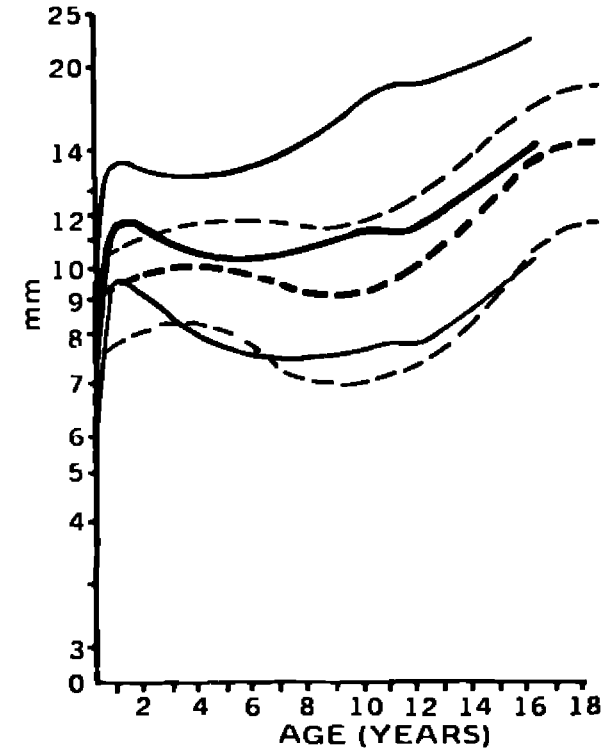
Figure 20

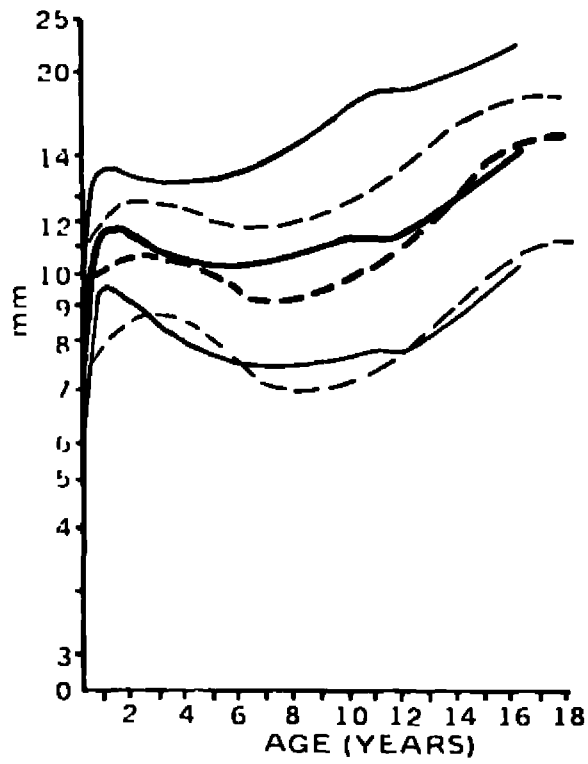
SKINFOLD THICKNESS IN FEMALES 0-18 YEARS OF AGE IN RURAL AREAS

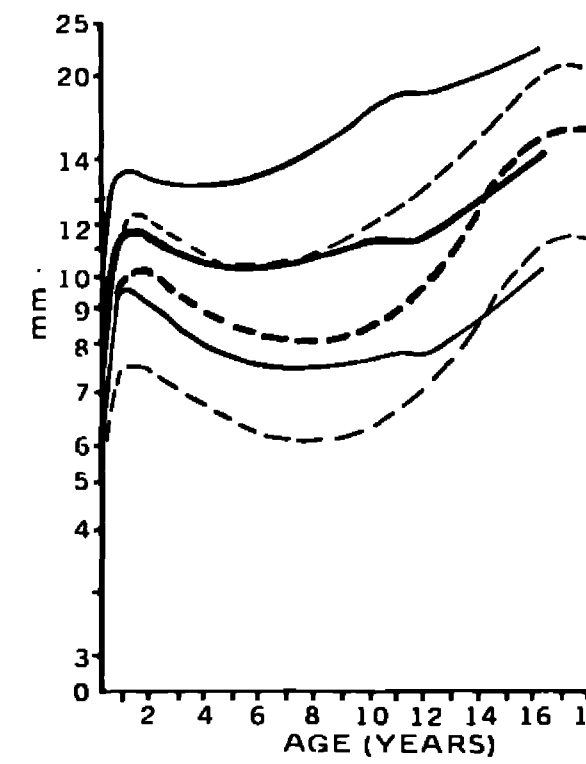












LEGEND:

STANDARD [1]PERCENTILES 10, 50, + 90

RURAL MEDIAN ± S.D.

[1]TANNER, J. M., WHITEHOUSE, R. H., BRIT. MED. J., 1:446, 1962.

American average is already below the standard average, more so in girls than in boys. At 12 months of age the average Central American child weighs the equivalent of a standard 6-month-old. By the age of 2 years, the retardation has reached approximately 1 year and by the age of 5 years, 2 years in females and almost 2 years in males.

Figures 13 and 14 show the weight curves up to the age of 20 years for both sexes, and also the weight increment per year and by age. The retardation in weight already described up to the age of 5 years persists for both sexes. The curve of yearly weight increment shows that at 1 year of age it is about one half that of the standard. It then continues below but parallel to the standard. The pubertal growth spurt begins and peaks 2 years behind the standard. In the males it reaches the same rate of increment while in the females its peak remains 1 kg below the standard.

Height. The picture of height is very similar to that of weight, as shown in Figures 15 and 16. At 3 months of age the average for both sexes in Central America is already below the average of the standard. At the age of 2 years both sexes show a retardation of almost 1 year, and at the age of 5 years the Central American children are almost 2 years behind the standard.

The height curves up to 20 years of age and the height increments per year are shown in Figures 17 and 18. At the age of 17 years the males show a retardation of approximately 15 cm and the females of 13 cm in relation to the standard. The yearly height increment in both sexes falls below the standard during the preschool period and then continues more or less along the level of the standard, and again shows a retardation of 2 years for the pubertal growth spurt. This spurt equals the standard in males and is slightly lower in females.

Leg length. The data on leg length are consistent with the height measurements and are not republished in this report. For these data the reader is referred to the separate country reports of the surveys.[1/]

Head circumference. The percent of retardation in head circumference is even greater than that observed in weight and height. This could be explained by the proportionally more rapid growth of the head than that of the other body segments during infancy and early childhood. Normally 90 percent of adult head size is attained by the age of 4 years.

Tricipital skinfold thickness. As shown on Figures 19 and 20, the females have a thicker skinfold at all ages. This becomes much more accentuated after the age of 8 years and steadily increases. After 14 years the females have a skinfold about twice as thick as

---

[1/] INCAP V-25, V-26, V-27, V-28, V-29, V-30

that of the males. These data indicate that at all ages the females accumulate more subcutaneous fat than the males, which is a known physiological difference between the sexes. This fact offers some evidence that the average caloric intake of the females was reasonably adequate.

V

BONE STUDIES

It has been well documented that severe protein-calorie malnutrition results in marked retardation in the appearance of ossification centers. The age of appearance of the 28 postnatal centers of ossification of the right wrist and hand was determined on children from birth to 8 years in all six countries. These results were compared with the standard of the Fels Research Institute of Yellow Springs, Ohio. The results, shown graphically in Figure 21, were as follows:

Guatemala

In both sexes all 28 centers were uniformly and systematically delayed. The average delay in appearance was 26 percent, although the delay increased with age. The first two centers, which appeared well before weaning, were already delayed but the delay of the next nine centers between 18 and 24 months of age was much more pronounced. Between 2 and 4 years of age, there was a reduction in the delay which again increased after that age.

Developmental abnormalities were studied in 2,700 Guatemalan individuals and were found to occur in approximately 5 percent of those studied. This is fifty times greater than in the United States. The most common abnormalities are reduction of the middle segment of the fifth digit, reduction of the middle segment of other digits, loss of the middle segment of one or more digits, several kinds of reduction of the distal segment of one or more digits, fused digital segments, and reduced and stunted fourth and fifth metacarpals.

El Salvador

Ossification delay in children was 27%, very similar to the delay in Guatemalan children. As illustrated in Figure 21, there were more children in the 0-3 year age group above the standard bone age (earlier maturation) than in the other countries with the exception of Panama.

The related skeletal delay was similar in boys and girls.

Honduras

Of the 56 postnatal ossification centers in the two sexes, only 7 appeared on time or slightly earlier. Until the age of one year and 3 months up to 18 months, the centers appeared in a normal manner, even among females. After 2 years of age, a delay was noted which increased with age up to 8 years. In view of the fact that the insults of malnutrition and infections were already beginning in the second year of life, it would seem that the effect on the appearance of the ossification centers occurs one year later.

A study was also made of the decalcification process which takes place as age increases. The bone loss by osteoporosis begins at the same time and at the same rate as in the United States. This finding contradicts the established belief that osteoporosis is less frequent in Honduras because of the relatively high calcium intake. A difference between the two populations is that in Honduras the endosteal bone loss is less while there is a greater increase in the cortical thickness.

Nicaragua

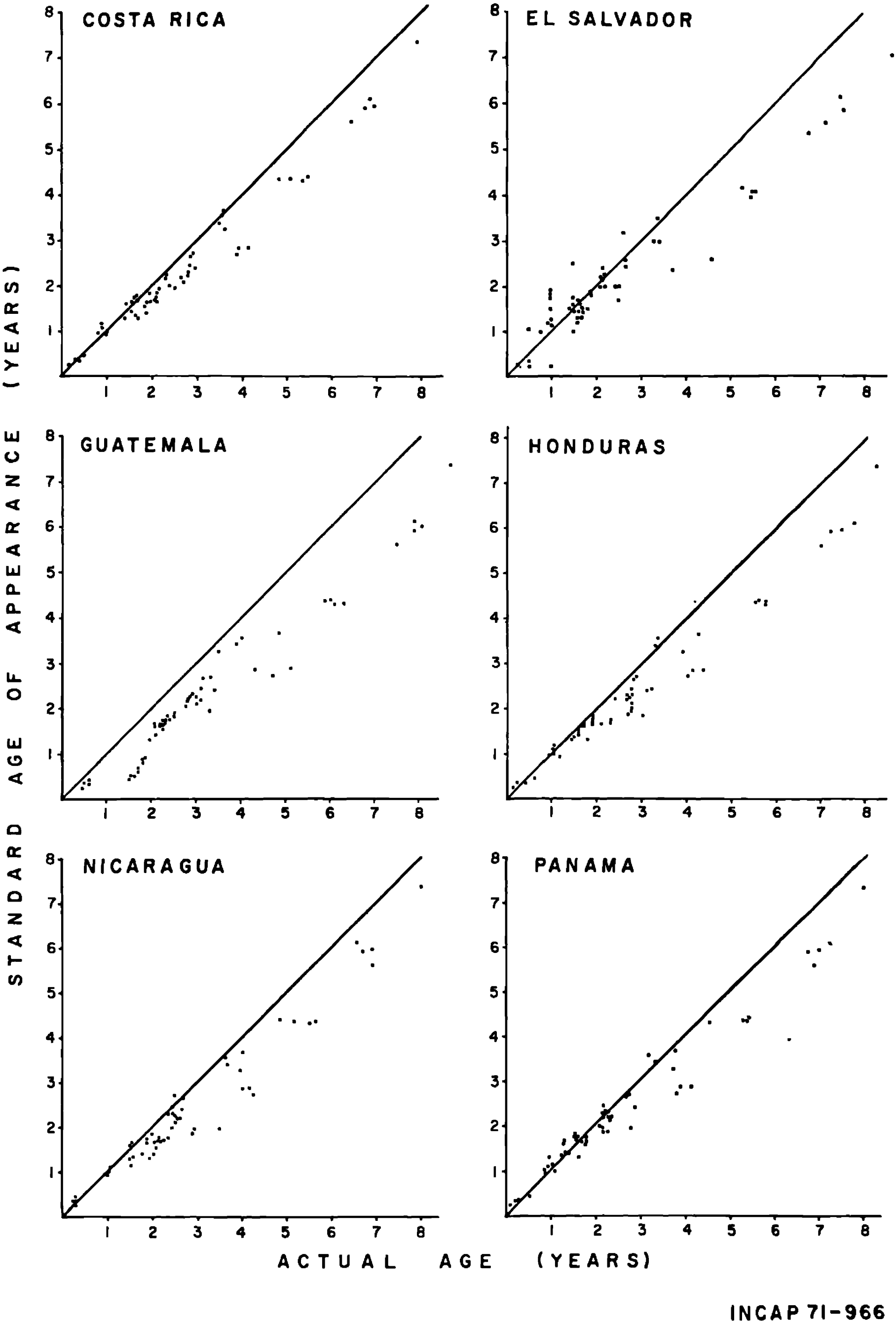
In the females all centers were delayed in their appearance, while in the males ten centers appeared before those for the standard. All the advanced centers appeared between 21 months and 3 years 9 months of age. The first 23 centers for both sexes, however, were delayed between 0.3 and 0.45 years. After the age of 4 years, the delay increased again with age. Since the greatest nutritional and infectious insults occur between 1-4 years of age, when the delay in the appearance of the centers is the least, it seems that the effect of these factors is delayed and becomes apparent after the age of 5 years. The first four centers for both sexes that should appear before the age of 6 months were already delayed about 3 months, even though the children at this time were still being breast fed.

Costa Rica

In the females, all but two centers were delayed in their appearance, while in the males, seven centers were either on time or earlier in their appearance. The first four centers for both sexes that should appear before the age of 6 months were already delayed at approximately

FIGURE 21

AGE AT APPEARANCE OF OSSIFICATION CENTERS OF HAND AND WRIST
(Rural and Urban)



INCAP 71-966

4 months, although the children were still apparently adequately nourished through their mothers' milk. From the ages of 15 months to 33 months, the centers were least delayed or appeared ahead of time. After that age, the delay continuously increased with age. The period of least delay in the appearance of the ossification centers coincided with the period in which children were exposed to the greatest nutritional and infectious insults. This seems to indicate that the effect of these factors on the appearance of the centers is retarded and becomes effective after the age of 3½ years.

In addition, the onset of decalcification with advancing age was studied. Osteoporotic bone loss begins at the same time and at the same rate as in the United States. This finding is contrary to previous beliefs that osteoporosis was less frequent in the Central American countries because of a high calcium intake. One difference from the United States populations is the fact that in the surveyed countries there is less endosteal bone loss while there is a greater gain in cortical thickness.

An interesting additional finding in Costa Rica was a high prevalence of medullary stenosis, defined as medullary cavity width below 0.99 mm in the second metacarpal at midshaft. This medullary stenosis is from five to ten times more frequent than in the other Central American countries and occurs with greater frequency in women than in men. This condition occurred in 14 of the 30 locations investigated and affected only a small number of families, thus appearing to be inherited. The significance of this condition is unknown.

Panama

During the first 2 years of life, the ossification centers made their appearance normally, most of them slightly early. In the fourth and fifth year of life, a retardation increased with age. Although the major insults of malnutrition and infections occur during the first 3 years of life, the greatest retardation in the appearance of the ossification centers occurs in the fourth year or later, which would indicate that the effect of these insults is delayed.

A study was also made of the onset and intensity of the decalcification which occurs with advancing age, but no difference was found in comparison with United States standards. Although the dietary survey in Panama showed a low intake of calcium, 1/3 to 1/4 that of other Central American countries, this had no effect on the onset or intensity of the osteoporosis.

Summary

These studies reveal two important facts. First, that the slow rate of physical growth (height and weight) discovered in the section on anthropometry is accompanied by a delayed maturation of the skeletal system, which begins as early as the first year of life. Second, that the intensity of decalcification which occurs with age was not more severe in Central America than in well developed countries. This included Panama where the dietary intake of calcium is considered low in relation to the recommended allowances.

VI

PHYSICAL FITNESS

To assess the physical fitness of young men between the ages of 15 and 40 years, 1,006 subjects in the six surveyed countries underwent the Harvard Step Test. This test measures the cardiovascular response of the subject to the heavy exercise of stepping up and down a 50 cm high bench at a rate of 30 times a minute for 5 minutes or until he is exhausted. The pulse is measured 1, 2 and 3 minutes after the exercise. An index is calculated using the following formula:

$$\text{Index} = \frac{\text{Time of exercise in seconds}}{\text{Sum of three pulses after exercise}} \times 100$$

Table 41 shows the results of the test by country. A number of factors which might influence the results of this test were investigated, and it was found that:

1. An inverse relationship exists between performance in the Harvard Step Test and age, basal pulse rate, blood pressure, weight, weight-height ratio, and skinfold thickness, as well as with environmental temperature;

2. A direct relationship exists between the performance and occupational activity and participation in sports;

3. No relationship exists between the performance and altitude or relative humidity.

These data indicate that the "rural" men, in spite of having undergone a period of protein-calorie malnutrition during their pre-school years and their consequent growth retardation, are well adapted, from the cardiovascular point of view, to this type of physical exertion. Undoubtedly, their leanness contributes to this good performance, since it has been shown that lean men perform better in this test than heavy or obese men. In addition, their heavy physical agricultural work may represent enough training to favorably influence the test. The "urban" group, which contains many more men with sedentary occupations, could be expected to perform more poorly.

TABLE 41. PERCENT DISTRIBUTION OF MEN AGED 15 TO 40 BY INDEX OF PHYSICAL FITNESS MEASURED BY HARVARD STEP TEST

Country	Number of Men Tested	Index of Physical Fitness				
		<55 (poor)	55-64 (low average)	65-79 (high average)	80-89 (good)	≥90 (excellent)
		Percentages				
Guatemala						
Rural	249	10	2	28	31	29
El Salvador						
Rural	93	7	5	48	20	19
Urban	22	50	18	18	14	0
Honduras						
Rural	111	14	4	39	26	17
Urban	40	50	7	28	15	0
Nicaragua						
Rural	124	19	5	40	20	15
Costa Rica						
Rural	204	10	6	40	24	19
Urban	20	40	5	35	15	5
Panama						
Rural	120	13	3	34	38	12
Urban	23	61	0	35	4	0

VII

DIABETES AND CARDIOVASCULAR DISEASE

Specific data are given in Table 42 by country and sex with regard to the portion of the sample population 35 years and older who were tested in special studies on diabetes. The subjects tested were only crudely representative of the universe from which they were drawn. Even so, the country-wide samples are much better than are usually available for estimating prevalence rates. As shown in Table 42, the number of locations surveyed ranged from twenty-six to forty-eight per country. Glucose loading tests were performed and certain related data collected on 2285 subjects. The frequency distribution of ages was the same for males and females. Frequency distribution of age by country and for all Central Americans is given in Table 46, page 54.

The number of subjects tested in each country for each sex is given in Table 42.

The Glucose Loading Test

All subjects received an oral glucose load of 1 gm./kg. of body weight, administered in an approximate concentration of 25 percent. Venous blood was drawn at two hours. Glucose levels were determined on plasma, using the Autoanalyzer method. The plasma values were later converted to whole blood values to facilitate comparison with results of other studies. This assumes that plasma levels were 14 percent higher than whole blood levels. Usually the load was administered three to four hours after breakfast but the duration of the fasting ranged from one to fourteen hours. In most instances, the subject had fasted for more than two hours prior to the administration of glucose.

TABLE 42. DIABETES-RELATED STUDIES IN CENTRAL AMERICA

Country	No. of Locations Surveyed	Subjects Tested		Mean Weight as Percent of Standard	
		Males	Females	Males	Females
Guatemala	48	204	294	92%	99%
% of sample tested		67%	67%		
El Salvador	29	97	168	91%	96%
% of sample tested		67%	68%		
Honduras	26	134	208	95%	100%
% of sample tested		66%	74%		
Nicaragua	35	130	259	98%	107%
% of sample tested		54%	69%		
Costa Rica	39	180	266	97%	109%
% of sample tested		60%	71%		
Panama	32	145	200	93%	103%
% of sample tested		56%	69%		

RESULTS

Prevalence of Diabetes

The frequency distribution of the two-hour blood glucose levels for all subjects tested in Central America is shown in Table 43.

TABLE 43. FREQUENCY DISTRIBUTION OF 2-HOUR BLOOD GLUCOSE VALUES IN CENTRAL AMERICA

mg./100 ml.	>209	180-209	150-179	120-149	90-119	60-89	<60
Percent	1.5	0.8	2.4	7.8	29.0	50.6	7.9
Cumulative %	1.5	2.3	4.6	12.4	41.4	92.1	100.0

The results for each country are given in Table 44. Those subjects whose two-hour venous whole blood glucose values exceeded 149 mg/100 ml are arbitrarily classified as "diabetic". However, examination of Tables 43 and 44 permit determinations of prevalence rates using diagnostic criteria which are either more "conservative" or more "liberal" than these.

The observed rate of prevalence for all Central America was adjusted slightly by projecting a rate which takes into account the relative populations of the six countries; and another adjustment was applied to correct for the fact that the number of females tested was somewhat greater than the number of males. These two adjustments result in a change from an observed prevalence rate of 4.6 percent to a projected rate of 4.1 percent.

Table 44 gives the prevalence rates for each of the countries. Differences among countries were modest, ranging from 2.5 percent for Panama to 5.4 percent in Costa Rica. Small differences among countries in observed prevalence rates, such as 4.2 percent for Guatemala and 5.0 percent for Nicaragua, may not be significant. It is believed that larger differences, such as 5.4 percent for Costa Rica and 3.2 percent for El Salvador are significant.

TABLE 44. FREQUENCY DISTRIBUTION OF 2-HOUR GLUCOSE VALUES BY COUNTRY

Country	Glucose, mg/100 ml			
	>149	120-149	100-119	<100
	Percent of the Subjects			
Guatemala				
Males	2.9	2.9	8.8	85.3
Females	5.4	4.8	10.2	19.6
Both Sexes[1/]	4.2	3.9	9.5	83.5
Cumulative	4.2	8.1	17.6	100.1
El Salvador				
Males	2.1	6.2	16.5	75.3
Females	4.2	10.7	22.0	63.1
Both Sexes[1/]	3.2	8.5	19.3	69.2
Cumulative	3.2	11.7	31.0	100.2
Honduras				
Males	1.5	6.7	11.9	79.9
Females	6.7	12.5	20.7	60.1
Both Sexes[1/]	4.1	9.6	16.3	70.0
Cumulative	4.1	13.7	28.0	100.0
Nicaragua				
Males	2.3	4.6	11.5	81.5
Females	7.7	10.8	15.8	65.6
Both Sexes[1/]	5.0	7.7	13.7	73.5
Cumulative	5.0	12.7	26.4	99.9
Costa Rica				
Males	3.3	5.6	12.2	79.9
Females	7.5	3.2	16.9	62.4
Both Sexes[1/]	5.4	9.4	14.6	70.7
Cumulative	5.4	14.8	29.4	100.1
Panama				
Males	0.0	2.8	9.0	88.3
Females	5.0	8.0	17.5	69.5
Both Sexes[1/]	2.5	5.4	13.3	78.9
Cumulative	2.5	7.9	21.2	100.1

[1/]Rate based on projected results if an equal number of males and females had been tested.

Association of Diabetes Prevalence with Other Factors

As indicated in Table 44 the prevalence of diabetes was higher in females than in males in every country. For all subjects in Central America the observed rate in males was 2.1 percent while that in females was 6.2 percent. The higher rate in females cannot be attributed to parity because no association was demonstrable between parity and diabetes prevalence (see below). On the other hand, overweight was much more common in females than in males, and this could account for the difference in prevalence between the sexes (see below). The mean percent of standard weight for women was 103 percent and for men 95 percent.

The number of full-term pregnancies (7 or more months) was recorded for each woman tested. Mean parity was seven, and a substantial portion of these women had had from nine to twenty-two pregnancies. No significant relationship was found between parity and prevalence of diabetes.

Table 45 shows the negative relationship between age and glucose tolerance in Central America. This same inverse relationship was observed in each of the six countries as shown in Table 45. These data demonstrate the crucial importance of matching for age before making comparisons of prevalence.

TABLE 45. RELATIONSHIP OF AGE AND GLUCOSE TOLERANCE IN CENTRAL AMERICA

Ages	2-Hr. Glucose in mg/100 ml				
	<100	100-129	130-149	150-199	≥199
35-44 Years	77%	17%	4%	2%	0.4%
45-64 Years	72%	20%	4%	3%	2.0%
65 Years and Over	68%	20%	4%	4%	5.0%

There was a strong association between the prevalence of diabetes and socioeconomic status. In an independent survey these families were classified by socioeconomic level as "high", "medium", or "low". Diabetes was more than three times as common in those with "high" status as in those with "low" status.

TABLE 46. FREQUENCY-DISTRIBUTION OF SUBJECTS BY AGE AND PREVALENCE OF DIABETES BY AGE FOR EACH COUNTRY

Country	All Subjects	Age in Years 35-44	45-54	55-64	64
Guatemala	100%	36.5%	32.3%	14.7%	16.5%
Prevalence	4.4%	1.6%	3.7%	11.0%	6.1%
El Salvador	100%	36.2%	28.3%	18.9%	16.6%
Prevalence	3.4%	1.0%	2.7%	6.0%	6.8%
Honduras	100%	38.0%	26.3%	19.3%	16.4%
Prevalence	4.7%	4.6%	2.2%	3.0%	10.7%
Nicaragua	100%	32.1%	27.2%	20.6%	20.1%
Prevalence	5.9%	1.6%	6.6%	7.5%	10.3%
Costa Rica	100%	37.4%	29.6%	14.1%	18.8%
Prevalence	5.8%	4.2%	5.3%	3.2%	11.9%
Panama	100%	27.8%	32.7%	22.0%	17.4%
Prevalence	2.9%	0.0%	3.5%	3.9%	5.0%
All Countries	100%	34.6%	29.6%	17.8%	18.1%
Prevalence	4.6%	2.4%	4.1%	5.9%	8.7%

Relationship between Adiposity and Prevalence of Diabetes

In studying the relationship between prevalence of diabetes and various factors in the different countries, the most impressive correlation was with fatness. The data in Table 42 shows the mean percent of standard weight for each country by sex. Although the differences among countries were relatively small with respect to both diabetes prevalence and mean percent of standard weight, there was a good correlation between the two. For example, both weights and prevalence rates were lowest in Panama and El Salvador, while both weights and prevalence rates were highest in Costa Rica and Nicaragua. Table 47 shows the relationship of adiposity (percent of standard weight) and prevalence of "diabetes" in the Central American subjects (data for all countries combined). Impairment of glucose tolerance was more than three times as common in subjects whose weights exceeded 109 percent of standard as in the rest of the population.

TABLE 47. RELATIONSHIP IN CENTRAL AMERICA BETWEEN ADIPOSITY AND PREVALENCE OF ABNORMAL OR BORDERLINE GLUCOSE TOLERANCE

	Weight as % of Standard	Mean Age, Years	2-Hr. Blood Glucose ≥149 mg/100 ml	2-Hr. Blood Glucose 120-149 mg/100 ml
Very Lean	<80%	57	3%	5%
	80-89%	53	3%	7%
Lean	90-99%	50	3%	6%
Medium	100-109%	50	3%	6%
Fat	≥110%	50	10%	12%

In Central America the relatively high rates of diabetes in females, and for both sexes in Nicaragua and Costa Rica, were entirely "corrected" when adjustments were made for the greater fatness of these three subgroups of the general population. There were some differences among groups and subgroups that were not entirely corrected by matching for adiposity, but these differences associated with other factors (such as race, sex, etc.) were modest. In all of these countries, some of the diabetics had lost significant amounts of weight because of diabetes. Thus the association between adiposity and risk of diabetes is even stronger than suggested by these data.

Although older subjects had poorer glucose tolerance in all countries, associations between prevalence of diabetes and adiposity were not attributable to a greater adiposity of older subjects.

Sugar Consumption

It is difficult to determine with great precision the levels of sugar intake in large populations. Table 48 gives the levels of dietary sugar in the six countries. These figures should be taken as only rough estimates. Table 48 shows that there was a positive correlation between prevalence rate and sugar consumption. Although this association was not statistically significant, the failure to demonstrate statistical significance may be attributable to the relatively small number of populations (six).

TABLE 48. DIET AND PREVALENCE OF DIABETES IN CENTRAL AMERICA

Country	Diabetes Prevalence[1/]	Percent Distribution of Calories by Source			
		Total Carbohydrates	Sugar	Protein	Fat
Guatemala	4.2%	73%	10%	12%	15%
El Salvador	3.2%	70%	7%	12%	17%
Honduras	4.1%	66%	8%	13%	22%
Nicaragua	5.0%	66%	12%	13%	21%
Costa Rica	5.4%	69%	17%	11%	21%
Panama	2.5%	67%	9%	11%	22%

[1/]Venous blood glucose 149 mg/100 ml in subjects over 30 years of age. These prevalence rates differ slightly from observed rates because they have been adjusted to the predicted rate if an equal number of males and females had been tested.

Cholesterol

Information on levels of dietary cholesterol in the various populations of Central America is not yet available, but cholesterol intake is probably much lower than in the United States because fat intake is substantially less than in North America. Also, the portion of fat which is of animal origin is lower in Central America than in the United States. Plasma cholesterol levels for 2034 subjects (803 males and 1231 females) in Central America and the relationship of these levels to age are shown in Table 49. Cholesterol levels did not rise with age in either sex. On the contrary, in old age there was some decline in these values.

The relationship between glucose tolerance and cholesterol level is shown in Table 50. Cholesterol levels were substantially greater in subjects with impairment of glucose tolerance. In males a statistically significant increase in cholesterol values was observed even in those with minimal impairment of tolerances (2-hour glucose levels between 150 and 199 mg/100 ml). In females no significant change in cholesterol values was observed until 2-hour glucose values reached 200 mg/100 ml. Table 51 shows that there was some association between mean percent of standard weight and cholesterol level.

TABLE 49. RELATIONSHIP OF AGE AND PLASMA CHOLESTEROL IN 2034 CENTRAL AMERICAN SUBJECTS 35 YEARS AND OVER

Age	Mean Cholesterol (mg/100 ml)	
	Males	Females
35-44	142	141
45-54	137	154
55-64	136	151
65-74	139	149
75-84	129	142
≥85	119[a/]	123[a/]

[a/] Only 10 males and 11 females were over 85 years.

TABLE 50. RELATIONSHIP OF GLUCOSE TOLERANCE TO PLASMA CHOLESTEROL IN CENTRAL AMERICAN SUBJECTS[1/]

	2-Hour Venous Blood Glucose, mg/100 ml	Plasma Cholesterol, mg/100 ml		
		Both Sexes	Males	Females
Clearly Normal Tolerance	<120	142	137	147
High Normal or Borderline Tolerance	120-149	142	139	145
Slightly Abnormal Tolerance	150-199	152	166	140
Grossly Abnormal Tolerance	>200	173	179	168

[1/] 2034 subjects 35 years of age and over.

TABLE 51. RELATIONSHIP OF PLASMA CHOLESTEROL AND ADIPOSITY (% of Standard Weight) IN CENTRAL AMERICA

Weight as % of Standard	Mean Cholesterol (mg/100 ml)	
	Males	Females
<80%	138	146
80-89%	127	142
90-99%	142	140
100-109%	144	156
>109%	150	152

There was a positive relationship in Central America between socioeconomic status and cholesterol levels. In 271 males in whom socioeconomic status was graded as "low", "medium" or "high", mean cholesterol levels were 123, 138 147 mg/100 ml, respectively. In 427 females graded "low", "medium" or "high" in socioeconomic status, mean cholesterol levels were 136, 144 and 148 mg/100 ml, respectively.

Electrocardiographic Findings

Table 52 shows the relationship between glucose tolerance and electrocardiographic status in Central America.

Although 1645 individuals had both a glucose tolerance test and an electrocardiogram, the low prevalence of diabetes and the infrequency of some electrocardiographic abnormalities made it impossible to determine their relationship to abnormal glucose tolerance. The prevalence of abnormal electrocardiograms was substantially greater in those with abnormal glucose tolerances. Table 52 also shows the impressive relationship between abnormal glucose tolerance and the prevalence of nonspecific T wave changes. The number of older subjects was greater in the group with abnormal tolerances. This accounts to some extent for the higher rate of electrocardiographic abnormalities in hyperglycemic subjects. But Table 52 also indicates that the rate of electrocardiographic abnormalities was much greater in those with hyperglycemia even when the data were age-adjusted. There was little difference between the sexes in the rate of electrocardiographic abnormalities. It had previously been found that the difference between the sexes in coronary atherosclerosis was much less in Central America than in whites from New Orleans.

TABLE 52. RATES OF ELECTROCARDIOGRAPHIC ABNORMALITIES IN CENTRAL AMERICA AND THEIR RELATIONSHIP TO GLUCOSE TOLERANCE

	Abnormal ECG		Nonspecific T Wave Changes	
	Males	Females	Males	Females
Subjects with Clearly Normal Glucose Tolerance[1/]	34% (203 of 602)	37% (312 of 837)	9% (52 of 602)	14% (114 of 837)
Subjects with "Borderline" Glucose Tolerance[1/]	60% (18 of 30)	44% (43 of 98)	20% (6 of 30)	17% (17 of 98)
Subjects with Abnormal Glucose Tolerance[1/]	85% (11 of 13)	57% (37 of 65)	39% (5 of 13)	22% (14 of 65)
All Subjects	36% (232 of 645)	39% (392 of 1000)	10% (63 of 645)	15% (145 of 1000)
All Subjects (Age Adjusted)[2/]	43%	43%	12%	16%

1/This classification assumes that 2-hour glucose values over 149 mg/100 ml are abnormal, those under 120 mg/100 ml clearly normal, and those from 120 to 149 borderline.

2/Adjusted to match age distribution of subjects with abnormal tolerance.

Character of Diabetes

These studies were not designed to evaluate certain clinical characteristics of diabetes, and the 106 persons who had impairment of glucose tolerance were not studied systematically with respect to several important manifestations of diabetes. It was possible, however, to determine the frequency distribution of hyperglycemia. Table 43 shows that most of those with abnormal tolerance were only mildly diabetic; only about one-third (34 of 106) of those with abnormal tolerance had two-hour glucose levels greater than 209 mg/100 ml, but severe hyperglycemia was occasionally found. Ten persons had blood glucose levels between 300 and 400 mg/100 ml, and three persons had values of 500, 506, and 563 mg/100 ml, respectively.

Priority of Diabetes as a Health Problem

In view of other pressing health problems in Central America, diabetes-related programs would not seem to warrant highest priority. Nevertheless, diabetes is a very significant health problem in the region. No systematic studies were made in children or younger adults, but on the basis of glucose tolerance tests in a small number of military and civilian personnel, clinical experiences of local clinicians, and more than 1000 family histories, diabetes would appear to be less common in the younger segment of the population than in those thirty-five years of age and over. Assuming that the prevalence of diabetes is very small in young adults and that approximately two-thirds of the population are under thirty-five years of age, about 225,000 people in Central America have "diabetes" (1.5 percent of 15 million). Our data indicate that a majority of these "diabetics" have very mild abnormalities of glucose tolerance. Therefore, the total number of people in the six countries with "clinical" diabetes is roughly 50 to 100 thousand.

VIII

MORTALITY

Information was obtained on all deaths for the years 1958 to 1964 in 35 of the locations surveyed in Guatemala by date, age, sex and cause. The data were collected from the civil register in each location and processed afterwards at INCAP. The number of births for each year was also recorded and a life table prepared for the first 5 years of life. Comparable data were not obtained for the other countries.

A total of 43,894 deaths were recorded and 20,763 of these, or 47.3 percent, were those of children under 5 years. An analysis of these deaths of young children is reported here.

The causes of death, as declared in the civil register (and rarely medically certified) were re-interpreted and subdivided into various large groups on the basis of previous experience with causes of death in rural Guatemala. Causes such as prematurity, severe protein-calorie malnutrition and congenital malformation were investigated but were considered to have been largely ignored in the civil registers.

TABLE 53. DEATHS PER 1000 LIVE BIRTHS IN CHILDREN UNDER 4 YEARS, BY AGE AND CAUSE, IN 35 LOCATIONS IN GUATEMALA, 1958-1964

Selected Causes	Age At Death				
	Under 29 Days	1-11 Months	12-23 Months	24-35 Months	36-47 Months
	Deaths Per 1000 Live Births				
Respiratory Infections	15.6	22.3	13.6	9.0	6.5
Diarrheal Diseases	2.2	15.1	19.6	13.5	9.0
Whooping Cough	1.4	7.0	5.6	4.3	2.7
Measles	1.2	4.2	4.8	3.1	2.5
Severe Protein-Calorie Malnutrition	0.6	1.2	1.2	1.0	0.8
Premature Birth	7.9	-	-	-	-
Congenital Malformations	0.3	-	-	-	-
All Causes	35.7	58.0	50.1	35.7	25.0

Table 53 and Figure 22 show the deaths per 1000 live births of children under 4 years of age in the 35 locations over the 7 years. Respiratory infections are an important cause of death even in the neonatal period. They reach their maximum in the post-neonatal period, decreasing then with age. Diarrheal diseases increase rapidly after the neonatal period, reaching their highest level in the second year of life when they surpass respiratory infections, and then decrease with age.

FIGURE 22

ETIOLOGY OF CHILD MORTALITY IN GUATEMALA

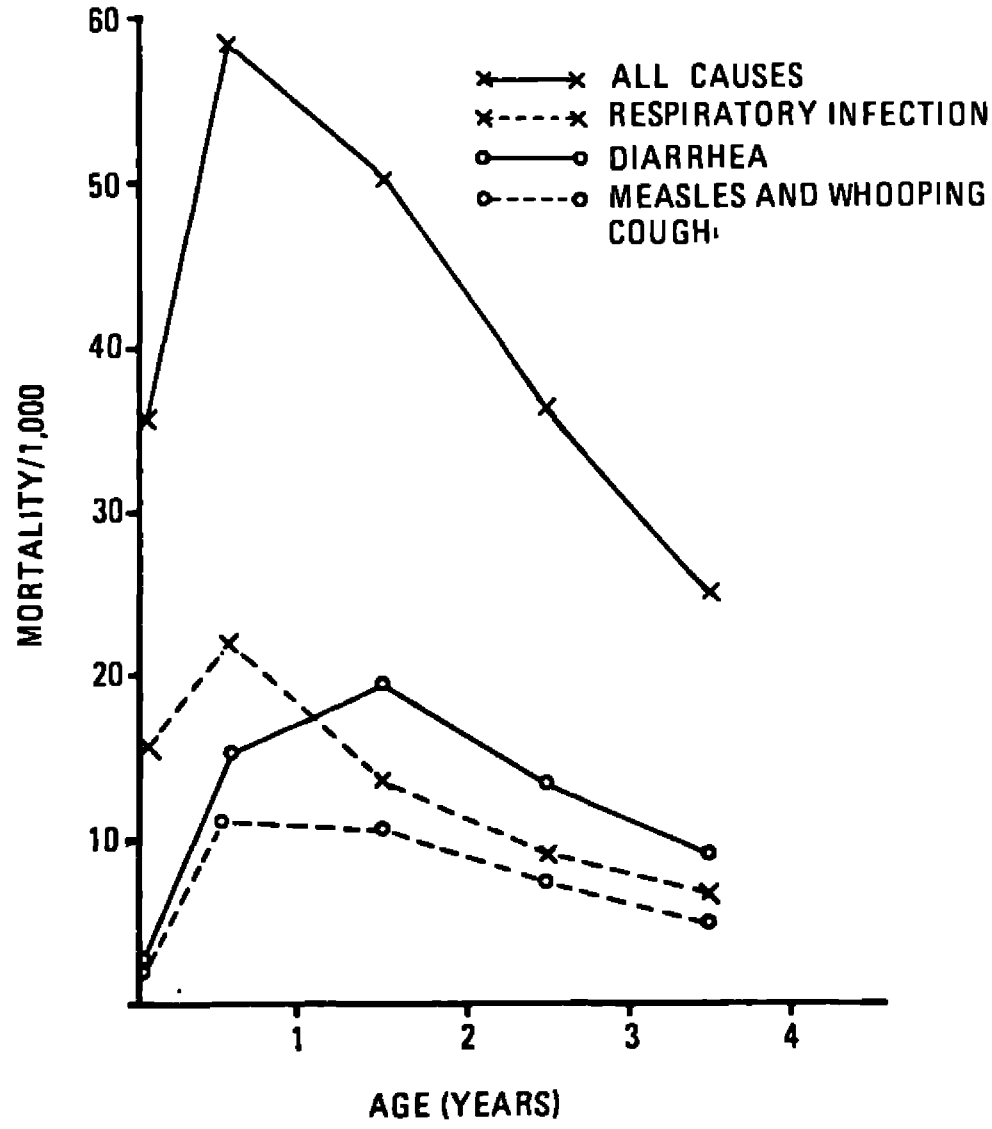
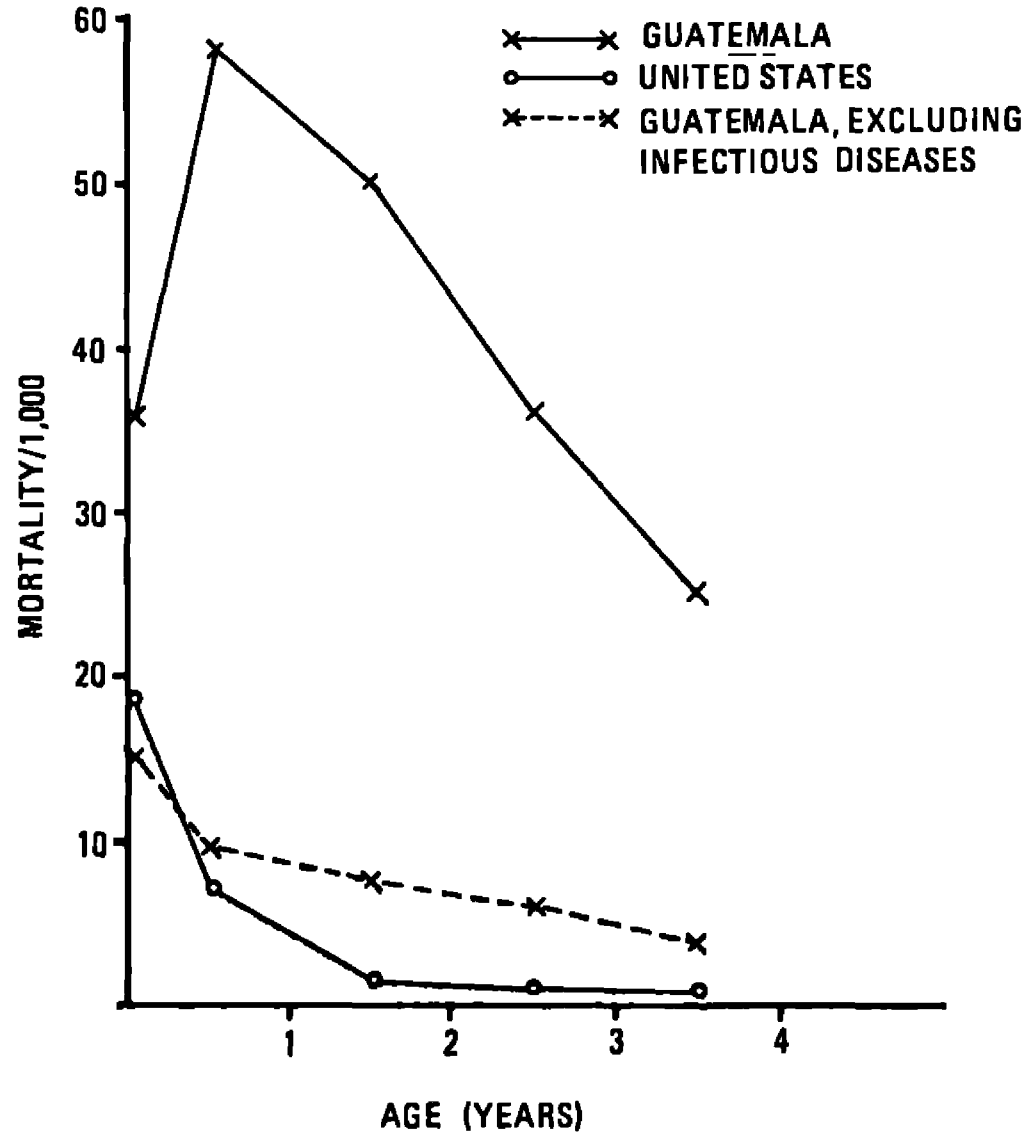


FIGURE 23

CHILD MORTALITY IN GUATEMALA FOR CAUSES OTHER THAN INFECTIOUS DISEASES



Whooping cough and measles reach their peak in the post-neonatal period and continue during the second year of life. Although the death rates from severe protein-calorie malnutrition of the kwashiorkor and marasmus type appear low in comparison with the infectious diseases, 519 deaths were due to this cause in the 35 locations during the 7 years. Since malnutrition is an important contributing factor in many deaths caused by diarrheal diseases, respiratory infections and the common diseases of childhood, it is estimated that severe protein-calorie malnutrition probably contributes to the deaths of more than 5,000 children per year. Total deaths from all causes reached their highest rates in the post-neonatal period. However, in 9 of the 35 locations the highest rates were reached in the second year of life, and in some locations they were almost double the rates in the post-neonatal period.

TABLE 54. DEATHS PER 1000 LIVE BIRTHS IN CHILDREN UNDER 4 YEARS, BY AGE AND SOCIOECONOMIC INDEX OF THE LOCATION, GUATEMALA 1958-1964

Age At Death	Socioeconomic Index	
	22 Locations Low(<2)*	13 Locations High(>2)*
Under 29 Days	46.7	31.6
1 to 11 Months	64.4	53.6
12 to 23 Months	54.6	41.9
24 to 35 Months	33.3	25.0
36 to 47 Months	22.4	16.5

*As defined in Chapter XI.

The deaths of the Guatemalan children under 4 years of age were compared to those of the same age group in the United States (Figure 23). During the neonatal period the Guatemalan rate is double that in the United States but becomes 8 times as great in the post-neonatal period, and 25 times as great in the second year of life. In the third and fourth year of life the Guatemalan rate maintains more or less the same relation with the rate in the United States. Figure 23 shows the Guatemalan rate when the infectious diseases are excluded. The curve then takes the same form as that of the United States and at a level only 3 to 5 times higher. The major part of the extremely high death rate of the Guatemalan children is obviously due to infections and malnutrition, the prevention of which merits the highest priority.

A comparison was also made between locations having high and low socioeconomic indices, as defined in Chapter XI. The mortality rate for each age group was consistently higher in the category of locations with the lower socioeconomic rating (Table 54).

IX

DENTAL EVALUATION

To determine the prevalence of oral disease, a complete examination of the oral cavity was performed on 21,903 persons, ranging from 3071 in Panama to 4405 in Guatemala. This examination included the lips, gums, mucous membranes, tongue and teeth and was performed by two dentists who had previously standardized their procedures. It was performed under natural light on portable dental chairs using tongue depressors and dental explorers and mirrors.

Methods

Dental caries was determined by the number of decayed, missing, or filled permanent teeth per person, or the number of decayed or filled primary teeth per person.

Periodontal disease was determined by means of two indices. The periodontal index determines the prevalence and severity of inflammation of the gum and loss of supporting bone. The simplified oral hygiene index establishes the presence and quantity of dental calculus and debris.

The following criteria were used for the different indices:

1. Decayed, Missing, Filled Teeth. Twenty-eight permanent teeth were evaluated, excluding the third molars. A tooth was considered carious if any of its surfaces showed obvious signs of caries or when the tip of the explorer was retained in fossae or fissures and macerated dental tissue was detected. Other enamel lesions, such as erosion, hypoplasia, the "Cauque" lesion and filled teeth with recurrent caries, were also considered as carious. A tooth was considered missing with history of extraction or when there were indications of extraction such as remnants of roots or exposed pulp due to caries. All missing teeth were considered to have been lost because of caries, although periodontal disease after the age of 30 years may be an important cause. A tooth was considered filled if any of its surface had been filled with any dental material.

2. Periodontal Index using a scale of 0-8. The following criteria were used:

   0 - Essentially normal periodontal tissues.

   1 - Mild gingivitis with inflammation of the free gingiva not surrounding the whole tooth.

   2 - Gingivitis with inflammation of the free gingiva

surrounding the whole tooth but without disruption of the epithelial attachment.

6 - Obvious periodontal disease with pocket formation but without interference of normal mastication. The tooth is firm in its alveolus.

8 - Advanced periodontal disease with loss of masticatory function.

3. Simplified Oral Hygiene Index representing the sum of the Debris and Dental Calculus subindices.

Each of these is valued from 0 to 3 by the following surfaces:

a. Buccal surfaces of superior first molars and lingual surfaces of inferior first molars.

b. Buccal surfaces of the superior right central incisor and the inferior left central incisor.

Debris Subindex

0 - Absence of debris

1 - Debris covering up to 1/3 of the gingival surface

2 - Debris covering between 1/3 and 2/3 of the surface

3 - Debris covering more than 2/3 of the surface

Calculus Subindex

0 - Absence of dental calculi

1 - Supragingival calculi covering up to 1/3 of the gingival surface

2 - Supragingival calculi covering between 1/3 and 2/3 of the surface or small subgingival calculi

3 - Supragingival calculi covering more than 2/3 of the surface or subgingival calculi in a continuous band

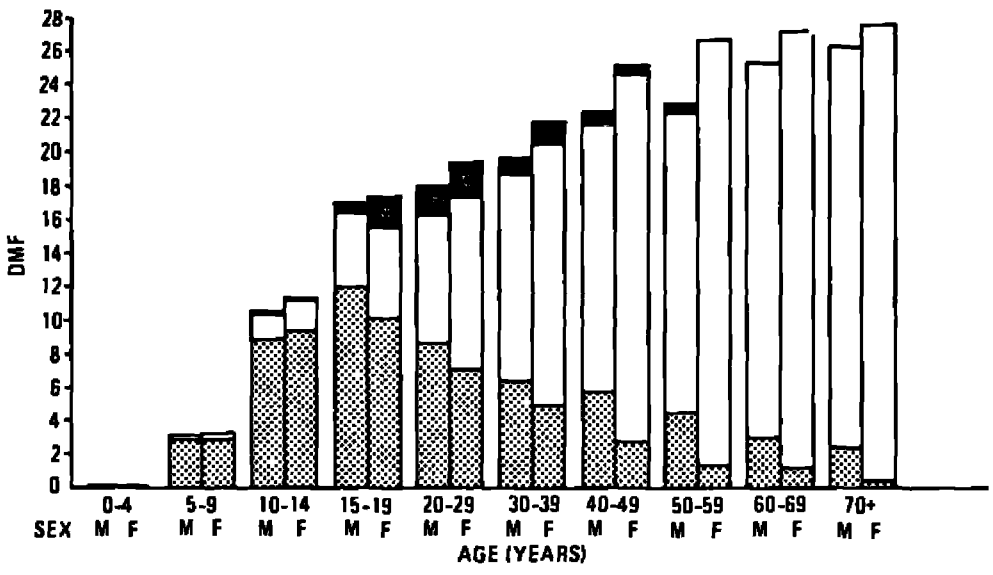
Results

Dental Caries. The numbers of decayed, missing and filled teeth by age and sex are shown in Table 55 and 56 and in Figure 24.

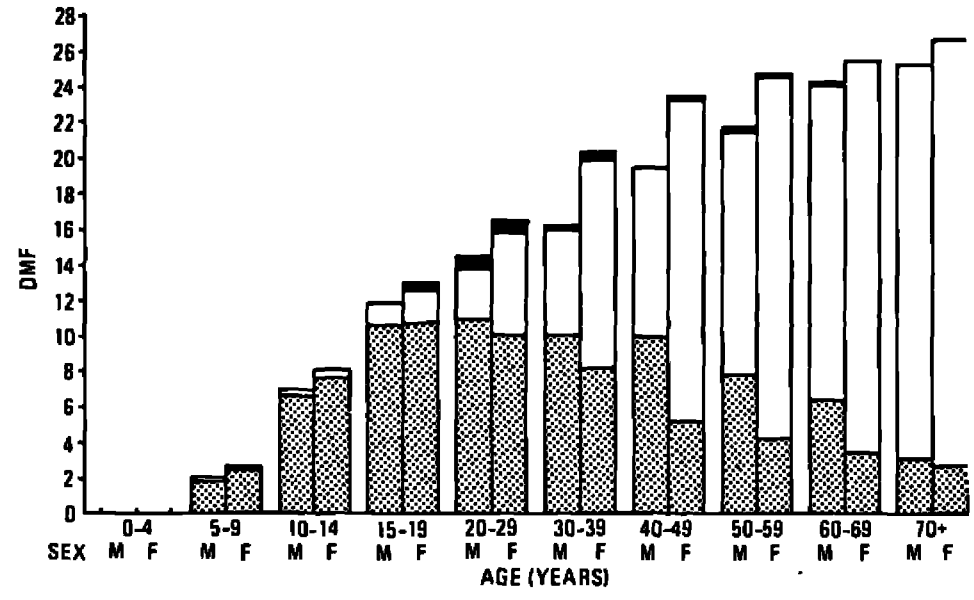
FIGURE 24

DECAYED, MISSING AND FILLED TEETH IN RURAL AREAS

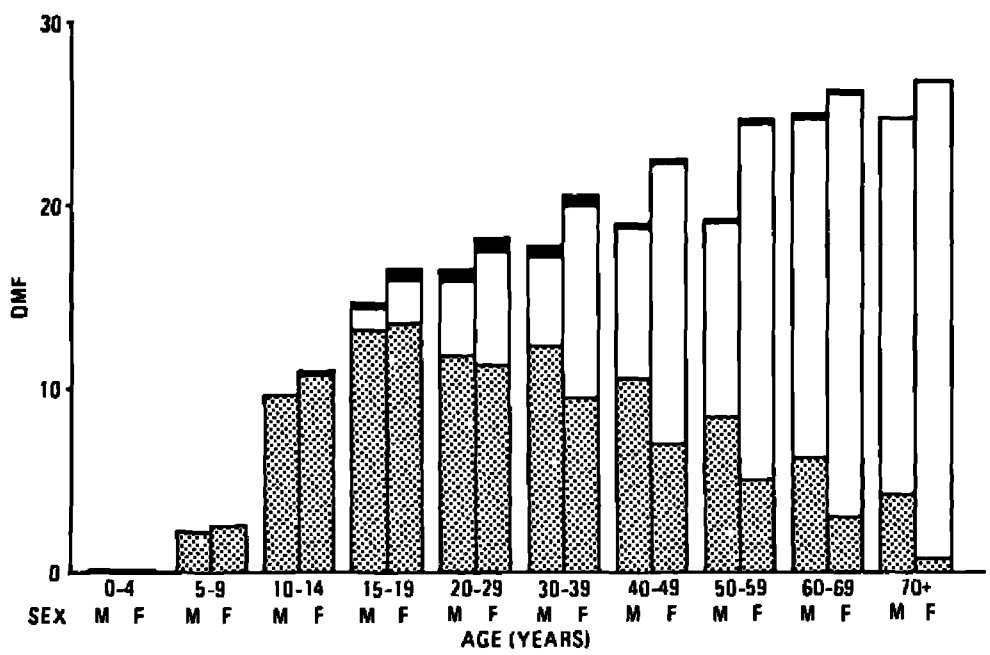
COSTA RICA



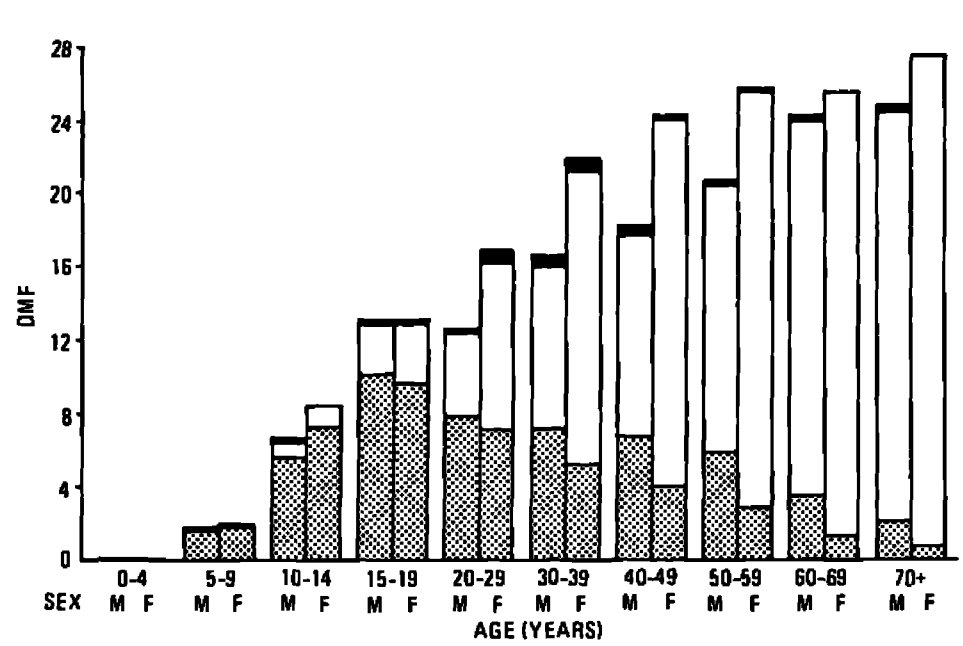
EL SALVADOR



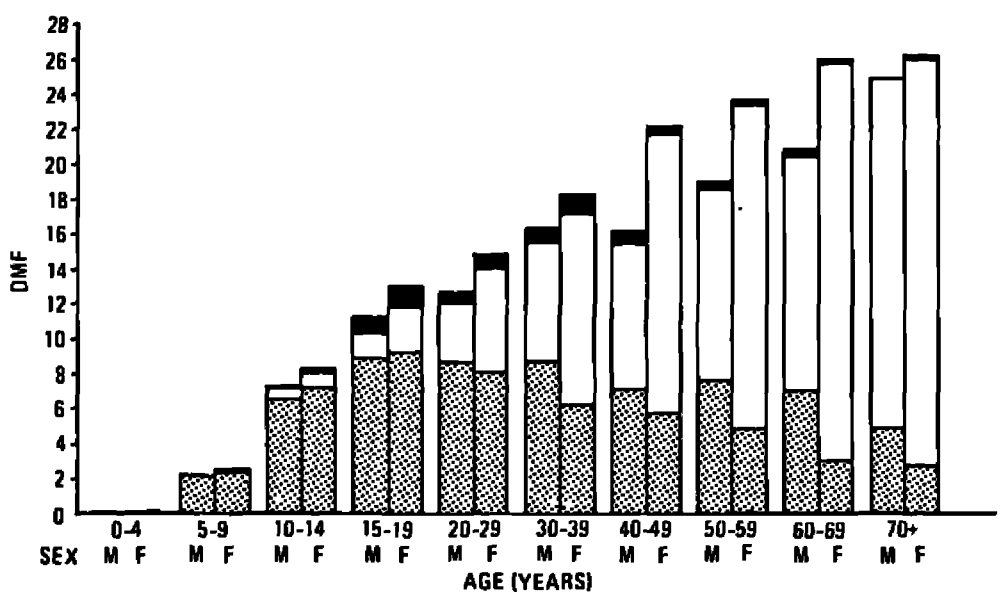
GUATEMALA



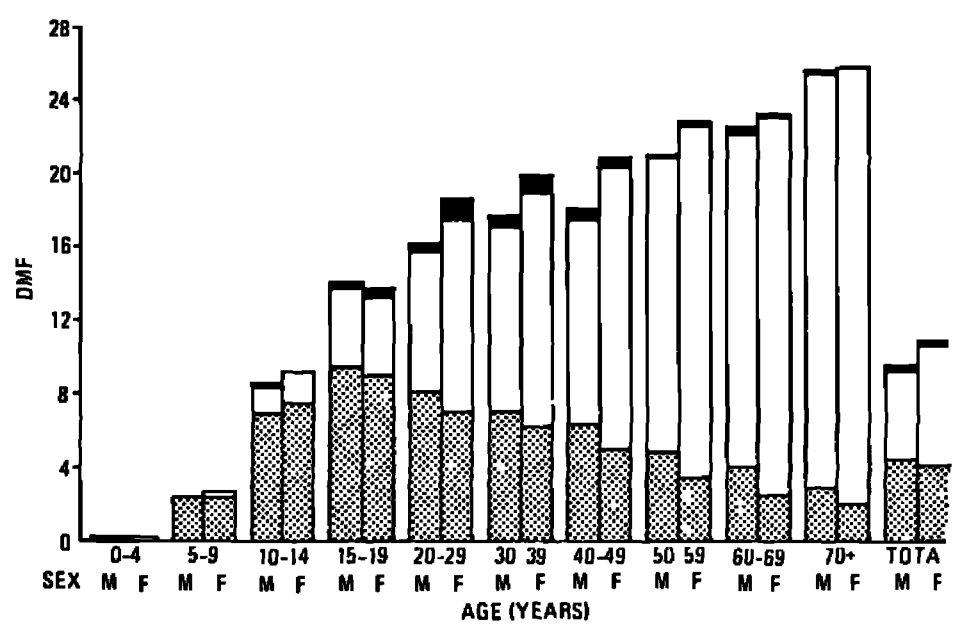
HONDURAS



NICARAGUA



PANAMA



LEGEND.

FILLED MISSING DECAYED

TABLE 55. AVERAGE NUMBER OF DECAYED, MISSING OR FILLED PERMANENT TEETH PER PERSON, BY AGE AND SEX
CENTRAL AMERICA AND PANAMA, 1965-1967

Age (Years)	Male		Female		Both Sexes		Rural Women	
	Rural	Urban	Rural	Urban	Rural	Urban	Pregnant	Lactating
Guatemala								
							P	L
0 - 4	0.0	0	0.0	0	0.0	0	---	---
5 - 9	2.2	1.6	2.5	2.0	2.4	1.8	---	---
10 - 14	9.6	5.9	10.9	8.4	10.3	7.2	---	---
15 - 19	14.6	11.7	16.5	12.7	15.8	12.2	18.4	18.0
20 - 29	16.4	14.4	18.1	15.0	17.3	14.8		
30 - 39	17.8	13.6	20.7	17.3	19.2	15.6	21.0	20.3
40 - 49	19.2	13.5	22.5	19.8	21.1	17.0	25.5	22.8
50 - 59	21.7	17.1	24.6	22.5	23.4	19.8	---	---
60 - 69	24.7	20.0	26.3	26.3	25.6	24.2	---	---
70+	24.8	17.3	26.8	24.0	25.9	22.7	---	---
TOTAL	8.4	8.4	12.7	12.7	10.6	10.6	19.5	19.2
El Salvador								
							P	L
0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	---	---
5 - 9	1.8	1.1	2.6	1.6	2.2	1.4	---	---
10 - 14	6.8	5.3	8.3	5.2	7.6	5.2	---	---
15 - 19	11.9	8.8	12.9	11.8	12.5	10.7	17.1	14.3
20 - 29	14.4	11.1	16.4	13.5	15.6	12.7	---	---
30 - 39	16.2	14.8	20.3	14.7	18.5	14.7	21.3	20.1
40 - 49	19.4	13.4	23.4	19.8	21.5	17.9	18.0	24.0
50 - 59	21.6	20.2	24.6	22.4	23.1	21.8	---	---
60 - 69	24.1	21.2	25.4	25.2	24.8	23.9	---	---
70+	25.1	18.0	26.6	26.7	25.9	24.8	---	---
TOTAL	---	5.9	---	10.9	---	8.8	---	---
Honduras								
							P	L
0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	---	---
5 - 9	1.8	1.4	1.9	1.9	1.9	1.6	---	---
10 - 14	6.6	5.0	8.5	6.9	7.6	6.0	---	---
15 - 19	13.1	10.1	13.1	9.8	13.1	9.9	17.9	19.0
20 - 29	12.6	11.6	16.9	14.6	15.1	13.6		
30 - 39	16.6	13.9	21.9	17.5	19.0	16.2	21.4	21.3
40 - 49	18.2	15.7	24.2	22.1	21.2	19.5	23.6	25.5
50 - 59	20.6	18.1	25.6	23.5	23.1	21.4	---	---
60 - 69	24.1	21.0	25.5	26.1	24.8	24.4	---	---
70+	24.7	--- a/	27.5	28.0	26.1	28.0	---	---
TOTAL		6.9		10.8		9.2	---	---

a/Only 1 subject examined.

TABLE 55--Continued

Age (Years)	Male Rural	Male Urban	Female Rural	Female Urban	Both Sexes Rural	Both Sexes Urban	Rural Women Pregnant	Rural Women Lactating
				Nicaragua				
							P	L
0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	---	---
5 - 9	2.2	1.7	2.5	2.1	2.3	1.9	---	---
10 - 14	7.3	5.1	8.2	6.3	7.8	5.8	---	---
15 - 19	11.2	9.6	13.0	10.7	12.2	10.3	12.9	15.8
20 - 29	12.6	10.5	14.8	13.8	13.8	12.9	15.1	
30 - 39	16.3	13.3	18.2	14.3	17.3	14.0	17.6	18.1
40 - 49	16.0	14.8	22.0	18.3	19.6	17.3	24.0	22.3
50 - 59	18.8	18.7	23.5	20.1	21.2	19.9	---	---
60 - 69	20.7	19.0	25.9	21.2	23.3	20.4	---	---
70+	24.8	19.0	26.1	--- [a]	26.2	---	---	---
TOTAL		5.6		8.5		7.4	---	---
				Costa Rica				
0 - 4	0.1	0.0	0.0	0.0	0.1	0.0		---
5 - 9	3.0	1.8	3.2	2.0	3.1	1.9		---
10 - 14	10.6	7.3	11.4	7.5	11.0	7.4		---
15 - 19	17.1	14.9	17.5	13.6	17.3	13.9		---
20 - 29	18.1	13.4	19.5	15.8	18.9	15.0		---
30 - 39	19.7	17.1	21.9	19.2	21.0	18.8		---
40 - 49	22.5	19.5	25.6	21.5	24.4	21.0		---
50 - 59	22.8	25.4	26.9	24.6	25.0	24.8		---
60 - 69	25.4	26.2	27.4	24.2	26.6	24.9		---
70+	26.5	26.8	27.8	28.0	27.2	27.4		---
TOTAL	9.9	8.8	12.2	12.1	11.2	10.8		---
				Panama				
0 - 4	0.0	0.0	0.0	0.0	0.0	0.0		
5 - 9	2.4	1.0	2.7	1.3	2.6	1.1		
10 - 14	8.6	4.6	9.3	6.1	9.0	5.3		
15 - 19	13.9	6.8	13.7	9.1	13.9	8.3		14.5
20 - 29	16.2	11.1	18.6	14.7	17.5	13.8		17.1
30 - 39	17.7	15.7	19.8	15.6	18.9	15.7		18.4
40 - 49	18.0	15.6	20.8	18.1	19.5	17.3		21.0
50 - 59	21.1	15.8	22.7	22.8	22.0	21.1		---
60 - 69	22.2	20.3	25.1	23.7	23.9	22.6		---
70+	25.6	---	25.8	---	25.7	---		---
TOTAL	9.4	6.0	10.8	9.5	10.2	8.0		17.8

[a] Only 1 subject examined.

The prevalence of dental caries is very high. It becomes evident at the age of 5-9 years and increases significantly with age. It is almost always higher in females. Table 56 shows the situation of dental caries in the primary teeth, which is especially severe in the rural areas.

TABLE 56. AVERAGE NUMBER OF DECAYED OR FILLED PRIMARY TEETH PER PERSON, BY AGE AND SEX CENTRAL AMERICA AND PANAMA, 1965-1967

Age (Years)	Male		Female		Total	
	Rural	Urban	Rural	Urban	Rural	Urban
Guatemala						
0 - 4	5.0	2.8	4.7	1.5	4.9	2.2
5 - 9	8.4	5.3	7.8	5.6	8.1	5.4
10 - 14	2.2	1.1	1.4	0.5	1.8	0.8
All Ages		1.6		0.8		1.2
El Salvador						
0 - 4	4.4	2.5	4.4	1.4	4.4	2.0
5 - 9	7.9	4.7	6.9	4.2	7.4	4.5
10 - 14	1.6	0.8	1.3	0.9	1.4	0.8
All Ages	---	1.8	---	0.9	---	1.2
Honduras						
0 - 4	3.0	2.2	3.2	1.3	3.1	1.8
5 - 9	6.8	5.6	6.3	4.9	6.6	5.3
10 - 14	1.5	0.5	0.8	0.7	1.2	0.6
15 - 19	---	0.0	---	0.3	---	0.2
All Ages	---	1.6		1.0		1.2
Nicaragua						
0 - 4	3.0	2.5	2.6	1.6	2.8	2.0
5 - 9	6.5	3.1	6.0	4.1	6.2	3.6
10 - 14	1.5	1.2	1.0	0.9	1.2	1.0
All Ages	---	1.6	---	1.1	---	1.3

TABLE 56--Continued

Age (Years)	Male Rural	Male Urban	Female Rural	Female Urban	Total Rural	Total Urban
			Costa Rica			
0 - 4	4.7	2.4	4.4	2.0	4.6	2.2
5 - 9	8.0	5.9	7.3	4.7	7.6	5.2
10 - 14	1.5	1.2	0.9	1.2	1.2	1.2
All Ages	3.1	1.8	2.5	1.2	2.8	1.4
			Panama			
0 - 4	4.0	1.9	3.4	0.3	3.7	1.1
5 - 9	7.2	2.1	6.6	4.3	6.8	3.2
10 - 14	1.4	0.7	0.9	0.6	1.1	0.6
All Ages	2.5	1.0	2.1	0.7	2.3	0.9

Periodontal Diseases

These diseases were not found to occur as frequently as dental caries. In the 10-14, 15-19 and 20-29 year age groups in the rural areas mild forms of gingivitis were found, which then advance to the final stages of periodontal disease later in life. Among pregnant and lcatating women the conditions were generally worse. They were somewhat more serious among the older age groups in the urban areas but less so in the younger. Advanced periodontal disease becomes more obvious after the age of forty, terminating in the complete destruction of the supporting tissues with the consequent functional loss of the teeth.

Oral Hygiene. Oral hygiene was very poor at all ages, and the debris subindex contributes mostly to the very high index during the early decades, in almost direct relation to the severity of periodontal disease. Dental calculi begin to appear during puberty and finally lead to bone and soft tissue degeneration, which in turn result in severe periodontal disease after the age of 40, especially in the urban sample. In the latter, the dental calculus sub-index was greater than the one for debris after that age.

Other Conditions. No cases of dental fluorosis nor leukoplakia were detected clinically. The habit of smoking cigarettes and cigars with the lit end inside the mouth was found fairly widespread among older women in Panama, leading to a blackened mucosa and a leukoplakia-like lesion of the palate. Only three cases of hare lip and one of cleft palate were found in Guatemala. A high frequency of filiform

and fungiform papillary atrophy of the tongue was found in the rural area of Guatemala only.

Summary

Caries is the main oral problem of the population. There is a tendency for an early eruption of both deciduous and permanent teeth and this may be a factor in the high prevalence of dental caries in children.

Periodontal disease is second in importance, and undoubtedly plays an important role in the high (decayed, missing or filled) index after the age of 30 years.

PRESENT AND PROJECTED FOOD REQUIREMENTS AND SUPPLY IN CENTRAL AMERICA

Introduction

A survey was conducted to ascertain food availability during 1965 in the six Central American countries. Data were obtained in each country from the Office of Statistics and Census; the National Planning Office; the Ministry of Agriculture, Livestock and Agrarian Reform; the Ministry of Public Health and Social Welfare; the Ministry of Economics and Finance; the National Institute of Development; and the Central Bank.

The final figures on food availability for 1965 in each country were developed by adding food imports to national food production and subtracting food exports, foodstuffs expended in industry, grains used for seed and livestock, and waste.

The total food demand for 1965 was calculated on the basis of the most recent population figures for each country, available from the Organization of Central American States (ODECA), and the recommended minimum nutrient intake for the different age and sex groups of the estimated 1965 population. Translated into food products, this is shown in Table 57.

TABLE 57. BASIC DIETS NUTRITIONALLY ADEQUATE FOR CENTRAL AMERICAN COUNTRIES
(grams per day per reference adult)

Food Group	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
Milk	250	250	300	400	300	300
Eggs	24	48	24	24	48	25
Meat, fish, poultry	90	90	90	90	90	90
Beans	75	75	75	75	75	30
Vegetables	240	210	130	180	130	105
Fruit	120	100	120	100	120	120
Bananas, plantains	100	150	150	150	150	150
Starchy roots, tubers	45	60	60	60	75	120
Corn	228	228	228	132	132	50
Wheat	114	114	97	114	105	60
Rice	45	60	60	60	90	180
Sugar	90	50	60	60	100	50
Fats	15	15	20	15	20	30

In calculating this diet, the objective was to fulfill the nutrient requirements or allowances, making use of available foods in an efficient manner, with due consideration for the dietary habits and general economic situation in each country.[1/2/] Expensive food items, those not generally used in the diet, and those often unavailable, were included in the diet in only minimal amounts.

Population Projection

The figures for the estimated populations of the six countries for the period 1965-1980, by five-year intervals, were obtained from the Organization of Central American States.[3/] This projection, based on an average annual population growth of 3 1/3 percent, would indicate that the estimated population of 12.5 million in 1965 would reach 20 million by 1980. A breakdown of this projection by country is shown in Table 58.

TABLE 58. PROJECTED POPULATIONS OF THE CENTRAL AMERICAN COUNTRIES 1965-1980 (in thousands)

Country	1965	1970	1975	1980
Guatemala	4,593	5,324	6,205	7,274
El Salvador	2,919	3,426	4,009	4,690
Honduras	661	764	895	1,052
Nicaragua	1,633	1,891	2,189	2,532
Costa Rica	1,493	1,769	2,100	2,499
Panama	1,181	1,396	1,649	1,947
Total	12,480	14,570	17,047	19,994

1/Ramirez, Marco Antonio. Demanda Minima Adecuada de Alimentos Basicos para Centro America y Panama - Proyecciones para 1965-1974. Economia (Guatemala) 4 (11): 19-46, 1966.

2/Ramirez, Marco Antonio y Werner Ascoli. Relacion entre la poblacion y la Nutricion. Archivos Latinoamericanos de Nutricion, 17: 9-30, 1967.

3/Organization of Central American States (ODECA). Seminar on the Demographic Situation of Central America, Perspectives and Consequences. San Jose, Costa Rica, July 1965.

Projected Food Requirements and Available Supply

The combined requirements of the Central American countries for each food group were projected for the 1965-1980 intervals on the basis of the recommended daily amounts of each food group for the reference adult in each country. The anticipated available food supply was also projected for the same period. Calculations were based on the historical production series and trends for each country.[1/] Several corrections were introduced to take into account recent agricultural developments influencing production, and the possible effect of food and nutrition policies which might be adopted by the governments of the area.

The estimated food requirements, the available supply, and the percentage of the requirements for each food group which are satisfied by the available supply, for 1965, 1970, 1975 and 1980, are shown in Table 59. The data from this table are presented in composite form in Figure 25 which indicates the deteriorating situation with respect to the ability of the population to meet the calorie requirements.

Discussion

The data presented in Table 59 and Figure 25 indicate the great inadequacy of the current and anticipated food supply for the area in those foods which contribute most to the qualitative improvements in the diet.

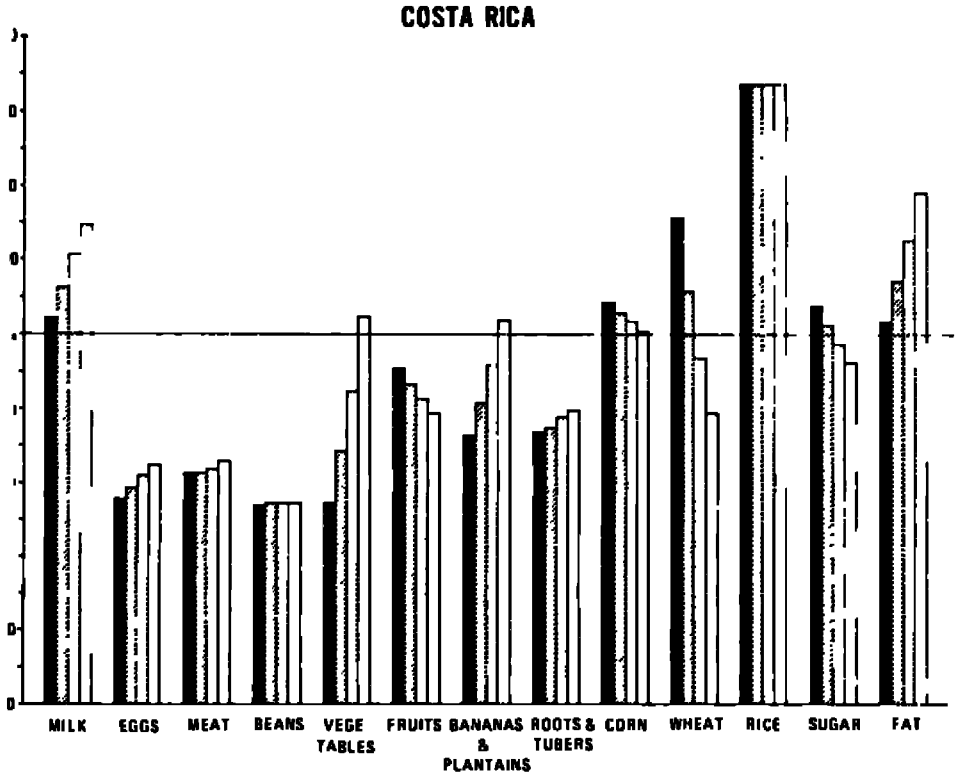
Marked deficiencies are observed in the supply of eggs, meat and beans. The projected small increases in adequacy in eggs and meat reflect efforts already being made in various countries to improve poultry and livestock production.

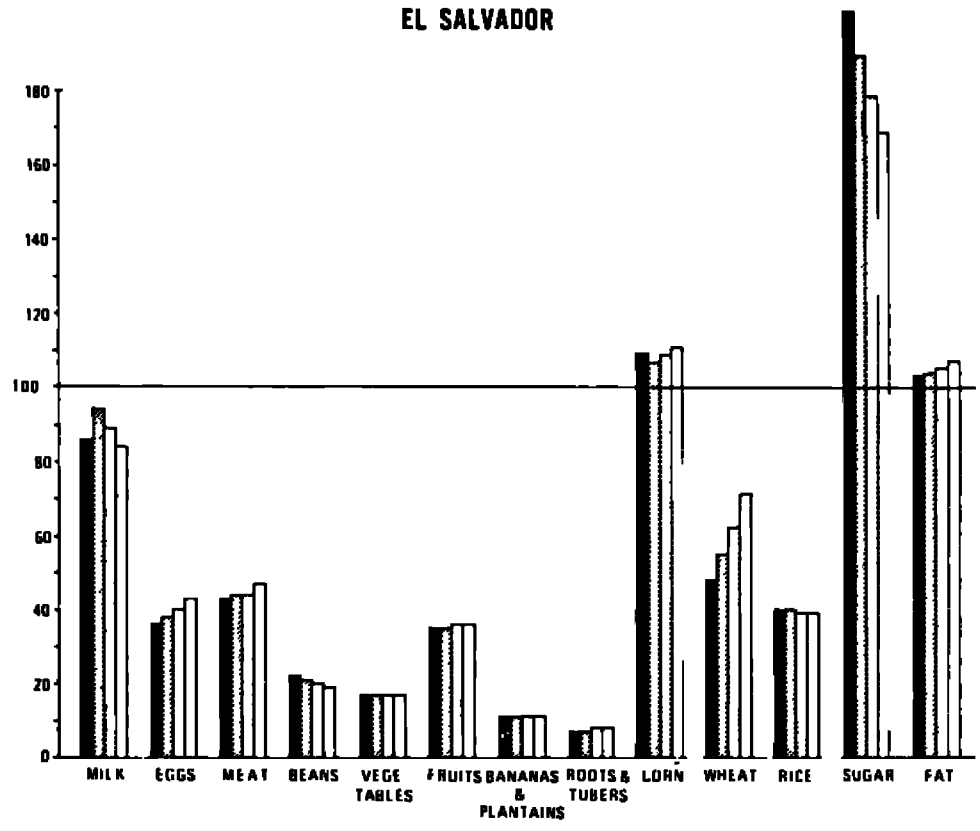
The figures for the current and anticipated availability of milk, approaching 90 percent of demand by 1980, have been greatly influenced by heavy investments in the promotion of the dairy industry in all six countries during the past two decades.

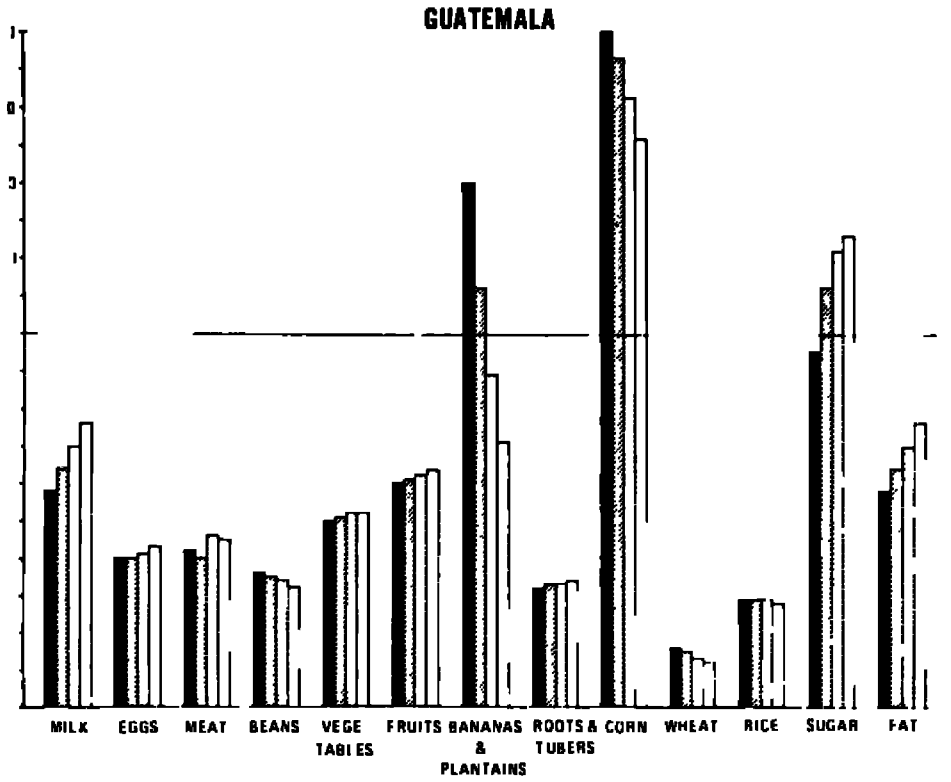
Vegetables and fruits are also in seriously short supply in the area. In the case of these products, current production actually exceeds the available supply but large losses have occurred due to poor roads and an inadequate marketing system. This also results in excessively high prices at markets that are far from production sites or difficult to reach.

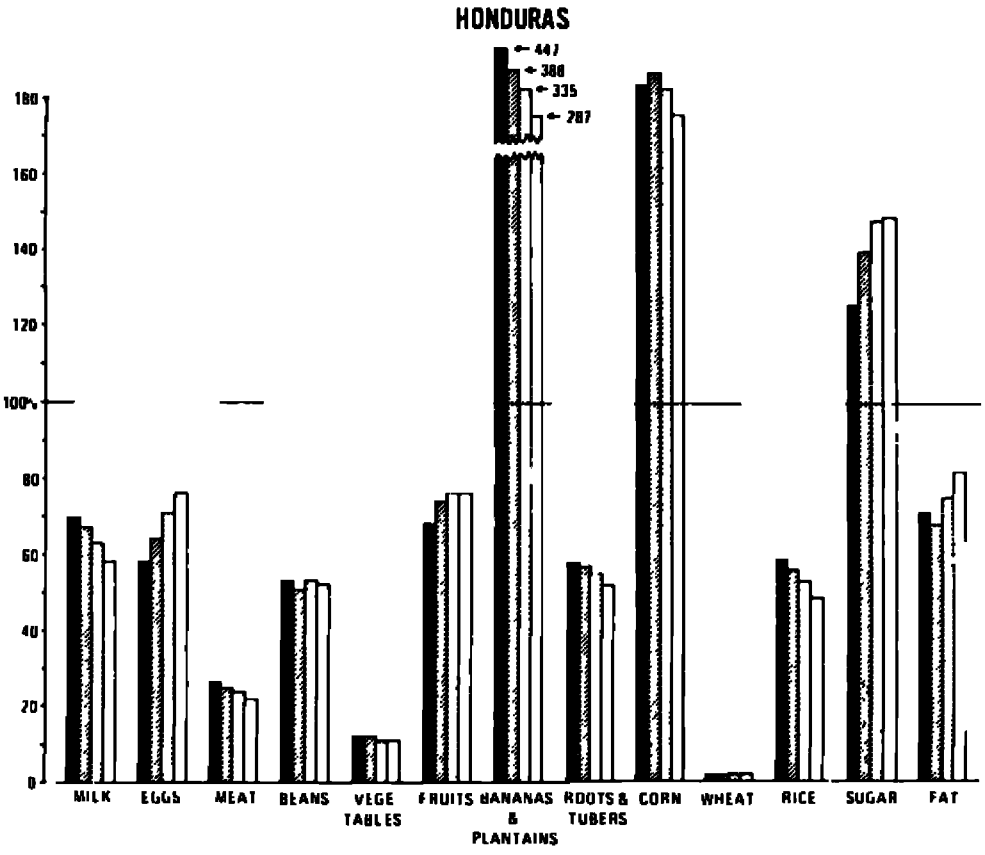
1/ INCAP V-25, p. 64; INCAP V-26, p. 62; INCAP V-29, p. 58; INCAP V-27, p. 59; INCAP V-28, p. 57; INCAP V-30, p. 67.

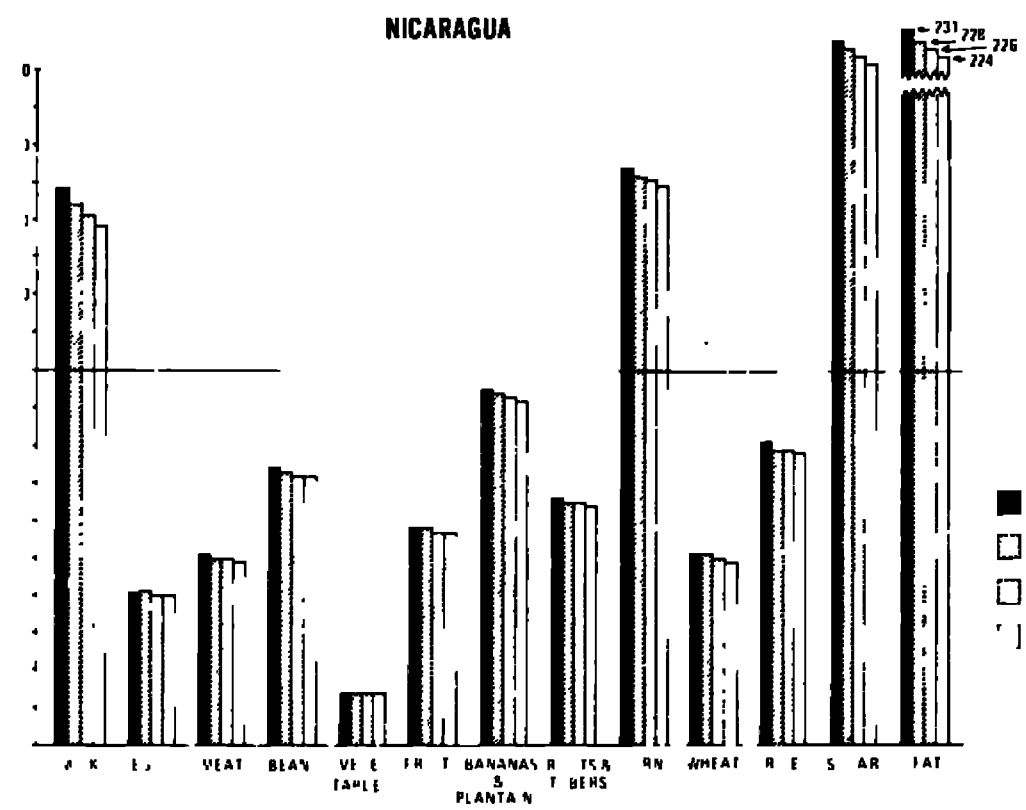
PRESENT AND FUTURE AVAILABILITY OF FOODS EXPRESSED AS PERCENTAGE OF ADEQUACY











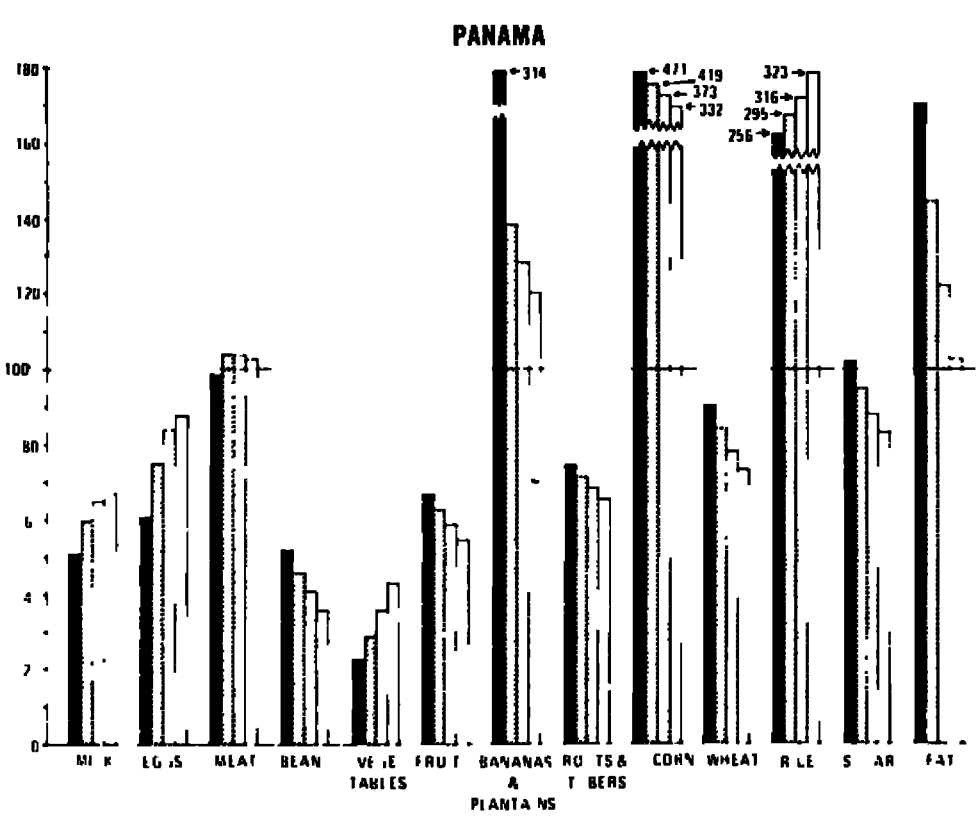


TABLE 59. CURRENT AND PROJECTED DEMAND AND SUPPLY OF FOODS IN CENTRAL AMERICA[1/]

	1965	1970	1975	1980
Demand, Metric Tons				
Milk	1232	1436	1677	1965
Eggs	133	155	182	213
Meats	373	435	508	590
Beans	303	353	412	483
Vegetables	804	937	1094	1281
Fruits	488	568	628	779
Bananas, plantains	534	623	727	842
Starchy roots, tubers	269	315	368	432
Corn	806	938	929	1282
Wheat	461	538	628	736
Rice	276	323	378	443
Sugar	293	342	399	468
Fats	68	80	93	109
Supply, Metric Tons				
Milk	1029	1257	1489	1762
Eggs	60	74	91	113
Meats	176	203	249	291
Beans	130	147	169	191
Vegetables	265	327	405	504
Fruits	296	347	405	470
Bananas, plantains	786	805	831	873
Starchy roots, tubers	130	150	174	202
Corn	1308	1480	1666	1867
Wheat	199	225	258	298
Rice	288	361	438	518
Sugar	371	454	540	629
Fats	70	83	99	119
Supply as Percent of Demand				
Milk	84	87	89	90
Eggs	45	47	50	53
Meats	47	47	49	49
Beans	43	42	41	40
Vegetables	33	35	37	39
Fruits	61	61	64	60
Bananas, plantains	147	129	114	102
Starchy roots, tubers	48	48	47	47
Corn	162	158	179	145
Wheat	43	42	41	40
Rice	104	112	116	117
Sugar	126	133	135	134
Fats	103	103	106	110

[1/]Data based on information from each country.

The current considerable excess in supply of bananas and plantains reflects the strong foreign market orientation of bananas. Demand for this product on the world market is cyclical. The current contraction phase is projected to end within the next decade, which should allow a satisfactory level of adequacy for domestic consumption even when production bottoms out before again moving upward.

Production of starchy roots and tubers does not anticipate major changes during the period encompassed by this study. Bananas and plantains are similar in nutritive value and interchangeable with starchy roots and tubers in the diet to a considerable extent. Thus any unfilled demand for starchy roots and tubers can be supplied by bananas and plantains. However, if the supply of these were also inadequate, increased market prices of starchy roots and tubers would undoubtedly stimulate production.

The supply of corn and rice is projected to exceed demand, while the availability of wheat, which is 100 percent imported by all the countries but Guatemala, will remain at approximately one-half of demand as defined in this study.

Sugar and fats, supplied entirely by area production, are expected to remain available in more than adequate amounts. International demand has historically encouraged sugar production, and development of the vegetable oil industry (primarily that of cottonseed and palm) has stimulated production of fats in the countries.

Thus the general food supply situation described for 1965 is predicted to prevail in 1970, 1975 and 1980. In other words, available calories per capita for the area are not expected to decrease and the diet will remain borderline-to-deficient in the protective nutrients.

Conclusion

It should be emphasized that "demand" as shown in Table 59 refers to physiological requirements, or amounts of each food necessary to supply sufficient calories and nutrients to the population of each country through the diet listed in Table 57. Thus "excesses" and "deficits" refer only to the established recommendations, and not necessarily to the effective demand. Data presented in Chapter XIV (Dietary Studies) indicate the extent to which the effective demand in each country currently varies with the diets listed in Table 57.

Also, in formulating estimates of food requirements for each country as a whole, and for the six countries as a single unit, equitable distribution of foodstuffs in the population is assumed. Geographic, economic and cultural factors, however, give rise to many differences in food consumption between countries, and between social and economic groups within countries.

In recent years, population growth, at an annual rate of 3 1/3 percent in the six Central American countries, has dramatically surpassed the one percent per year increase in food production. This trend, superimposed on the presently inadequate diets of large sectors of the population, indicates an urgent need to increase food production.

Historically, the agricultural population in the six countries has been receptive to promotion efforts in the past. Thus steady improvement may be expected if the countries establish food and nutrition policies supported by credit, guaranteed prices, better transportation and improved marketing and storage programs. Increase and diversification of production on small farms would automatically improve the diet of these families, which represent a large proportion of the total population. Stimulation of the food industry would aid both producers and consumers. Fortification with vitamins and minerals of processed staple foods (corn products, wheat flour, rice, dry skim milk) can at extremely low cost materially improve the diets of those people who cannot afford the expensive sources of protective nutrients.

XI

THE SOCIOECONOMIC STUDY

Since social, cultural and economic conditions influence food consumption, a study of these factors was made in the rural areas of the six countries. The study had the cooperation of the Interamerican Institute of Agricultural Sciences, based in San Jose, Costa Rica, and of the American International Association, a technical and philanthropic project of Nelson A. Rockefeller and his brothers.

The survey was made on a random subsample of one-half of the 20 families previously selected, as already described, in each survey site. Three classes of investigations were made in each location:

1. An investigation of the community as a whole including its natural resources, economic and social organization, trade within and without the community, geographic mobility of the population, and communication and exposure to mass media of communication.

2. A study of farming activities including sale of products, storage techniques, ownership, and care and feeding of livestock and livestock productivity.

3. A study of family living conditions, housing, sanitary aspects, family food production, occupation of the household head, family income from different sources, use of mass communication media and educational level of the family, level of nutrition knowledge, and concepts of adults about food and attitudes toward health services.

Rating of Rural Families According to Socioeconomic Status

The identification of socioeconomic strata in a population is basic to the allocation of nutritional and health problems within the social context. It also permits the comparison of nutritional parameters across those strata and allows provisional inferences as to the causes and processes leading to particular nutritional situations.

Information of this sort may help to increase the efficiency and decrease the cost of action programs by orienting them more closely toward specific social groups and making them fit their particular characteristics. Furthermore, for countries such as those of Central America, which have up to now depended on standards elaborated for regions biologically not comparable, this type of stratification has another advantage: The possibility of elaborating national physical and biochemical standards based on the dietary and nutritional characteristics reported for those families within the nation having the benefit of the best socioeconomic conditions.

It was considered fundamental that the techniques developed for differentiating the social strata be inexpensive and easy to apply by technical personnel. Such a procedure should satisfy the other requisites also listed in Table 60.

TABLE 60. CRITERIA FOR THE ELABORATION OF A SOCIOECONOMIC INDEX

1. Simple to apply
2. Low Cost
3. It should define the strata of the population in a manner as precise and quantitative as possible.
4. The questions should be relevant to the socioeconomic context.
5. The questions should be relevant to the problem under investigation, in this case, the nutritional problem.
6. It should contribute to the understanding of the socioeconomic mechanisms which lead to disease and permit the formulation of hypotheses about relationships between social factors and health and nutritional status.

The following section describes the techniques used in the development of a socioeconomic index for the families according to the principles enumerated.

A problem encountered in the handling of cultural data is the qualitative character of the information. To obviate this difficulty a questionnaire was devised in such a way as to permit the immediate translation of the answers and observations to a numerical system transferable to IBM cards. This allowed a quantitative expression of the socioeconomic situations of the families as presented in Table 61. In this example the house was owned by the family. It had a dirt floor, tile roof, and a mud-bench stove for cooking with woodfire. The numbers 1, 2, and 3 are in themselves a classification: 1) represents the worst situation; for example, a straw roof; 2) the intermediate wooden roof and 3) the best, represented in this example, by a tile or tin roof.

This type of scale cannot be used for items such as income which form a continuous series of values. In this case the procedure consisted in ranging the families from the worst to the best economic situation. The families within the first quartile were assigned a value of 1, those between the first and the third, a value of 2, and those in the highest quartile, a value of 3.

TABLE 61. PARTIAL EXAMPLE: HOUSING CONDITIONS

Question No.	Column No.[1/]	Code	Question
1	10	3	Possession: 1, Tenant; 2, Free user; 3, owner.
2	11	1	Floor: 1, dirt; 2, wood; 3, smooth and washable surface.
3	12	3	Roof: 1, straw; 2, wood; 3, tile, tin, concrete or similar.
8	23	2	Cooking: 1, on the floor; 2, on mud or brick bench; 3, manufactured stove.

[1/]Column number in IBM card.

One or more indicators compose a single index. The indicators and indices were selected because of their importance and discriminative character in vast cultural complexes pertaining to the physical environment, the economic system, the social relations, and to strictly "cultural" issues. Thus they are potential indicators of the overall situation of the families in these four areas. They were also selected because of their theoretical relevance to nutritional aspects and problems. Table 62 lists the eight subindices that served as bases for the overall socioeconomic index of the families.

Each one of these subindices represents average situations of the families with respect to the specific items or indicators. Thus, following the example given in Table 61, the index of Housing Conditions included ownership, type of floor, type of roof and kitchen facilities. The value given to each one of these items could be 1, 2, or 3. The arithmetic mean of the values obtained represents the classification of the family with respect to housing conditions. A similar procedure was followed with each of the seven other subindices.

TABLE 62. SOCIOECONOMIC INDICES

Physical Environment
1. Housing conditions
2. Sanitary conditions of the house
3. Space/occupancy ratio
Economic Aspects
4. Food production
5. Family income per capita
Cultural Aspects
6. Index of formal education of the family
7. Exposure to communication media
Social Aspects
8. Occupation of the head of the family

The index of Sanitary Conditions of the house included type of bed, availability of drinking water, disposal of excreta and waste, and number and proximity of domestic animals to living quarters. The Occupancy Index included the following quotients: number of rooms, bedrooms and beds, divided by the number of persons sleeping in the house. For the Index of Food Production the following parameters were used: annual production of milk, cheese, grains, vegetables, roots, tubers, and fruits, expressed in pounds and divided by the number of members in the family. The Index of Family Income was obtained from the total monthly income divided by the number of family members. The Index of Schooling represented the sum of the number of grades completed by the members of the family divided by the sum of grades that they should have completed according to their age and the legal requirements of the country. The Index of Exposure to Communication Media was measured in terms of the number of hours that the family listened to radio, watched television or movies, and the number of magazines and books that the family read per week. Finally the Occupation was measured in terms of percentage of total work per year devoted to agriculture.

The values obtained for each family in each of the eight indices were ranged from lowest to highest. Using the procedure of quartiles once more, they were reassigned the values of 1, 2, and 3, according to their allocation in the first, second and third, or fourth quartiles. The arithmetic average of the sum of these values is the overall index of the family and expresses a "low", "medium", or "high" socioeconomic level.

In several sections of this report examples are given showing the relevance of this classification in terms of characteristics which reflect the nutritional status of the population. For example, several biochemical parameters differ markedly between families at the "low", "medium", and "high" socioeconomic levels. A similar finding was observed with regard to mortality of children between one and five years of age. Differences in food consumption and nutritive value and adequacy of the diets at the three socioeconomic levels in the populations of the countries will be the subject of later reports.

Results

An absence of organization among the rural people in the six countries was considered responsible in part for the low levels of development found. Food production, distribution and consumption were mostly individual family undertakings. Cooperatives of production, consumption and finance in the communities surveyed were few. In El Salvador, Honduras and Nicaragua these numbered from 17 to 19 in the 30 locations while Panama had 37. Wage work was scarce in most rural areas. It was often only seasonal and almost always supplementary to the domestic subsistence economy. In four countries in 30 localities each, there were from 235 to 700 economic establishments of one kind or another where persons other than family members were employed. These businesses usually included stores, workshops or small industries producing furniture, clothing and other consumer goods. However, in four countries where figures are given, from 44 to 70 percent of these businesses were concentrated in from three to seven of the largest of the 30 localities.

El Salvador differed from the other countries in having some 700 establishments offering wage work to residents of the 30 communities studied. These establishments in this case included many small plantations, as well as stores, workshops, etc., employing persons other than family members. In El Salvador, food production was centered in the small plantations or labor contractors, and the distribution in the hands of storekeepers.

Voluntary noneconomic organizations existed in the rural areas of the six countries but they were few in number and not highly developed. These included religious and civic committees or groups. Although the religious committees were often inactive, both groups were considered potentially important as fields for future education in improved techniques of production, health and nutrition.

The isolation of rural communities in Central America from exposure to modern knowledge and technical advances was considered an important factor in their unsatisfactory social and economic development and in their adherence to traditional concepts concerning foods and nutrition. Two measures of the degree of their isolation from modern influences

were developed. One was an index of the level of family education, obtained by dividing the sum of the years of schooling which each member actually had by the sum of the years which each member should have had in accordance with the minimum legal requirements of six years. This index is expressed as percent of the legal minimum in the following table.

TABLE 63. DISTRIBUTION OF RURAL FAMILIES BY INDEX OF FORMAL EDUCATION AS PERCENT OF LEGAL MINIMUM

Formal Education	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
(Number of Families)	(392)	(299)	(276)	(273)	(299)	(293)
Percent of Legal Minimum			Percent of Families			
0	26	17	8	13	3	3
10 to 29	15	23	17	22	6	7
30 to 59	29	33	34	33	29	21
60 to 99	20	21	31	26	44	43
100 to 240	8	6	10	6	18	25

In about a fourth of the rural families in Guatemala and a sixth of those in El Salvador, no person had had any schooling at all. This educational lack was least in Costa Rica and Panama. These latter two countries, moreover, had the highest proportion of families with educational levels exceeding the minimum of six years. From about 60 to 75 percent of the families in El Salvador, Guatemala, Nicaragua and Honduras have barely over half the minimum years of schooling required.

A second measure of the isolation of the rural families from the influences of the modern world was their access to different mass means of communication, shown in Table 64.

Radio is the most widely used source of information from the outside world for the rural families in all the countries. The proportion of families listening to radio ranges from 53 percent in Guatemala to 88 percent in Panama. However, families listening frequently (daily by at least one member) vary from 36 percent in Guatemala to 72 percent in Costa Rica.

The second most common information facility is the newspaper, and families reading them range from 45 percent in Guatemala to 79 percent in Panama. However, families reading newspapers frequently (defined as subscribing to at least one paper) vary from nine percent in Nicaragua to 23 percent in Costa Rica. In all the countries, the great majority of those reading or subscribing to newspapers are concentrated in a very few of the larger communities. It was also noted that the books listed included religious books and those brought home by children from school.

TABLE 64. PERCENT DISTRIBUTION OF RURAL FAMILIES USING DIFFERENT SOURCES OF INFORMATION

	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
Number of Families	400	299	276	273	299	293
	Percent of Families Using (figures in parentheses represent frequent users)					
Radio	53 (36)	59 (37)	67 (52)	63 (48)	83 (72)	88 (68)
Newspapers	45 (12)	56 (13)	45 (8)	50 (9)	72 (23)	79 (10)
Books	46 (22)	55 (43)	52 (21)	43 (13)	56 (22)	47 (5)
Magazines	39 (8)	38 (6)	49 (9)	43 (7)	65 (12)	72 (4)
Motion Pictures	40 (20)	20 (5)	26 (5)	38 (12)	44 (11)	35 (3)
Television	7 (3)	16 (5)	6 (1)	2 (1)	34 (12)	39 (10)

The proportion of families who see motion pictures ranges from 20 percent in El Salvador to 44 percent in Costa Rica. The proportion seeing them frequently (defined as those in which any member sees a show at least once a month) varies from five percent in El Salvador and Honduras to 20 percent in Guatemala. The hours per week spent seeing motion pictures are, however, concentrated in a few of the largest communities in the various countries. Because of its high cost, television was expectedly the least used source of information. The viewers varied from two percent of the families in Nicaragua to 39 percent in Panama, but those viewing television frequently were much less numerous. From 50 to 90 percent of the television sets recorded during the survey were located in from one to five of the largest communities in the different countries.

Although exposure to information from the outside world by mass media is greatest in Costa Rica and Panama, it is in general limited and the level of formal education in most of the rural areas is low. These are two important considerations in the development of educational programs designed to improve current conditions. The survey concluded that it was not yet possible to find a receptive population or medium sufficiently widespread to bring about rapid change.

Knowledge and Beliefs of the People Concerning Nutrition and Disease

The knowledge and beliefs of the rural population were generally insufficient for resolving their nutritional problems. Table 65 shows the concepts of adults concerning marasmus and kwashiorkor, children's

TABLE 65. PERCENT DISTRIBUTION OF HOUSEHOLD HEADS BY CAUSES ASCRIBED TO MARASMUS AND KWASHIORKOR

Attributed Causes	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
	Percent of Household Heads					
Causes for Marasmus						
Does not know	34	50	50	36	31	48
Nutrition[1/]	18	23	25	31	54	23
Ample understanding	7	0	1	0	0	3
Magical beliefs	9	1	3	3	0	1
Parasites	10	6	10	17	3	10
Unspecified infections	25	20	11	13	13	15
Causes for Kwashiorkor						
Does not know	30	51	51	30	26	43
Nutrition[1/]	14	24	26	50	53	18
Ample understanding	2	1	1	0	0	3
Magical beliefs	13	7	1	2	0	3
Parasites	0	6	8	9	0	18
Unspecified infections	21	11	13	9	11	15

[1/] Partial or erroneous concepts.

diseases caused by calorie-protein malnutrition. From some 30 to 50 percent of the adults questioned had no notion of the cause of either disease. Less than 20 to over 50 percent in the various countries thought that nutrition was involved but their understanding was incomplete or erroneous. Few persons in any of the rural areas had an ample understanding of the subject. Somewhat larger groups ascribed a number of magical causes to these diseases and a substantial proportion thought that intestinal parasites or other infections were responsible.

Replies to questions about what foods were believed to be most important for different ages and physiological states are summarized in Table 66.

TABLE 66. PERCENT DISTRIBUTION OF INFORMANTS BY FOODS CONSIDERED GOOD FOR DIFFERENT AGES AND PHYSIOLOGICAL STATES

	Milk Products	Eggs, Meat	Vege-tables	Fruit	Cereals	Other Foods	No Belief
	Percent of Informants						
Guatemala							
Children under 2 years	36	12	8	2	12	-	30
Children 2 to 5 years	27	15	7	2	16	-	33
Pregnant women	23	19	4	4	7	-	43
Lactating women	18	11	4	4	25	-	38
El Salvador							
Children under 2 years	17	6	10	1	8	-	38
Children 2 to 5 years	30	7	9	2	4	-	48
Pregnant women	18	9	7	1	1	-	63
Lactating women	14	7	6	2	1	-	68
Honduras							
Children under 2 years	29	4	6	5	6	-	30
Children 2 to 5 years	23	6	6	5	3	-	57
Pregnant women	15	8	3	4	2	-	68
Lactating women	13	11	4	1	5	-	66
Nicaragua							
Children under 2 years	40	12	15	3	14	-	16
Children 2 to 5 years	45	17	10	0	6	-	22
Pregnant women	27	25	12	4	6	-	26
Lactating women	31	21	10	1	10	-	27
Costa Rica							
Children under 2 years	32	12	5	11	3	2	35
Children 2 to 5 years	26	19	3	5	2	3	42
Pregnant women	22	14	6	7	1	3	47
Lactating women	11	13	12	2	7	2	53
Panama							
Children under 2 years	12	4	11	2	6	3	62
Children 2 to 5 years	12	10	6	1	4	3	64
Pregnant women	12	10	3	2	2	4	67
Lactating women	9	6	5	2	5	3	70

The figures show that most rural women expressing an opinion on the matter agreed that milk and milk products were most important for children during the first year of life as well as for pregnant and lactating women. A marked preference is also indicated for foods of animal origin for both children and mothers. However, a large proportion of the women in most of the countries professed no opinion at all. The data suggest that if economic conditions permitted some part of the population would, of its own accord, feed their children and themselves better than they now do. However, a group equally large promises no such favorable change. These findings are important in making a balanced judgment between how much can be expected from programs of nutrition education and improvement in socioeconomic conditions.

Agricultural Activities

The farming families ranged from 30 percent of the total rural population studied in Costa Rica to 59 and 60 percent respectively in Panama and Guatemala (Table 67).

TABLE 67. PROPORTION OF FARMING FAMILIES IN THE RURAL POPULATION

Country	Total Families Studied	Farming Families	
		Number	Percent
Guatemala	400	242	60%
El Salvador	299	136	45%
Honduras	276	139	50%
Nicaragua	273	91	33%
Costa Rica	299	89	30%
Panama	293	173	59%

Both the number of crops cultivated and the amounts produced were limited (Table 68). In Guatemala and Panama, 98 percent of the farming families cultivated a total of 10 different crops while five or six crops were the limit in the other four countries. From four to eight additional crops were reported in the various countries by less than two percent of the farming families. The four crops reported most commonly in all six countries were corn, beans, rice and bananas or plantains.

Those producing corn varied from 58 percent of all the farming families in Costa Rica to 100 percent in El Salvador. However, 60 percent of the families growing corn in El Salvador produced less than 1,000 pounds per year, although the average amount consumed in

TABLE 68. PERCENT DISTRIBUTION OF FARMING FAMILIES BY QUANTITY OF PRINCIPAL FOOD CROPS PRODUCED PER YEAR

Production (pounds per year)	Corn	Beans	Rice	Bananas, Plantains	Sorghum	Cassava	Wheat	Potatoes	Broad Beans	Sweet Potatoes	Vege-tables	Oranges	Mangoes	Sapotes	Coconuts	Coffee
								(Percent of Farming Families)								
Guatemala (N=242)[a]	(81)	(47)	(7)	(13)	(7)	-	(11)	(9)	(10)	-	(4)	-	-	-	-	(20)
< 1,000	29	42	3	3	3	-	4	5	10	-	3	-	-	-	-	9
1,000 - 24,999	28	4	3	5	3	-	4	3	<.5	-	1	-	-	-	-	3
25,000 - 99,999	21	1	1	4	1	-	2	1	0	-	<.5	-	-	-	-	5
≥100,000	3	0	0	1	0	-	1	0	0	-	0	-	-	-	-	3
El Salvador (N=137)[a]	(100)	(34)	(11)	(17)	(42)	-	-	-	-	-	-	-	-	-	-	-
< 1,000	60	33	9	7	22	-	-	-	-	-	-	-	-	-	-	-
1,000 - 24,999	26	1	2	3	17	-	-	-	-	-	-	-	-	-	-	-
25,000 - 99,999	13	0	0	7	3	-	-	-	-	-	-	-	-	-	-	-
≥100,000	1	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
Honduras (N=139)[a]	(84)	(49)	(13)	(27)	(11)	(12)	-	-				-				-
< 1,000	17	33	7	9	3	3	-	-				-				-
1,000 - 24,999	32	12	4	4	6	2	-	-				-				-
25,000 - 99,999	25	4	2	6	1	3	-	-				-				-
≥100,000	10	0	0	8	1	4	-	-				-				-
Nicaragua (N=91)[a]	(97)	(57)	(9)	(23)	(38)	-	-	-				(10)				-
< 1,000	42	34	3	1	15	-	-	-				3				-
1,000 - 24,999	26	17	2	7	15	-	-	-				5				-
25,000 - 99,999	26	6	1	7	8	-	-	-				2				-
≥100,000	3	0	3	8	0	-	-	-				0				-
Costa Rica (N=89)[a]	(58)	(22)	(22)	(46)	-	(17)	-	-		-	(12)	-				-
< 1,000	26	18	12	22	-	9	-	-		-	8	-				-
1,000 - 24,999	21	3	9	14	-	5	-	-		-	1	-				-
25,000 - 99,999	8	1	1	9	-	3	-	-		-	0	-				-
≥100,000	3	0	0	1	-	0	-	-		-	3	-				-
Panama (N=173)[a]	(85)	(26)	(81)	(53)	-	(68)	-	-		(40)	-	(21)	(17)	(6)	(6)	-
< 1,000	37	24	34	29	-	39	-	-		28	-	11	13	4	0	-
1,000 - 24,999	28	0	31	16	-	21	-	-		9	-	3	3	1	3	-
25,000 - 99,999	19	2	14	7	-	8	-	-		2	-	5	1	1	3	-
≥100,000	1	0	2	1	-	0	-	-		1	-	2	0	0	0	-

[a] Number of families.

that country by a rural family would be about 1,700 pounds per year (Table 3). In Guatemala 29 percent also produced this insufficient amount. In the other four countries, the dependence upon corn was less.

Fewer families produced beans, and they ranged from 22 percent of the farming families in Costa Rica to 57 percent in Nicaragua. The very large majority of them produced less than 1,000 pounds per year, and in half the countries, less than 500 pounds per year. However, the amount of beans required is less than the amount of corn. On the basis of data from the dietary study on the average consumption of beans, it was estimated that a rural family would need amounts per year ranging from about 100 pounds in Panama to 365 pounds in Nicaragua.

Substantial numbers of farming families lost significant proportions of their crops of corn and beans before the harvest, due to plagues, weather and other conditions beyond their control (Table 69).

TABLE 69. CROP LOSSES BEFORE HARVEST REPORTED BY FARMING FAMILIES

		Losses as Percent of Expected Yield			
	Families	0	<10	10-24	25-49	≥50
		Percent of Families				
Corn						
Guatemala	195	52	6	13	21	8
El Salvador	136	52	4	11	19	14
Honduras	110	30	4	13	28	24
Nicaragua	91	30	0	5	19	46
Costa Rica	44	-	-	-	-	-
Panama	144	48	5	19	11	17
Beans						
Guatemala	116	52	-	3	12	33
El Salvador	50	46	0	8	26	20
Honduras	70	21	0	9	27	41
Nicaragua	48	42	0	0	23	33
Costa Rica	20	-	-	-	-	-
Panama	42	69	2	5	10	14

In Nicaragua 46 percent of the farming families lost one-half or more of their crop of corn before the harvest, and in neighboring Honduras, this number was 24 percent. Farmers in the other countries also lost much of their corn. The situation in regard to beans was even somewhat worse.

Other factors also limited the production of food crops by the farming families. Improved varieties of seed were little used in most

of the countries (Table 70). Only in Honduras and Panama did a substantial proportion of farmers plant better corn, and in Panama, improved varieties of beans.

TABLE 70. SEED SELECTION, USE OF FERTILIZER AND STORAGE PRACTICES AMONG FARMERS

	No. of Families	Seed Selection		Fertilizers Used			Storage Facilities	
		Natural	Improved	None	Organic	Chemical	Poor	Adequate
		% of Families		% of Families			% of Families	
Corn								
Guatemala[1/]	195	86	10	50	32	13	86	14
El Salvador[1/]	136	89	5	77	1	16	70	22
Honduras[1/]	110	58	41	95	2	2	90	9
Nicaragua	91	93	7	92	0	8	96	4
Costa Rica	44	98	2	85	0	14	98	2
Panama	144	70	30	97	0	3	99	1
Beans								
Guatemala[1/]	113	93	4	60	26	11	66	34
El Salvador[1/]	50	90	6	90	0	0	60	28
Honduras[1/]	70	98	1	96	3	0	89	10
Nicaragua[1/]	48	96	0	94	0	2	79	17
Costa Rica	20	100	0	95	0	5	100	0
Panama	42	71	29	100	0	0	74	26

[1/]Responses were incomplete or lacking for some families.

Only in Guatemala did substantial numbers of farmers report using fertilizer, and this was largely organic. In the other countries, smaller proportions of farmers used fertilizers, and mainly chemical.

Poor storage practices resulted in the loss of crops after harvest due to insect pests and rodents. Very few families in the six countries had adequate storage for their corn. Others had poorly constructed, improperly protected structures or none at all. Thus a portion of the limited supplies produced were subsequently destroyed.

Livestock, including poultry, is owned by the large majority of all rural families (Table 71), or from 87 percent in Nicaragua to 100 percent in Costa Rica and Panama. The livestock numbers are, however, limited and the ownership is concentrated in a relatively small number of families except in the case of poultry. The percent

of the families owning cattle ranged from eight percent in Costa Rica to 26 percent in Honduras and Panama. The families of Honduras, Nicaragua and Panama had the largest number of cattle and owned, on the average, from about 23 to 29 head per family. The smallest numbers of cattle were held by families in El Salvador, the most densely populated country, and Guatemala, the most mountainous.

TABLE 71. LIVESTOCK OWNERSHIP BY THE RURAL FAMILIES

	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
Number of Families Studied	400	299	276	273	299	293
Percent of Families Owning						
Cattle	9	14	26	16	8	26
Sheep and goats	2	0	2	0	0	0.3
Pigs	27	38	40	50	12	19
Poultry	54	57	74	62	53	74
Average Number per Family						
Cattle	7.9	5.2	27.5	29.4	11.4	23.2
Sheep and goats	12.1	0	2.5	0	0	6.0
Pigs	2.5	4.4	5.5	3.9	3.4	4.6
Poultry	12.0	11.4	14.1	14.0	20.5	24.9

Pigs were more widely distributed and the percentage of families owning them ranged from 12 percent in Costa Rica to 50 percent in Nicaragua. The average number per owner was small, ranging from 2.5 in Guatemala to 5.5 in Honduras.

Many families owning pigs fed them exclusively on kitchen and other wastes. Over half, however, fed them grain, which was usually corn. They rarely received concentrates (Table 72).

Poultry was the most widely distributed and the percent of families keeping poultry ranged from 53 percent in Costa Rica to 74 percent in Honduras and Panama. The average size of flock varied from about 11 or 12 in El Salvador and Guatemala to 20 and 25 in Costa Rica and Panama.

Poultry almost always received corn and occasionally concentrates. Good breeds of chickens, as well as of pigs, were rare. A flock of about a dozen hens produced an average of two eggs a day. In Costa Rica and Panama, where flocks averaged over 20 chickens, three eggs a day were reported. Pigs or chickens were rarely vaccinated against disease. In Guatemala, El Salvador and Nicaragua, families reported

as many chickens lost to disease the year before as remained on hand at the time of the survey. In Panama the number lost was calculated as 57 percent of those remaining.

TABLE 72. CUSTOMS OF FEEDING FARM ANIMALS

Feeding Materials	Guate-mala	El Sal-vador[1/]	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percent of Families			
For Pigs						
Waste materials only	41	2	9	20	46	39
Grain	56	95	91	78	51	56
Some concentrates	3	1	0	2	3	5
For Poultry						
Grain	98	98	98	92	94	96
Some concentrates	2	1	2	8	6	4

[1/] No information from two percent of the families on pigs, and from one percent, on poultry.

Cows produced an average of less than three liters of milk a day in most countries, but Costa Rica reported an average yield of about four liters. Very few families owned good breeds of cattle. The vaccination of cattle was somewhat more common than that of pigs or poultry.

Family Income

The total cash income of rural families, farming or not, during the month preceding the socioeconomic study in each country, is shown in Table 73. The factors influencing the availability of wage work or other sources of cash at different times of the year could not be taken into account in the planning. The month for which income was reported in each country is shown. Although months other than those chosen might have provided better descriptions of the situation, it was considered that differences which might have been found would not affect the general validity of the conclusions.

The degree to which the rural economy was a subsistence one is suggested by the proportion of families with little or no cash income. Families without any cash income ranged from two percent in Honduras and El Salvador to 18 percent in Guatemala. Families obtaining cash but less than $5.00 per person during the month ranged from 14 percent

TABLE 73. PERCENT DISTRIBUTION OF RURAL FAMILIES BY TOTAL CASH INCOME PER PERSON DURING MONTH PRECEDING THE SURVEY

	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
Number of Families	400	299	276	273	299	293
Month Recorded	Jan.	Sept.-Oct.	Sept.	Dec.-Jan.	May	Dec.-Jan.
			(Percent of Families)			
Total Cash Income from All Sources[1]						
0	18	2	2	3	3	9
<5.00	34	46	28	20	19	14
5.00 - 9.99	20	23	25	29	31	17
10.00 - 19.99	14	16	18	23	26	25
20.00 - 49.99	9	10	17	17	15	24
≥50.00	3	2	5	6	5	7
No Information	2	-	5	-	1	4
			(Percent of Families)			
From Agricultural and Commercial Articles						
0	74	83	83	82	93	86
<5.00	14	8	8	5	4	6
5.00 - 9.99	4	4	3	2	0	2
10.00 - 19.99	14	3	4	4	2	2
20.00 - 49.99	2	1	1	3	1	3
≥50.00	3	0	0	3	0	1
No Information	-	-	1	-	-	-
			(Percent of Families)			
From Products of Small Industries & Other Articles						
0	31	12	9	7	5	19
<5.00	33	45	30	24	19	13
5.00 - 9.99	17	20	22	27	32	15
10.00 - 19.99	10	14	15	22	27	23
20.00 - 49.99	6	7	16	14	13	21
≥50.00	1	2	4	4	4	6
No Information	2	-	4	-	-	3

[1]/In U. S. dollars.

in Panama to 46 percent in El Salvador. Families at these levels would have to produce much of their own food and other necessities. Plantation workers in some areas, however, receive rations of corn and other food items as part of their pay. Half or more of the families in most of the countries made less than $10.00 cash per person for the month. From 12 percent of the rural families in Guatemala to 31 percent in Panama

obtained more than $20.00 cash per person for that time. In the group at the highest level, earning over $50.00 cash per person, were rural families ranging from two percent in El Salvador to seven percent in Panama.

The contribution to the total cash income of the families made by the sale of agricultural and other (not specified) products is also shown in the table. From 74 percent of the families in Guatemala to 93 percent in Costa Rica reported no cash income at all from such sources. These numbers would necessarily include families which did not farm. Only Guatemalan families had some significant cash returns from farm products.

The contribution to the total cash income made by crafts and other articles (not specified) was greater than that of agriculture. Although from five to 31 percent of the rural families gained no cash at all from crafts and other items, others obtained substantial amounts.

Population Imbalance

The total number of persons in the families selected at random from each Central American country for the nutrition survey varied from 4,800 in El Salvador to over 6,000 in Costa Rica (Table 74).

TABLE 74. AGE AND SEX GROUPS IN THE SAMPLE POPULATIONS

Country	No. in Total Sample	Age Groups As Percent of Total Population				M per 100 F 1/	
		<10 Years	<15 Years	15-64 Years	≥65 Years	In Total Sample	15-44 Years
Guatemala	6132	32.5	46.6	50.0	3.4	94.4	80.7
El Salvador	4809	32.8	46.9	48.8	4.3	88.7	80.1
Honduras	5196	34.3	49.1	46.7	4.2	84.0	73.8
Nicaragua	5582	34.0	48.7	47.2	4.1	84.3	75.2
Costa Rica	6185	33.1	48.3	48.0	3.7	95.4	86.4
Panama	4899	32.7	46.7	48.6	4.7	95.8	99.6

1/Males per 100 females.

The data showed that persons under 15 years formed a large proportion of the total in each country. The proportion of those 15 to 64 years, which is the main labor force in a population, was less than one-half of the total sample in all countries except Guatemala, where it was just 50 percent. The economic burden in most of the Central American countries is, therefore, borne by one-half or less of the population, if the random sample selected was representative. It must, however, be said that children under 15 make significant contributions to the family

economy in many rural areas, boys helping men in the fields and girls taking important responsibilities in the home. Children take part with the adults in farm labor at harvest times in some areas.

It was also noted in the population samples of all six countries that females outnumbered males. In the samples as a whole the males per 100 females ranged from 84.0 percent in Honduras to 95.8 percent in Panama. The imbalance was, however, particularly striking in the 15 to 44 year group where the males per 100 females ranged from 73.8 percent in Honduras to 99.6 percent in Panama. This suggests an emigration of males of prime working age from their rural family environment in some countries.

It was brought out in an earlier section of the report (Chapter X) that the annual population growth in Central America is of the order of three and one-third percent while the increase in food production is one percent. The possibilities for accelerating food production are tied up with a number of population characteristics, among these: the small proportions which make up the effective labor force; the low educational level of adults in the rural areas and their inadequate agricultural techniques; the isolation of the rural communities from modern influences; the poverty of a substantial proportion of the rural population; and the small degree of social cohesiveness in the communities, so that cooperative action is uncommon. An aggravation of nutritional problems may be expected from the rapid population growth and slow agricultural development.

XII

STUDY OF INTESTINAL PARASITES

The role of intestinal parasites in the nutritional problems of the human host has not been well characterized (Scrimshaw et al., 1968). However, there are data which show that Giardia, Strongyloides, hookworm, Trichuris, and Ascaris may interfere in some way with the nutrition of the host. The worm burden seems more important when the child is receiving an inadequate diet and is underweight. In addition, some parasites (E. histolytica, D. fragilis, Giardia, Strongyloides) are responsible for a proportion of the diarrheas and dysenteries which undoubtedly contribute to nutritional deterioration.

Although common knowledge of the sanitary conditions in Central America points to an expected high prevalence of infection, there has been inadequate information on the extent of the problem. Previous studies have been in hospitalized populations or in groups attending health centers, usually in the cities or nearby towns, leading to non-representative sample results. Some of these studies represented pooled longitudinal and cross-sectional observations; remote and less accessible rural areas were usually not represented at all. In addition, a wide variety of methods was used for the investigation of parasites resulting in conflicting information. Furthermore, statistical sampling and analysis have rarely been considered in these studies.

A parasitological study which met the following requirements was carried out in this survey:

1. To study the prevalence and intensity of intestinal parasites in a statistically-drawn sample of the population;

2. To analyze the data in such a way as to unveil related host and environmental factors.

Materials and Methods

Specimens were collected and processed the same day in the field. Fecal suspensions in 5 percent formalin solution (in a 1:1 proportion), and in polyvinyl alcohol-Schaudinn fixative (PVA) (in a 1:3 proportion),[1] were prepared. When insufficient sample was available, only a PVA preparation was made. The formalinized material was used to perform egg counts[2] and smears were prepared from the PVA's and stained with the trichromic technique.[3] Egg counts and examination of stained smears were performed by technicians with satisfactory agreement in the diagnosis.

Results

Before discussing results, the following observations regarding the methods should be taken into consideration. The Stoll egg count technique, as performed in this study, shows infections when at least 100 eggs per gram of wet feces are passed and probably does not reveal all mild infections. Overall rates for helminths, therefore, are likely to be lower than they would appear with other techniques. Furthermore, for hookworm species and Strongyloides fecal cultures are indicated to reveal most of the infections.

The procedures used in this study are not adequate to establish the prevalence of pinworms, where the cellophane tape technique is indicated.

The staining technique is recommended to demonstrate most infections with protozoa. However, infections with Enteromonas hominis tend to escape diagnosis by the trichromic method.

Urban Areas

The prevalence of helminths among the urban subjects in all countries was relatively high, with Ascaris lumbricoides and Trichuris trichiura as the predominant species. Hookworms were prevalent throughout Central America, but in lowlands. Comparatively, Taenia, Hymenolepis, and H. nana were less frequent (Tables 75 to 80).

Rural Areas

Prevalence. The overall prevalence of helminths in the rural areas was higher than in the cities. The frequency of infection by age is shown in Tables 75 - 80. Helminths were found in the first year of life with certain regularity. Rates of all helminths increased progressively with age. Rates of helminths in relation to altitude are presented in Tables 81 to 86.

Intensity of Infection

Tables 87-93 show the figures for Ascaris ova counts by age. Most Ascaris infections were mild (less than 10,000 eggs per gram). Some were moderate (10,000 to 49,900 eggs per gram) and a few were severe (50,000 or more).

Most Trichuris infections were mild (Tables 94-98), but some moderate and severe (5,000 eggs or more) infections were found. Regarding hookworm, the rate of infections with 2,000 or more ova per gram of feces (severe infections) was significant although

relatively low (Tables 99-103 , with no particular distribution by age.

Comment

Intestinal parasites occur commonly in Central America because of four factors which favor infection and dissemination: (1) characteristics of climate, mainly rainfall, temperature and humidity, that are optimal for embryonation of eggs and development of infective larvae; (2) characteristics of the soil which permit sustained conditions for the development of intermediary phases of parasites; (3) poor environmental sanitation, (inadequate disposal of feces and waste, unsafe water supply), which provide sources of infection and favor spreading and (4) low levels of personal hygiene permitting frequent transmission by direct and indirect contact.

The present findings indicate a high frequency of the most important intestinal parasites in the rural and urban areas surveyed. The endemicity became evident with the high rates of infection found by several species of helminths and protozoa. Furthermore, quantitative determination of helminth eggs showed a considerable number of moderate and severe infections by Ascaris, Trichuris and hookworm.

The analysis of the data by age groups indicates that infection in the first year of life is low, increasing abruptly to reach maximum levels at 2 to 4, 5 to 9 and 10 to 14 years of age.

1/ Brooke, M.M., and M. Goldman, Polyvinyl alcohol - fixative as preservative and adhesive for protozoa in dysenteric stools and other liquid materials. J. Lab. and Clin. Med., 34:1554-1560, 1948.

2/ Stoll, N.R., Investigations on the control of hookworm disease XV. An effective method of counting hookworm eggs in feces. Am. J. Hyg., 3:59-70, 1923.

3/ Wheatley, W.B. A rapid staining procedure for intestinal amoebae and flagellates. Am. J. Clin. Path., 21:990-991, 1951.

TABLE 75. PERCENT PREVALENCE OF INTESTINAL PARASITES BY AGE IN GUATEMALA

Parasites	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
Urban	Percent Prevalence								
Ascaris lumbricoides	0		23	24	21[a]				
Trichuris trichiura	0		0	8	4[a]				
Hookworm	0		3	0	1[a]				
Entamoeba histolytica	0		3	19	12[a]				
Entamoeba coli	0		17	24	19[a]				
Endolimax nana	0		9	24	16[a]				
Iodamoeba butschlii	0		0	11	6[a]				
Trichomonas hominis	0		3	2	2[a]				
Chilomastix mesnili	0		14	2	5[a]				
Giardia intestinalis	13		31	27	27[a]				
Rural									
Ascaris lumbricoides	11[b]	51	53	59	61	47	46	47	32
Trichuris trichiura	4[b]	14	23	22	22	18	13	14	16
Hookworm	4[b]	9	6	10	14	11	12	9	11
Taenia spp.	0[b]	0	1	1	1	1	2	1	.8
Entamoeba histolytica	4[b]	12	14	23	29	29	26	25	22
Entamoeba coli	12[b]	16	24	35	42	38	33	43	33
Endolimax nana	4[b]	5	8	20	23	17	19	13	15
Iodamoeba butschlii	8[b]	10	18	27	31	37	31	31	17
Trichomonas hominis	0[b]	2	.4	.8	.3	.4	0	1	0
Chilomastix mesnili	0[b]	10	9	9	8	8	7	12	9
Giardia lamblia	8[b]	18	22	18	10	5	3	4	2

[a]/Over 10 years of age.
[b]/Under 2 years of age.

TABLE 76. PERCENT PREVALENCE OF INTESTINAL PARASITES BY AGE IN EL SALVADOR

Parasites	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
Urban[1/]	Percent Prevalence								
Ascaris lumbricoides	0	33	52	65	63	48	39	29	15
Trichuris trichiura	0	33	35	73	61	43	33	29	15
Hookworm	0	0	10	12	16	19	8	6	0
Strongyloides stercoralis	0	0	0	0	0	0	0	0	0
Enterobius vermicularis	0	0	0	0	0	0	0	0	0
Taenia spp.	0	0	0	0	2	0	0	3	0
Hymenolepis nana	0	0	0	8	4	7	0	0	0
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0
Rural									
Ascaris lumbricoides[2/]	39	80	80	87	87	78	77	72	63
Trichuris trichiura	0	12	36	43	43	30	27	27	23
Hookworm	0	4	14	33	38	41	31	29	31
Strongyloides stercoralis	0	0	0	.6	.4	.4	3	0	0
Enterobius vermicularis	0	0	.5	1	2	1	1	0	.8
Taenia spp.	0	0	3	1	1	3	2	1	2
Hymenolepis nana	0	0	4	4	3	1	0	.7	.8
Hymenolepis diminuta	0	0	0	.3	0	0	0	0	0
Entamoeba histolytica[3/]	2	7	19	27	29	30	31	30	24
Entamoeba coli	0	11	35	49	50	55	58	52	54
Endolimax nana	0	4	11	13	14	13	15	15	13
Iodamoeba butschlii	3	10	24	38	43	39	49	38	34
Trichomonas hominis	2	1	3	2	2	1	2	1	1
Chilomastix mesnili	0	6	17	17	11	11	16	12	15
Giardia lamblia	5	29	29	17	12	15	8	8	5

[1/] Based on 295 Stoll examinations.
[2/] Based on 1,679 specimens.
[3/] Based on 2,494 specimens.

TABLE 77. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY AGE IN HONDURAS[1/]

Helminths	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
Urban[1/]	Percent Prevalence								
Ascaris lumbricoides	0	20	64	55	55	36	29	43	25
Trichuris trichiura	0	20	82	70	62	47	48	29	25
Hookworm	0	0	9	25	7	6	0	0	5
Strongyloides stercoralis	0	0	0	0	0	0	0	0	0
Enterobius vermicularis	0	20	0	0	3	3	0	0	0
Taenia spp.	0	0	0	0	3	3	5	0	0
Hymenolepis nana	0	0	9	5	0	0	0	0	0
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0
Rural[2/]									
Ascaris lumbricoides	23	46	70	78	79	71	65	57	55
Trichuris trichiura	27	34	56	59	62	48	46	47	49
Hookworm	4	11	18	25	27	25	18	17	14
Strongyloides stercoralis	0	0	0	0	0	.5	0	0	.4
Enterobius vermicularis	4	6	0	2	2	3	3	2	2
Taenia spp.	0	6	4	2	3	3	4	3	1
Hymenolepis nana	0	0	4	3	3	1	.7	0	.4
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0

[1/] Based on 158 Stoll examinations.
[2/] Based on 1,386 specimens.

TABLE 78. PERCENT PREVALENCE OF INTESTINAL PARASITES BY AGE IN NICARAGUA[1/]

Parasites	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
Urban[1/]	Percent Prevalence								
Ascaris lumbricoides	0	38	65	50	50	38	31	33	12
Trichuris trichiura	0	12	46	50	44	41	22	11	0
Hookworm	0	0	8	9	3	11	3	6	0
Strongyloides stercoralis	0	0	0	0	0	0	0	0	0
Enterobius vermicularis	0	0	0	2	0	3	0	0	0
Taenia spp.	0	0	0	2	0	0	6	0	0
Hymenolepis nana	0	0	4	17	16	11	0	0	0
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0
Rural									
Ascaris lumbricoides[2/]	25	44	69	69	71	65	61	53	54
Trichuris trichiura	9	27	53	65	58	50	44	46	39
Hookworm	9	3	22	35	38	36	28	31	20
Strongyloides stercoralis	0	0	2	5	6	5	4	5	3
Enterobius vermicularis	0	0	.8	1	.3	.8	0	1	.3
Taenia spp.	0	0	.8	1	2	3	1	3	.3
Hymenolepis nana	0	2	8	8	8	4	5	2	.7
Hymenolepis diminuta	0	0	.8	.3	.3	0	0	0	0
Entamoeba histolytica[3/]	2	13	22	27	30	25	29	26	23
Entamoeba coli	4	13	37	43	40	41	44	40	36
Endolimax nana	1	11	17	16	18	17	15	15	18
Iodamoeba butschlii	3	10	27	32	32	32	33	31	31
Trichomonas hominis	1	1	3	2	1	.3	.1	2	3
Chilomastix mesnili	3	12	23	18	20	17	17	18	19
Giardia lamblia	9	35	26	19	16	12	7	9	4

[1/] Based on 228 Stoll examinations.
[2/] Based on 1,948 specimens.
[3/] Based on 2,716 specimens.

TABLE 79. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY AGE IN COSTA RICA

Helminths	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
Urban[1/]	Percent Prevalence								
Ascaris lumbricoides	0	17	22	30	31	7	13	15	7
Trichuris trichiura	0	17	43	67	44	67	12	39	16
Hookworm	0	0	0	0	3	20	13	8	3
Strongyloides stercoralis	0	0	0	3	0	0	0	0	3
Enterobius vermicularis	0	0	0	0	0	0	0	0	0
Taenia spp.	0	0	0	0	0	0	0	0	0
Hymenolepis nana	0	0	9	18	22	0	0	0	0
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0
Rural[2/]									
Ascaris lumbricoides	12	41	46	45	32	27	20	16	7
Trichuris trichiura	10	30	57	69	57	47	32	36	26
Hookworm	6	0	10	18	22	24	19	10	14
Strongyloides stercoralis	0	0	2	4	2	2	1	1	1
Enterobius vermicularis	0	0	0	0	.3	0	0	0	0
Taenia spp.	0	0	0	1	.3	.4	1	.7	0
Hymenolepis nana	2	0	6	6	4	1	1	0	.5
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0

[1/]Based on 171 Stoll examinations.
[2/]Based on 1,712 specimens.

TABLE 80. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY AGE IN PANAMA[1/]

Helminths	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
Urban[1/]	Percent Prevalence								
Ascaris lumbricoides	0	33	31	39	29	7	9	0	9
Trichuris trichiura	0	33	44	50	38	20	27	0	9
Hookworm	0	0	0	11	4	13	9	0	4
Strongyloides stercoralis	0	0	0	0	4	7	0	0	4
Enterobius vermicularis	0	0	0	0	0	0	0	0	0
Taenia spp.	0	0	0	0	0	0	0	0	0
Hymenolepis nana	0	0	0	0	0	0	0	0	0
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0
Rural[2/]									
Ascaris lumbricoides	12	54	51	45	42	18	26	25	17
Trichuris trichiura	4	15	44	37	26	23	18	12	13
Hookworm	0	5	26	39	46	51	40	39	45
Strongyloides stercoralis	0	0	2	5	4	4	3	3	5
Enterobius vermicularis	0	0	.6	0	.5	.6	0	0	0
Taenia spp.	0	0	0	0	0	0	0	0	0
Hymenolepis nana	0	0	0	0	0	0	0	0	0
Hymenolepis diminuta	0	0	0	0	0	0	0	0	0

[1/] Based on 126 Stoll examinations.
[2/] Based on 1,452 specimens.

TABLE 81. PERCENT PREVALENCE OF INTESTINAL PARASITES BY ALTITUDE IN GUATEMALA

Parasites	Altitude Feet						
	<1,000	1,000-1,900	2,000-2,900	3,000-3,900	4,000-4,900	5,000-5,900	6,000+
	Number of Persons Examined						
	323	65	357	276	102	200	566
Ascaris	59	52	59	51	68	48	36
Trichuris	36	17	35	7	53	7	2
Hookworm	22	14	20	8	10	3	1
Strongyloides	.6	0	1	.4	0	.5	.2
Enterobius	.6	0	.3	1	1	0	.5
Taenia	.3	0	.3	3	2	1	1
H. nana	2	0	.6	0	0	2	1
E. hystolytica	24	19	22	32	13	31	19
E. hartmanni	4	2	3	2	1	0	5
E. coli	38	34	40	36	25	28	33
E. nana	16	9	12	16	16	20	20
I. butschlii	26	21	24	29	16	30	28
D. fragilis	1	5	.8	3	4	3	.5
T. hominis	1	3	.6	.4	0	0	.2
Ch. mesnili	11	8	9	8	5	5	10
G. intestinalis	11	12	6	13	11	13	9

TABLE 82. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY ALTITUDE IN RURAL EL SALVADOR

Helminths	Altitude (feet)			
	<1,000	1,000-1,900	2,000-2,900	3,000-3,900
Ascaris lumbricoides	80	75	83	84
Trichuris trichiura	31	29	41	46
Hookworm	38	30	29	20
Strongyloides stercoralis	.6	.4	0	2
Enterobius vermicularis	.3	1	1	1
Taenia spp.	3	1	2	.6
Hymenolepis nana	1	2	1	2

TABLE 83. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY ALTITUDE IN RURAL HONDURAS

Helminths	Altitude (feet)					
	<1,000	1,000-1,900	2,000-2,900	3,000-3,900	4,000-4,900	5,000+
Ascaris lumbricoides	58	79	68	75	71	59
Trichuris trichiura	52	43	52	57	43	21
Hookworm	26	23	24	11	8	9
Strongyloides stercoralis	0	0	.4	0	0	0
Enterobius vermicularis	2	2	1	2	4	2
Taenia spp.	3	5	2	3	3	3
Hymenolepis nana	1	0	2	3	1	1

TABLE 84. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY ALTITUDE IN RURAL NICARAGUA

Helminths	Altitude (feet)			
	<1,000	1,000-1,900	2,000-2,900	3,000-3,900
Ascaris lumbricoides	57	72	68	87
Trichuris trichiura	45	58	56	94
Hookworm	25	33	45	24
Strongyloides stercoralis	3	5	6	4
Enterobius vermicularis	.7	.8	1	0
Taenia spp.	1	2	3	0
Hymenolepis nana	8	5	1	0

TABLE 85. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY ALTITUDE IN RURAL COSTA RICA

Helminths	Altitude (feet)					
	<1,000	1,000-1,900	2,000-2,900	3,000-3,900	4,000-4,900	5,000+
Ascaris lumbricoides	28	34	21	26	37	67
Trichuris trichiura	50	53	46	44	48	50
Hookworm	21	25	11	11	14	0
Strongyloides stercoralis	3	3	0	2	2	0
Enterobius vermicularis	0	0	0	.2	0	0
Taenia spp.	.1	0	0	.7	1	0
Hymenolepis nana	1	1	4	5	6	3

TABLE 86. PERCENT PREVALENCE OF INTESTINAL HELMINTHS BY ALTITUDE IN RURAL PANAMA

Helminths	Altitude (feet)		
	<1,000	1,000-1,900	2,000+
Ascaris lumbricoides	33	44	32
Trichuris trichiura	25	47	21
Hookworm	40	58	9
Strongyloides stercoralis	4	0	2
Enterobius vermicularis	.2	0	0
Taenia spp.	0	0	0
Hymenolepis nana	0	0	0

TABLE 87. PERCENT INTENSITY OF HELMINTH INFECTION BY AGE IN RURAL GUATEMALA

Age in Years	No. of persons examined	Thousand Eggs per Gram of Feces: Ascaris <1	Ascaris 1-9	Ascaris 10-49	Ascaris 50+	Trichuris <1	Trichuris 1	Trichuris 2-4	Trichuris 5+	Hookworm <1	Hookworm 1
<1	27	4	7	0	0	0	4	0	0	0	4
1	65	3	45	3	0	2	5	1	6	0	6
2 - 4	236	2	49	2	0	3	9	.8	10	.8	2
5 - 9	389	3	52	3	.3	1	9	3	8	1	5
10 - 14	316	4	54	2	0	2	11	4	5	2	7
15 - 24	257	2	44	.4	0	2	10	1	4	2	6
25 - 34	186	1	44	1	.5	0	9	2	2	0	7
35 - 44	179	5	42	0	0	.6	9	2	2	2	3
45+	264	3	28	.4	0	2	12	1	1	3	6

TABLE 88. PERCENT INTENSITY OF HELMINTH INFECTION BY AGE IN GUATEMALA CITY

Age in Years	No. of persons examined	Thousand Eggs per Gram of Feces: Ascaris <1	Ascaris 1-9	Ascaris 10-49	Ascaris 50+	Trichuris <1	Trichuris 1	Trichuris 2-4	Trichuris 5+	Hookworm <1	Hookworm 1	Hookworm 2+
Under 2	15	0	0	0	0	0	0	0	0	0	0	0
2 - 4	35	9	14	0	0	0	0	0	0	0	3	0
5 - 9	62	2	23	0	0	3	3	2	0	0	0	0
Under 10	112	4	17	0	0	2	2	1	0	0	1	0
All ages	456	3	11	0	0	1	2	.7	0	1	1	.2

TABLE 89. PERCENT INTENSITY OF ASCARIS INFECTION BY AGE IN RURAL EL SALVADOR

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	29	55	24	23	24	27	32	28	37
1,000-9,900	11	22	50	56	60	49	44	43	25
10,000-49,900	0	4	6	7	3	2	2	1	.8
50,000 or more	0	0	.5	0	0	0	0	0	0

[1/] Based on 1,679 Stoll examinations.

TABLE 90. PERCENT INTENSITY OF ASCARIS INFECTION BY AGE IN RURAL HONDURAS

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	4	14	11	12	17	16	12	12	16
1,000-9,900	12	26	38	49	45	42	43	35	35
10,000-49,900	8	6	16	16	17	13	10	9	4
50,000 or more	0	0	6	2	1	0	0	.8	.4

[1/] Based on 1,386 Stoll examinations.

TABLE 91. PERCENT INTENSITY OF ASCARIS INFECTION BY AGE IN RURAL NICARAGUA

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	9	9	16	14	20	24	22	18	25
1,000-9,900	9	16	23	31	34	28	32	25	23
10,000-49,900	7	14	23	20	13	13	5	7	6
50,000 or more	0	5	7	4	4	.8	1	2	.7

[1/] Based on 1,948 Stoll examinations.

TABLE 92. PERCENT INTENSITY OF ASCARIS INFECTION BY AGE IN RURAL COSTA RICA

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	4	13	11	13	13	12	11	10	5
1,000-9,900	6	23	24	23	16	12	9	5	2
10,000-49,900	1	5	10	7	3	2	1	1	0
50,000 or more	0	0	2	2	0	0	0	0	0

[1/] Based on 1,712 Stoll examinations.

TABLE 93. PERCENT INTENSITY OF ASCARIS INFECTION BY AGE IN RURAL PANAMA

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	4	23	12	14	19	7	10	13	8
1,000-9,900	8	10	22	23	19	10	15	11	9
10,000-49,900	0	13	13	8	4	.6	.6	2	.4
50,000 or more	0	8	4	1	.5	0	.6	0	0

[1/] Based on 1,452 Stoll examinations.

TABLE 94. PERCENT INTENSITY OF TRICHURIS INFECTION BY AGE IN RURAL EL SALVADOR

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	0	12	34	38	42	29	27	26	23
1,000-1,900	0	0	2	2	1	1	0	.7	0
2,000-4,900	0	0	1	2	.4	0	0	0	0
5,000 or more	0	0	0	1	0	0	0	0	0

[1]Based on 1,679 Stoll examinations.

TABLE 95. PERCENT INTENSITY OF TRICHURIS INFECTION BY AGE IN RURAL HONDURAS

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	23	31	33	41	41	40	34	37	43
1,000-1,900	4	3	10	8	10	6	5	6	4
2,000-4,900	0	0	8	6	9	2	6	4	2
5,000 or more	0	0	5	4	1	.5	.7	0	0

[1]Based on 1,386 Stoll examinations.

TABLE 96. PERCENT INTENSITY OF TRICHURIS INFECTION BY AGE IN RURAL NICARAGUA

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	5	20	36	41	39	40	36	39	30
1,000-1,900	2	5	9	11	10	7	5	5	6
2,000-4,900	2	0	6	7	6	3	1	2	2
5,000 or more	0	2	2	6	3	.4	1	.6	.7

[1]Based on 1,948 Stoll examinations.

TABLE 97. PERCENT INTENSITY OF TRICHURIS INFECTION BY AGE IN RURAL COSTA RICA

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	8	21	38	49	44	43	30	32	25
1,000-1,900	2	5	11	11	7	1	.6	3	1
2,000-4,900	0	2	6	6	3	2	.6	.7	0
5,000 or more	0	2	2	3	3	.4	.6	0	0

[1/] Based on 1,712 Stoll examinations.

TABLE 98. PERCENT INTENSITY OF TRICHURIS INFECTION BY AGE IN RURAL PANAMA

Number of Eggs per Gram of Feces[1/]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	4	15	34	30	22	20	16	11	13
1,000-1,900	0	0	4	3	3	3	2	0	.8
2,000-4,900	0	0	3	2	1	0	0	.8	0
5,000 or more	0	0	4	2	1	0	0	0	0

[1/] Based on 1,452 Stoll examinations.

TABLE 99. PERCENT INTENSITY OF HOOKWORM INFECTION BY AGE IN RURAL EL SALVADOR

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	0	4	14	31	36	39	28	26	28
1,000-9,900	0	0	0	2	2	2	2	3	2
10,000 or more	0	0	.5	0	.4	0	.6	0	.8

[1]Based on 1,679 Stoll examinations.

TABLE 100. PERCENT INTENSITY OF HOOKWORM INFECTION BY AGE IN RURAL HONDURAS

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	4	11	17	24	26	24	17	16	14
1,000-9,900	0	0	.7	.8	1	2	0	.8	.4
10,000 or more	0	0	0	.8	0	0	.7	0	0

[1]Based on 1,386 Stoll examinations.

TABLE 101. PERCENT INTENSITY OF HOOKWORM INFECTION BY AGE IN RURAL NICARAGUA

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	9	3	19	28	31	28	25	28	16
1,000-9,900	0	0	.8	3	3	4	3	1	2
10,000 or more	0	0	2	4	3	4	0	2	2

[1]Based on 1,948 Stoll examinations.

TABLE 102. PERCENT INTENSITY OF HOOKWORM INFECTION BY AGE IN RURAL COSTA RICA

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	6	0	8	15	19	20	15	7	12
1,000-9,900	0	0	1	1	1	2	2	2	2
10,000 or more	0	0	1	1	2	3	1	.7	.5

[1]Based on 1,712 Stoll examinations.

TABLE 103. PERCENT INTENSITY OF HOOKWORM INFECTION BY AGE IN RURAL PANAMA

Number of Eggs per Gram of Feces[1]	Age in Years								
	<1	1	2-4	5-9	10-14	15-24	25-34	35-44	45+
100-900	0	5	24	33	41	39	37	36	39
1,000-9,900	0	0	2	3	4	6	2	2	3
10,000 or more	0	0	0	2	2	5	2	.8	4

[1]Based on 1,452 Stoll examinations.

XIII

SEROLOGY AND IMMUNOLOGY

Although the Central American countries vary widely in environmental conditions (altitude, rainfall and climate, flora and fauna), they can generally be classed as tropical. The prevailing conditions are optimum for sustaining a wide variety of infectious agents (viruses, bacteria and parasites). A knowledge of the interaction of nutrition and infection is important in determining the magnitude of the forces of infection acting upon the Central American population.

A serum bank consisting of two identical collections of sera was assembled for each country. These are stored at the Division of Microbiology of INCAP, Guatemala, and at the Middle America Research Unit (MARU) in Panama.

Over 16,000 blood samples were obtained for serological studies from Central American families who were not included in the biochemical or hematological studies. Preliminary results for Guatemala are available.

The sera have been studies so far for several groups and serotypes of arboviruses, stomatitis viruses, rubella, syphilis, Brucella, and Trypanosoma cruzi as shown in Table 104.

TABLE 104. SEROLOGICAL FINDINGS IN GUATEMALAN SERA

Antibodies to:	Total Tested	Age Sampled	Techniques[2/]	Percent Positive
Arbovirus Group B	134[1/]	<15 years	HI	46
Arbovirus Group A	1,233	<15 years	HI	21
VSV[3/] - NJ	754	Adults >15 years	NT	40
VSV - IND	756	Adults >15 years	NT	16
Rubella	686	10 to 19 years	NT	55
Syphilis	2,990	All ages	USR	1.4
Brucella	2,990	All ages	RST	0.6
Trypanosoma cruzi	3,187	All ages	CFT	2.5

[1/] Six villages (see text).

[2/] Techniques:
HI = hemagglutination inhibition test.
NT = neutralization (plaque reduction) test.
USR = unheated serum reagin test.
RST = rapid slide test.
CFT = complement fixation test.

[3/] VSV = vesicular stomatitis virus. (NJ = New Jersey; IND = Indiana).

Group B Arbovirus. A definite relationship between geographical location and the presence of viruses was found. In the central highlands, the prevalence was very low, most likely because the altitude and climate are unfavorable to the mosquito vectors. A high prevalence was detected along the northern and southern mountain slopes. La Gomera, Iztapa, Guazacapan, Usumatlan, Concepcion las Minas and Quesada were of special interest.

Of 256 sera from subjects over 15 years of age, 33 percent were positive and suggestive of Ilheus or St. Louis virus. Among children under 15 years of age, 46 percent were positive, indicating a high endemicity of the virus and that HI antibodies in adults are more difficult to discover after several years.

Group A Arbovirus. Three foci of antibodies to the Venezuelan Equine Encephalitis (VEE) virus were detected (Puerto Barrios, Santo Domingo Suchitepequez and Panzos). In the first two, positives were predominantly in males and antibodies were not detected in children, indicating that the infection probably did not occur in or near these locations. In Panzos, however, 40 percent of the sera, including children, were positive, indicating that within or near this location exists an endemic focus of this virus. These were obtained in 1967 predicting a likely outbreak of V.E.E. in Guatemala, which in fact did occur in 1969.

The Vesicular Stomatitis Virus. The prevalence of antibodies to VSV (types NJ and IND) are shown in Table 104. It is important to note how frequently this "cattle virus" attacks humans. The distribution is very similar to the Arbovirus Group B, although even in the central highlands it was found in all locations with a total prevalence of 17 percent. The prevalence of the Arbovirus Group B, however, was only 0.9 percent in the same locations.

Rubella. Antibodies to the rubella virus were found in 55 percent of subjects 10-19 years of age. Analysis was limited to those locations from which at least 10 sera were tested (Table 104). Locations where over 70 percent of the subjects were immune are concentrated in the central highlands, probably because of greater mobility of the population. Less than half of the subjects were immune in more isolated locations. The data indicate that in Guatemala fewer women within the reproductive age are immune to rubella than in the United States or England and that improving communications, especially in the coastal areas, may result in epidemics of this disease and a large number of severely deformed children. Whenever an effective vaccine against rubella becomes available, vaccination of 6-to 12-year-old school girls should receive high priority.

Syphilis. An overall prevalence of 1.4 percent in a large sample of sera (2,990) was demonstrated by the unheated serum reagin test (U.S.R.). It should be noted that this technique, like most syphilis

tests, mainly reveals only recent infections. The analysis of a subsample by means of the fluorescent antibody technique is presently being considered.

Brucella. The rapid slide test performed in the same sample indicated an overall prevalence of 0.6 percent. The result will be analyzed according to occupation where particular risks are involved.

Eventually, the prevalence of antibodies to many of the agents currently investigated will be analyzed in conjunction with nutritional, socioeconomic and other ecological information.

Chagas' Disease. Complement fixation tests to T. cruzi have resulted in the preliminary data presented in Table 104. A prevalence of over 10 percent was found only in two locations in the east, while a prevalence of 5-9 percent was found in five locations in the east and south. The central highlands had a prevalence of less than 5 percent or none at all. Apparently, there is no difference in prevalence by age or sex. It should be mentioned that a great endemic area of Chagas' disease was discovered by this type of sero-epidemiology in the Pacific coast of Nicaragua.

XIV

DIETARY STUDY

Although the season of the year ordinarily affects the availability of foods, particularly in rural subsistence areas, it was not possible to plan the nutrition surveys in the Central American countries at comparable times or to repeat them at other points in the year. However, the altitudes in mountainous parts of Central America modify the effects of tropic latitudes to some extent, diversifying seasons of various crops, while local trade distributes the specialties of one region to another. Nevertheless, food intake should be studied at some future time in small subsamples of families at systematic points in the year. The year and season when the studies were made in the rural and urban populations in each country are shown in Table 105.

TABLE 105. YEAR, MONTHS AND SEASONS OF DIETARY STUDIES IN CENTRAL AMERICA

	Rural Areas			Urban Areas		
Country	Year	Months	Season	Year	Month	Season
Guatemala	1965	Feb.-Apr.	Dry	1965	Aug.	Rainy
El Salvador	1965	Sept.-Nov.	Late rainy/early dry	1967	May	Start of rains
Honduras	1966	Sept.-Nov.	Late rainy/early dry	1966	Nov.	Early dry
Nicaragua	1966	Jan.-Mar.	Dry	1967	May	Start of rains
Costa Rica	1966	Apr.-June	Late dry/early rainy	1967	Apr.	Late dry
Panama	1967	Jan.-Mar.	Dry	1967	Feb.	Dry

Methods

Samples of families larger than originally contemplated were ultimately used in the dietary studies. Instead of five families out of every 20 families selected in each survey site in the various countries, 10 or more families were actually included. Several different survey techniques were also applied:

1. In the rural populations, food consumption data for all the families in the dietary study were obtained in home visits by the 24-hour recall technique.

2. In a subsample of these families, a three-day record of food consumption was then obtained during home visits by weighing all foods in so far as possible.

3. Information on the distribution of foods within the family was obtained by weighing individual portions consumed by family members during one day. This provided important data on food intake, among others, of preschool children of the families.

4. When the survey in a country was completed, a number of localities was selected representing areas of characteristically different food consumption patterns. Typical day's meals were calculated on the basis of data collected, and replica meals prepared by local housewives. Composite samples of meals were stabilized for later chemical analysis.

In the urban populations, in the city selected in each country, the sample of about 100 families was surveyed only by the 24-hour recall technique.

The data used in this report are based on the 24-hour recall method, since only these data are available for both rural and urban populations. The data obtained with the other methods will be used for statistical analysis comparing the different survey techniques.

Food Consumption

While cereals are the mainstay of the diet in all the areas, they vary in kind and amount from Guatemala in the north to Panama in the south (Table 106). Corn is the principal cereal in rural Guatemala, El Salvador, Honduras and Nicaragua, but decreases progressively to small amounts in Costa Rica and Panama. Corn is more commonly used by rural than by urban families in all the countries. In Guatemala, where the Indian proportion in the population is high, all the rural families in the survey consumed corn tortillas. The corn is of several colors, most importantly, yellow and white. Rural families, or those with native antecedents, tend to prefer yellow corn. Some call it a "stronger" food than the white, although ignorant of the vitamin A value which the yellow corn possesses.

In Panama, unlike in the rest of Central America, corn is not treated with lime (or its substitute), or milled on a grinding stone as in the neighboring countries to the north. It is pounded in a mortar to remove the hull and germ, as in Colombia and Venezuela to the south. A culture area seems to have ended. An exception is the northernmost section of Panama, along the Costa Rican border, where the tortilla is still found, although not prepared with lime.

As corn consumption declines, that of rice increases, and rice becomes the staple cereal in Costa Rica and Panama. In all the countries, it is more consumed by urban than by rural families. Only in Panama, do the rural families eat more rice than the urban. All the countries produce some rice. In rural Guatemala, El Salvador and Honduras, rice is commonly used as a thickener in soups, but it becomes a main dish in Costa Rica and Panama, combined with beans or some other food.

TABLE 106. CONSUMPTION OF FOODS PER PERSON PER DAY IN RURAL AND URBAN AREAS, 1965-67
(grams, edible portion)

Foods	*Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
Rural Areas (No. of Families)	(203)	(293)	(331)	(355)	(456)	(361)
(Persons per Family)	(6.5)	(6.0)	(7.1)	(6.3)	(6.9)	(6.3)
Milk products (fluid equiv.)	84	190	194	243	193	73
Eggs	13	10	13	12	15	11
Meat, poultry, fish	44	37	41	58	40	90
Beans	54	59	56	72	57	20
Vegetables	66	53	51	27	66	25
Fruits	14	17	40	41	7	50
Bananas & plantains	20	16	43	72	47	99
Starchy roots & tubers	14	13	22	33	46	82
Cereal products(as grain, meal)	(412)	(411)	(276)	(240)	(199)	(261)
corn (subtotal as grain)	(359)	(352)	(224)	(139)	(41)	(32)
tortillas & tamales	544	533	340	190	62	6
degerminated corn	0	0	0	0	0	29
toasted meal (pinol)	0	0	0	14	0	0
rice	16	27	29	54	100	186
wheat bread	36	26	12	28	54	37
wheat flour & pastes	4	0	8	7	12	10
other cereals	2	6	5	16	0	0
Sugars	52	41	39	58	89	51
Fats & oil	4	15	16	19	19	26
Urban Areas (No. of Families)	(103)	(100)	(99)	(98)	(98)	(96)
(Persons per Family)	(6.2)	(5.8)	(7.0)	(6.9)	(5.8)	(5.5)
Milk products (fluid equiv.)	246	237	289	377	350	163
Eggs	31	31	21	21	23	19
Meat, poultry, fish	85	77	87	90	74	134
Beans	49	52	47	50	48	19
Vegetables	150	90	56	74	126	68
Fruits	58	71	54	52	60	99
Bananas & plantains	64	49	49	75	57	75
Starchy roots & tubers	34	12	24	24	55	70
Cereal products(as grain, meal)	(339)	(281)	(264)	(213)	(206)	(228)
corn (subtotal as grain)	(150)	(164)	(134)	(82)	(14)	(6)
tortillas & tamales	228	249	203	84	21	0
degerminated corn	0	0	0	0	0	6
toasted meal (pinol)	0	0	0	26	0	0
rice	34	55	50	80	103	150
wheat bread	169	66	74	51	80	65
wheat flour & pastes	5	0	9	0	16	9
other cereals	5	5	7	7	4	7
Sugars	74	38	45	63	77	42
Fats & oil	24	37	21	29	41	35

*See footnote No. 3 on Page 11.

In Panama it is the custom to wash rice vigorously before cooking to remove all adhering starch. This also removes a significant amount of the water-soluble vitamins of the grain, a fact reflected in the nutritive content of the diet.

Wheat is not a staple food in any Central American country, and is produced to some extent only in Guatemala, in its cool highland areas. As in the case of rice, the urban populations are the greatest consumers of wheat, most often in the form of bread. The largest per capita bread consumption is in Guatemala City. A few other cereals occur in minor amounts ; among them is sorghum produced in some dry areas, and made into the familiar tortilla.

In many coastal or warm lowland areas, cassava and other starchy roots form a relatively important part of the diet, supplementing or sometimes replacing cereals. In the same way, bananas and plantains, which are starchy fruits, often take the place of cereals. The plantains are cooked or fried green and are common in areas where they are easily produced.

Sugarcane was introduced in Mexico and Central America in the early colonial period, and Indians paid tribute to the Spanish in terms of brown sugar cakes, now called panela, which is cane juice boiled down and hardened in molds. Sugar in this form was fully adopted by the native populations and panela is the favored sugar in rural areas, whereas refined or white sugar is more popular in urban areas, or wherever urbanization has been greatest. The greatest sugar consumer is Costa Rica. As Table 103 shows, 89 grams of sugar per person per day (mostly panela) is used in the rural area, compared to 77 grams (mostly white) in the urban. The flavor of the brown panela is highly esteemed and sugar water is drunk at meals and in between. The morning coffee is boiled with panela.

Beans (Phaseolus vulgaris) are a native food as characteristic of Central America as corn tortillas. The consumption of beans is somewhat greater in rural than in urban areas of all the countries, and it is lowest in Panama where corn tortillas are also scarce. Black beans are preferred in Guatemala but red ones in Honduras and the red beans are, in general, more popular in the countries to the south. Although of no known significance, the preferences shown for the different colors are strong. Beans are cooked with onion, epazote (goosefoot) or coriander leaf for flavor, and lard is often added. Because of the long cooking time, enough beans for two or even more days are sometimes cooked at one time. In some areas it is customary to strain the cooked beans to remove the hulls, especially as food for small children. In rural Guatemala, beans and sometimes uncultivated greens form the main dish of the meal, except on occasions when meat is available. In Costa Rica, beans with rice are a common breakfast dish, a combination also common in Panama, but not in countries to the north.

Both vegetables and fruits are used in larger amounts by urban than by rural families. Vegetables are usually expensive foods, since a few carrots may buy a pound of corn. Many rural families grow vegetables to sell in larger towns where more affluent people live. The markets in Guatemala City are rich in fine vegetables, fruits and flowers, brought by Indians from their mountain fields within commuting distance of the capital. The vegetables most commonly sold and less often eaten by rural families include lettuce, peas, cabbage, carrots, spinach, beets, etc. The Indians of Guatemala eat the green leaves of a variety of uncultivated plants no longer eaten in most other parts of Central America. Most cultivated vegetables eaten by rural families are native to this continent and include tomatoes, peppers, squash, chayote (Secchium edulis), avocado, etc. Tomatoes and onions, even though in minute amounts, are used by all classes in all areas to flavor stews and other dishes.

Oranges and bananas are the most common fruits consumed and are available for many months in the year. Other varieties, mangoes, pineapple, papaya, etc., have shorter seasons. Since vegetables and fruits are nutritionally similar, the amounts in Table 106 can be summed. It is then seen that urban families in almost all the countries consume more than twice as many vegetables and fruits as rural families.

Meat, an expensive food, was consumed in larger amounts by urban than rural families. The lowest intake was 37 grams per person per day in El Salvador. More than double that amount was consumed in the capital of that country, and 141 grams per person per day in Panama City. In rural Panama, the figure was 90 grams, or more than in the other rural areas.

Beef was the principal meat, and pork, second. Various rural families raise pigs and some specialize in slaughtering, marketing the meat, lard and sausage locally. The slaughter of beef, on the other hand, is not usually a family enterprise. Most rural families raise chickens but do not often eat them. However, poultry may soon become more available generally because of modern projects started in several countries for improving breeds, feed and care of flocks. Fish is eaten mainly on the coasts and islands, although dried, smoked and salted fish finds its way to interior markets to some extent, especially at Easter time. Other marine products, for example, large sea turtles, are seen in some coastal markets, in Costa Rica and elsewhere. Despite the long coast lines, fish is not an important food in most of Central America.

In many countries, eggs are the most expensive source of protein and they are not widely eaten in the Central American area, least of all in the rural areas where they are produced. Many rural housewives

trade eggs for less expensive foods or use them like cash for other family needs. Eggs may, however, become cheaper as a result of the poultry improvement projects already started.

Like the other expensive foods, fats are less consumed in rural than urban areas. Fat consumption increased from 4 grams per person per day in rural Guatemala to 41 grams in urban Costa Rica. The most common fat in rural areas is lard and in the cities, vegetable oil. In Panama City, 80 percent of the fat used was oil. In rural Guatemala, almost all the fat was lard. Some Indian families cook without any fat at all, believing that fat is harmful. Small amounts of butter and margarine were reported in city diets.

Note: Although the figures from the three-day record method of reporting food consumption were used in the report for Guatemala (INCAP V-25), the 24-hour recall data were used in the present combined report, in conformity with the reports of the other five countries.

The Nutritive Value of the Diets:

The average calorie and nutrient content of the Central American diets is shown in Table 107.

TABLE 107. AVERAGE INTAKE OF CALORIES AND NUTRIENTS PER PERSON PER DAY BY FAMILIES OF CENTRAL AMERICA AND PANAMA

		Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
Rural Areas							
Calories		2117	2146	1832	1986	1894	2089
Total protein	g	68.0	67.9	58.0	64.4	53.6	60.1
Animal protein	g	15.4	17.3	18.5	23.6	18.5	26.6
Fat	g	31.4	39.3	44.1	47.5	43.9	49.8
Carbohydrate	g	411	396	315	338	332	357
Calcium	mg	1100	1092	883	763	580	301
Phosphorus	mg	1360	1341	1140	1184	981	932
Iron	mg	17.9	11.6	15.5	18.2	15.4	14.3
Vitamin A	I.U.	2420	893	1280	1693	1796	1826
Thiamine	mg	1.26	1.06	.89	.86	.76	.92
Riboflavin	mg	.80	.78	.79	.93	.84	.69
Niacin	mg	16.6	12.0	10.3	10.7	10.7	14.3
Ascorbic Acid	mg	38	36	59	66	52	87
Urban Areas							
Calories		2532	2209	2061	2108	2330	2101
Total protein	g	80.5	69.9	70.9	72.2	67.3	70.9
Animal protein	g	30.8	28.3	30.7	35.3	31.3	37.9
Fat	g	63.5	69.4	59.9	59.6	66.8	58.7
Carbohydrate	g	422	338	322	331	344	328
Calcium	mg	961	865	864	901	855	419
Phosphorus	mg	1448	1232	1203	1224	1157	1034
Iron	mg	18.1	13.8	13.3	15.4	16.3	14.9
Vitamin A	I.U.	3490	3050	2286	3141	3696	3670
Thiamine	mg	1.22	.99	.96	.88	.97	.91
Riboflavin	mg	1.23	1.08	1.12	1.33	1.28	.98
Niacin	mg	18.1	12.1	12.8	11.9	13.3	14.8
Ascorbic Acid	mg	76	91	74	82	102	107

The average calorie intake is consistently lower in the rural groups, although their requirements for energy expenditure might expectedly be greater than those of the urban populations. The average protein and fat intakes are likewise less in the rural areas, particularly the protein from animal sources, biologically the more valuable but

economically the more expensive. Guatemala has the highest average intake of total protein among both rural and urban population groups in the countries, but the lowest level of animal protein in its rural diet. Panama has the highest intake of animal protein in both sectors.

Table 108 shows the relative importance of the three energy-yielding constituents of food in the average diets of the six countries:

TABLE 108. PERCENT DISTRIBUTION OF CALORIES FROM PROTEIN, FAT AND CARBOHYDRATE IN CENTRAL AMERICAN DIETS

Country	Protein		Fat		Carbohydrate	
	Rural	Urban	Rural	Urban	Rural	Urban
	Percentages					
Guatemala	12.4	12.5	12.9	22.2	74.7	65.3
El Salvador	12.3	12.4	16.0	27.7	71.7	59.9
Honduras	12.3	13.5	21.0	25.5	66.7	61.0
Nicaragua	12.7	13.5	21.0	24.9	66.3	61.6
Costa Rica	11.0	12.0	20.4	26.8	68.6	61.3
Panama	11.3	13.4	21.2	24.9	67.5	61.6

The calories from protein ranged from 11 percent in rural Costa Rica to 13.5 percent in urban Honduras and Nicaragua. The protein calories were slightly higher in the urban than rural diets.

The calories from the fat component of the foods were considerably higher in all the urban diets. In the rural diets they varied from 12.9 percent in Guatemala to 21.2 percent in Panama, and in the urban diets, from 22.2 percent in Guatemala to 27.7 percent in El Salvador.

The carbohydrate calories in the rural diets ranged from 66.3 percent in Nicaragua to 74.7 percent in Guatemala and in the urban diets, from 59.9 percent in El Salvador to 65.3 percent in Guatemala.

The average calcium intake in the rural areas fell progressively from 1100 mg per person per day in Guatemala to 300 mg in Panama, as the consumption of corn prepared with lime decreased. The corn consumption in the urban populations also fell progressively but the milk intake increased, leaving the calcium levels relatively balanced between 961 mg per person per day in Guatemala City and 855 mg in San Jose, Costa Rica. In Panama, where the milk consumption was the lowest, the average calcium intake was 419 mg.

The average vitamin A intake in the urban areas was higher than in the rural, largely due to the greater use of fruits, vegetables and milk. However, the seasonal availability of many fruits and vegetables makes the vitamin A from this source highly variable.

The riboflavin intake among the urban groups also surpassed that of the rural, due mainly to their greater milk consumption. The differences between rural and urban diets with respect to thiamine and niacin were less pronounced than those of vitamin A and riboflavin.

Contribution of the Major Food Groups to the Diet:

The role of the different categories of foods in the diets of the Central American countries is shown for calories and nutrients in Tables 109 to 117.

TABLE 109. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE CALORIE CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	2.8	5.6	6.9	7.3	7.3	2.7
Eggs	1.0	.7	1.1	.9	1.3	.8
Meat, poultry, fish	3.9	3.3	5.0	5.4	3.8	7.2
Beans	9.5	9.7	10.7	13.0	10.7	3.9
Vegetables	1.4	.9	1.4	.6	2.2	1.1
Fruits	0.6	.6	1.8	1.5	0.4	4.1
Bananas & plantains	1.1	1.0	2.9	4.8	3.2	5.9
Starchy roots & tubers	0.6	.7	1.8	2.2	2.6	4.9
Cereal products	65.1	61.8	49.5	41.5	39.3	47.4
Sugars	9.4	7.4	8.2	11.5	17.9	8.8
Fats, oils	2.6	6.9	8.8	9.3	9.8	11.7
Miscellaneous	1.9	1.4	1.8	1.8	1.5	1.3
Urban Areas						
Milk products	7.2	7.9	10.8	11.5	10.6	5.1
Eggs	1.8	2.1	1.5	1.5	1.5	1.3
Meat, poultry, fish	5.2	6.0	7.7	6.1	5.1	9.6
Beans	6.9	8.4	8.1	8.7	7.6	3.7
Vegetables	2.5	2.4	1.2	1.4	2.0	1.7
Fruits	1.3	2.0	1.4	1.6	1.3	2.6
Bananas & plantains	2.8	2.7	2.7	4.6	2.9	4.5
Starchy roots & tubers	1.2	.6	1.2	1.4	2.4	4.0
Cereal products	48.4	44.1	44.2	38.5	36.7	41.3
Sugars	11.3	6.9	8.7	11.7	12.8	8.0
Fats, oils	8.0	15.4	9.9	11.8	14.5	15.1
Miscellaneous	3.3	1.5	2.4	1.2	2.4	3.1

Cereals were the principal calorie source in all the countries and provided from 65 percent of the total calories in the diet of rural Guatemala to 37 percent in urban Costa Rica (Table 109). Sugar provided 18 percent of the calories in rural Costa Rica, fats 15 percent in urban El Salvador, beans 13 percent in rural Nicaragua, and milk 12 percent

in urban Nicaragua. These were maximum levels and no other foods provided as much as 10 percent of the total calories in any area.

TABLE 110. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE PROTEIN CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	5.5	10.9	13.2	13.7	13.5	4.8
Eggs	2.3	1.8	2.6	2.2	3.4	2.2
Meat, poultry, fish	14.8	12.8	16.1	20.7	17.7	37.3
(Subtotal: animal products)	(22.6)	(25.5)	(31.9)	(36.6)	(34.6)	(44.3)
Beans	19.4	20.5	22.8	26.8	25.2	8.8
Vegetables	1.8	1.2	1.4	0.7	1.9	1.6
Fruits	0.2	0.3	0.8	0.7	0.2	1.7
Bananas & plantains	0.3	0.3	0.9	1.4	1.0	1.8
Starchy roots & tubers	0.4	0.3	0.4	0.6	1.4	2.0
Cereal products	50.8	50.1	39.2	30.9	32.7	37.8
Sugars	0.1	0.1	0.1	0.0	0.3	0.1
Fats, oils	0.0	0.0	0.0	0.0	0.1	0.0
Miscellaneous	4.3	1.7	2.3	2.1	2.6	1.8
Urban Areas						
Milk products	11.2	12.2	15.0	18.3	18.6	7.9
Eggs	4.4	5.1	3.4	3.3	3.9	3.0
Meat, poultry, fish	22.6	23.7	24.9	27.3	24.0	42.6
(Subtotal: animal products)	(38.2)	(41.0)	(43.3)	(48.9)	(46.5)	(53.5)
Beans	14.4	17.8	15.8	16.7	17.4	7.4
Vegetables	2.8	2.4	1.3	1.5	2.7	2.2
Fruits	0.5	0.8	0.7	0.6	0.7	1.1
Bananas & plantains	0.9	0.8	0.8	1.2	0.9	1.2
Starchy roots & tubers	0.7	0.3	0.6	0.5	1.4	1.6
Cereal products	37.8	35.2	35.4	29.5	27.1	30.4
Sugar	0.0	0.0	0.0	0.0	0.0	0.0
Fats, oils	0.0	0.0	0.1	0.1	0.2	0.1
Miscellaneous	4.4	1.7	2.2	1.0	3.0	2.4

Cereals are the largest protein source in both rural and urban diets in every country except Panama. There the group comprising meat,

poultry and fish surpasses cereals. In rural Guatemala and El Salvador, cereals provide over half of the total protein. Beans are second as a protein source in the rural diets of all the countries except Panama. Beans are surpassed by the meat group in all the urban centers. Milk is more important in the urban diets and generally ranks fourth as a protein source. The protein from all animal sources combined ranges from 23 percent of the total protein in rural Guatemala to 44 percent in rural Panama. In the urban centers this proportion varies between 38 percent in Guatemala City to 53 percent in Panama City.

TABLE 111. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE CALCIUM CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	13.8	24.4	37.2	51.1	54.8	38.7
Eggs	0.7	0.5	0.8	0.9	1.5	2.2
Meat, poultry, fish	0.8	1.2	1.4	2.9	1.6	11.5
Beans	7.1	7.0	7.6	10.8	12.2	7.2
Vegetables	2.2	1.4	1.2	1.1	2.8	3.2
Fruits	0.4	0.6	1.7	1.9	0.6	6.8
Bananas & plantains	0.2	0.1	0.4	0.8	0.7	2.8
Starchy roots & tubers	0.2	0.3	0.8	1.2	1.4	7.8
Cereal products	69.3	62.2	45.3	25.8	16.8	11.9
Sugars	0.9	0.9	1.1	0.6	3.9	2.8
Fats, oils	0.0	0.0	0.3	0.5	0.5	0.8
Miscellaneous	4.4	1.4	1.9	2.4	3.1	4.2
Urban Areas						
Milk products	40.0	41.6	49.8	68.2	66.4	49.2
Eggs	1.8	2.0	1.4	1.2	1.5	2.4
Meat, poultry, fish	1.8	1.8	1.9	1.9	1.7	9.1
Beans	7.0	7.1	6.4	6.3	7.7	5.2
Vegetables	3.5	3.4	1.8	2.0	4.1	4.3
Fruits	1.3	1.6	2.2	1.6	2.0	6.6
Bananas & plantains	0.6	0.5	0.5	0.7	0.6	1.5
Starchy roots & tubers	0.4	0.2	0.5	0.6	1.2	3.8
Cereal products	36.8	39.6	32.3	14.9	8.8	10.5
Sugars	0.4	0.4	0.3	0.4	0.9	0.6
Fats, oils	0.4	0.1	0.4	1.1	2.1	0.8
Miscellaneous	6.1	1.7	2.6	1.0	2.9	5.8

In rural Guatemala and El Salvador where lime-treated corn is eaten in the greatest amounts, 69 and 62 percent respectively of the calcium in the diet comes from the cereal group of foods. As rice progressively replaces corn, calcium from cereal foods diminishes, dropping to 12 percent in Panama. The milk consumption in the meantime increases and the calcium from this source rises from 14 percent in Guatemala to 55 percent in Costa Rica. In the urban centers milk is consistently the major calcium source.

TABLE 112. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE IRON CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	1.3	4.9	4.0	4.0	3.6	1.1
Eggs	2.0	2.3	2.2	1.7	2.6	2.0
Meat, poultry, fish	9.4	15.1	11.0	14.3	11.3	24.4
(Subtotal, animal origin)	(12.7)	(22.3)	(17.2)	(20.0)	(17.5)	(27.5)
Beans	23.2	37.1	26.2	29.2	27.2	11.3
Vegetables	4.3	4.4	2.9	1.4	4.0	2.8
Fruits	1.0	1.3	2.7	2.0	0.6	5.6
Bananas & plantains	0.8	1.1	2.0	3.2	2.4	5.3
Starchy roots & tubers	0.8	1.2	1.6	1.8	2.8	6.8
Cereal products	44.3	22.0	39.5	39.2	31.9	34.4
Sugars	4.0	6.4	4.9	1.1	10.9	3.8
Fats, oils	0.0	0.0	0.1	0.1	0.4	0.2
Miscellaneous	8.8	4.2	2.8	1.8	2.2	2.1
Urban Areas						
Milk products	3.6	3.9	6.3	7.4	6.3	1.5
Eggs	4.3	5.7	4.0	3.4	3.6	3.2
Meat, poultry, fish	16.3	21.2	20.6	23.3	17.3	32.1
(Subtotal, animal origin)	(24.2)	(30.8)	(30.9)	(34.1)	(27.2)	(36.8)
Beans	19.9	27.8	25.8	24.5	22.5	10.6
Vegetables	7.5	7.3	4.3	4.2	7.3	5.2
Fruits	2.1	3.7	3.0	3.7	2.5	4.5
Bananas & plantains	2.2	2.6	2.2	3.9	2.5	3.9
Starchy roots & tubers	1.6	0.9	1.8	1.5	3.2	5.4
Cereal products	32.9	22.8	28.3	26.0	28.3	28.9
Sugars	0.4	1.0	0.4	0.5	2.6	0.5
Fats, oils	0.5	0.3	0.4	0.3	0.8	0.8
Miscellaneous	8.5	2.9	2.9	1.4	3.0	3.3

Cereals, beans and meats are the principal sources of iron in the Central American diets in both rural and urban groups (Table 112). In the rural areas, the proportion of the total iron derived from vegetable sources ranged from 87 percent in Guatemala to 72 percent in Panama, corresponding to 76 and 63 percent respectively in Guatemala City and Panama City.

TABLE 113. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE VITAMIN A CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	5.3	33.0	24.1	19.4	14.6	5.5
Eggs	2.4	5.0	4.5	3.1	3.7	2.7
Meat, poultry, fish	6.6	11.8	15.8	11.7	10.5	10.6
(Subtotal: animal sources)	(14.3)	(49.8)	(44.4)	(34.2)	(28.8)	(18.8)
Beans	0.6	1.8	1.2	1.2	0.9	0.3
Vegetables	54.0	28.6	10.6	7.6	32.2	19.6
Fruits	7.6	4.2	4.1	5.2	2.2	11.7
Bananas & plantains	3.6	11.5	26.5	46.6	24.9	39.8
Starchy roots & tubers	0.5	0.2	0.3	0.4	0.3	0.5
Cereal products	17.3	1.2	10.0	0.9	1.2	4.7
Sugars	0.0	0.0	0.0	0.0	0.0	0.0
Fats, oils	0.5	2.0	2.8	3.6	9.1	4.1
Miscellaneous	1.6	0.5	0.2	0.2	0.5	0.5
Urban Areas						
Milk products	10.5	12.6	23.3	15.4	13.2	5.6
Eggs	3.7	4.3	3.9	2.8	2.6	2.2
Meat, poultry, fish	0.4	22.1	18.0	25.7	19.4	26.6
(Subtotal: animal sources)	(14.6)	(39.0)	(45.2)	(43.9)	(35.2)	(34.4)
Beans	0.4	0.5	0.6	0.4	0.4	0.2
Vegetables	63.3	27.7	31.2	14.4	39.5	23.7
Fruits	3.6	21.0	4.7	15.0	5.6	12.2
Bananas & plantains	6.9	8.1	10.6	20.9	9.7	14.3
Starchy roots & tubers	0.3	0.0	0.5	0.1	0.2	0.2
Cereal products	0.8	0.5	0.2	0.4	0.4	1.0
Sugars	0.0	0.0	0.0	0.0	0.0	0.0
Fats, oils	5.8	2.7	6.3	4.6	8.6	6.9
Miscellaneous	4.4	0.3	0.7	0.1	0.4	7.1

The Central American countries vary in their major sources of vitamin A, due in part perhaps to the seasons when the surveys were made. Table 110

shows that milk makes substantial contributions to the vitamin A intake in several countries. Vegetables are important sources of vitamin A in most countries, but particularly in Guatemala. Bananas and plantains (the equivalent of bread in some diets) provide a sizable share of the vitamin A in rural Honduras and some other areas to the south. The use of yellow corn in rural Guatemala, Honduras and even Panama is evidenced by figures for vitamin A from cereals.

The total vitamin A from animal sources in rural areas varies from 14 percent in Guatemala to 50 percent in El Salvador. In the urban centers it ranges from 15 percent in Guatemala to 45 percent in Honduras.

TABLE 114. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE THIAMINE CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	1.7	3.4	3.9	5.9	9.2	2.3
Eggs	1.3	1.2	1.8	1.8	2.5	1.5
Meat, poultry, fish	7.3	7.0	13.8	14.3	9.0	12.2
Beans	21.3	23.7	23.9	30.9	29.9	15.3
Vegetables	3.3	2.7	3.3	1.6	4.8	4.2
Fruits	1.0	1.4	4.4	4.4	1.0	6.4
Bananas & plantains	0.8	0.8	2.6	5.4	3.6	6.1
Starchy roots & tubers	0.9	0.9	1.7	2.9	5.0	8.3
Cereal products	56.7	57.9	44.2	32.3	34.3	43.0
Sugars	0.1	0.1	0.1	0.0	0.4	0.1
Fats, oils	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	5.7	0.9	0.2	0.4	0.4	0.5
Urban Areas						
Milk products	6.6	7.5	9.2	12.4	13.0	4.0
Eggs	3.1	3.9	2.7	2.9	3.0	2.6
Meat, poultry, fish	8.4	16.3	17.8	14.5	10.6	16.8
Beans	19.1	19.3	17.5	20.5	21.9	9.6
Vegetables	7.4	6.5	3.2	4.0	7.2	6.7
Fruits	2.1	3.2	4.7	4.2	4.1	7.8
Bananas & plantains	2.4	2.5	2.4	5.0	3.0	4.4
Starchy roots & tubers	2.2	0.9	2.0	2.2	4.8	7.8
Cereal products	40.9	39.3	40.0	33.7	31.6	38.7
Sugars	0.0	0.0	0.0	0.0	0.1	0.0
Fats, oils	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	7.9	0.5	0.6	0.4	0.5	1.6

Table 114 shows that most of the thiamine in the Central American diets comes from cereals, beans and meat, as is the case with iron. Beans contribute more thiamine than meat in all areas except Panama City and urban Honduras.

TABLE 115. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE RIBOFLAVIN CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	18.1	34.3	36.8	41.3	46.4	21.1
Eggs	6.0	4.8	5.9	4.8	6.6	5.8
Meat, poultry, fish	13.2	11.4	14.2	15.4	12.7	28.5
Beans	10.0	10.6	9.8	11.5	9.4	6.0
Vegetables	5.2	3.5	3.3	1.2	4.6	3.6
Fruits	1.0	0.9	1.7	1.4	0.5	3.5
Bananas & plantains	1.0	0.8	2.1	2.9	2.0	5.2
Starchy roots & tubers	0.4	0.4	1.0	1.1	1.5	3.3
Cereal products	34.2	30.7	22.9	19.3	11.6	20.9
Sugars	1.9	1.8	1.8	0.4	4.4	1.4
Fats, oils	0.0	0.0	0.1	0.1	0.0	0.0
Miscellaneous	8.8	0.6	0.4	0.6	0.3	0.6
Urban Areas						
Milk products	36.6	39.1	46.1	48.6	53.6	26.8
Eggs	9.0	10.1	6.7	5.6	6.4	6.9
Meat, poultry, fish	13.8	18.8	17.6	18.4	16.0	33.7
Beans	5.9	6.8	6.1	5.3	5.5	4.3
Vegetables	6.5	5.1	2.5	2.0	5.0	4.4
Fruits	1.6	2.6	1.4	1.6	1.5	2.6
Bananas & plantains	2.0	1.6	1.8	2.1	1.6	2.6
Starchy roots & tubers	0.6	0.3	0.6	0.5	1.2	1.9
Cereal products	16.9	14.7	16.5	15.4	7.9	14.2
Sugars	0.0	0.2	0.0	0.0	0.5	0.0
Fats, oils	0.0	0.0	0.0	0.1	0.2	0.0
Miscellaneous	7.0	0.6	0.6	0.4	0.5	2.4

Milk and meat are the major sources of riboflavin in the Central American diets (Table 115). They are less important in the rural areas, where cereals and beans make substantial contributions. Cereals are the principal riboflavin source in rural Guatemala. Milk provides more riboflavin than meat in all the countries except Panama, which

combines a low milk intake with the highest meat consumption in the Central American area. Eggs make a moderate contribution in all the countries.

TABLE 116. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE NIACIN CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	0.4	0.9	1.0	1.3	1.8	0.5
Eggs	0.1	0.1	0.1	0.1	0.1	0.1
Meat, poultry, fish	10.5	14.1	17.1	20.6	15.6	27.8
Beans	7.4	10.6	11.8	14.9	11.7	3.6
Vegetables	3.0	2.8	3.7	1.6	4.9	2.9
Fruits	0.6	0.9	1.3	1.2	0.4	1.8
Bananas & plantains	0.8	0.9	2.4	3.7	2.5	4.1
Starchy roots & tubers	1.3	1.3	2.1	2.8	5.4	4.1
Cereal products	39.2	55.6	43.5	38.9	40.0	46.3
Sugars	0.3	0.4	0.5	0.1	1.0	0.3
Fats, oils	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	36.5	12.4	16.5	14.7	16.6	8.6
Urban Areas						
Milk products	1.2	1.6	1.9	2.4	2.5	0.9
Eggs	0.1	0.2	0.1	0.1	0.1	0.1
Meat, poultry, fish	20.4	24.4	28.2	26.9	21.6	34.4
Beans	5.9	9.4	8.1	9.2	8.1	3.4
Vegetables	6.0	6.5	3.5	3.8	6.2	4.7
Fruits	1.1	2.3	1.1	2.0	1.3	1.6
Bananas & plantains.	2.1	2.5	2.3	3.6	2.5	3.0
Starchy roots & tubers	2.7	1.4	2.5	2.0	5.7	4.0
Cereal products	27.6	40.9	38.6	41.5	33.5	38.8
Sugars	0.0	0.0	0.0	0.0	0.2	0.0
Fats, oils	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	32.8	10.7	13.7	8.4	18.3	9.0

As in the case of iron and thiamine most of the niacin in the Central American diets comes from cereals, meat and beans (Table 116).

TABLE 117. PERCENT CONTRIBUTION OF THE DIFFERENT FOOD GROUPS TO THE ASCORBIC ACID CONTENT OF THE AVERAGE DIETS

Food Groups	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percentages			
Rural Areas						
Milk products	1.4	2.4	1.4	1.8	3.6	0.6
Eggs	0.0	0.0	0.0	0.0	0.0	0.0
Meat, poultry, fish	0.2	0.3	0.2	0.2	0.3	0.3
Beans	1.5	1.0	0.3	0.2	0.5	0.4
Vegetables	48.0	39.8	21.9	14.9	36.6	12.2
Fruits	29.5	34.0	44.3	38.6	14.3	39.9
Bananas & plantains	9.9	10.1	16.9	29.2	22.6	25.7
Starchy roots & tubers	8.0	11.0	14.2	14.8	20.5	20.3
Cereal products	0.0	0.0	0.0	0.0	0.0	0.0
Sugars	0.9	1.0	0.6	0.1	1.5	0.5
Fats, oils	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.6	0.4	0.1	0.2	0.3	0.2
Urban Areas						
Milk products	2.7	2.1	3.2	1.8	3.3	0.5
Eggs	0.0	0.0	0.0	0.0	0.0	0.0
Meat, poultry, fish	0.0	0.3	0.4	0.2	0.3	0.5
Beans	0.7	0.1	0.0	0.2	0.3	0.3
Vegetables	43.5	39.2	31.3	14.9	35.9	27.7
Fruits	27.4	43.6	42.7	38.6	35.4	41.1
Bananas & plantains	14.9	10.6	12.8	29.2	11.7	15.2
Starchy roots & tubers	9.4	3.7	8.5	14.8	12.8	11.4
Cereal products	0.0	0.0	0.0	0.0	0.0	0.0
Sugars	0.1	0.1	0.0	0.1	0.2	0.0
Fats, oils	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	1.3	0.3	1.0	0.2	0.2	3.2

According to Table 117, fruits, vegetables, bananas and plantains and the starchy roots and tubers provide nearly all the ascorbic acid in the average Central American diets. Since the nutritive values are determined by the use of food composition tables based on uncooked foods, and most vegetables and the starchy roots and tubers are cooked, the fruits and vegetables eaten raw will actually be the major sources of ascorbic acid.

The Adequacy of the Average Diets

The figures for the adequacy of the average diets in the various countries tell the extent to which the foods available would meet the dietary needs of those population groups if the foods were distributed according to the requirements of the individual families. Such conditions are unlikely to exist. The average figures, however, serve to indicate which nutrients may be in short supply in an area, and permit steps to be taken in agricultural planning or in trade to fill the deficiencies.

When the average intake of calories and nutrients of the Central American families (Table 107) are compared with the recommended allowances for those same population groups, a measure of the adequacy of the diets is obtained (Table 118).

TABLE 118. PERCENT ADEQUACY OF THE AVERAGE INTAKE OF CALORIES AND NUTRIENTS IN THE CENTRAL AMERICAN COUNTRIES

	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
	Percent Adequacy					
Rural Families						
Calories	109	109	89	96	91	104
Protein	133	128	108	115	98	112
Calcium	207	207	166	144	112	59
Iron	178	114	152	175	150	141
Vitamin A	68	24	34	44	49	49
Thiamine	162	136	109	105	93	116
Riboflavin	70	66	64	75	68	58
Niacin	130	93	75	78	78	108
Ascorbic Acid	87	62	130	144	117	194
Urban Families						
Calories	120	106	99	99	106	98
Protein	142	122	124	119	111	120
Calcium	192	170	168	173	165	80
Iron	179	133	129	149	155	143
Vitamin A	93	79	60	83	97	97
Thiamine	144	121	116	104	111	107
Riboflavin	98	86	90	104	97	76
Niacin	130	88	93	84	92	105
Ascorbic Acid	169	198	163	180	221	230

The average calorie intake was adequate in all the urban centers. It was also adequate in all the rural areas except those of Honduras and Costa Rica, where it was marginal. The rural groups may however have greater energy requirements, although the same standards were applied as for the urban groups.

The average protein intake was ample or liberal in all areas, if the biological value of the protein is not taken into account. Table 107 showed that the animal protein component varied from country to country and from rural to urban area.

The average calcium intake was well above the recommended allowances in all countries except Panama. It was highest in Guatemala and El Salvador, where the consumption of lime-treated corn was greatest. The decreased consumption of corn in the countries to the south was compensated by the increased milk consumption. In Panama, where the milk consumption was low and no calcium-enriched corn was eaten, the calcium intake was inadequate by the standards applied. In rural Panama the intake was 59 percent of the recommended allowances, and in Panama City, 80 percent.

The average intake of iron appeared to be generous in all the countries, in both rural and urban areas although the availability of the iron from different food sources is uncertain.

A different picture was presented by vitamin A. In no country did the average intake among rural families meet the recommended allowances. The average levels there varied from 24 percent of adequacy in El Salvador to 68 percent in Guatemala. A better showing was made in the urban centers. Urban Guatemala, Costa Rica and Panama nearly met the recommended levels, and the intake in the other three countries varied from 60 to 83 percent of these levels.

The average thiamine intake was adequate in all the countries except rural Costa Rica where it was marginal.

The average riboflavin intake was inadequate in the rural areas of all the countries, ranging from 58 percent of the recommended level in Panama to 75 percent in Nicaragua. The urban centers were better off. The intakes in urban Guatemala, Nicaragua and Costa Rica were adequate while in the other three urban areas, the intakes ranged from 76 to 86 percent of the desirable amounts.

The average intake of niacin was adequate only in the rural and urban areas of Guatemala and Panama. In the rural areas of the other four countries, the intake ranged from 75 to 93 percent of the desirable amount, and in the urban centers, from 84 to 93 percent. However, the comparison of intake with allowances did not take into consideration the availability in the foods of the amino acid tryptophan, the forerunner of niacin.

The average intake of ascorbic acid was generous in both rural and urban areas of all the countries except Guatemala and El Salvador. The intake in rural El Salvador was 62 percent of the recommended amount and in rural Guatemala, 87 percent.

Distribution of the Families by Percent Adequacy of the Diet

The calorie and nutrient intake of each individual family was compared to its estimated requirements and the distribution of the families according to the adequacy of intake presented in this section.

TABLE 119. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF CALORIE INTAKE

Adequacy	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
	Percent of Families					
Rural						
<25%	0	0	1	0	0	0
25 to 49%	2	4	6	6	6	3
50 to 74%	12	16	27	22	26	16
75 to 99%	28	23	33	31	28	28
≥100%	58	58	33	41	41	53
Urban						
<25%	0	0	0	0	0	0
25 to 49%	0	1	2	3	1	0
50 to 74%	5	14	17	19	22	26
75 to 99%	25	29	33	35	23	24
≥100%	70	56	48	43	54	50

The data of Table 119 shows that a considerable proportion of the rural families had diets which more than met their energy requirements. On the other hand, from 14 to 34 percent had diets providing less than three-fourths of their calorie needs. A smaller number in all the countries had extremely low calorie intakes.

Among the urban families, proportions generally larger than among rural families had adequate or generous calorie intakes. Nevertheless, substantial numbers obtained less than three-fourths of the calories required and small percentages in each country had even less than one-half the requirements.

Over half the rural families in five of the countries had protein intakes 100 percent or more of the recommended allowances (Table 120). Guatemala and El Salvador had the highest proportions of rural families with such generous protein intakes. They were also the countries in which the total protein contained the smallest proportion of animal protein (Table 107). From eight to 30 percent of the families in the six countries had protein intakes under three-fourths of the recommended

level. From one to nine percent had under 50 percent of the recommended amount.

TABLE 120. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF PROTEIN INTAKE

Adequacy	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
			Percent of Families			
Rural						
<25%	0	0	1	0	1	1
25 to 49%	1	0	3	3	8	5
50 to 74%	7	12	14	17	21	15
75 to 99%	19	19	25	21	25	21
≥100%	73	69	56	59	45	59
Urban						
<25%	0	0	0	0	0	0
25 to 49%	0	0	1	1	4	2
50 to 74%	4	8	9	15	15	15
75 to 99%	14	28	20	17	20	20
≥100%	82	64	70	67	61	63

In the urban population a still larger proportion of the families obtained adequate or generous amounts of protein in the diet. Nevertheless, substantial proportions in some countries received less than three-fourths of the recommended amounts, and a small proportion in most of the countries, less than half of that recommended. Since protein of animal origin is expensive, it is likely that families at the lower economic level also have protein of lower biological value.

As seen in Table 121, 95 and 96 percent of the rural families in El Salvador and Guatemala have diets meeting or exceeding the recommended calcium intake. These two countries are the largest consumers of lime-treated corn. As this practice declines with the consumption of corn in the countries to the south, disappearing in Panama, the proportion of rural family diets meeting the calcium needs decreases to a low of 16 percent in Panama. From 9 percent of the rural families in Honduras to 49 percent in Panama have diets containing less than half the calcium recommended.

TABLE 121. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF CALCIUM INTAKE

Adequacy	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
			Percent of Families			
Rural						
<25%	0	0	2	2	4	13
25 to 49%	0	0	7	14	17	36
50 to 74%	0	1	5	11	19	24
75 to 99%	3	3	9	13	12	12
≥100%	96	95	77	60	48	16
Urban						
<25%	0	0	1	1	2	5
25 to 49%	0	1	0	5	7	23
50 to 74%	0	5	4	7	11	25
75 to 99%	7	11	10	6	7	18
≥100%	93	83	85	81	72	28

TABLE 122. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF IRON INTAKE

Adequacy	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
			Percent of Families			
Rural						
<25%	0	0	1	0	0	0
25 to 49%	2	8	3	1	1	2
50 to 74%	6	15	13	6	7	7
75 to 99%	14	21	16	10	15	12
≥100%	79	56	67	82	77	79
Urban						
<25%	0	0	0	0	0	0
25 to 49%	0	1	4	2	0	1
50 to 74%	1	15	5	4	6	7
75 to 99%	3	9	19	13	9	18
≥100%	96	75	71	81	85	74

The diets of a very large proportion of both rural and urban families in Central America are shown to reach or exceed recommended iron intake

levels. Standards used in the analysis of this data were, however, very low in comparison with revised figures for allowances recently recommended by a joint FAO/WHO expert group on nutrition[1/]. By the old standards, the iron problem in Central America would be underestimated.

The available information showed that iron absorption varies widely with diet, and absorption is greater with most foods of animal origin. Using data from food consumption surveys in population groups, the expert group classified diets into those in which animal foods provided calories below 10 percent, between 10 and 25 percent, and over 25 percent, respectively, of the total calories. On the basis of experimental evidence, recommended intakes of food iron were estimated for each type of diet to ensure an adequate amount of absorbed iron. Diets with less than 10 percent of total calories from animal foods were considered to require about twice as much food iron as heretofore recommended. Diets with 10 to 25 percent of calories from animal foods were considered to require a smaller increase over former recommended levels.

Table 123 shows the percentages of calories and iron from animal foods in the diets of Central American populations.

TABLE 123. PERCENT OF CALORIES AND IRON FROM ANIMAL FOODS

	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
	(Percent from animal sources)					
Calories						
Rural	7.7	9.6	13.0	13.6	12.4	10.7
Urban	14.2	16.0	20.0	19.1	17.2	16.0
Iron						
Rural	12.7	22.3	17.2	20.0	17.5	27.5
Urban	24.2	30.8	30.9	34.1	27.2	36.8

The vitamin A intake in the large majority of the rural families was deficient (Table 124). Only two to 17 percent in the six countries reached the recommended intake level. From 66 to 88 percent of the rural families failed to obtain one-half, and from 42 to 69 percent, not even one-fourth, of the amount recommended. The vitamin A from

---

[1/] Requirements of Ascorbic Acid, Vitamin D, Vitamin B_{12}, Folate, and Iron. Food and Agriculture Organization of the United Nations and World Health Organization, Geneva, 1970.

TABLE 124 . PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF VITAMIN A INTAKE

Adequacy	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
	Percent of Families					
Rural						
<25%	44	69	56	46	44	42
25 to 49%	22	19	26	23	26	32
50 to 74%	10	7	9	13	11	13
75 to 99%	6	3	2	8	7	5
≥100%	17	2	6	11	12	8
Urban						
<25%	20	26	38	18	17	11
25 to 49%	19	21	22	25	22	36
50 to 74%	13	17	17	26	20	19
75 to 99%	15	9	9	10	11	11
≥100%	33	27	14	21	30	23

vegetable sources in the rural areas ranged from 56 percent of the total in Honduras to 86 percent in Guatemala.

In the urban population groups, larger proportions of the families had adequate or generous intakes of vitamin A while fewer families had extremely small amounts. Nevertheless, 39 to 60 percent of the urban families failed to obtain half of the recommended amounts.

TABLE 125. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF THIAMINE INTAKE

Adequacy	Guate-mala	El Sal-vador	Hon-duras	Nica-ragua	Costa Rica	Pana-ma
	Percent of Families					
Rural						
<25%	0	0	1	0	0	1
25 to 49%	0	1	6	9	11	6
50 to 74%	3	8	17	17	27	15
75 to 99%	8	18	29	24	22	22
≥100%	89	72	47	50	40	57
Urban						
<25%	0	0	0	0	0	0
25 to 49%	1	0	1	3	9	2
50 to 74%	1	14	16	29	15	25
75 to 99%	15	24	26	19	16	19
≥100%	83	62	57	49	60	54

Since cereals form a major source of thiamine in diets, the Central American countries with the highest cereal consumption tended to have the most generous thiamine intakes. In Guatemala and El Salvador, 89 and 72 percent of the rural families met or surpassed the thiamine requirements. In the other four countries, 40 to 57 percent had ample intakes. Yet, despite high average thiamine levels in Central America, from three to 38 percent of the rural families obtained less than three-fourths, and from one to 11 percent, less than one-half of the recommended thiamine allowance.

Among the urban families, the situation was similar. Large proportions of the urban families had adequate or generous intakes of thiamine, but two to 32 percent of the families in the six countries received less than 75 percent of the requirements. However, fewer urban families fell into even lower categories.

TABLE 126. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF RIBOFLAVIN INTAKE

Adequacy	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
	Percent of Families					
Rural						
<25%	2	5	8	8	13	9
25 to 49%	30	29	33	24	30	38
50 to 74%	37	29	28	24	22	26
75 to 99%	18	16	14	19	13	14
≥100%	14	20	16	25	22	13
Urban						
<25%	0	6	3	2	5	5
25 to 49%	13	19	14	13	18	25
50 to 74%	27	18	19	14	12	32
75 to 99%	17	16	21	20	23	13
≥100%	43	41	43	51	42	25

From 14 to 25 percent of the rural families had adequate or generous intake levels of riboflavin (Table 126). From 56 to 73 percent met less than three-fourths of their recommended allowances and from 32 to 47 percent, less than one-half.

Only 25 to 51 percent of the urban families met or exceeded the recommended riboflavin allowances. Twenty-nine to 62 percent had less than three-fourths, and 13 to 30 percent, less than one-half of this amount. Smaller groups had extremely low levels.

TABLE 127. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF NIACIN INTAKE

Adequacy	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
			Percent of Families			
Rural						
<25%	0	1	2	1	1	1
25 to 49%	0	11	15	15	18	3
50 to 74%	7	23	39	31	31	16
75 to 99%	19	26	24	26	26	20
≥100%	74	39	20	27	24	61
Urban						
<25%	0	0	0	1	0	0
25 to 49%	1	7	5	4	6	2
50 to 74%	16	35	31	38	22	21
75 to 99%	26	25	19	25	32	27
≥100%	57	33	45	32	40	50

Over half the families in both rural and urban areas of Guatemala and Panama met or exceeded the recommended allowances of niacin (Table 127). In the other four countries, from 20 to 39 percent of the rural, and 32 to 45 percent of the urban families are in that high range. Larger numbers of rural than urban families have less than 50 percent of the recommended allowances. In assessing the niacin values of the family diets, tryptophan content was not taken into account.

TABLE 128. PERCENT DISTRIBUTION OF FAMILIES BY LEVEL OF ADEQUACY OF ASCORBIC ACID INTAKE

Adequacy	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama
			Percent of Families			
Rural						
<25%	36	41	36	30	24	10
25 to 49%	18	14	7	8	12	8
50 to 74%	10	8	7	6	10	7
75 to 99%	8	10	8	5	12	12
≥100%	30	28	42	51	41	63
Urban						
<25%	7	7	15	6	0	0
25 to 49%	5	9	9	10	15	4
50 to 74%	6	8	8	9	6	15
75 to 99%	14	7	12	4	9	8
≥100%	68	69	56	71	70	73

Although the average diets of most of the Central American population groups met or exceeded the recommended ascorbic acid allowances, many families, particularly in the rural areas, had intakes lower than these levels (Table 128). However, the standards used in the analysis of the data were very high (approximately double) compared to figures recently recommended by an FAO/WHO expert nutrition group re-evaluating the ascorbic acid requirements[1/]. By applying the later standards the proportions of families with diets not meeting the recommended levels would be much smaller.

As distribution of foods within the populations proved to be inequitable, so distribution of foods within the family often failed to follow good nutrition practices. Studies made in subsamples of families on the food intake of individual members showed that the small child was likely to be the most deprived. These will be the subject of later INCAP reports.

[1/] Requirements of Ascorbic Acid, Vitamin D, Vitamin B_{12}, Folate, and Iron. Food and Agriculture Organization of the United Nations and World Health Organization, Geneva, 1970.

APPENDIX I

TABLE ON DAILY NUTRITIONAL RECOMMENDATIONS
(Revised June 1965)

Sex & Age	Weight kg	Calories	Protein g	Calcium mg	Iron mg	Vit. A Act. mg	Thia-mine mg	Ribo-flavin mg	Niacin Equiv. mg	Ascorbic Acid mg
Children										
(both sexes)										
0- 6 months	(a)					(b)				
7-12 months	9.3	1020	25	550	6	0.4	0.4	0.6	7.0	20
1- 3 years	12.6	1100	25	450	7	0.6	0.4	0.7	7.3	25
4- 6 years	18.8	1500	30	450	8	0.8	0.6	0.9	9.9	35
7- 9 years	25.3	1900	40	450	10	1.0	0.8	1.1	12.5	40
Boys										
10-12 years	34.2	2400	50	650	12	1.1	1.0	1.4	15.8	50
13-15 years	48.0	3000	70	650	15	1.3	1.2	1.8	19.8	60
16-19 years	62.5	3200	80	550	13	1.3	1.3	1.9	21.1	65
Girls										
10-12 years	34.7	2200	50	650	12	1.1	0.9	1.3	14.5	50
13-15 years	48.3	2500	70	650	15	1.3	1.0	1.5	16.5	50
16-19 years	53.5	2100	70	550	13	1.3	0.8	1.3	13.9	50
Adults										
Men	55	2700	65	450	10	1.3	1.1	1.6	17.8	50
Women	50	2000	60	450	10	1.3	0.8	1.2	13.2	45
Pregnant (2nd & 3rd trimesters)	--	2200	70	1100	14	1.6	0.9	1.3	14.5	65
Lactating	--	2800	85	1100	14	2.1	1.1	1.7	18.5	95

(a) **Breast feeding is accepted as the most adequate means for satisfying the nutritional needs of infants 0-6 months old.**

(b) Vitamin A activity varies somewhat from the recent FAO/WHO recommended intakes for retinol. The percent of adequacy given in other tables are based on the above values.

NOTES

The figures for the nutritional recommendations were derived from the following sources: Calorie Requirements. Report of the Second Committee on Calorie Requirements, FAO, Rome, 1957; Protein Requirements. Report of a Joint FAO/WHO Expert Group, Rome, 1963; Calcium Requirements. Report of an FAO/WHO Expert Group, Rome, 1961; and Recommended Dietary Allowances, National Research Council, Washington, D. C., 1963. The values were adapted to the weight, environmental temperature and type of diet of the Central American population.

Calories

The values are the estimated requirements according to sex, age and weight, and a moderate activity. Sedentary people require fewer calories and active people more. In adults the calorie requirements decrease with age according to the following table:

Age (years)	Percent of Reference
20 to 30	100.0
30 to 40	97.0
40 to 50	94.0
50 to 60	86.5
60 to 70	79.0
70 and over	69.0

The figures were calculated for an environmental temperature of 20 degrees centigrade. If the mean annual temperature is higher, the requirements decrease by 5 percent for every 10 degrees centigrade above 20 degrees centigrade.

Protein

The protein recommendations were calculated on the assumption that the protein of the Central American diet has a net utilization of 60 percent. The following recommendations per kg of body weight were used:

7 - 12 months	2.25 g
1 - 3 years	1.75 g
4 - 6 years	1.61 g
7 - 9 years	1.54 g
10 - 12 years	1.44 g
13 - 15 years	1.39 g
16 - 19 years	1.27 g
Adults	1.18 g
Pregnant women	+10 g to total
Lactating women	+25 g to total

It is recommended that the diet contain 30 percent protein of high biological value for the adult and at least 50 percent for children.

Vitamin A

One I.U. is equal to 0.3 mcg of active vitamin A. The recommended amounts assume that 1/5 of the total intake is in the form of preformed vitamin A and 4/5 in the form of beta-carotene.

Thiamine

The recommendations were based on 0.4 mg per 1,000 calories.

Riboflavin

The recommendations were based on 0.6 mg per 100 calories.

Niacin

The recommendations were based on 6.6 mg per 1,000 calories.

Weights

For children and adolescents the average weights of the Iowa curves were used. These are considered applicable to the well-nourished Central American populations.

Pregnancy and Lactation

The recommendations correspond to a woman whose weight before pregnancy is 50 kg.

APPENDIX II

GUIDES FOR INTERPRETATION OF BIOCHEMICAL AND HEMATOLOGICAL FINDINGS

REFERENCES

Manual for nutrition surveys, Second Edition, 1963,
Interdepartmental Committee on Nutrition for National Defense,
National Institutes of Health, Bethesda, Maryland, U.S.A.

Wintrobe, M. M.,
Clinical hematology, 5th Edition
Philadelphia, Lea and Febiger, 1961.

Hurtado, A., Merino, C. and Delgado, E.,
Influence of anoxemia on the hemopoietic activity.
Arch. Int. Med. 75: 284, 1945.

Guest, G. M. and Brown, E. W.,
Erythrocytes and hemoglobin of the blood in infancy and childhood.
A.M.A. Jour. Diseases of Child. 93: 486, 1957.

Darby, W. J.,
Iron and copper, Chapter in Handbook of Nutrition, 2nd Edition
Blakiston Co., New York, 1951, pp 89-110.

WHO. Nutritional anaemias; Report of a WHO Scientific Group,
Geneva, 1968 (Tech. Rep. Ser. No. 405).

Bothwell, Thomas H., Finch, Clement A., Iron metabolism,
Boston Little Brown and Co. (c1962).

Bainton, Dorothy Ford, M.D., and Finch, Clement A.,
The Diagnosis of iron deficiency anemia.
American Journal of Medicine, Vol. 37, July 1964, p. 62-70.

Herbert, V.,
Biochemical and hematologic lesions in folic acid deficiency.
Am. J. Clin. Nutr. 20: 562, 1967.

Herbert, V., Baker, H., Frank, O., Pasher, I., Sobotka, H. and Wasserman, L. R.,
The measurement of folic acid activity in serum: A diagnostic aid in the
differentiation of the megaloblastic anemias.
Blood 15: 228, 1960.

Shinton, N. K.,
Total serum vitamin B_{12} concentration in normal human adult serum assayed
by E. gracillis, Clin. Sci. 18: 389, 1959.

TABLE 1. GUIDE TO INTERPRETATION OF BLOOD DATA[1/]

Constituent	Deficient	Low	Acceptable	High
Total plasma protein: gm/100 ml	<6.0	6.0 - 6.4	6.5 - 6.9	≥7.0
Serum albumin (electrophoretic method): gm/100 ml	<2.80	2.80- 3.51	3.52- 4.24	≥4.25
Serum globulin (percent of serum protein):				
$Alpha_1$			4 - 7	
$Alpha_2$			9 -11	
Beta			11 -15	
Gamma			12 -16	
Hemoglobin, gm/100 ml:				
Men	<12.0	12.0 -13.9	14.0 -14.9	≥15.0
Women (nonpregnant, nonlactating; ≥13 yrs)	<10.0	10.0 -10.9	11.0 -14.4	≥14.5
Children (3-12 years)	<10.0	10.0 -10.9	11.0 -12.4	≥12.5
Hematocrit (PCV), percent:				
Men	<36	36 -41	42 -44	≥45
Women (nonpregnant, nonlactating; ≥13 yrs)	<30	30 -37	38 -42	≥43
Children (3-12 years)	<30.0	30.0 -33.9	34.0 -36.9	≥37.0
Plasma ascorbic acid: mg/100 ml	< 0.10	0.10- 0.19	0.20- 0.39	≥ 0.40
Plasma vitamin A: mcg/100 ml	<10	10 -19	20 -49	≥50
Plasma carotene: mcg/100 ml		20 -39	40 -99	≥100
Red cell riboflavin: mcg/100 ml-red blood cells	<10.0	10.0 -14.9	15.0 -19.9	≥20

[1/]Except for the particulates in blood, serum levels of nutrients in children do not differ appreciably beyond infancy from those of adults. Similarly, with the exception of hemoglobin and hematocrit, the serum levels of blood constituents in women of child-bearing age are comparable to those of males. Data on pregnant women are presented separately by trimester in Table 2.

TABLE 2. GUIDE TO INTERPRETATION OF BLOOD DATA IN PREGNANT WOMEN[1/]

Constituent	Trimester	Deficient	Low	Acceptable	High
Total serum protein: gm/100 ml	1	< 6.0	6.0-6.4	6.5-6.9	≥ 7.0
	2	< 5.5	5.5-5.9	6.0-6.9	≥ 7.0
	3	< 5.5	5.5-5.9	6.0-6.9	≥ 7.0
Serum albumin: gm/100 ml	1	< 3.0	3.0-3.9	4.0-4.9	≥ 5.0
	2	< 3.0	3.0-3.4	3.5-4.4	≥ 4.5
	3	< 3.0	3.0-3.4	3.5-4.4	≥ 4.5
Serum globulin: gm/100 ml	1	< 1.4	1.4-1.9	2.0-2.9	≥ 3.0
	2	< 1.4	1.4-1.9	2.0-2.9	≥ 3.0
	3	< 1.7	1.7-2.1	2.2-2.9	≥ 3.0
Hemoglobin: gm/100 ml	1	< 10.0	10.0-10.9	11.0-14.4	≥ 14.5
	2	< 9.5	9.5-10.4	10.5-12.9	≥ 13.0
	3	< 9.0	9.0-10.4	10.5-12.9	≥ 13.0
Hematocrit (PCV): percent	1	< 30	30-37	38-42	≥ 43
	2	< 30	30-34	35-37	≥ 38
	3	< 30	30-32	33-34	≥ 35
Mean corpuscular hemoglobin concentration percent	1				
	2	< 28.0	28.0-30.4	30.5-34.9	≥ 35.0
	3				
Plasma ascorbic acid			Same as values given in Table 1		
Plasma vitamin A			Same as values given in Table 1		
Plasma carotene: μg/100 ml	1		20-39	40-99	≥ 100
	2		30-79	80-199	≥ 200
	3		40-79	80-249	≥ 250

[1/] Based on observations in: The Vanderbilt cooperative study of maternal and infant nutrition. IV. Dietary, laboratory and physical findings in 2,129 delivered pregnancies. J. Nutrition 51, 565-598, 1953.
Values for pregnant women in the first trimester do not differ appreciably from those of nonpregnant women in the same age group.

TABLE 1. GUIDE TO INTERPRETATION OF BLOOD DATA[1/]

Constituent	Deficient	Low	Acceptable	High
Total plasma protein: gm/100 ml	<6.0	6.0 - 6.4	6.5 - 6.9	≥7.0
Serum albumin (electrophoretic method): gm/100 ml	<2.80	2.80- 3.51	3.52- 4.24	≥4.25
Serum globulin (percent of serum protein):				
$Alpha_1$			4 - 7	
$Alpha_2$			9 -11	
Beta			11 -15	
Gamma			12 -16	
Hemoglobin, gm/100 ml:				
Men	<12.0	12.0 -13.9	14.0 -14.9	≥15.0
Women (nonpregnant, nonlactating; ≥13 yrs)	<10.0	10.0 -10.9	11.0 -14.4	≥14.5
Children (3-12 years)	<10.0	10.0 -10.9	11.0 -12.4	≥12.5
Hematocrit (PCV), percent:				
Men	<36	36 -41	42 -44	≥45
Women (nonpregnant, nonlactating; ≥13 yrs)	<30	30 -37	38 -42	≥43
Children (3-12 years)	<30.0	30.0 -33.9	34.0 -36.9	≥37.0
Plasma ascorbic acid: mg/100 ml	< 0.10	0.10- 0.19	0.20- 0.39	≥ 0.40
Plasma vitamin A: mcg/100 ml	<10	10 -19	20 -49	≥50
Plasma carotene: mcg/100 ml		20 -39	40 -99	≥100
Red cell riboflavin: mcg/100 ml-red blood cells	<10.0	10.0 -14.9	15.0 -19.9	≥20 .

[1/]Except for the particulates in blood, serum levels of nutrients in children do not differ appreciably beyond infancy from those of adults. Similarly, with the exception of hemoglobin and hematocrit, the serum levels of blood constituents in women of child-bearing age are comparable to those of males. Data on pregnant women are presented separately by trimester in Table 2.

TABLE 2. GUIDE TO INTERPRETATION OF BLOOD DATA IN PREGNANT WOMEN[1/]

Constituent	Trimester	Deficient	Low	Acceptable	High
Total serum protein: gm/100 ml	1	< 6.0	6.0-6.4	6.5-6.9	≥ 7.0
	2	< 5.5	5.5-5.9	6.0-6.9	≥ 7.0
	3	< 5.5	5.5-5.9	6.0-6.9	≥ 7.0
Serum albumin: gm/100 ml	1	< 3.0	3.0-3.9	4.0-4.9	≥ 5.0
	2	< 3.0	3.0-3.4	3.5-4.4	≥ 4.5
	3	< 3.0	3.0-3.4	3.5-4.4	≥ 4.5
Serum globulin: gm/100 ml	1	< 1.4	1.4-1.9	2.0-2.9	≥ 3.0
	2	< 1.4	1.4-1.9	2.0-2.9	≥ 3.0
	3	< 1.7	1.7-2.1	2.2-2.9	≥ 3.0
Hemoglobin: gm/100 ml	1	< 10.0	10.0-10.9	11.0-14.4	≥ 14.5
	2	< 9.5	9.5-10.4	10.5-12.9	≥ 13.0
	3	< 9.0	9.0-10.4	10.5-12.9	≥ 13.0
Hematocrit (PCV): percent	1	< 30	30-37	38-42	> 43
	2	< 30	30-34	35-37	≥ 38
	3	< 30	30-32	33-34	≥ 35
Mean corpuscular hemoglobin concentration percent	1				
	2	< 28.0	28.0-30.4	30.5-34.9	≥ 35.0
	3				
Plasma ascorbic acid		Same as values given in Table 1			
Plasma vitamin A		Same as values given in Table 1			
Plasma carotene: μg/100 ml	1		20-39	40-99	≥ 100
	2		30-79	80-199	≥ 200
	3		40-79	80-249	≥ 250

[1/] Based on observations in: The Vanderbilt cooperative study of maternal and infant nutrition. IV. Dietary, laboratory and physical findings in 2,129 delivered pregnancies. J. Nutrition 51, 565-598, 1953.
Values for pregnant women in the first trimester do not differ appreciably from those of nonpregnant women in the same age group.

TABLE 3. GUIDE TO INTERPRETATION OF URINARY VITAMIN EXCRETION DATA

Constituent	Deficient	Low	Acceptable	High
	ADULTS (MALES AND NONPREGNANT, NONLACTATING FEMALES)[1/]			
Thiamine:				
μg/6 hours	< 10	10-24	25-49	≥ 50
μg/gm creatinine	< 27	27-65	66-129	≥ 130
Riboflavin:				
μg/6 hours	< 10	10-29	30-99	≥ 100
μg/gm creatinine	< 27	27-79	80-269	≥ 270
N'-Methylnicotinamide:				
mg/6 hours	< 0.2	0.2-0.59	0.6-1.59	≥ 1.6
mg/gm creatinine	< 0.5	0.5-1.59	1.6-4.29	≥ 4.3
	PROVISIONAL GUIDE FOR URINARY EXCRETIONS IN CHILDREN[2/]			
Thiamine: μg/gm creatinine:				
Age (years):				
1-3	< 120	120-175	176-600	> 600
4-6	< 85	85-120	121-400	> 400
7-9	< 70	70-180	181-350	> 350
10-12	< 60	60-180	181-300	> 300
13-15	< 50	50-150	151-250	> 250
Riboflavin: μg/gm creatinine:				
Age (years):				
1-3	< 150	150-499	500-900	> 900
4-6	< 100	100-299	300-600	> 600
7-9	< 85	85-269	270-500	> 500
10-15	< 70	70-199	200-400	> 400

[1/] The urinary values indicated above for adults are based on an expected creatinine excretion of 1.5 gm daily for a reference man weighing 65 kg, for creatinine coefficient of 23. Values for pregnant women are presented in Table 4.

[2/] The guides offered here for children are based on considerably less extensive data than are the guides for adults.

TABLE 4. GUIDE TO INTERPRETATION OF URINARY VITAMIN EXCRETION IN PREGNANT WOMEN[1/]

Constituent	Trimester	Deficient	Low	Acceptable	High
Thiamine: μg/gm creatinine	1	< 27	27-65	66-129	≥ 130
	2	< 23	23-54	55-109	≥ 110
	3	< 21	21-49	50-99	≥ 100
Riboflavin: μg/gm creatinine	1	< 27	27-79	80-269	≥ 270
	2	< 39	39-119	120-399	≥ 400
	3	< 30	30-89	90-299	≥ 300
N'-Methylnicotinamide: mg/gm creatinine	1	< 0.5	0.5-1.59	1.6-4.29	≥ 4.3
	2	< 0.6	0.6-1.99	2.0-4.99	≥ 5.0
	3	< 0.8	0.8-2.49	2.5-6.49	≥ 6.5

[1/] Based on observations in: The Vanderbilt cooperative study of maternal and infant nutrition. IV. Dietary, laboratory and physical findings in 2,129 delivered pregnancies. J. Nutrition 51, 565-598, 1953. Values for pregnant women in the first trimester do not differ appreciably from those of nonpregnant women in the same age group.

TABLE 5. GUIDE TO INTERPRETATION OF HEMOGLOBIN ACCORDING TO ALTITUDE, AGE, SEX AND TERM OF PREGNANCY

Age	Sex	Altitude (feet) 0-2499			2500 - 4999			5000 - 7499			7500 +		
		Deficient	Low	Acceptable	Deficient	Low	Acceptable	Deficient	Low	Acceptable	Deficient	Low	Acceptable
3-11 m	M&F	-9.0	9.0- 9.5	9.6+	-9.2	9.2- 9.7	9.8+	-9.4	9.4- 9.9	10.0+	- 9.5	9.6-10.1	10.2+
12-35 m	M&F	-9.5	9.5-10.2	10.3+	-9.7	9.7-10.4	10.5+	-9.9	9.9-10.6	10.7+	-10.1	10.1-10.8	10.9+
3-11 y	M&F	-10.1	10.1-11.0	11.1+	-10.3	10.3-11.2	11.3+	-10.5	10.5-11.4	11.5+	-10.7	10.7-11.6	11.7+
12-17 y	M	-11.9	11.9-13.8	13.9+	-12.1	12.1-14.0	14.1+	-12.3	12.3-14.2	14.3+	-12.5	12.5-14.4	14.5+
12-17 y	F	-10.8	10.8-11.7	11.8+	-11.0	11.0-11.9	12.0+	-11.2	11.2-12.1	12.2+	-11.4	11.4-12.3	12.4+
18-44 y	M	-12.1	21.1-14.0	14.1+	-12.3	12.3-14.2	14.3+	-12.5	12.5-14.4	14.5+	-12.7	12.7-14.6	14.7+
18-44 y	F	-10.1	10.1-11.0	11.1+	-10.3	10.3-11.2	11.3+	-10.5	10.5-11.4	11.5+	-10.7	10.7-11.6	11.7+
45-64 y	M&F	-11.1	11.1-12.5	12.6+	-11.3	11.3-12.7	12.8+	-11.5	11.5-12.9	13.0+	-11.7	11.7-13.1	13.2+
65+ y	M&F	-10.9	10.9-12.3	12.4+	-11.1	11.1-12.5	12.6+	-11.3	11.3-12.7	12.8+	-11.5	11.5-12.9	13.0+
Pregnant Women													
1st	Trimester	-10.1	10.1-11.0	11.1+	-10.3	10.3-11.2	11.3+	-10.5	10.5-11.4	11.5+	-10.7	10.7-11.6	11.7+
2nd	Trimester	- 9.6	9.6-10.5	10.6+	- 9.8	9.8-10.7	10.8+	-10.0	10.0-10.9	11.0+	-10.2	10.2-11.1	11.1+
3rd	Trimester	- 9.1	9.1-10.5	10.6+	- 9.3	9.3-10.7	10.8+	- 9.5	9.5-10.9	11.0+	- 9.7	9.7-11.1	11.1+

m = months y = years M = males F = females

TABLE 6. GUIDE TO INTERPRETATION OF HEMATOCRIT ACCORDING TO ALTITUDE, AGE, SEX AND TERM OF PREGNANCY

Age	Sex	Altitude (feet) 0-2499			2500 - 4999			5000 - 7499			7500 +		
		Deficient	Low	Acceptable	Deficient	Low	Acceptable	Deficient	Low	Acceptable	Deficient	Low	Acceptable
3-11 m	M&F	-26.5	26.5-27.9	28.0+	-27.0	27.0-28.5	28.6+	-27.6	27.6-29.1	29.2+	-28.2	28.2-29.7	29.8+
12-35 m	M&F	-28.8	28.8-30.9	40.0+	-29.4	29.4-31.5	31.6+	-30.0	30.0-32.1	32.2+	-30.6	30.6-32.7	32.8+
3-11 y	M&F	-30.1	30.1-32.8	32.9+	-30.7	30.7-33.4	33.5+	-31.3	31.3-34.0	34.1+	-31.9	31.9-34.6	34.7+
12-17 y	M	-34.9	34.9-40.5	40.6+	-35.5	35.5-41.0	41.1+	-36.1	36.1-41.6	41.7+	-36.6	36.6-42.2	42.3+
12-17 y	F	-31.7	31.7-34.3	34.4+	-32.2	32.2-34.9	35.0+	-32.8	32.8-35.5	35.6+	-33.4	33.4-36.1	36.2+
18-44 y	M	-35.5	35.5-41.0	41.1+	-36.1	36.1-41.6	41.7+	-36.6	36.6-42.2	42.3+	-37.2	37.2-42.8	42.9+
18-44 y	F	-29.6	29.6-32.2	32.3+	-30.2	30.2-32.8	32.9+	-30.8	30.8-33.4	33.5+	-31.4	31.4-34.0	34.1+
45-64 y	M&F	-32.6	32.6-36.6	36.7+	-33.1	33.1-37.2	37.3+	-33.7	33.7-37.8	37.9+	-34.3	34.3-38.4	38.5+
65+ y	M&F	-32.0	32.0-36.1	36.2+	-32.6	32.6-36.6	36.7+	-33.1	33.1-37.2	37.3+	-33.7	33.7-37.8	37.9+
Pregnant Women													
1st	Trimester	-29.6	29.6-32.2	32.3+	-30.2	30.2-32.9	33.0+	-30.9	30.9-33.5	33.6+	-31.5	31.5-34.1	34.2+
2nd	Trimester	-28.2	28.2-30.9	31.0+	-28.8	28.8-31.5	31.6+	-29.4	29.4-32.0	32.1+	-30.0	30.0-32.6	32.7+
3rd	Trimester	-26.7	26.7-30.8	30.9+	-27.4	27.4-31.5	31.6+	-27.9	27.9-32.0	32.1+	-28.5	28.5-32.6	32.7+

m = months y = years M = males F = females

TABLE 7. GUIDE TO INTERPRETATION OF SERUM IRON ACCORDING TO AGE, SEX, AND PHYSIOLOGICAL STATE (ALL ALTITUDES)

Age	Sex	Deficient	Low	Acceptable
3 - 11 m	M & F	-18.0	18.0-29.9	30.0+
12 - 35 m	M & F	-30.0	30.0-49.9	50.0+
3 - 11 y	M & F	-30.0	30.0-49.9	50.0+
12 - 17 y	M	-30.0	30.0-59.9	60.0+
12 - 17 y	F	-30.0	30.0-59.9	60.0+
18 - 44 y	M	-30.0	30.0-59.9	60.0+
18 - 44 y	F	-30.0	30.0-59.9	60.0+
45 - 64 y	M & F	-30.0	30.0-49.9	50.0+
65 +	M & F	-30.0	30.0-49.9	50.0+
Pregnant Women				
1st Trimester		-30.0	30.0-59.9	60.0+
2nd Trimester		-30.0	30.0-59.9	60.0+
3rd Trimester		-45.0	45.0-59.9	60.0+
Lactating Women		-30.0	30.0-59.9	60.0+

m = months y = years M = Males F = Females

TABLE 8. GUIDE TO INTERPRETATION OF TOTAL IRON BINDING CAPACITY ACCORDING TO AGE, SEX, & PHYSIOLOGICAL STATE (ALL ALTITUDES)

Age	Sex	Low[1/]	Acceptable	High[2/]
3 - 11 m	M & F	180-229	230-299	300+
12 - 35 m	M & F	200-249	250-349	350+
3 - 11 y	M & F	200-249	250-349	350+
12 - 17 y	M	200-299	300-399	400+
12 - 17 y	F	200-299	300-399	400+
18 - 44 y	M	200-299	300-399	400+
18 - 44 y	F	200-299	300-399	400+
45 - 64 y	M & F	200-299	300-399	400+
65 +	M & F	200-249	250-349	350+
Pregnant Women				
1st Trimester		200-299	300-399	400+
2nd Trimester		200-299	300-399	400+
3rd Trimester		250-299	300-449	450+
Lactating Women		200-299	300-399	400+

m = months y = years M = males F = females

1/ "Low" signifies protein deficiency.
2/ "High" signifies iron deficiency.

TABLE 9. GUIDE TO INTERPRETATION OF PERCENT SATURATION OF TRANSFERRIN ACCORDING TO AGE, SEX & PHYSIOLOGICAL STATE (ALL ALTITUDES)

Age	Sex	Deficient	Low	Acceptable
3 - 11 m	M & F	-10.0	10.0-12.9	13.0+
12 - 35 m	M & F	-15.0	15.0-19.9	20.0+
3 - 11 y	M & F	-15.0	15.0-19.9	20.0+
12 - 17 y	M	-15.0	15.0-19.9	20.0+
12 - 17 y	F	-15.0	15.0-19.9	20.0+
18 - 44 y	M	-15.0	15.0-19.9	20.0+
18 - 44 y	F	-15.0	15.0-19.9	20.0+
45 - 64 y	M & F	-15.0	15.0-19.9	20.0+
65 +	M & F	-15.0	15.0-19.9	20.0+
Pregnant Women				
1st Trimester		-15.0	15.0-19.9	20.0+
2nd Trimester		-15.0	15.0-19.9	20.0+
3rd Trimester		-15.0	15.0-19.9	20.0+
Lactating Women		-15.0	15.0-19.9	20.0+

m = months y = years M = Males F = Females

TABLE 10. GUIDE TO INTERPRETATION OF SERUM FOLATE ACCORDING TO AGE, SEX, AND PHYSIOLOGICAL STATE (ALL ALTITUDES)

Age	Sex	Deficient	Low	Acceptable
3 - 11 m	M & F	-3.0	3.0-4.9	5.0+
12 - 35 m	M & F	-3.0	3.0-4.9	5.0+
3 - 11 y	M & F	-3.0	3.0-4.9	5.0+
12 - 17 y	M	-3.0	3.0-4.9	5.0+
12 - 17 y	F	-3.0	3.0-4.9	5.0+
18 - 44 y	M	-3.0	3.0-4.9	5.0+
18 - 44 y	F	-3.0	3.0-4.9	5.0+
45 - 64 y	M & F	-3.0	3.0-4.9	5.0+
65 +	M & F	-3.0	3.0-4.9	5.0+
Pregnant Women				
1st Trimester		-3.0	3.0-4.9	5.0+
2nd Trimester		-3.0	3.0-4.9	5.0+
3rd Trimester		-3.0	3.0-4.9	5.0+
Lactating Women		-3.0	3.0-4.9	5.0+

m = months y = years M = Males F = Females

TABLE 11. GUIDE TO INTERPRETATION OF SERUM VITAMIN B_{12} LEVELS ACCORDING TO AGE, SEX AND PHYSIOLOGICAL STATE (ALL ALTITUDES)

Age	Sex	Deficient	Low	Acceptable
3 - 11 m	M & F	-100	100-149	150+
12 - 35 m	M & F	-100	100-149	150+
3 - 11 y	M & F	-100	100-149	150+
12 - 17 y	M	-100	100-149	150+
12 - 17 y	F	-100	100-149	150+
18 - 44 y	M	-100	100-149	150+
18 - 44 y	F	-100	100-149	150+
45 - 64 y	M & F	-100	100-149	150+
65 +	M & F	-100	100-149	150+
Pregnant Women				
1st Trimester		-100	100-149	150+
2nd Trimester		-100	100-149	150+
3rd Trimester		-100	100-149	150+
Lactating Women		-100	100-149	150+

m = months y = years M = Males F = Females

ADDITIONAL PUBLICATIONS BASED ON DATA FROM THE NUTRITION SURVEY OF CENTRAL AMERICA AND PANAMA

INCAP Publications	Reference
E-387	Ramírez, Marco Antonio. La explotación de los recursos y los intereses privados y sociales en el Itsmo Centroamericano. Revista Universidad de San Carlos (Guatemala) , 67:39-49 , 1965. (Volumen impreso en 1967).
E-403	Arroyave, Guillermo y Oscar Pineda. Relación entre la ingesta de tiamina y su excreción urinaria. Archivos Latinoamericanos de Nutrición, 18: 375:382, 1968.
E-408	Flores, Marina y María Teresa Menchú. Evaluación dietética por análisis químico y por cálculo aplicando tablas de composición de alimentos. Archivos Latinoamericanos de Nutrición, 18: 283-300, 1968.
E-411	Mata, Leonardo J. Infección intestinal en niños de áreas rurales centroamericanas y sus posibles implicaciones nutricionales. Archivos Latinoamericanos de Nutrición, 19: 153-172 , 1969.
E-424	Arroyave, Guillermo, Alfredo Méndez y Werner Ascoli. Relación entre índices bioquímicos del estado nutricional y nivel socio cultural de las familias en el área rural de Centro América y Panamá. Archivos Latinoamericanos de Nutrición, 20 : 195-216 , 1970.
E-425	Flores, Marina, María Teresa Menchú y Guillermo Arroyave. Ingesta de micronutrientes en las áreas rurales de Centro América y Panamá. Archivos Latinoamericanos de Nutrición, 19 : 265-278 , 1969.
E-435	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Moisés Béhar. Dieta adecuada de costo mínimo para Guatemala. Instituto de Nutrición de Centro América y Panamá, 1969. 17 p.
E-438	Méndez, Alfredo. Método para medir la situación socio cultural de las familias rurales centroamericanas y su aplicación a los programas de salud. Archivos Latinoamericanos de Nutrición, 20 :281-291 , 1970.

INCAP Publications	Reference
E-450	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Miguel A. Guzmán. Relación entre la ingesta de calorías y nutrientes en niños pre-escolares y la disponibilidad dietética familiar. Archivos Latinoamericanos de Nutrición, 20: 41-58 , 1970.
E-458	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Moisés Béhar. Dieta adecuada de costo mínimo para la República de El Salvador. Guatemala, Instituto de Nutrición de Centro América y Panamá, 1969.
E-459	Ascoli, Werner y Guillermo Arroyave. Epidemiología del bocio endémico en Centro América. Archivos Latinoamericanos de Nutrición, 20: 309-320, 1970.
E-464	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Moisés Béhar. Dieta adecuada de costo mínimo para la República de Nicaragua. Guatemala, Instituto de Nutrición de Centro América y Panamá.
E-473	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Moisés Béhar. Dieta adecuada de costo mínimo para la República de Honduras. Instituto de Nutrición de Centro América y Panamá, Guatemala, 1970.
E-478	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Moisés Béhar. Dieta adecuada de costo mínimo para la República de Costa Rica, Instituto de Nutrición de Centro América y Panamá, Guatemala, 1970
E-530	Flores Marina, María Teresa Menchú y Marta Yolanda Lara. Valor nutritivo de los alimentos para Centro América y Panamá. Instituto de Nutrición de Centro América y Panamá, Guatemala 1971.
V-25	Evaluación nutricional de la población de Centro América y Panamá. Guatemala. Instituto de Nutrición de Centro América y Panamá (INCAP); Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU) ; Ministerio de Salud Pública y Asistencia Social. Guatemala, Instituto de Nutrición de Centro América y Panamá, 1969.

INCAP Publications	Reference
V-26	Evaluación Nutricional de la población de Centro América y Panamá. El Salvador. Instituto de Nutrición de Centro América y Panamá (INCAP); Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU); Ministerio de Salud Pública y Asistencia Social. Guatemala, Instituto de Nutrición de Centro América y Panamá, 1969.
V-27	Evaluación nutricional de la población de Centro América y Panamá. Nicaragua. Instituto de Nutrición de Centro América y Panamá (INCAP); Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU); Ministerio de Salubridad Pública. Guatemala, Instituto de Nutrición de Centro América y Panamá (INCAP), 1969.
V-28	Evaluación nutricional de la población de Centro América y Panamá. Costa Rica. Instituto de Nutrición de Centro América y Panamá (INCAP) ; Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU) ; Ministerio de Salubridad Pública. Guatemala, Instituto de Nutrición de Centro América y Panamá, 1969.
V-29	Evaluación nutricional de la población de Centro América y Panamá. Honduras. Instituto de Nutrición de Centro América y Panamá (INCAP) ; Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud Pública y Asistencia Social. Guatemala, Instituto de Nutrición de Centro América y Panamá, 1969.
V-30	Evaluación nutricional de la población de Centro América y Panamá. Panamá. Instituto de Nutrición de Centro América y Panamá (INCAP); Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU); Ministerio de Salud Pública. Guatemala, Instituto de Nutrición de Centro América y Panamá (INCAP) 1969.
C-25	Garn, Stanley M., Jeremy J. Brigham, Cristabel G. Rohmann and Werner Ascoli. Further evidence for continuing bone expansion. Am. J. Phys. Anthropol., 1969.

INCAP Publications	Reference
C-29	Garn, Stanley M., Christabel G. Rohmann, Betty Wagner, Gail H. Dávila and Werner Ascoli. Population similarities in the onset and rate of adult endosteal bone loss. Clinical Orthopaedics and Related Research. 65: 51-60 , 1969.
C-39	Frisancho, A. Roberto, Stanley M. Garn y Werner Ascoli. Subperiosteal and Endosteal Bone Apposition during adolescence. Human Biology, 42 :639-664 , 1970.
C-40	Frisancho, A. Roberto, Stanley M. Garn y Werner Ascoli. Unaltered cortical area of pregnant and lactating women. Studies of the Second metacarpal Bone in North and Central American Populations. Investigative Radiology , 6 : 119-121, 1971.
M-6	Ramírez, Marco Antonio. Los alimentos en Centro América . la. ed. San Salvador, El Salvador, Secretaría General de la Organización de Estados Centroamericanos (ODECA), 1968. Guatemala Litografía Byron Zadik y Cía., S. C., 1969 , vi + 124 pags. Serie de Monografías Técnicas 3.
DE-494	(To be Published in Arch. Latinoamer. Nutrición) Menchú María Teresa, Marina Flores, Marta Yolanda Lara y Moisés Béhar. Lactancia y destete en el área rural de Centro América y Panamá.
DE-527	Flores, Marina, María Teresa Menchú, Marta Yolanda Lara y Moisés Béhar. Dieta del pre-escolar en el área rural de El Salvador.
DE-538	Viteri, Fernando, de Tuna Velia and Miguel A. Guzman. Establishment of normal hematological values in the Central American Population. Sent for publication to British Journal of Hematology.

List of Theses

T-71	Torún, Benjamín (Médico y Cirujano). Exploración de la respuesta cardiovascular del adulto joven Guatemalteco ante el ejercicio físico severo. Universidad de San

INCAP Publications	Reference
	Carlos de Guatemala, Facultad de Ciencias Médicas. Septiembre de 1965.
T-81	Delgado, María Lourdes (Médico y Cirujano). Desarrollo físico del niño Nicaragüense. Universidad Nacional de Nicaragua, Facultad de Medicina. Diciembre de 1966.
T-82	Tahay Reina, Mariano Ramiro (Cirujano Destista). Indice periodontario e índice de higiene oral en una muestra representativa de Guatemala- Informe preliminar. Universidad de San Carlos de Guatemala, Facultad de Odontología. Junio de 1966.
T-83	Guillén, Lozano, Luis René (Cirujano Dentista) Indice de caries dentaria en una muestra de la población de la República de Guatemala. Universidad de San Carlos de Guatemala, Facultad de Odontología. Febrero de 1967.
T-84	Barrera Polanco, Marta Amanda (Trabajadora Social). Factores socio-culturales que influyen en la malnutrición. Estudio de 400 familias en 40 comunidades rurales de Guatemala. Instituto Guatemalteco de Seguridad Social, Escuela de Servicio Social. 1966.
T-86	Granillo, Norma Gladys (Doctora en Química Biológica y Farmacia) . Razón de aminoácidos no esenciales a esenciales como índice de nutrición protéica. Universidad de El Salvador, Facultad de Ciencias Químicas. Febrero de 1967.
T-87	Ventura, Ana Guadalupe (Doctora en Química y Farmacia). Evaluación bioquímica del estado nutricional con respecto a riboflavina en la población rural de Guatemala. Universidad de El Salvador, Facultad de Ciencias Químicas. Agosto de 1967.
T-91	González Ceballos, Carlos Humberto (Químico Farmacéutico). Evaluación bioquímica del estado nutricional con respecto a riboflavina de la población rural de Guatemala. Universidad de San Carlos de Guatemala, Facultad de Ciencias Químicas y Farmacia. Agosto de 1967.

INCAP Publications	Reference
T-98	Aguilar Arriola, José Héctor (Quĭmico Farmacéutico). Evaluación bioquĭmica del estado nutricional de la población rural de Guatemala con respecto a niacina. Universidad de San Carlos de Guatemala Facultad de Ciencias Quĭmicas y Farmacia. Julio de 1966.
T-102	Moscoso, Yolanda Montoya de (Quĭmico Farmacéutico). Evaluación bioquĭmica del estado nutricional con respecto a proteĭnas de la población rural de Guatemala. Universidad de San Carlos de Guatemala, Facultad de Ciencias Quĭmicas y Farmacia. Octubre de 1969.

Other References

Keusch, Mata, Grady
Shigella enterotoxin: Isolation and characterization.
Bact. Proc., 70th Meet., p. 99, April 26-May 1, 1970.
Clin. Res., 18:442 1970

Mata, Gangarosa, Mendizábal
Epidemic Shiga dysentery in Guatemala
Fed. Proc., 29 (2): 256, Abs. April 12-17, 1970 (I-514)

Mata Gangarosa, Cáceres, Perera, Mejicanos
Epidemic Shiga dysentery in Central America. I. Etiologic Investigations in Guatemala, 1969.
J. Infect. Dis., 122 (3): 170-190, 1970 (I-509)

Gangarosa, Perera, Mata, Mendizábal, Guzmán, Reller
Epidemic Shiga dysentery in Central America. II. Epidemiologic studies in 1969.
J. Infect. Dis., 122 (3) : 182-190, 1970 (I-528)

Mendizábal, Mata, Gangarosa, Guzmán
Epidemic Shiga dysentery in Central America. III. Magnitude of the outbreak and mortality in Guatemala in 1969.
J. Infect. Dis. (I-526)

Mata , Mendizábal-Morris, Gangarosa, Perera
A Central American Epidemic of bacillary dysentery due to Shigella dysenteriae type 1 (Shiga bacillus) confused with amebiasis. (Abs.) Presented at the X International Congress of Microbiology, Mexico Vol.. VIII, p. 109, 1970.

Mata, Cáceres, Torres
Epidemic Shiga dysentery in Central America. Lancet, March 30, 1971, 1:600-601. 1971 .

Mata, J. L.
Infección intestinal en niños de áreas rurales Centroamericanas y sus posibles implicaciones nutricionales. Arch. Lat.-Am. Nutr., 19:153-172, 1969.

Richter, Mata, Cáceres
Anticuerpos a Shigella en niños preescolares de Guatemala. Revista del Colegio Médico, 21:85-89, 1970. (E-462)

Lechtig, Mata, Arroyave
Evaluación de la Técnica de Inmunodifusión Radial para la Determinación de inmunoglobulinas y una Fracción del Complemento Hemolítico en el Suero.
Rev. Lat-amer. Microbiol. 12:131-136, 1970 (E-463)

Mata, Gangarosa, Mendizábal
Informe sobre una epidemia de disentería Shiga en Guatemala. Presentado en el III Congreso Internacional de Microbiología y Parasitología en el Perú, Trujillo, Perú. Abril 26-Mayo 1, 1970. (E-471)

Cáceres, Mata
Hemaglutinación indirecta para la investigación de anticuerpos a enterobacteriáceas.
Rev. Lat-amer. Microbiol., 12:137-144, 1970 (E-465)

Mata, Mejicanos
Investigación de la epidemia de diarrea en Nicaragua.
Reporte enviado al Ministro de Salubridad Pública de Nicaragua, Julio, 1970.

Mata, Mendizábal, Gangarosa
Informe sobre la epidemia de disentería Shiga en Guatemala.
Rev. Col. Med., 1970 (E-471)

Other Publications

Klevay, Leslie M. Hair as a biopsy material. I. Assessment of zinc nutriture. American Journal of Clinical Nutrition, 23 (3): 284-289, 1970.

West, Kelly M. and John M Kalbfleisch. Influence of nutritional factors on prevalence of diabetes. Diabetes (In press).