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NUTRITIONAL STATUS OF A GROUP OF

BOLIVIANS LIVING IN THE

STATE OF COCHABAMBA

by

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The nutritional status of 710 Bolivians was evaluated in connection with a project sponsored by the United States Agency for International Development for the promotion of soybean utilization. Rural and urban families residing in the state of Cochabamba were included in the study. Criteria used to evaluate nutritional status included demographic factors, anthropometric data, energy and nutrient intakes, and hemoglobin and hematocrit determinations.

The adequacy of the diets with regard to eight nutrients and energy was evaluated using the Food and Agricultural Organization Recommended Dietary Intakes, and the amino acid content of proteins ingested by the Bolivian sample was compared to the FAO reference pattern. Anthropometric data on weight and height/age and arm measurements/age were compared to the 50th percentiles of the National Center for Health Statistics (NCHS) and the Frisancho standards, respectively. The Gomez and Waterlow classifications were used to determine the degree of protein-energy malnutrition found in the sample population. Hematological data were compared to the appropriate World Health Organization (WHO) standards, and partial correlations were used to examine the relationships between iron intakes and hemoglobin and hematocrit levels. Multiple regression analysis was used to determine the relationships of five demographic variables and the overall adequacy of the Bolivian diets.

Only 6 percent of the sample received diets which appeared to be adequate in all nutrients and energy. Using the 67 percent level of the FAO Recommended Dietary Intake standards, 50 percent of the sampled individuals had energy intakes below this level while 17 percent of the sample had protein intakes below this value. Low thiamin, riboflavin, niacin, ascorbic acid, and vitamin A intakes were found in 33, 33, 44, 20, and 70 percent of the sample, respectively. Only 23 percent of the sample had iron intakes below the 67 percent level of the standards, but 63 percent of the sample were quite deficient in calcium intake. The most limiting amino acids in the diets of the Bolivians sampled were methionine and cystine. Based on the Gomez classification, 9.3, 15.9, and 10.3 percent of the Bolivians had 3rd, 2nd, and 1st degree malnutrition, respectively, while 22.9 percent, 0.9, and 42.1 percent were stunted and wasted, wasted, and stunted according to the Waterlow classification. Hemoglobin and hematocrit values below the WHO standards were found in 19 and 37 percent of the sample, respectively. Daily iron intakes correlated significantly with hematocrit level. Sex, age, household size, place of residence, and education had a highly significant effect on variation in the diet adequacy.

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CHAPTER I

INTRODUCTION

Malnutrition is one of the most serious problems confronting the human species today. Many widespread and deeplyseated imbalances exist between the nutrients that are consumed and the nutrients that are required for the maintenance of existing tissue, the growth of new cells, and the metabolic support for the range of activities in which humans participate. According to the Food and Agricultural Organization (FAO) of the United Nations (1974), about 13 to 30 percent of the population living in Latin America, Africa, the Near East, and the Far East are suffering from inadequate nutrition. Even in the developed countries, approximately three percent of their population are exposed to malnutrition.

Nutrient intake is but one of a myriad of environmental factors that affect the nutritional status of an individual. Differences in levels of dietary intakes are often associated with other profound differences in familial characteristics and environmental circumstances. Thus, malnutrition does not occur in isolation, and many of the nonnutritional factors may operate to influence the nutritional adequacy of an individual. The most common nutritional problems in the world, particularly in developing countries, are protein-energy malnutrition, vitamin A deficiency, and nutritional anemias (World Health Organization, 1970). Therefore, it seems reasonable to direct intervening nutrition programs toward these problems that have the greatest impact on mankind. In order to design effective nutrition programs, one must attempt to understand the nature of the problem. This involves identifying the levels and characteristics of the severity, type, and causes of the nutritional deficiencies. After the problem is identified, appropriate strategies and potential interventions may be designed to improve nutrition.

The importance of adequate nutrition for the health and functioning of individuals in society, and thus for the development of the nation, has been recognized by many developing countries. With the help and support of developed countries and international organizations, developing nations have started research programs to determine nutritional problems prevailing among their people and possible means of intervention or prevention. As a result of these concentrated efforts, many of the diseases associated with severe nutritional deficiencies have been almost eliminated. Examples of such diseases are beriberi, pellagra, rickets, and scurvy. Much of the world population, however, still suffers from a variety of nutritional problems, and additional efforts are needed to overcome these problems.

In some of the developing countries, concentrated efforts to improve the nutritional status of the population started many years ago. Other developing countries, however, have initiated nutrition intervention programs fairly recently and still have far to go to achieve program goals. Representative of this latter group is Bolivia, a country where few research efforts have been directed to the area of nutrition. As is the case in most developing countries, most nutritional research efforts that have been conducted in Bolivia were supported by the international agencies. Results from such limited efforts were often not published. For example, a study by the United States Department of Defense (DOD) to evaluate the nutritional status of Bolivian military personnel was made in 1964 upon the request of the Bolivian government at that time.

Because of such a paucity of published data about the nutritional status of the Bolivians, nutritional intervention programs have also been limited and have usually aimed at the problems identified in other countries as being the most common, namely, protein-energy malnutrition. One of these programs was a project sponsored by the United States Agency for International Development (AID) in 1976 for the promotion of soybean utilization in Bolivia.

Thus, research efforts directed toward identifying existing nutritional problems and factors associated with the development of such problems, and identifying the groups of Bolivian population at risk would be helpful in planning intervention programs and in providing the basis for evaluations of such programs. Therefore, the purposes of this study were to evaluate the nutritional adequacy of the Bolivians' diet and to examine the relationship between the nutritional status of the Bolivians and selected environmental factors.

Objectives of the Study

This study had the following objectives:

1. To evaluate the nutritional adequacy of the diets of Bolivians living in the state of Cochabamba with respect to
    a) Eight nutrients and energy intakes
    b) The quality of dietary protein
    c) The prevalence of iron deficiency anemia
    d) The relationship of iron status and dietary energy intake

2. To correlate the anthropological measurements of individuals with other nutritional status measurements

3. To examine the effects of age, sex, household size, place of residence, and education on nutritional status

CHAPTER II

REVIEW OF THE LITERATURE

The studies reported are mainly concerned with research findings related to evaluations of dietary intakes. Research conducted in various countries provides valuable information about the nature, prevalence, and severity of world-wide nutritional problems. Results of these studies can be useful in the planning, implementation, and evaluation of nutrition intervention programs.

The review of literature is presented in two parts. In the first part, literature related to nutritional assessment is divided into groups according to geographical areas in which studies were conducted. The areas include the Far East, Africa, the Near East, Europe, North America, and Latin America. Within each geographical area reviewed, studies involving the general population are presented first followed by studies involving specific segments of the population. The studies are organized in chronological order, and brief descriptions of methods used to collect and analyze the data as well as specific findings are presented separately.

Methods used for collecting and analyzing data vary from one study to another, and the validity of comparing results obtained by the various methods has been the target for criticism. Studies pertaining to methods are reviewed in the second part of this chapter.

Nutritional Assessment Studies

The Far East. Brown et al. (1968) used the 24-hour dietary recall to examine the diet and nutritional status of Nepalese people. Clinical examinations were made on individuals for signs of malnutrition, and blood samples were collected for evaluation of hematocrit status. Fecal smears were taken of children aged 4, 8, and 12 for examination of parasite contamination. The nutritive value of the diets was computed, and the per capita consumption of 11 nutrients was calculated. Results of the study revealed that the average energy intake was higher than that reported by the FAO for the Far East in general. Eighty-one percent of the energy was supplied by cereal grains primarily in the form of rice. Corn predominated in a few villages, while consumptions of wheat and other grains were negligible. The average intake of protein was 66.3 percent of the FAO standard and rice and cereal grains supplied 70 percent of the protein. Although the consumption of animal protein was practically negligible, some milk and milk products were the main source of animal protein consumed by individuals surveyed. Vitamin A, ascorbic acid, riboflavin, and calcium intakes were uniformly low throughout the population sampled, while thiamin and niacin intakes were judged to be adequate. In spite of the low intakes of certain vitamins and minerals, clinical signs of deficiencies were rarely found. The lack of such clinical symptoms may have been due to seasonal variation in the diet. Blood analyses revealed acceptable levels of hemoglobin among the population except in a small number of children. Seventy-two percent of all stools examined showed parasite contamination, and 37 percent of the stools contained hookworms.

The nutritional status of various socioeconomic rural groups in India was studied by Rao and Satyanarayana (1976). The site of the study was a village with a population of 12,000 individuals living in 2,200 households. A 10 percent sample of the village population was selected for study using a systematic random sample design. Dietary information was collected by means of the the 24-hour dietary recall. Height, weight, arm circumference, and triceps skinfolds were taken and recorded by an anthropologist. Clinical assessments were conducted by a physician using the World Health Organization (WHO) standards for Medical Assessment of Nutritional Status. The families studied were divided into three income groups according to the sizes of their land holdings. The per capita consumption of different food items was calculated, and the nutritive value of the foods consumed was determined using the food tables for India. Results of the study revealed that polished rice was the staple food in all three income groups, and the consumption of rice increased as the family income decreased. The lower income group had lower mean intakes of pulses, and fewer vegetables (with the exception of leafy vegetables), fats, oils, fruits, sugar (including brown sugar), milk, and milk products than the other two groups. The low income group, however, had a higher intake of flesh foods due to consumption of field rats. The proportion of persons having one or more signs of nutritional deficiency was 11.0 percent, 16.6 percent, and 30 percent for the upper, middle, and low income groups, respectively. Signs of protein-energy malnutrition were found only in the preschool children from the low income group. The mean heights and weights were significantly different among the three groups with the low income group having the lowest means. The statural differences were more marked in adult males than the females.

Freedman (1978) reported that during the period 1950-1960 a variety of nutritional investigations were conducted in mainland China using volunteers from the armed forces, road construction corps, students, and working-class persons. The major nutritional research projects conducted were (1) quantitative analysis of dietary amino acids and vitamins, (2) investigations into determining normal caloric and vitamin requirements of the average Chinese, (3) surveys of the national nutritional state, (4) research into effect of processing, cooking, and storage on vitamin content in foods, (5) preparation of cereals and nutritional evaluation of infant milk substitutes, and (6) studies of nutritional deficiency diseases, preventive measures, and the effects of animal-based and vegetarian diets upon adult nitrogen balance. Mild deficiencies of ascorbic acid were observed during the spring and summer months in contrast to the absence of such deficiencies during the winter. This apparent seasonal nutrient deficiency was probably associated with the availability of sources of vitamin C which were abundant in winter but not during the other seasons. Pregnant women also traditionally reduced their intake of fresh fruits and vegetables during pregnancy, so decreased intakes of Vitamin C were observed in women during pregnancy. High occurrances of riboflavin deficiency were found in the general population. This was attributed primarily to inclusion of millet in the diet and to food preparation and cooking practices. Severe vitamin A deficiency states were observed throughout the population tested, and as a result of this finding, specific massive investigations were conducted to establish recommended levels of dietary vitamin A. Subsequently, the recommended dietary vitamin A intake for the adult Chinese was established at 2,000 - 3,500 IU. Anemia was quite prevalent in the general population with infants, adolescents, and pregnant women being among the most affected groups. Approximately 20.5 percent of the population in the Peking area exhibited mild symptoms of rickets. Some survey results revealed mild deficiencies of thiamin, while other survey data suggested adequate thiamin intake in general.

Guzman et al. (1976) assessed dietary intake, intelligence, physical growth, and clinical signs of malnutrition of 600 children from five Philippine communities. Selection of the five communities was based on the difference in their staple foods which were rice, fish, corn, coconut, and sweet potatoes. The children, aged from 8 to 10 years, were selected at random from schools within the communities. Demographic data such as place of residence, socioeconomic status, sex, and age were collected on individuals sampled. Dietary information was collected by the 24-hour recall method. The nutritive values of the foods were computed using Philippine and American food composition tables. Adequacy of intake was assessed in relation to established recommended allowances for the Philippine population. Weight, height, head circumference, upper arm and calf circumferences, intercromial and cristal diameters, and triceps and subscapular skinfolds were measured. Each child was examined by a pediatrician for clinical signs of nutritional deficiencies. Analysis of variance for each nutrient was used to test differences among the five communities.

The reported results indicated that nutrient intakes varied considerably from one community to another with the nature and extent of the nutritional problems being a function of the nutrient composition of the staple food and the availability and acceptance of accessory foods. Protein, calcium, and iron intakes were adequate, and ascorbic acid intake was low in communities where fish was a dietary staple. Vitamin C and iron intakes were adequate, while calcium and thiamin were limiting nutrients when sweet potatoes were used to provide large portions of the total caloric intake. A different pattern was noticed in the communities utilizing coconuts in that calcium, thiamin, and riboflavin deficiencies were prevalent. In all communities, caloric intakes were low. The most inadequate diets were observed in communities where rice was the staple food. People living in communities where corn was included in the diet were found to have the most adequate diet due to the distribution of "nutribun" (an enriched bread). Clinical examinations revealed vitamin A deficiency in almost 100 percent of the population. Iron deficiency anemia and symptoms of general malnutrition were observed in approximately one third of the children in spite of adequate intakes of vitamin A and iron. Malabsorption resulting from low intakes of fat and the presence of parasites may have been major contributing factors for the anemia and general states of malnutrition.

Anderson (1979) used anthropometric measurements to determine the nutritional status of preschool children in Pakistan. This study was part of a worldwide review by the Cooperative for American Relief Everywhere (CARE) of its supplementary feeding programs in 1976. Data gathered included age, sex, height, weight, and arm circumference of children who were 9 to 66 months of age. The sample consisted of 1,258 children with an approximately equal number of males and females. The children were selected randomly from the lower socioeconomic class in rural and urban areas of Pakistan. Median values for height and weight for age by sex from the reference standards of the National Center for Health Statistics (NCHS) were used for analyzing the data. The Gomez classification of weight for age and the WHO classifications of weight for height and height for age were used for diagnosis of malnutrition. The fact that children of the 4- to 5-year age group had a weight for age less than 75 percent of the standard than did children from the 1- to 2-year age group indicated stunted growth or chronic malnutrition. Also, the rates of stunting increased with each preschool year. Acute malnutrition, as indicated by weight for height less than 80 percent of standard, was on the average three times more common in children 1 to 2 years old than in children 4 to 5 years old. No difference in degree of malnutrition as indicated by weight for heights was revealed when the data were analyzed according to sex. Arm circumference measurements were positively correlated with weight for height measures, which indicated the usefulness of this measure in populations with high degrees of severe malnutrition and stunted growth.

Africa. Uyanga (1979) used a two-stage sample survey to study food habits and nutritional status in Nigeria. Sites included in the survey were three urban centers and ten villages. Twenty-five percent of the participants were randomly sampled from each urban center, and a 10 percent sample was drawn from each village. Information pertaining to food consumption, with the exception of beverages, was collected by measuring and weighing those items available in the households and from estimates by the respondents of what was consumed. Weekly consumption of nonperishable items such as sugar, tea, coffee, and milk was estimated and included in the calculated per capita intakes.

The average expenditure of all households for food items was 42 percent of average monthly income. Per capita outlays of all income groups for food were higher in the urban areas than in the rural areas. The relatively lower total protein and caloric intakes were evident in the rural areas where the inhabitants' intake of vegetable protein, root tubers, and other starchy foods was high. Urban residents tended to consume more eggs, meat, fish, milk and milk products, sugar, fruits, and vegetables. Yams, rice, bread, garri, plantain, and potatoes were found to be common to the diets of all income groups. Consumption of animal protein constituted 10 percent, 15 percent, and 29 percent of total energy intake for the low, middle, and upper income groups, respectively. A large proportion of the total population was found to lack adequate dietary calcium, vitamin A, and riboflavin, but this was especially true for the low income group.

Kreysler & Mndeme (1975) used a cluster sampling technique to select a sample of 200 children, 5 years of age and under, from the rural area of Luchoto, Tanzania. Demographic information of the sample was obtained by interviews. Anthropometric measurements, clinical examination, blood sampling, and stool sampling were made on 95 percent of the sample.

Mortality rate of children under five years of age was 17.9 percent. Nine percent of the children in this age category were severely protein-calorie malnourished, and 14 percent were moderately protein-calorie malnourished. Other signs of nutrient deficiencies were rare. There was no significant difference between the mean heights of children with or without protein-calorie deficiency. Maize, beans, and cassava represented the staple foods of the children in this area, and legumes represented the primary source of protein. The diets also contained a variety of fruits and vegetables. The variety of food ingested by the children and the availability of protein indicated that the diet was more likely to be deficient in quantity rather than quality.

The nutritional status of 1,180 New Guinean children ranging from newborn to 14 years of age in two villages was assessed by Ferro-Luzzi et al. (1978). Information on ages, morbidity and mortality rates, birth weights, and weight gains from birth to three years were obtained from hospital records, local missions, or tax registers. Anthropometric measurements included weight, height, skinfold thicknesses, and arm circumference, while the biochemical analysis included urine and blood analysis. The children were also clinically examined for signs of malnutrition.

Clinical examination revealed the presence of several signs of protein-energy malnutrition in six children, while signs of vitamin deficiencies and obesity were absent. Anthropometric evaluations suggested 2nd or 3rd degree stunting (less than 90 percent weight for height standard) in approximately 50 percent of the children, and 2nd and 3rd degree wasting (less than 80 percent weight for height standard) in only 3 percent of the children. Urea nitrogen/creatinine ratios, and inorganic sulphate sulfur/creatinine ratios confirmed the dietary findings of low protein intakes. Serum non-essential/essential amino acid ratios and hydroxyproline indices were essentially normal. Birth weights were low, but growth was satisfactory up to six months of age. Beyond this age there was a gradual decrease in the rate of growth.

Wenlock (1979) attempted to identify the social factors, nutritional status, and mortality rate in a rural subsistence economy of Zambia. Data for the study came from the FAO food consumption and nutritional status surveys. The per capita food consumption per day was calculated and compared with the WHO-recommended daily intakes. The social factors and nutritional status of the children under five years of age were tested for statistical significance using the chi-square technique. There was a general deficiency of energy intake throughout the rural population, and riboflavin intake was below the WHO standard. Both protein and fat provided 12.3 percent of total calories, and the average intake of animal protein was 18.9 gm per capita per day. Social factors correlating significantly with the child death rates included the parity of the mother, tribal customs, educational attainment of the parents, and father's occupation. Malnutrition correlated highly with child death rates. Thus, malnutrition that resulted from the primary food deficiency together with malaria were the major causes of death among Zambian children under the age of five.

The Near East. McLaren and Pallet (1970) compared the protein quality of Middle Eastern diets using food balance data, the FAO amino acid standards score, and the protein quality of the American diet. Two dietary surveys were also conducted in two areas in Lebanon. One of the locations was in a dry land area and involved farmers of low socioeconomic status. The other survey was conducted in a mountain village and involved fruit farmers of substantially higher socioeconomic status. Twenty to 30 families were involved in each survey, and 60 percent of the individuals surveyed were below 15 years of age. The protein quality of the diets was computed using the FAO standard. In addition, 36 different Iranian and Lebanese diets were chemically analyzed for amino acid composition and total sulfur. Types of diets analyzed included Iranian diets, urban Lebanese meals and snacks, orphanage diets and baby food, and Lebanese village diets. Diets were homogenized, freeze dried, and analyzed for nitrogen, amino acids, and energy content. Diet samples were then combined and used in rat experiments, and the data from the experiments were used to calculate the Net Dietary Protein as percentage of total calories (NDPCAL%).

McLaren & Pullet (1970) also conducted a study on child nutrition in Jordan and Lebanon. The sample included 95 malnourished children and 35 individuals in a control group. The study involved a four-year period in a hospital in Jordan, while the last three years of research was done in Lebanon. Biochemical and clinical data were obtained from the children soon after admission to the hospital.

The results of the study (McLaren & Pullet, 1970) can be summarized as follows

1. Calculation of protein calories as a percentage of the total caloric intake from the food balance sheet revealed rather small differences between the countries of the region and the USA, with only Jordan being below 10 percent of calories as protein, despite very large variations in the total energy value of the diet. With regard to calories from fat, only Israel and perhaps the Sudan approached the high level observed in the USA. Both of these countries apparently had a higher consumption of animal products than is common for other countries in the region. Proteins consumed in most of the countries of the region were deficient in the sulfur-containing amino acids rather than lysine. Threonine and tryptophan did not appear to be limiting amino acids in such diets.

2. The average caloric and protein intakes for the two Lebanese villages were above the calculated allowances for the region. Protein, however, was limiting in the sulfur containing amino acids.

3. The study of the Iranian diets showed that bread was a major constituent in all cases and that most of the diets were poor with regard to their NDPCAL% (below 8.0). The diets were not adequate for young children and were only marginally adequate for pregnancy, lactation, and adolescence. All the diets were limiting in sulfur containing amino acids except one diet which was limiting in lysine.

The NDPCAL% of the Lebanese diets ranged from 5.1 - 9.0, a value which was comparable to that of the Iranian diets. The Lebanese diets were also limiting in the sulfur containing amino acids. Lysine and tryptophan were also found to be limiting in some diets. The orphanage diets for babies were apparently adequate in quality, while the diet for toddlers was generally inadequate in quantity and quality. The imported commercial baby food was generally poor in quality because it was mixed with water instead of milk.

4. The most significant differences between the malnourished children and the control group were found in the serum albumin and total serum protein levels. Children classified as kwashiorkoric had the lowest levels followed with marasmic-kwashiorkoric. As the condition of malnutrition proceeded in those classified as marasmic, serum albumin and total protein levels tended to increase. Significant differences were also found between the marasmic children and the controls for weight, height, hemoglobin, hematocrit, serum total lipids, serum lipoprotein fractions, serum carotenoids, serum vitamin E, and liver vitamin A. During a rehabilitation period the kwashiorkorics lost their edema in the first few days and responded to treatment quickly in

contrast with marasmic children who showed poor progress in the first month. Mid-arm and muscle circumferences and chest/head circumference ratio were the most sensitive anthropometric measurements to show changes during recovery.

In the Arab Republic of Egypt (ARE), a national nutrition survey was undertaken to provide information on the prevalence and regional distribution of protein-energy malnutrition, anemia, and other nutrient deficiencies among preschool children (ARE Ministry of Health, 1978). Nine locations, representing rural areas, large villages, small towns, and cities, were selected from throughout 17 governorates (geopolitical units) in Upper and Lower Egypt. Two extra locations were designated to include the most underprivileged urban populations of Cairo and Alexandria. In addition, a group of socioeconomically advantaged children were used to serve as a standard of potentially obtainable nutritional status. A representative sample of 11,677 children was selected randomly from the different locations, and data pertaining to dietary intake, breast feeding and weaning practices, histories of infection, family planning, and anthropometric measurements were collected. The Gomez criteria and the Waterlow classification were used to classify the nutritional status of the children.

Approximately 21 percent of the sample suffered from long-term stunted growth indicating chronic malnutrition. Acute malnutrition manifested by wasting prevailed in 0.6 percent of the sample, while 3.1 percent were overweight. Anemia appeared to be a major health problem since 29.7 percent of the sample was estimated to have low hemoglobin levels. Anemia and stunting occurred in the rural areas, particularly of Upper Egypt, and among the low socioeconomic group in Cairo and Alexandria. Riboflavin deficiency was found in 2.9 percent of the sample, while vitamin A and D deficiencies were uncommon.

Cast and Kies (1980) compared the nutritional status of two groups of adolescents living in Morocco and Nebraska. Food diaries were kept for 3 days each month over an 8-month period by 30 Moroccan boys and girls aged 9 to 15 years. Anthropometric measurements were recorded on the children. Food intakes and anthropometric measurements records for 15 Nebraskan boys of the same age as the Moroccan subjects for an 8-month period were selected from the records of the Department of Human Nutrition and Food Service Management, Lincoln, Nebraska. The anthropometric data were compared to the USA percentiles and the Moroccan percentiles. Frequencies of the food ingested were computed, and one-way analysis of variance was used to test for difference among groups in food pattern. Blood samples were analyzed for hematocrit, glucose, urea nitrogen, uric acid, bilirubin, serum cholesterol, and triglycerides.

Significant differences were found between the eating patterns of the two groups, and these differences appeared to be reflected by the blood compositions of the subjects. American boys had significantly higher serum cholesterol, fasting glucose, and hematocrit levels than the Moroccan subjects. Beef, pork, eggs, dairy products, fats, and refined sugar were characteristic of the American diets, while the Moroccans consumed more bread, lamb, fish, vegetables, and sweetened beverages, primarily mint tea. When the anthropometric measurements were compared to the USA percentile, the Moroccans were in the lower quartile, while the Americans ranked around the 50th percentiles. When compared with local standards, all but three Moroccan boys ranked over the 50th percentile.

Europe. Varela (1971) studied the nutritive state of a sample of 20,800 families from urban and rural areas of Spain. The families were divided into 52 groups, and the families of each group were studied for a week. The quantities of the foods consumed by each family were recorded by the housewife in a notebook provided for this purpose. The FAO food composition tables were used to determine the nutrient contents of the foods recorded. The foods that were only consumed in Spain and had no corresponding values in the FAO tables were analyzed for various nutrients. Average caloric consumption per person per day exceeded the recommended standard in both urban and rural groups. Bread contributed 30 percent of the total caloric supply, while fats provided approximately 34 percent of total calories. Alcoholic drinks supplied less than 10 percent of total calories. The families in the rural areas had much higher intakes of energy, protein, and fat than did those in the urban families. Riboflavin and vitamin A consumption in all cases, particularly in the rural population, was low. Calcium and iron consumption appeared to be adequate in both urban and rural families surveyed.

Ferber (1973) examined the nutritional status of Yugoslavians using the Statistical Annual Report as a source of data for the study. High average daily consumption of calories was observed in both urban and rural populations, although the rural population tended to have higher caloric intakes than the urban population. Bread and cereals accounted for 50 percent of all calories. Protein constituted 8 percent of total energy, while fat accounted for 10 percent of total calories. Vitamin A and riboflavin deficiencies were particularly common among children, and ascorbic acid deficiency was common in all cases in the spring. Iron deficiency anemia was a national problem, especially in children and pregnant women.

Hejba and Masek (1973) reported that the average daily intake of fat in Czechoslovakia exceeded the recommended intake by as much as 50 percent. The source of most of this fat was from animal products. The ascorbic acid consumption was particularly inadequate in winter and spring for all segments of the population. Obesity also represented a serious problem in the population with 29 percent of adult males and 47 percent of adult females exceeding the 115 percent of desirable weight. Atherosclerosis was another threatening problem in the population, and there was a highly significant correlation between fat intake and clinical and morphological atherosclerosis. Eight percent of adult men and women were also found to be anemic.

Hartog (1975) reported a high incidence of infantile obesity in children in the Netherlands. The diets of toddlers were generally adequate in most nutrients with the exception of iron and thiamin and the dietary levels of these two nutrients were below the recommended dietary allowances. Three percent of the 739 school-age children examined received less than 20 g animal protein per day. Thirteen percent of the children had low calcium intakes, and 27 percent ingested insufficient amounts of riboflavin. Five percent of the boys and 6 percent of the girls were obese. The problem of obesity also plagued the adult male population. Of the 6,500 men examined 40 percent were obese, and the incidence of obesity increased with advancing age. In addition to obesity, cardiovascular diseases were also a threatening health problems in adult males. In the sample group, 63 percent of the protein intake was from animal sources, and fat supplied over 40 percent of the total caloric intake. The total caloric intake was judged to be much higher than the recommended dietary allowances. Obesity was also found in adult women and the range of the weights of the 970 women studied was 45 kg to 108 kg. The average amounts of fat and protein in their diets were 109 g and 75 g respectively. Lactating women had a low intake of calcium, iron, riboflavin, and vitamin C. Diets of lactating women appeared to be within the recommended allowances with regard to calories, protein, and thiamin. In a group of 60 men between 71 and 92 years of age, the average caloric intake was 1,696 calories with approximately 40 percent and 15 percent of the total calories supplied by fat and protein, respectively. Alcohol consumption supplied 1.2 percent of the calories. Except for low serum lipid levels and low blood pressure, nutritional status and health of these individuals were generally good.

North America. One of the most comprehensive studies of the nutritional status of a population was the Ten-State Survey conducted by the U.S. Department of Health, Education and Welfare (USDHEW, 1972). Ten states were selected, and approximately 24,000 families were randomly identified from the 1960 census in these states. The average income was in the lowest quartile. A sample of approximately 86,000 individuals, representing the low income families, whites, blacks, and Spanish-Americans, were included in the survey. Data collected in the survey included a medical history, physical examination, anthropometric measurements, X-rays of the wrist, and hemoglobin and hematocrit evaluation. Dietary information was obtained by the 24-hour dietary recall method. Selected high-risk populations received more detailed biochemical and dietary evaluation and included infants and young children, adolescents, pregnant and lactating women, and persons over 60 years of age. The standards used for diet evaluation were based on the 1968 US Recommended Dietary Allowances (RDA), and the FAO/WHO Recommended Dietary Intakes for the various nutrients.

A significant proportion of the population surveyed was malnourished or was at risk of developing nutritional problems. Evidence of malnutrition was particularly evident in blacks and Spanish-Americans. Generally, there was increasing evidence of malnutrition as income level decreased. Adolescents between the ages of 10 and 16 years had the highest prevalence of inadequate nutritional status, and male adolescents showed more evidence of malnutrition than females. Elderly persons were another age group with evidence of increased nutritional deficiencies.

Iron and vitamin A deficiencies constituted major health problems throughout all segments of the population. Many adolescents and adult males exhibited low hemoglobin levels and evaluation of iron intakes in relation to hemoglobin levels, suggesting an association between low hemoglobin levels and low iron intakes. Vitamin A deficiency was particularly noticeable in the Spanish-Americans of the low income group. Up to 50 percent of all age and sex groups in this segment of the population had low vitamin A levels. Generally, low vitamin A levels were prevalent in young people in all subgroups.

A relatively large proportion of pregnant and lactating women demonstrated low serum albumin levels, suggesting marginal protein nutriture in this group. Dietary proteins intakes, however, were generally adequate for the rest of the population. Although vitamin C deficiency was not a major health problem among the population studied, lower serum vitamin C levels were more prevalent in males than in females. The prevalence of vitamin C deficiency increased with age. Riboflavin status was poor among blacks and in young people of all ethnic groups. Goiter was also found to be prevalent in certain communities, suggesting the possible existence of iodine deficiency.

The physical and anthropometric data revealed that obesity was a substantial problem in most groups. From 5 to 25 percent of adult men and 10 to 55 percent of adult women were classified as obese. Obesity was more prevalent in black women and less prevalent in black men than in whites. The prevalence of obesity in adolescents ranged from 5 to 33 percent.

From 18 to 46 percent of the children had height and weight measurements which were below the 15th percentile for height and weight, indicating a substantial number of children who were small for their age. Black children tended to be taller and more advanced in skeletal age than white children.

Other health problems revealed in the Ten-State survey were the prevalence of dental caries, periodontal disease, and poor oral hygiene among the population. These problems may have been related to the nature of the foods eaten and the adequacy of fluoride intake. They appeared to be community related because dental problems were prevalent in some communities, but not in others.

Sabry et al. (1974) examined the nutritional status of the Canadian population. The population was sampled on the basis of enumeration areas selected at random to represent five regions (Atlantic, Quebec, Ontario, Prairies, and British Colombia), three types of communities (metropolitan, urban, and rural), two income levels (low and others), and two seasons (summer - early fall and winter - early spring). Households were selected randomly in each area. The total sample consisted of 14,947 persons. Data, including physical, dental, anthropometric, hematological, and dietary examination, were collected during a two-year period.

Findings of the survey indicated that approximately 50 percent of the adult population was overweight. In the general population, 40 percent of young men and women, and over 60 percent of the middle-aged and senior adults were obese. Serum cholesterol levels indicated that

10 to 13 percent of adult men, and 14 to 34 percent of adult women were at risk from hypercholesteremia.

Iron deficiency affected a large number of Canadians of all ages, regardless of sex. Overt anemia, however, was not apparent except in pregnant women. Over a third of infants and toddlers, and about a quarter of children of school age were anemic. The prevalence of anemia was greater in adolescent and adult females than in adolescent and adult males.

The survey also revealed protein and caloric deficits in pregnant women and in young children under five years of age. Vitamin D and calcium deficiencies were most common among infants, children, and adolescents. About one-fifth of the children, one-fourth of the adolescent boys, and one-third of the adolescent girls surveyed had inadequate intakes of vitamin D and calcium. Evidence of vitamin C deficiency in Eskimos was found and to a lesser extent in the Indian and general populations. There was a moderate vitamin A deficit noted in pregnant Indians and Eskimos.

Latin America. In an unpublished report by the Interdepartmental Committee on Nutrition for National Defense, USDOD (1964), the nutritional status of Bolivian military personnel and some selected civilian families were studied. The sample consisted of 3,805 military personnel and 396 civilians. The civilian sample was selected at random from 12 cities and represented the various altitude levels of Bolivia, including the city of Cochabamba. The data collected included dietary information, biochemical evaluation, and clinical examination. Methods used for collection of dietary information included the 24-hour dietary recall, recipe calculation, and food composite analysis. The average daily intake of the various nutrients were calculated and compared to US Recommended Dietary Allowances (USRDA). The study also included an estimation of the amino acids cystine and methionine from the data obtained by the methods used to collect dietary information. Biochemical analyses included analysis for serum protein, plasma hemoglobin and hematocrit, vitamin A, and vitamin C levels, and urinary thiamin and riboflavin concentrations.

The results obtained from the dietary study of the civilians indicated that the Bolivians consumed large quantities of tubers and grains and limited quantities of fruits and vegetables. Beef and mutton or llama were the principal meat items consumed. Pork was seldom eaten, and fish appeared in the civilian homes only in isolated areas of the country. Eggs and milk were seldom eaten, and the meals served tended to be monotonous and generally low in animal protein, calcium, thiamin, and riboflavin.

Comparisons between the nutrient intakes obtained by the three methods with regard to altitude revealed that there were no significant differences between the average nutrient intakes obtained by the three methods in the low or the medium altitude levels. The 24-hour dietary recall, however, tended to underestimate nutrient intakes in the high altitude level. This was probably due to the difficulty in interpreting the language of the Indian inhabitants of the high altitude areas and thus in preparing the questionnaire. The average energy and nutrient intakes for the medium altitude areas, where Cochabamba is located, were 1,630 calories, 49.3 g vegetable protein, 18.1 g animal protein, 303 g carbohydrates, 26.2 g fat, 171 mg calcium, 11.9 mg iron, 2,384 IU vitamin A, 0.86 mg thiamin, 0.59 mg riboflavin, 12.6 mg niacin, and 84 mg vitamin C. The average energy and nutrient intakes for the high altitude population were greater than those of the the medium or low altitudes in all nutrients. The low altitude population had intakes of energy and nutrients that were similar to those of the medium altitude except for calcium which was higher.

Evaluation of energy intakes based on USRDA showed that these intakes ranged from 83 to 88 percent of the standard, in the three altitude populations were below the USRDA. Protein intakes met the USRDA standards except in the low altitude zone. Calcium intakes ranged between 20 and 30 percent of the standard for all groups, indicating very low intakes of calcium. Furthermore, vitamin A intakes were low in the three groups and ranged from 25 to 85 percent of the standard. Riboflavin and thiamin intakes were also low in the medium and low altitude zones. Iron and vitamin C intakes, however, exceeded the standards in all groups.

Evaluation of hemoglobin data indicated that anemia was prevalent in 13.1 percent of the males and in 19.8 percent of the females studied. The age groups at risk were children under 9 years of age and females over 15 years. Interpretation of hematocrit data indicated that anemia was prevalent in 12 percent of the males and in 12.7 percent of the females.

A stratified random sample of 848 families representing urban and rural groups was used to study the nutritional status of the Puerto Rican population (Fernadez et al. 1972). Data pertaining to socioeconomic status included family income, education level, family composition, waste disposal and facilities for cooking, serving, storing, and consuming foods. Dietary patterns and frequency of food consumption were collected. Clinical and biochemical examinations included hemoglobin and hematocrit; plasma levels of total protein, albumin, carotene, vitamin A, and vitamin C; and urinary excretion rates of thiamin and riboflavin. Stool tests for parasites were also conducted on 543 persons.

Dietary patterns of the rural population were reflected in various meal combinations. The breakfast meals for rural families usually consisted of coffee, milk, and bread, while lunch consisted of codfish with starchy vegetables. Suppers in the rural areas included rice and beans with meat. Breakfast meals for urban families usually consisted of coffee, milk, eggs, and bread, while lunch and supper were mainly rice, beans, and meat. Eggs were used more frequently than any other types of protein food. Smoked ham was the meat product most widely used in both population groups, while red kidney beans was preferred among legumes. Potatoes were popular in all families, and the banana was the favored fruit, regardless of income. Among the cereals, rice was consumed most frequently. Coffee was a national drink, and thus was consumed by most Puerto Ricans.

The clinical findings showed that symptoms related to vitamin A, thiamin, riboflavin, niacin, and protein deficiencies occurred more often in urban families, whereas those related to vitamins C and D deficiencies prevailed more often in the rural areas. In addition, there was a high prevalence of obesity among adults, particularly women. Ten to 20 percent of urban and rural children and adolescents were underweight.

The biochemical evaluation revealed low hemoglobin levels in 5 to 7.2 percent of the population, and 14 percent were found to have low hematocrit values. Infants under 12 months showed the highest frequency of low hematologic values. Low albumin and total protein in plasma were found in children 2 to 5 years of age, adolescents, and persons over 60 years of age.

Composite food samples for 5,000 children in the Dominican Republic were analyzed and were found to be deficient in all the B-complex vitamins, vitamin A, calcium, magnesium, zinc, and copper (Sebrell, 1975). The most limiting amino acids were methionine, cystine, and tryptophan. The biochemical examinations of the children showed that a high percentage of those under five years of age had low levels of serum albumin, even though protein intake was generally adequate.

Black et al. (1977) found that the nutritional status of Brazilian Indians little affected by exogenous cultures was generally good. Infants observed in the study were small, but as age increased the infants gained relative to standard growth curves. Weight for height ratios and mid-arm muscle circumferences compared favorably to USA norms. Hair root diameters were slightly below the available norms, but the proportion of roots in the growing phase was normal. Serum albumin levels of one of the tribes were slightly lower than the Caucasian standards. The lower serum albumin may have been due to the prevalence of malaria in this particular tribe.

The nutritional status of 304 infants and young children birth to 60 months of age was assessed in three Miskito Indian villages in Nicaragua (Horner et al., 1977). The 24-hour dietary recall method was used for data collection, and the Institute of Nutrition for Central America and Panama (INCAP) standards were used to evaluate the nutrient intakes. Anthropometric data were classified according to the Gomez classification. Energy was the major dietary deficit, and a mean intake of 675 kcal for all children 12 to 60 months, which supplied only 59 percent of the standard, was observed. Protein and fat each supplied 12 percent of total calories. Other nutrient intakes below the INCAP standards were vitamin A, calcium, iron, and protein.

Height was the most affected nutritional indicator, and only 40 percent of the sample met or exceeded the Boston standards. Thirty-nine percent of the children showed first or second degree malnutrition based on the Gomez criteria for weight for age. Ninety-two percent of the children attained less than 90 percent of the standard weight for height which suggested they were small for age. Growth rates dropped sharply during the second year of life coinciding with the infant weaning period.

An investigation of the nutritional status of a group of Chilean children was carried out by Plail and Young (1977). The sample consisted of 108 children under the age of 5 years who attended a government clinic in South Chile. Demographic, social, dietary, anthropometric, nutritional, and hematological factors were used to ascertain nutritional status.

Bread was a staple food for the families of these children, while pasta, rice, and beans were second in frequency of intake. The main protein food for the families was eggs, while milk provided a good protein source for the children. Fresh fruits and vegetables were not eaten regularly except in the summer. The main beverages for adults were coffee and tea. Generally, the diet of the families was not severely impaired and appeared to be of satisfactory quality. The quantity of food ingested, however, was insufficient to supply many nutrients needed by growing children.

According to the Gomez criteria, 41.5, 11.4, and 1.0 percent of the children had 1st, 2nd, and 3rd degree malnutrition, respectively. In both the height and weight results, there was a decrease in the percentage of children above the means in the 18 months to 5-year period when compared to the first 18 months of life, which suggested a decline in nutritional status as the child got older. In addition, the hematological analysis showed that 46.1 percent of the children had hemoglobin levels below those recommended by the WHO as acceptable. The low hemoglobin levels appeared to be correlated with low iron intakes.

Ortiz and Borosotti (1978) studied 194 families to evaluate the relative importance of social, cultural, economical, educational, and emotional variables on the nutritional status of rural and urban children from Ecuador. Significant differences were observed between the urban and the rural populations in terms of maternal age and maternal education. The average ingestion of animal protein was lower in the rural population. Multiple regression analysis revealed a strong correlation between the nutritional status of the children and the ingestion of animal protein. A high correlation between vegetable protein and nutritional status was also evident. Sociocultural environmental variables were significantly correlated with nutritional status;however, there were differences in ranks of importance among the various rural and urban population groups.

Valverde et al. (1980) studied the life styles and nutritional status of children from different ecological areas of El Salvador. The areas were coffee, cotton, and grain growing regions and the slums of the capital city, San Salvador. A total of 5,348 male and female children aged 6 to 59 months were selected. The data included socioeconomic information and anthropological observations. Analyses of the socioeconomical information showed that problems shared by all regions were lack of potable water, unsanitary waste disposal, inadequate housing, education, medical care, unemployment, and low incomes. Differences between regions, however, included income-generating activities, food availability, climate, isolation, level of effective community organization, family composition, access to government programs, and the need for seasonal labor.

Based on the Gomez classification, 50 percent of the children in all groups had 1st-degree malnutrition. Twenty percent suffered from 2nd-degree malnutrition, and 1.5 percent suffered from 3rd-degree malnutrition. Analysis of height for age indicated that a large proportion of the children in all groups were growth retarded with almost 40 percent being below 90 percent of the standard. Weight for height analysis revealed, however, that only 18 percent of the children in all groups were below the 90 percent of the standard. The children most affected were those who lived in the grain and coffee-growing regions.

Marchione and Prior (1980) conducted a nutritional assessment survey of 500 Jamaican children under 36 months of age using cluster-stratified random sampling. Over a period of two years, sociocultural, clinical, and anthropometric data were collected. The children were reported to have low intakes of proteins relative to energy and were referred to as "sugar babies." This may have been due to high consumption of sugar and tea, diluted sweetened condensed milk, and starchy porridges. Weight and height for age were determined relative to the 50th percentile of the Boston standards. The degree of protein-energy malnutrition (PEM) in the children was based on the Gomez criteria. It was found that 7.4 percent of the children had 2nd- and 3rd-degree malnutrition. Taking children under 12 months, 10.9 percent, and 36.7 percent had 2nd- and 1st-degree malnutrition, respectively. The evaluation of height for age revealed that 11 percent of the children were below the 90 percent of the standard suggesting that these children were small for age. Factor analysis was used to determine the sociocultural variables that were most likely to predict the nutritional status of the children. These factors were found to be agriculture subsistence representing the dependency of the household on its agriculture production, maternal-guardian maturity, family demographic stress reflecting the number of children in the household, family cohesion or the presence and support of the parents in the household, monetary wealth, age of the child, clinic care, and diet. Dietary dependence on home-grown food, mothers under 20 years of age, increased number of children in the household, mothers' absence, and lack of fathers' support, low income and food expenditures, and increased age of the child were also good predictors of malnutrition.

Graham et al. (1981) examined the relationship between the nutrient intakes and growth patterns of Peruvian children. Seven-day, individual, weighed dietary intakes and anthropometric measurements were determined in 123 children, 2 to 9 years of age, from 26 poor families in Lima. The heights and weights of the children were evaluated relative to the 50th percentile of Boston standards, while the average daily intake of nutrients was evaluated according to the FAO/WHO recommended dietary intakes. Regression analysis was used to determine the relationships between the nutritional status of the children and patterns of growth. Regression analysis revealed high correlations between total calories and most nutrients and particularly vegetable proteins, iron, thiamin, and niacin which were highly correlated with each other because of the predominantly cereal (wheat and rice) origins that they shared. Both wheat and rice constituted about 50 percent of the diets. Fat intake was highly correlated with animal protein, calcium, thiamin, and riboflavin. Milk and meats were the source of these nutrients in the children's diets. Vitamins A and C were not correlated with any other nutrients. For those nutrients closely correlated to each other, height and weight were consistently better predictors of intakes than age. Intakes of vitamins A and C appeared to be independent of age, height, and weight indicators.

In males, multiple regression analysis revealed that the percentage of protein from animal sources and beta carotene intakes were highly correlated with achieved height and weight while the percentage of fat calories was highly correlated with weight for age/height for age ratios. In females, the correlations were not as high, possibly because a significant percentage of them had reached the menarche some time before the survey and were probably no longer growing. Nevertheless, calorie intake was prominent in the regressions for height for age ratios and percentage of fat calories in weight for age ratios.

The Cuban population was one of the populations that was inaccessible to investigation until the recent studies on Cuban refugees. The following study pertaining to the nutritional status of Cuban refugees in the USA is included under the Latin America section of the review because all of the refugees in the study group had been in the United States less than a week, and most of them were studied within 48 hours of their arrival. Therefore, the sample may possibly reflect the nutritional status of the original Cuban population rather than the status of the refugees in the USA.

A study of Cuban refugees arriving at the Public Health Service Station in Dade County, Florida was conducted by Gordon (1982). The sample consisted of 138 refugees who were selected at random over a period of seven days. After arriving at this station, the refugees were assigned to one of six cubicles where the immigration physicals were being conducted. Gordon and his assistants occupied one of the cubicles, and the refugees channelled to this cubicle were included in the survey. The data consisted of medical examination, socioeconomic and dietary histories, physical examination, anthropometry, and hematological examination.

Physical examination revealed that 25 percent of the refugees under 15 years had dental caries, while 74 percent of adult males and 60 percent of adult females had dental caries. The anthropometric evaluation indicated that 25 percent of refugees under 15 years of age suffered from 1st-degree malnutrition. Seventeen percent of adult women were obese, and 25 percent of adult males had significantly low adipose tissue stores. Eighty-eight percent of all adults had adequate lean body mass. In addition, the hematological examination showed that 15 percent of the adults and 12 percent of the children were anemic. The foods most frequently consumed by the refugees included bread, eggs, rice, and chick peas. Fruits and vegetables were generally not consumed by the refugees.

In summarizing the review of literature related to nutritional assessment, several methodological approaches were observed. The methods used to collect the dietary data were primarily the 24-hour recall, 3-days records, and 7-days records. In a few instances samples of diets were chemically analyzed. The method most frequently used was the 24-hour dietary recall.

The analysis of the dietary data usually involved the calculation of the nutrient content of diets with the aid of various food composition tables. The average daily nutrient consumption was reported or further evaluated relative to appropriate standards. In most cases, the standards were the Recommended Dietary Intakes by the FAO/WHO or a version of these modified to fit the population under study.

Most studies included anthropometric evaluation of the population, and in some instances this was the only method of nutritional assessment used. The measurements were first translated into percentage of standards, Boston growth percentiles or the US National Center for Health Statistics percentiles and then compared to the Gomez classification for weight for age and/or WHO classifications that utilized height for age and weight for height ratios.

Hemoglobin and hematocrit levels were the most frequently reported hematological indicators. Serum levels of other nutrients such as albumin, total protein, and various vitamins were evaluated in some of the studies.

Regardless of the various methods that were used to collect and analyze the data, the findings of many of the studies were similar. Vitamin A, vitamin C, B complex vitamins (particularly riboflavin), calcium, and iron deficiencies were mentioned repeatedly in most studies as the most limiting nutrients. Chronic protein-energy malnutrition (PEM) rather than the acute PEM with different degrees of prevalence was found in almost all the nations studied. The risk groups were generally identified as children, adolescents, pregnant and lactating women, and low-income groups.

Methodology Related Studies

Many factors affect the selection of methods to be used in collecting and analyzing dietary survey data. The purpose of the study, the size of the sample, characteristics of the population to be studied, the amounts of funds, time, personnel, and available equipment are some important factors that must be considered in selecting the appropriate method (Christakis, 1978).

If the purpose of the study is to collect information about population food patterns, family food consumption records are considered to be the appropriate method to use. It was found that in the developing countries, the study of families as units was often the most appropriate and most sound approach (Trulson, 1962). Family dietary studies, however, did not provide information on the distribution of nutrients among individual family members. Moreover, an adequate family dietary intake did not assure the same for each member of the family (Flores, 1962). Family food intake patterns, however, often influenced the types of foods that were eaten by individuals (Krehl and Hodges, 1965).

The size of the sample needed to obtain valid dietary survey results has been debated by many researchers. Woolf (1954) and Flores (1962) pointed out that it was important to keep the size of the sample small so that precise and detailed information could be obtained. They also contended that a randomly selected small population sample minimized the problems of refusals to cooperate. Large samples, moreover, involved complications and difficulties in the collection of accurate and detailed data. Christakis (1978) indicated that the size of the sample was a function of the purpose of the study, and a large sample was appropriate for identifying the food patterns of the population under consideration. He also indicated that a large sample was necessary if the 24-hour dietary recall method was employed in the study.

The length of time required to collect valid dietary data is another factor to be considered. Not all researchers, however, agree on how many days one should collect data. Some investigators used the period of seven days (Varela, 1971; Sabry, 1974; Graham, 1981), while others indicated that the period of three days was sufficiently long (Cast & Kies, 1980). Several investigators have used only one day to collect dietary data. The 24-hour data collection has been criticized on the basis that it did not provide a reliable estimate of the usual intake of the individual or a reliable description of the distribution of usual intakes of the population (Pekkarinen, 1970; Marr, 1971; Garn et al., 1978). However, the use of such a short data collection period was reported to have the advantage of examining a large sample with a wide representation of dietary intakes. (Young et al., 1953; Christakis, 1978).

The use of the recall method in calculating the dietary data has been criticized by some investigators for its inaccuracy (Garn et al., 1978). Garn et al. (1978) found that the age of the participants was inversely related to their ability to recall their food intake. It was concluded that the method was more appropriate for individuals between

20 to 40 years of age. Young et al. (1953) reported, however, that both recording and recall methods produced equal results. The recording method has also been criticized as being inaccurate, time consuming, lengthy, and expensive (Flores, 1962). Weighing and measuring foods that were consumed by the individuals provide better estimations on the quantities of food. Many investigators, however, agreed that the method was impractical for dietary surveys especially those involving large samples. Also, this method tended to alter food intake patterns of the individuals (Pekkarinen, 1970; Marr, 1971; Christakis, 1978). Although each method used for dietary data collection has its limitations, many investigators agree that the 24-hour recall method is the practical, efficient, and useful way to collect data for identifying dietary characteristics of a population (Young et al., 1953; Flores, 1962; Trulson, 1962; Christakis, 1978).

Pike and Brown (1975) discussed the limitations of tables of food composition in evaluating dietary intakes. In addition to the wide variability in nutrient content of foods in the raw forms as a result of differences in cultivation, harvesting, and storage, few data were available for processed and commercially prepared foods and on nutrient losses during preparation and cooking. Also, variations in the methods of preparation and cooking of foods, particularly of mixed dishes, may result in differences between calculated values and values obtained by laboratory analysis of meals and individual mixed dishes. Davidson et al. (1975) suggested, however, that in spite of all these limitations, the tables were a useful tool in providing the information on general chemical makeup of the foods and were serving their purpose of evaluating group diets adequately.

Caliendo (1979) reported that dietary standards used for the evaluation of dietary data had the limitations of inapplicability to evaluation of an individual's diet, the generous margins of safety, and the literal interpretation of the results of the evaluation of the diet. However, Pike and Brown (1975) pointed out that the dietary standards served as guides in planning dietaries, in evaluating food consumption of population groups and in devising rational plans for maintaining an adequate food supply. The dietary standards were assessed periodically and revised as new data became available. Standards tended to vary between countries because populations and environmental conditions and interpretation of adequate levels of dietary intake varied. Pike and Brown (1975) also suggested that the use of such standards for the evaluation of individual diets should be based on understanding of the philosophical and scientific rationale for the standards and the recognition that the individuals vary in their nutrient needs.

Young et al. (1953) emphasized the importance of trained interviewers for gathering valid dietary data. Establishing rapport, accurate interview techniques, knowledge of food and nutrition, and appropriate judgement for the respondent's answers were among the qualities required for sucessful interviewers. Interviewers who were to use the 24-hour recall method needed a more detailed instruction method than did the persons who used the recording method.

In a comparison of amino acid scoring patterns for evaluating proteins based on amino acid requirements, Williams et al., (1974) stated that the 1965 FAO scoring pattern overestimated the sulfur-containing amino acids and tryptophan content of the protein evaluated. These two amino acids and lysine were often limiting in most common foods. However, Irwin and Hegsted (1970) suggested that proposed amino acid requirements were an inadequate base from which to establish safe allowances or standards. This was due to the unavailability of requirement data for certain age groups of the populations, the small number of people in the studies of amino acid requirements, unestablished statistical estimates of the accuracy of the requirement figures, and unexplained variability in the requirements of the individuals. The authors also indicated that any allowances or standards must be established higher than the average needs to provide for most subjects. Furthermore, Harper (1978) reported that the 1965 FAO scoring pattern was a satisfactory guide in evaluating protein quality and that the amino acid score often agreed well with the results of biological evaluation.

The interpretation of laboratory evaluation of blood levels of hemoglobin and hematocrit has often been a subject of disagreement. The levels of hemoglobin and hematocrit set by the WHO as levels below which an individual was considered anemic have been criticized as being arbitrary, oversimplified, and inadequate for population studies (Baker & DeMaeyer, 1979). Sauberlich et al. (1974), however, reported that the WHO criteria for anemia was in general agreement with criteria developed for the United States, Norway, Canada, and Central America.

Moreover, in the report of the WHO on nutritional anemias (1968), the usefulness and applicability of the criteria in the evaluation of the prevalence of anemia in the various populations of the world was established. Furthermore, the use of blood hemoglobin as an indicator of iron status has been reported to lack specificity and to be relatively insensitive because of the variability of values obtained in normal subjects. Errors thus occurred frequently when the attempt to separate iron-deficient and normal subjects was based on hemoglobin measurements (Cook et al., 1979). Graitcer et al. (1981), however, showed that hemoglobin tests were more reliable than hematocrit tests in the detection of anemia, and were better than hematocrit tests. Sauberlich et al.(1974) stated that both kinds of tests were simple, practical, and inexpensive ways of evaluating nutritional anemias in populations.

The relative merits of weight, height, skin-fold thickness of various sites of the body, and calf, arm, chest, and head circumferences as indicators of nutritional status were examined by Rao and Singh (1970). It was found that the measurements which showed maximal variation in children with protein-energy calorie malnutrition (PEM) were weight, weight-for-height ratio, and calf circumference. Trowbridge and Staehling (1980) concluded that arm circumference for age was more sensitive than simple arm circumference or the arm circumference for height in identifying low weight-for-age children. Lee et al. (1981) also reported that weight for height, and weight for squared heights were unbiased indicators for evaluating obesity among populations.

CHAPTER III

DATA SOURCE AND METHODOLOGY

For several years, international agencies have supported various projects directed toward promoting the consumption of soybeans in the developing countries. In 1976, the United States Agency for International Development (USAID) awarded a contract to the Department of Nutrition at the University of North Carolina at Chapel Hill to establish a methodology for the promotion of soybean utilization by rural populations in the developing countries. Bolivia was selected from several candidate countries because it had an adequate supply of soybeans that were not utilized for human consumption, and local institutes with adequate facilities and manpower were available to implement the project. The interest and cooperation of the government were also present in Bolivia. The project was a collaborative program between the Greater University of San Simon at Cochabamba, Bolivia and the University of North Carolina at Chapel Hill. In addition, representatives from the University of North Carolina at Greensboro and North Carolina State University were asked to participate in the program. Three adjacent provinces of Punata, Jordan, and Esteban Arce in the state of Cochabamba with a total population of 100,000 were selected as the project site (Appendix B).

The project had three principal objectives:

1. To obtain the demographic, socioeconomic, communication systems, and dietary data required to develop a potentially successful strategy for the promotion of dry soybeans as a direct food source

2. To implement the developed promotional strategies

3. To obtain baseline data for the evaluation of the project

Sample Selection

A stratified random sample of 983 households (approximately 5 percent of the households in selected areas) was selected by a multistage sampling technique . Twenty-five percent of the sectors in each of three subpopulations (disperse population, populated center, and urban center) in each of the three provinces were randomly selected. All the segments in the selected sectors were grouped into the three subpopulations, and a 20 percent random sample of segments in each subpopulation was drawn. This sample was used for the collection of household data. A subsample (approximately 20 percent) of the 938 households was also selected for collection of detailed household dietary data such as recipes for mixed dishes, and for obtaining individual health and nutrition data on all occupants of these households.

Data Collection

The interview method was used for the collection of data, and an appropriate data collection instrument was prepared. The Bolivian team was trained in the proper use of the instrument and in the correct procedures for taking and recording measurements. The training program of the team included classroom sessions on nutrition and health, laboratory sessions pertaining to taking and recording of measurements, and actual field experiences. When all training was completed, a pretest of the entire procedure was made. Twenty-four households in a community similar to, but distinct from, the study population were tested, and final revisions of the questionnaire were made.

The baseline data were collected over a period of 12 months of the four-year period allocated for the project. Eighteen months were allocated for promotional activities. The remaining 18 months were utilized for evaluation of the project and data analyses. Demographic, socioeconomic, communication systems, and dietary data were collected by five interviewers, while detailed individual dietary intakes were collected by four nutritionists using the 24-hour recall method. Clinical, anthropometric, and laboratory data were collected by three biochemists and a nurse. All field workers were Bolivians.

Data Source

Baseline data collected from approximately 197 households that were selected for obtaining detailed individual health and nutrition data were used in this study. Such data included demographic, dietary, biochemical, and anthropometric information collected from all individuals living in the 197 households.

The sample consisted of 710 individuals and represented three segments of the population. Complete anthropometric and biochemical data, however, were available for only 254 of those 710 individuals. The demographic characteristics of both samples are summarized in Table 1. The percentages of the demographic characteristics of the subsample (254) were quite similar to the demographic characteristics of the total sample (710).

Approximately 56.2 percent of the 710 Bolivians sampled were females. Preschool age children constituted 18.6 percent of the sample, while 13.1 percent were school age children. Adolescents constituted 13.5 percent of the sample, and 38.3 percent were adults between 20 - 50 years of age. Individuals over 50 years of age accounted for 16.5 percent of the sample.

Fifty-seven percent of the 710 Bolivians lived in dispersed centers, 26.3 percent in populated centers, and 16.6 percent in urban centers. Approximately half of the Bolivians had had 1 to 6 years of schooling while almost one-third had not attended schools at all. In addition, 14.6 percent had received 7 to 12 years of education, and only

Table 1

Distribution of Total Sample and of Subsample Used

for Anthropometric and Biochemical Measurements

by Selected Demographic Characteristics

Characteristics	Total sample	Subsample
Sex		
Male	43.6	44.1
Female	56.4	55.9
Total	100.0	100.0
Age		
< 2 years	4.6	2.8
2 - 6 years	14.0	13.9
7 - 12 years	13.1	10.0
13 - 19 years	13.5	17.1
20 - 50 years	38.3	43.5
> 50 years	16.5	12.7
Total	100.0	100.0
Place of residence		
Dispersed centers	57.0	54.3
Populated centers	26.3	24.4
Urban centers	16.6	21.3
Total	100.0	100.0
Years of education		
None	32.0*	26.6**
1 - 6 years	52.2	49.2
7 - 9 year	8.8	12.5
10 - 12 years	5.8	9.3
> 12 years	1.2	2.4
Total	100.0	100.0
Household size		
1	0.6	0.8
2	5.4	3.1
3	11.3	8.7
4	22.7	26.0
5	25.5	23.2
6	11.8	11.8
7	11.7	8.7
8	8.5	12.6
9	2.7	5.1
Total	100.0	100.0
Sample size	710	254

*N = 693
**N = 248

1.2 percent had attended schools for more than 12 years.

Household sizes ranged from 1 to 9 individuals in the household. Approximately, 46 percent of the sample lived in a household composed of 4 or 5 individuals, while 11.3, 11.8, and 11.7 percent lived in households of 3, 6, and 7 persons, respectively. Almost 5.4 percent of the sample lived with another person, while 0.6 percent lived alone. Households with 8 and 9 persons constituted 8.5, and 2.7 percent of the sample, respectively.

Age and Sex Composition of the Sample

Table 2 shows the age and sex composition of the sample. There was a greater number of females than males among the preschool-age children, adolescents, adults from 20 to 50 years of age, and over 50 years of age. The school-age children were about equally divided between the two sexes. The sex ratio was approximately 78 males for each 100 females (78%).

Table 2

Composition of the Sample by Age and Sex

Age (years)	Sex: Male	Sex: Female	Total
	%	%	%
< 2	1.6	3.0	4.6
2 - 6	6.8	7.2	14.0
7 - 12	6.6	6.5	13.1
13 - 19	5.7	7.8	13.5
20 - 50	15.3	23.0	38.3
> 50	7.6	8.9	16.5

Note: Sample size = 710

Demographic Characteristics by Place of Residence

The distribution of the test sample studied in relation to demographic characteristics and place of residence is presented in Table 3. The urban centers with a sex ratio of 55% had the lowest proportion of males. One possible explanation of the low proportion of males, particularly in the urban centers, was a greater male migration from the rural areas and small villages and towns included in the study to the larger cities, including Cochabamba.

The average age for the total sample was 26.7 years, with approximately half the individuals under the age of 20. The age pattern of the three subpopulation groups was essentially the same and was similar to that of the total population.

The average for the total sample was 3.5 years of education. Thirty-five percent of the rural group and 20 percent of the urban group, however, did not attend schools. Percentages of urban and rural groups that had had more than 9 years of schooling were approximately equal.

The pattern of household size among the three subpopulations was similar. More people in each group lived in households of 4, 5, 6, and 7 persons, and the average household size for the total sample was 5 individuals. There was a greater number of people living in households of 8 and 9 persons in the rural areas than in the urban centers.

Table 3

Distribution of the Sample by Place of Residence

and Selected Demographic Characteristics

Characteristic	Place of residence						Total
	Dispersed centers		Populated centers		Urban centers		
	No	%	No	%	No	%	%
Sex							
Male	180	25.4	89	12.5	42	5.9	43.8
Female	225	31.7	98	13.8	76	10.7	56.2
Total	407	57.1	187	26.3	118	16.6	100.0
Age							
< 2	18	2.6	11	1.6	4	0.6	4.6
2 - 6	55	7.7	30	4.4	14	2.0	14.0
7 - 12	55	7.7	33	3.2	15	2.1	13.1
13 - 19	60	8.4	12	2.7	17	2.4	13.5
20 - 50	149	21.0	77	10.8	46	6.5	38.3
> 50	68	9.6	27	3.8	22	3.1	16.5
Total	405	57.0	187	26.4	118	16.6	100.0
Years of education*							
None	142	20.5	56	8.1	24	3.5	32.0
1 - 6	199	28.7	108	15.6	55	7.9	52.2
7 - 9	36	5.2	9	1.3	16	2.3	8.8
10 - 12	20	2.9	6	0.9	14	2.0	5.8
> 12	0	0	1	0.1	7	1.0	1.2
Total	397	57.3	180	26.0	116	16.7	100.0
Household size							
1	4	0.6	0	0	0	0	0.6
2	21	3.0	11	1.5	6	0.8	5.4
3	38	5.4	25	3.5	17	2.4	11.3
4	100	14.1	39	5.5	22	3.1	22.7
5	103	14.5	36	5.1	42	5.9	25.5
6	30	4.2	45	6.3	9	1.3	11.8
7	56	8.2	25	3.5	0	0	11.7
8	38	5.4	6	0.8	16	2.3	8.5
9	13	1.8	0	0	6	0.8	2.7
Total	405	57.0	187	26.4	118	16.6	100.0

Note: Sample size = 710 except for years of education
*Sample Size = 693

Table 4 shows the composition of the sample by place of residence, age, and sex. The proportion of males to females appeared to decrease as the age increased. This was particularly true in the urban centers where the reduction in male/female ratio appeared as early as the age of 13.

Table 4

Composition of the Sample by Place of Residence, Age and Sex

Age (years)	Place of residence: Dispersed centers Males		Dispersed centers Females		Populated centers Males		Populated centers Females		Urban centers Males		Urban centers Females		Total
	No	%	No	%	No	%	No	%	No	%	No	%	
< 2	3	0.4	15	2.1	6	0.8	5	0.7	3	0.4	1	0.1	4.6
2- 6	25	3.5	30	4.2	19	2.7	11	1.5	4	0.6	10	1.4	14.0
7-12	28	3.9	27	3.8	13	1.8	10	1.4	6	0.8	9	1.3	13.1
13-19	30	4.2	30	4.2	6	0.8	13	1.8	5	0.7	12	1.7	13.5
20-50	65	9.2	89	12.5	36	5.1	48	6.8	13	1.8	36	5.1	38.3
>50	29	4.1	34	4.8	9	1.3	11	1.5	11	1.5	8	1.1	16.5
Total	180	25.4	224	31.7	89	12.5	98	13.8	42	5.9	76	10.7	100.0

Note: Sample size = 710

The distribution of the sample by years of education, age, and sex is found in Table 5. A greater number of females than males over the age of 20 years were found to have had no education. This may have been due to a cultural bias against education of females in the past. Otherwise, the number of males and females who attended schools were about equal over all age groups.

Table 5

Percentage Distribution of the Sample by Years of Education, Age, and Sex

Age Years	Years of Education: 0		1 - 6		7 - 9		10 - 12		> 12		Total Percent
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
2-6	5.3	6.2	1.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9
7-12	0.4	0.2	6.4	6.2	0.2	0.4	0.0	0.0	0.0	0.0	13.8
13-19	0.3	0.3	2.1	3.8	2.1	2.4	1.3	1.2	0.0	0.0	13.5
20-50	0.9	8.3	12.2	14.8	2.6	0.8	1.2	1.8	0.3	0.5	43.3
>50	1.7	5.1	4.5	2.3	0.3	0.5	0.5	0.0	0.5	0.0	15.4
Total	8.6	20.1	26.6	28.1	5.2	4.1	3.0	3.0	0.8	0.5	100.0

Note: Sample size = 693

Table 6 presents the distribution of the Bolivians studied with regard to household size, age, and sex. The distribution of males and females under the age of 20 living in households with 4 or more persons was similar to that of the group over 50 years of age with almost equal numbers of males and females for each household size. In the age group between 20 and 50 years, the number of males was smaller than that of females for each household size of 3 or more persons. Furthermore, individuals who were reported to live alone were mostly men over the age of 50.

Methods of Analysis

Evaluation of nutrient intakes. The data of food intakes from the 24-hour dietary recall were analyzed for nutrient contents using the Food Composition Table for Bolivia (*Table de Composicion de Alimentos*, 1977). Daily nutrient intakes of individuals were also compared to the FAO Recommended Dietary intake (1974) to derive the nutrient adequacy ratios (Appendix C).

The arbitrary value of 67 percent of the FAO standards was used to classify the nutrient adequacy ratios into adequate and inadequate. Adequate nutrient ratio was one that equaled or exceeded 67 percent of the standard, while an inadequate ratio was one that was less than 67 percent of the standard.

Table 6

Distribution of the Sample by Age

Household Size, and Sex

Household Size	Age (years) < 20 Male		Female		20 - 50 Male		Female		> 50 Male		Female		Total
	No	%	No	%	No	%	No	%	No	%	No	%	%
1	0	0	0	0	1	0.2	0	0	2	0.3	1	0.2	0.7
2	0	0	4	0.6	8	1.1	6	0.8	8	1.1	12	1.7	5.3
3	12	1.7	10	1.4	15	2.1	22	3.1	12	1.7	9	1.3	11.3
4	33	4.6	32	4.5	33	4.6	46	6.5	9	1.3	8	1.1	22.6
5	39	5.5	59	8.3	27	3.8	38	5.3	7	1.0	11	1.5	25.4
6	23	3.2	21	3.0	12	1.7	22	3.1	3	0.4	3	0.4	11.8
7	20	2.8	25	3.5	12	1.7	19	2.7	4	0.6	3	0.4	11.7
8	18	2.5	17	2.4	5	0.7	14	2.0	2	0.3	4	0.6	8.5
9	3	0.4	5	0.7	1	0.2	6	0.8	2	0.3	2	0.3	2.7
Total	148	20.8	173	24.4	114	16.1	173	24.4	49	6.8	53	7.5	100.0

Note: Sample size = 710

The FAO Recommended Dietary Intakes do not represent the minimum individual needs of nutrients but include a safety margin ranging from 10 to 50 percent of the standard to compensate for nutrient losses in the processing of the foods, for the wide variation of nutrient needs in the population, and for increased needs of nutrients in cases of stress. Therefore, 67 percent of the FAO standard was considered as a critical level in this study. Furthermore, Guthrie (1971) indicated that in most nutritional research status intakes of two-thirds of the recommended intake were considered adequate. Intakes below this level were indicative of a possible but not necessarily a suboptimal state of nutrition.

A second arbitrary value of 33 percent of the FAO standard was used to identify the proportion of the sample studied which had severe deprivation of intake of various nutrients. The reason for selecting the 33 percent of the standard as a critical level was that the safety margin included in the standards was as high as 50 percent for some nutrients; thus an intake as low as 33 percent of the standards would reflect inadequacy of these nutrients' intake.

Nutrient adequacy ratios were calculated for energy, protein, vitamin A, ascorbic acid, thiamin, riboflavin, niacin, calcium, and iron. Because of unavailability of data in the food composition table or unavailability of data in FAO recommendation for the other nutrients, the study was limited to these eight nutrients and energy.

The overall nutritional adequacy of an individual's diet was also assessed using a nutrient sum index (NS). This index represents the total number of nutrients for which an individual intake meets or exceeds the 67 percent level of the FAO standards (Abdel-Ghany, 1978). Since the 67 percent level was computed for eight nutrients and energy, the NS ranged from zero to nine.

Evaluation of the quality of protein. Individual daily intake of protein was analyzed for amino acids composition using the FAO table for amino-acid content of foods (UNFAO, 1970). The amino acids content of one gram of the protein ingested by each individual was further compared to the FAO amino acid reference pattern (Appendix C). In order to identify the most limiting amino acids in the diet of the test sample studied, average scores for the essential amino acids isoleucine, leucine, lysine, methionine, and cystine, phenylalanine and tyrosine, threonine, tryptophan, and valine were calculated. In practice cystine is included with methionine and tyrosine is included with phenylalanine, although cystine and tyrosine are not considered essential amino acids. The lowest score designated the most limiting amino acid, and the protein quality of the food was estimated from that amino acid score.

Evaluation of the anthropometric data. Weight and height of the Bolivians studied were compared to the National Center for Health Statistics (NCHS) percentiles (Appendix C). The weight for age, weight for height, and height for age were calculated for each individual and compared to NCHS 50th percentiles.

The nutritional status of the Bolivians was then evaluated according to the classification of Gomez et al. (1956). The classification is as follows:

Adequate nutritional status = 90% or over of median weight for age

1st degree malnutrition = 75 - 89% of median weight for age

2nd degree malnutrition = 60 - 74% of median weight for age

3rd degree malnutrition = under 60% of median weight for age.

Although the Gomez classification does not distinguish between acute and chronic malnutrition, the review of literature revealed that it is still the most widely used classification in the developing countries for evaluating degrees of malnutrition.

An alternative classification is recommended by the WHO/FAO/UNICEF Expert Committee on Nutritional Surveillance (Waterlow, 1972). This classification, referred to as the Waterlow Classification in this study, includes the following designations for general growth:

Stunted (chronic) = below 90% of median height for age

Wasted (acute) = below 80% of median weight for height

Stunted and wasted = below 90% of median height for age and below 80% of median weight for height

This classification distinguishes between chronic and acute malnutrition. In the process of adaptation to malnutrition, children faced with chronic nutrient deficiencies first appear to reduce their rate of linear growth (stunting) without altering normal weight for height relationships. Loss of fat and muscle reserves, called wasting, begins when malnutrition becomes so severe that body reserves are utilized for basal metabolic functions over extended periods. This classification was also used in the study as an alternate way of identifying malnutrition.

Triceps skin fold, arm circumference, and arm muscle area were evaluated by comparing measurements of individuals with the 50th percentile proposed by Frisancho (1974) (Appendix C). The formula of Gurney (1969) was used for the calculation of the arm muscle area.

Estimation of the prevalence of anemia. The WHO criteria for the diagnoses of anemia (UNWHO, 1968) were adopted to evaluate iron status among the Bolivians studied. Anemia was considered to exist in those whose hemoglobin levels (mg/100 ml of venous blood) were lower than the following figures for persons residing at sea level:

Children aged 6 months to 6 years:	11
Children aged 6 to 14 years	12
Adult males	13
Adult females, nonpregnant	12

Haas (1980) found that there was an increase of 0.8 mg/100ml in hemoglobin levels for each kilometer rise in altitude in Bolivia. Since average altitude of study sites was 2.557 km, the WHO guidelines were adjusted by 2 mg/100ml (0.8 x 2.557), and the values obtained were used. The hematocrit values corresponding to the hemoglobin concentrations previously given were obtained by multiplying 3 as recommended by the WHO.

Correlation between iron status and energy intake. The relationship between iron status and energy intake of the Bolivians was examined by means of partial correlation. The partial correlation has been defined by Rummel (1970) as the product-moment correlation between two variables while the variance of other specified variables remains constant. This correlation is based on the assumptions of linear relationships between the variables.

The partial correlations between iron intake and hemoglobin and hematocrit levels holding the variance of energy intake constant were computed. The purpose of this analysis was to determine whether low hemoglobin and hematocrit levels were associated with insufficient intake of iron or inadequate intake of total energy.

Regression analysis. The multiple regression is a method of analyzing the separate and collective contributions of two or more independent variables, to the variation of a dependent variable (Kerlinger & Pedhazur, 1973). It allows the prediction of the dependent variable from the knowledge of two or more independent variables. Predictions are seldom perfect, and in most cases they involve a certain amount of error. Regression analysis, therefore, is based on the least squares criterion, which minimizes the sum of squared deviations between the observed and predicted values of the dependent variable.

When the independent variables include some qualitative variables such as sex and race, there is a need to use dummy variables. The observations of the qualitative variable must fall into mutually exclusive classes, and the effect of class differences is to change the value of the constant term of the regression equation rather than the measure of the strength of the relationship, that is the regression coefficient.

Multiple regression analysis was used to examine the effects of sex, age, place of residence, years of education, and household size on the overall nutritional adequacy as represented by the nutrient sum index. Dummy variables included in these analyses were sex and place of residence.

CHAPTER IV

RESULTS

Dietary Intake

The average daily intake of foods most frequently consumed by the Bolivians is presented in Table 7. Potatoes and corn apparently represented staple foods for the Bolivians. Intake of cereals was generally high, while legumes represented an important source of protein. The average intake of chicha, an alcoholic beverage, was high and supplied a considerable amount of energy.

Table 8 shows the average daily intake of the various nutrients and energy and the average intake of these for each meal of the day. Lunch and supper were equally important meals for the Bolivians, but breakfast was less important. However, there was a wide variation between individuals according to daily and meal intake of nutrients. Since this difference could have been due to variations between the various age groups, average daily intake of the various nutrients by age were calculated and are shown in Tables 9 - 12. Table 9 shows the average daily nutrient intake for infants and toddlers. The average daily nutrient intake for children 4 to 12 years of age is given in Table 10, while Table 11 contains the average daily nutrient intake for adolescents. Table 12 presents average daily nutrient intake for adults. Even after grouping the Bolivians by age, there was still wide variation in nutrient intake between individuals within each group.

Table 7

Foods Frequently Served for the Bolivians*

Foods	Average intake(g/day)**
Rice	90.8 ± 27.9
Quinua (Millet)	35.5 ± 10.8
Corn (Maize)	119.2 ± 15.7
Yellow Corn	154.7 ± 61.7
Noodles	57.7 ± 17.7
Bread	122.4 ± 18.7
Flour	47.0 ± 14.8
Cassava	75.0 ± 21.0
Sugar	106.9 ± 14.1
Potatoes	547.5 ± 20.3
Dried Beans	51.5 ± 19.5
Dried Peas	69.2 ± 19.8
Tarhui (Lupine Beans)	14.4 ± 4.9
Habas (Dried Lima Beans)	72.5 ± 23.9
Soy Beans	31.3 ± 12.3
Dried Meat	21.4 ± 8.1
Chicken	56.0 ± 17.0
Fresh Peas	21.4 ± 5.7
Fresh Lima Beans	72.4 ± 23.6
Chicha (Alcoholic Beverages)	294.0 ± 37.4

*N = 254
**Mean ± standard deviation

Table 8

Distribution of Daily Nutrient

Intakes by Meal*

Nutrient	Daily total	Breakfast	Meals Lunch	Supper
Energy: kcal	2013 ± 1305**	482 ± 605	625 ± 647	701 ± 962
Protein: g	156 ± 614	54 ± 236	104 ± 535	113 ± 486
Fat: g	78 ± 357	39 ± 190	48 ± 362	79 ± 389
Carbohydrate: g	374 ± 205	94 ± 95	116 ± 193	116 ± 179
Fiber: g	49 ± 315	22 ± 137	41 ± 352	43 ± 304
Calcium: mg	419 ± 476	108 ± 274	135 ± 615	185 ± 633
Phosphorus: mg	1211 ± 1001	273 ± 742	455 ± 684	523 ± 1526
Iron: mg	89 ± 345	71 ± 456	75 ± 423	95 ± 490
Vitamin A: mg	477 ± 1391	83 ± 456	259 ± 655	252 ± 1406
Thiamin: mg	65 ± 350	49 ± 288	69 ± 446	72 ± 442
Riboflavin: mg	24 ± 154	25 ± 136	30 ± 223	17 ± 128
Niacin: mg	52 ± 283	51 ± 321	62 ± 428	40 ± 281
Ascorbic Acid: mg	135 ± 440	72 ± 394	126 ± 767	75 ± 386

*N = 254

**Each value is the mean ± standard deviation

Table 9

Average Daily Nutrient Intakes

for Infants and Toddlers

Nutrient	Age categories < 12 months	12-23 months
Energy: kcal	357 ± 427*	1029 ± 801
Protein: g	35 ± 62	254 ± 736
Fat: g	20 ± 41	185 ± 546
Carbohydrate: g	70 ± 86	264 ± 349
Fiber: g	8 ± 20	171 ± 496
Calcium: mg	116 ± 218	560 ± 1073
Phosphorous: mg	228 ± 322	537 ± 564
Iron: mg	29 ± 72	112 ± 275
Vitamin A: mg	72 ± 103	309 ± 422
Thiamin: mg	30 ± 80	26 ± 71
Riboflavin: mg	11 ± 35	16 ± 40
Niacin: mg	6 ± 16	65 ± 154
Ascorbic Acid: mg	38 ± 100	74 ± 112
Number of samples**	15	18

*Each value is the mean ± standard deviation
**Total sample size = 710

Table 10

Average Daily Nutrient Intakes

for Children

Nutrient	Age categories			
	2 - 3 Years	4 - 6 Years	7 - 9 Years	10 - 12 Years
Energy: kcal	1009 ± 1359*	1198 ± 1286	1152 ± 927	1381 ± 892
Protein: g	243 ± 605	230 ± 518	272 ± 519	202 ± 493
Fat: g	115 ± 323	142 ± 353	214 ± 498	138 ± 495
Carbohydrate: g	167 ± 120	177 ± 148	272 ± 256	266 ± 271
Fiber: g	124 ± 290	98 ± 294	242 ± 519	163 ± 491
Calcium: g	291 ± 299	208 ± 237	566 ± 1104	418 ± 994
Phosphorous: mg	733 ± 622	846 ± 1142	1050 ± 1429	1280 ± 1986
Iron: mg	230 ± 573	181 ± 483	233 ± 362	392 ± 945
Vitamin A: mg	313 ± 412	463 ± 751	480 ± 844	637 ± 995
Thiamin: mg	117 ± 240	151 ± 442	230 ± 657	218 ± 560
Riboflavin: mg	83 ± 171	82 ± 213	114 ± 317	73 ± 189
Niacin: mg	139 ± 370	149 ± 408	210 ± 563	201 ± 544
Ascorbic Acid: mg	227 ± 466	250 ± 786	373 ± 1187	247 ± 600
Number of samples**	43	56	44	49

*Each value is the mean ± standard deviation
**Total sample size = 710

Table 11

Average Daily Nutrient Intakes

for Adolescents

Nutrient	Age categories 13 - 15 Years	16 - 19 Years
Energy: kcal	1542 ± 2310*	1719 ± 1278
Protein: g	540 ± 1183	359 ± 938
Fat: g	318 ± 740	229 ± 692
Carbohydrate: mg	269 ± 352	387 ± 330
Fiber: g	370 ± 929	274 ± 735
Calcium: mg	513 ± 1047	705 ± 1411
Phosphorous: mg	803 ± 759	1234 ± 1163
Iron: mg	319 ± 607	357 ± 975
Vitamin A: mg	361 ± 466	568 ± 934
Thiamin: mg	188 ± 446	253 ± 953
Riboflavin: mg	126 ± 237	98 ± 294
Niacin: mg	247 ± 500	282 ± 799
Ascorbic Acid: mg	386 ± 867	337 ± 1094
Number of samples**	49	42

*Each value is the mean ± standard deviation
**Total sample size = 710

Table 12

Average Daily Nutrient Intakes

for Adults

Nutrient	Age categories 20 - 50 Years	> 50 Years
Energy: kcal	1896 ± 2167*	1670 ± 1635
Protein: g	441 ± 984	461 ± 1003
Fat: g	293 ± 682	362 ± 854
Carbohydrate: mg	316 ± 304	332 ± 356
Fiber: g	275 ± 813	354 ± 928
Calcium: mg	511 ± 827	686 ± 1383
Phosphorous: mg	1161 ± 1137	1007 ± 1063
Iron: mg	400 ± 968	287 ± 856
Vitamin A: mg	716 ± 1233	943 ± 1811
Thiamin: mg	285 ± 754	299 ± 825
Riboflavin: mg	158 ± 407	153 ± 412
Niacin: mg	373 ± 1007	327 ± 894
Ascorbic Acid: mg	513 ± 1401	594 ± 1615
Number of samples**	287	102

*Each value is the mean ± standard deviation
**Total sample size = 710

The percentage contributions of protein, fat, and carbohydrates to the total daily energy are found in Table 13. Total protein energy constituted about 14 percent, a value which is similar to that of the typical North American pattern (12 percent). Only 4.4 percent of total energy, however, came from animal protein sources. Fat energy was low (15 percent) compared to that of the North Americans (35 percent), and carbohydrates represented the major energy source for the Bolivians.

Table 13

Sources of Daily Energy

Nutrient	Percent of daily energy Animal sources	Vegetable sources	Total Percent
Protein	4.4	9.8	14.2
Fat	8.8	6.3	15.1
Carbohydrate	0.9	69.8	70.7
Total	14.1	85.9	100.0

Table 14 shows the distribution of the Bolivians by their level of nutrient adequacy ratios as percentage of daily intake of nutrients from the FAO Recommended Dietary Intakes.

Table 14

Distribution of the Sample by Levels of

Nutrient Adequacy Ratios

Nutrient	Frequencies (percent of total sample)* < 33_% RDA	33 - 66_% RDA	> 66_% RDA
Energy	33.5	19.2	47.2
Protein	13.7	3.9	82.4
Vitamin A	46.3	23.1	30.6
Thiamin	16.9	16.5	66.6
Riboflavin	22.4	10.8	66.8
Niacin	24.6	19.7	55.6
Ascorbic Acid	16.5	4.6	78.9
Calcium	43.0	19.7	37.3
Iron	16.1	7.2	76.8

*N=710

Approximately 50 percent and 45 percent of the Bolivians studied had intake of energy and niacin below the 67 percent of the standard respectively, while about one-third of them had intake of energy and niacin below the 33 percent level. Almost 70 percent and 63 percent of the individuals had vitamin A and calcium intake below 67 percent of the standard respectively, and approximately 45 percent of them did not meet even the 33 percent level of intake for both nutrients. About 34 percent of the individuals had intake of thiamin and riboflavin below the 67 percent of the FAO standards, while only 17 to 23 percent of the

Bolivians had intake of protein, ascorbic acid, and iron less than the 67 percent level. Generally, the diet of almost 50 percent of the Bolivians studied was inadequate in one or more nutrients under consideration.

The distribution of the Bolivians by their energy and nutrient adequacy ratios, age, and sex are presented in Tables 15 to 23. The percentage of frequencies presented for each sex group are relative to the number of subjects in each age group. Each table pertains to one adequacy ratio.

Table 15 shows that the highest frequencies of energy adequacy ratios below 33 percent were for children under one year old and adolescents between 13 - 15 years of age followed by children 7 to 9 years old. Generally, a greater percentage (56 percent) of the male population had lower levels of energy adequacy ratios than the females (50 percent) for most age groups.

The age group most deficient in protein intake was children under one year of age with one third of the females and two-thirds of the males having protein adequacy ratios below 66 percent (Table 16). Furthermore, almost one-third of males from 7 to 9 years old and one-third of female adolescents had protein adequacy ratios below 33 percent.

Table 15

Energy Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	Female	33 - 66% RDA Male	Female	> 66% RDA Male	Female
< 12 months	15	26.7	33.3	6.7	0.0	6.7	26.7
12 - 23 months	18	5.5	16.8	5.5	27.8	22.2	22.2
2 - 3 years	43	16.2	6.9	6.9	16.2	27.9	25.6
4 - 6 years	56	19.6	16.1	7.1	7.1	19.6	30.4
7 - 9 years	44	20.4	20.4	9.1	11.4	25.0	13.6
10 - 12 years	49	24.5	8.2	8.2	14.3	14.3	30.6
13 - 15 years	42	16.7	30.9	9.5	11.9	16.7	14.3
16 - 19 years	54	11.1	18.5	9.3	11.1	22.2	27.8
20 - 50 years	287	14.9	16.7	8.0	10.8	16.7	32.7
> 50 years	102	13.7	19.6	10.8	5.9	23.5	26.5

*Total N = 710

**Percentage of total number of individuals in each age group

Table 16

Protein Adequacy Ratio Distribution

Among the Sample according to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	Female	33 - 66% RDA Male	Female	> 66% RDA Male	Female
< 12 months	15	13.3	20.0	13.3	0.0	13.3	40.0
12 - 23 months	18	0.0	0.0	0.0	5.6	33.3	61.1
2 - 3 years	43	2.3	0.0	2.3	0.0	46.5	48.8
4 - 6 years	56	5.3	5.3	3.5	1.7	37.5	46.4
7 - 9 years	44	13.6	6.8	0.0	2.2	40.9	36.4
10 - 12 years	49	6.1	4.1	6.1	2.0	34.6	46.9
13 - 15 years	42	0.0	19.0	4.8	0.0	38.1	38.1
16 - 19 years	54	1.8	12.9	0.0	0.0	40.7	44.4
20 - 50 years	287	7.7	7.6	1.0	1.7	31.4	50.9
> 50 years	102	2.9	8.8	2.9	2.9	42.2	40.2

*Total N = 710
**Percentage of total number of individuals in each age group

With regard to vitamin A adequacy ratios (Table 17), the highest frequencies of levels below the 33 percent RDA were found in children under one year old, followed by adults over 50, and adults between 20 and 50 years of age. A greater percentage of the female population had vitamin A adequacy ratios below the 66 percent level than the male population.

The Bolivians showed similar patterns of distribution with regard to thiamin, riboflavin, and niacin adequacy ratios (Tables 18, 19, and 20). Children under one year of age and adolescents from 13 to 15 years of age were the groups most deficient in the three nutrients. Males, on the average, had lower levels of adequacy for riboflavin and niacin, while there was no apparent sex difference in relation to thiamin adequacy ratios.

There were no apparent differences between the various age groups as to the level of ascorbic acid adequacy with the exception of children under the age of one year. These individuals had the highest frequencies of adequacy ratios below the 33 percent (Table 21). Also, there were as many males as females who had levels of the nutrient adequacy below the 66 percent of the standard.

Of all age groups, a greater percentage of females had below the 66 percent level of calcium adequacy ratios than did males (Table 22). The age groups most deficient were children under one year, 10 to 12 years, and 4 to 6 years, and adolescents 13 to 15 years, respectively.

Table 17

Vitamin A Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	Female	33 - 66% RDA Male	Female	> 66% RDA Male	Female
< 12 months	15	33.3	46.7	0.0	6.7	6.7	6.7
12 - 23 months	18	5.6	33.3	5.6	11.1	22.2	22.2
2 - 3 years	43	16.3	20.9	9.3	11.6	25.6	16.3
4 - 6 years	56	17.8	17.8	7.1	5.3	21.4	30.4
7 - 9 years	44	22.7	18.2	15.9	9.1	15.9	18.2
10 - 12 years	49	20.4	24.5	8.2	10.2	18.4	18.4
13 - 15 years	42	19.0	30.9	16.6	11.9	7.1	14.3
16 - 19 years	54	14.8	27.8	18.5	22.2	9.3	7.4
20 - 50 years	287	17.1	31.0	10.4	13.6	12.2	15.7
> 50 years	102	23.5	27.4	9.8	10.8	14.7	13.7

*Total N = 710
**Percentage of total number of individuals in each age group

Table 18

Thiamin Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	< 33% RDA Female	33 - 66% RDA Male	33 - 66% RDA Female	> 66% RDA Male	> 66% RDA Female
< 12 months	15	20.0	20.0	13.3	13.3	6.7	26.7
12 - 23 months	18	0.0	16.7	5.6	22.2	27.8	27.8
2 - 3 years	43	2.3	2.3	6.9	6.9	41.9	39.5
4 - 6 years	56	12.5	7.1	3.6	12.5	30.6	33.9
7 - 9 years	44	9.1	11.4	13.6	4.5	31.8	29.5
10 - 12 years	49	12.2	2.0	8.2	14.2	26.5	36.7
13 - 15 years	42	10.7	21.4	9.5	9.5	26.2	26.2
16 - 19 years	54	5.6	5.6	14.8	7.4	22.2	44.4
20 - 50 years	287	7.3	10.1	5.2	8.7	27.1	41.5
> 50 years	102	4.9	8.8	5.9	7.8	37.2	35.3

*Total N = 710
**Percentage of total number of individuals in each age group

Table 19

Riboflavin Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA		33 - 66% RDA		> 66% RDA	
		Male	Female	Male	Female	Male	Female
< 12 months	15	33.3	26.7	6.7	6.7	0.0	26.7
12 - 23 months	18	5.7	16.7	0.0	5.7	27.8	44.4
2 - 3 years	43	9.3	6.9	2.3	2.3	39.5	39.5
4 - 6 years	56	8.9	12.5	5.4	5.4	32.1	35.7
7 - 9 years	44	13.6	9.1	2.2	6.8	38.6	29.5
10 - 12 years	49	14.3	6.1	4.1	12.2	28.6	34.7
13 - 15 years	42	11.9	23.8	9.5	7.1	21.4	26.2
16 - 19 years	54	5.5	9.3	3.7	9.3	33.3	38.9
20 - 50 years	287	7.7	13.9	3.5	5.9	28.7	40.4
> 50 years	102	12.7	8.8	6.9	5.8	28.4	37.2

*Total N = 710
**Percentage of total number of individuals in each age group

Table 20

Niacin Adequacy Ratio Distribution of

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	Female	33 - 66% RDA Male	Female	> 66% RDA Male	Female
< 12 months	15	33.3	26.6	6.7	13.3	0.0	20.0
12 - 23 months	18	11.1	16.7	0.0	16.7	22.2	33.3
2 - 3 years	43	9.3	9.3	6.9	9.3	34.9	30.2
4 - 6 years	56	16.1	8.9	8.9	14.3	21.4	30.4
7 - 9 years	44	11.4	13.6	6.8	9.1	36.4	22.7
10 - 12 years	49	16.3	10.2	4.1	22.4	26.5	20.4
13 - 15 years	42	11.9	23.8	11.9	9.5	19.0	23.8
16 - 19 years	54	11.1	11.1	14.8	9.2	16.7	37.0
20 - 50 years	287	10.8	13.2	6.9	10.4	21.9	36.6
> 50 years	102	11.7	6.9	11.7	9.8	24.5	35.3

*Total N = 710

**Percentage of total number of individuals in each age group

Table 21

Ascorbic Acid Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	< 33% RDA Female	33 - 66% RDA Male	33 - 66% RDA Female	> 66% RDA Male	> 66% RDA Female
< 12 months	15	20.0	26.7	6.7	0.0	13.3	33.3
12 - 23 months	18	5.6	11.1	0.0	5.7	27.7	50.0
2 - 3 years	43	9.3	6.9	4.6	2.3	37.2	39.5
4 - 6 years	56	7.1	7.1	5.4	3.6	33.9	42.8
7 - 9 years	44	6.8	9.1	0.0	2.3	47.7	34.1
10 - 12 years	49	12.2	2.0	0.0	4.1	34.7	46.9
13 - 15 years	42	7.1	14.3	0.0	4.7	35.7	38.1
16 - 19 years	54	5.5	7.4	0.0	0.0	37.0	50.0
20 - 50 years	287	5.9	10.1	1.4	2.8	32.4	47.4
> 50 years	102	8.8	2.9	6.9	2.9	36.3	42.2

*Total N = 710
**Percentage of total number of individuals in each age group

Table 22

Calcium Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	Female	33 - 66% RDA Male	Female	> 66% RDA Male	Female
< 12 months	15	40.0	46.7	0.0	6.7	0.0	6.7
12 - 23 months	18	5.6	38.9	5.6	11.1	22.2	16.7
2 - 3 years	43	30.2	23.2	9.3	9.3	11.6	16.3
4 - 6 years	56	25.0	21.4	16.1	17.8	5.4	14.3
7 - 9 years	44	25.0	18.2	13.6	13.6	15.9	13.6
10 - 12 years	49	24.5	22.4	10.2	26.5	12.2	4.1
13 - 15 years	42	21.4	40.5	11.9	4.8	9.5	11.9
16 - 19 years	54	9.3	16.7	11.1	14.8	22.2	25.9
20 - 50 years	287	17.4	22.3	3.4	9.8	18.8	28.2
> 50 years	102	15.7	22.5	7.8	11.7	24.5	17.6

*Total N = 710
**Percentage of total number of individuals in each age group

Results indicated that children of both sexes up to 12 years of age, and females 15 years of age or older were the risk groups with regard to iron nutriture (Table 23). The highest frequencies with iron adequacy ratios below the 33 percent were females from 13 to 15 years.

The overall nutritional adequacy of the Bolivians' diet as indicated by the nutrient sum index is shown in Table 24. Only 6.3 percent had diets that met or exceeded the 67 percent of the FAO standards for all eight nutrients and energy, while over 50 percent had diets that were below that level for 5 or more nutrients. Approximately 27 percent of the Bolivians had diets that were inadequate in one or two nutrients.

Protein Quality.

The essential amino acid scores of the diets consumed by the Bolivians tested in the survey are summarized in Table 25. The most limiting amino acids were methionine and cystine, and the second most limiting amino acids were phenylalanine and tyrosine. These results suggested that the quality of protein consumed by most Bolivians in the survey was poor and that the protein was particularly deficient in the sulfur-containing amino acids.

Table 23

Iron Adequacy Ratio Distribution

Among the Sample According to

Age and Sex

Age	Total* individuals	Percent frequencies** < 33% RDA Male	Female	33 - 66% RDA Male	Female	> 66% RDA Male	Female
< 12 months	15	13.3	20.0	13.3	0.0	13.3	40.0
12 - 23 months	18	5.6	11.1	0.0	5.6	27.8	50.0
2 - 3 years	43	2.3	2.3	9.3	2.3	39.5	44.2
4 - 6 years	56	8.9	7.1	3.6	0.0	33.9	46.4
7 - 9 years	44	11.4	4.5	0.0	4.5	43.2	36.4
10 - 12 years	49	4.2	2.0	2.0	2.0	40.8	49.0
13 - 15 years	42	7.2	21.4	2.4	2.4	33.3	33.3
16 - 19 years	54	0.0	7.4	3.7	7.4	38.9	42.6
20 - 50 years	287	6.3	10.8	0.7	6.9	32.8	42.5
> 50 years	102	9.8	9.8	0.0	6.9	38.2	35.3

*Total N = 710
**Percentage of total number of individuals in each age group

Table 24

Nutrient Sum Index of

Bolivians Surveyed

No. of energy and/or nutrients deficient in the diet	Frequencies	Percentages
9	20	2.8
8	33	4.6
7	62	8.7
6	65	9.2
5	68	9.6
4	73	10.3
3	79	11.1
2	138	19.4
1	127	17.9
0	45	6.3
Total	710	100.0

Table 25

Amino Acid Scores of

Bolivian Diets*

Amino acid	Percent of FAO reference pattern
Isoleucine	1.33
Leucine	0.69
Lysine	0.69
Methionine + Cystine	0.39
Phenylalanine + Tyrosine	0.40
Theronine	0.66
Tryptophan	1.15
Valine	0.60

*N = 710

Anthropometric Evaluation

The averages of the various anthropometric measurements for the males and females surveyed are presented in Tables 26 and 27, respectively. There was a steady increase in the averages of the various measurements with age in the male population. A particularly wide variation in averages was observed in children up to 15 years of age. Similar patterns of growth were seen in the females surveyed with the exception of girls between the ages of 15 and 23 months. The average height, weight, and triceps measurements for this group were low with large variation indicating that some of the girls growth patterns were falling below that of their peers' patterns.

Heights and weights of males were greater than females, but females 13 years and older had average triceps and biceps skinfold measurements greater than males. Arm circumference averages were similar in both sexes. Such patterns in body structure and composition were expected, since the male growth patterns are generally greater than those of females. Females tend to incorporate more body fat stores than do males as they grow older (Frisancho, 1974).

Growth measurements of the sample were compared to the 50th percentile of the North Americans of the same age and sex. The results are summarized in Tables 28 to 33.

Table 26

Average Anthropological Data for Males*

Age	Total individuals	Height cm	Weight kg	Triceps skinfold mm	Biceps skinfold mm	Arm circumference mm
12-23 mo	1	71.0± 0**	7.90± 0	8.0±0	3.0±0	13.3±0
2-3 yrs	7	86.7± 4.3	12.71± 1.1	9.4±2.9	5.3±1.4	15.4±1.0
4-6 yrs	9	98.5± 6.3	15.78± 1.8	8.8±1.3	4.6±1.0	15.9±0.7
7-9 yrs	5	100.6±56.8	24.50± 3.8	6.8±1.3	3.4±0.8	17.2±1.2
10-12 yrs	5	132.9±10.2	29.48± 5.6	8.4±2.6	4.0±1.4	17.6±1.5
13-15 yrs	8	134.9±38.2	41.07± 5.8	9.2±3.3	4.5±2.2	21.5±1.3
16-19 yrs	13	160.2± 5.4	52.52± 6.3	7.1±2.9	3.6±1.3	23.4±2.0
20-50 yrs	41	159.7± 6.1	58.44± 8.8	9.1±4.7	4.4±3.2	26.1±2.9
>50 yrs	21	162.1± 6.7	63.59±12.6	10.3±4.0	4.9±2.4	27.2±2.9

*N = 251
**Mean ± standard deviation

Table 27

Average Anthropological Data for Females*

Age	Total individuals	Height cm	Weight kg	Triceps skinfold mm	Biceps skinfold mm	Arm circumference mm
6-8 mo	1	65.5± 0**	6.75± 0	6.0±0	4.0±0	13.5±
9-14 mo	1	65.3± 0	6.90± 0	8.0±0	5.0±0	12.5±0
15-17 mo	2	68.8± 6.0	3.20± 4.5	7.0±1.4	4.0±1.4	12.8±1.8
18-23 mo	2	38.5±54.4	4.95± 7.0	7.0±0	4.0±0	15.1±0.6
2-3 yrs	10	74.6±27.2	11.40± 2.9	9.7±1.1	5.1±1.3	14.7±1.5
4-6 yrs	9	97.7± 6.1	14.70± 2.2	9.2±1.9	4.6±1.7	15.5±1.1
7-9 yrs	6	116.1± 4.6	21.75± 2.0	7.0±1.5	3.0±0	17.0±1.3
10-12 yrs	9	137.4± 8.7	31.04± 5.2	9.1±2.8	4.7±1.1	18.9±1.5
13-15 yrs	9	147.2± 3.4	46.03± 4.2	14.1±4.9	6.6±2.1	23.6±1.7
16-19 yrs	13	151.6± 6.1	52.45± 4.9	16.3±3.4	8.4±2.8	25.4±3.3
20-50 yrs	68	151.9± 5.7	57.52± 9.6	17.3±5.3	7.7±3.8	26.8±3.1
>50 yrs	11	149.4± 4.9	56.96±16.7	16.7±6.1	7.1±3.8	26.6±4.5

*N = 251
**Mean ± standard deviation

Table 28 presents the percentage distribution of the Bolivians by age and sex according to height for age measurements. The results revealed that most children of all ages were below the 50th percentile of the North American standard. Only 60 percent of the girls from 6 to 12 years of age and all girls from 13 to 18 years of age had height for age levels similar to that of North Americans. Most of the children less than two years of age were below 60 percent of the standard, and only 14 percent of them were between 60 and 80 percent of the standard. Between 2 and 5 years, approximately 80 percent of the girls were below 80 percent of the standard, and only 16 percent were between 80 and 90 percent of the standard. Boys of the same age group, on the other hand, had better height for age levels with 70 percent of them between 80 and 90 percent of the standard and only 30 percent of them below that level. The same pattern of height for age of the boys existed in the age groups 6 to 12 years and 13 to 18 years, while the girls' pattern for both age groups was much better than the boys' and the girls of other age groups with only 40 percent of the girls 6 to 12 years of age being between 80 and 90 percent of the standard.

The distribution for weight for age of Bolivian children was slightly different from that for height for age with approximately 75 percent of the boys and girls 6 to 12 years and all boys and girls in the age group 13 to 18 were within 100 percent of the standard (Table 29). Only 19 percent of the children between 6 and 12 were between 80 to 90 percent of the standard and 7 percent of them were below that level.

Table 28

Percent Frequencies for Height/Age

by Age and Sex*

Age & Sex	Total individuals	Percent of NCHS 50th percentile < 60	60 - 79	80 - 89	90 - 110	> 110
<12 months	2	100.0	-	-	-	-
Boys	-	-	-	-	-	-
Girls	2	100.0	-	-	-	-
12-23 months	5	80.0	20.0	-	-	-
Boys	1	100.0	-	-	-	-
Girls	4	75.0	25.0	-	-	-
2-5 years	33	24.3	33.3	39.4	-	-
Boys	14	-	28.6	71.4	-	-
Girls	19	42.1	42.1	15.8	-	-
6-12 years	27	3.7	11.1	51.9	33.3	-
Boys	12	8.3	25.0	66.7	-	-
Girls	15	-	-	40.0	60.0	-
13-18 years	40	2.5	15.0	32.5	50.0	-
Boys	20	5.0	30.0	65.0	-	-
Girls	20	-	-	-	100.0	-

*N = 251

Table 29

Percent Frequencies for Weight/Age

by Age and Sex*

Age & Sex	Total individuals	Percent of NCHS 50th percentile < 60	60 - 79	80 - 89	90 - 110	> 110
<12 months	2	100.0	-	-	-	-
Boys	-	-	-	-	-	-
Girls	2	100.0	-	-	-	-
12-23 months	5	80.0	20.0	-	-	-
Boys	1	100.0	-	-	-	-
Girls	4	50.0	50.0	-	-	-
2-5 years	33	15.1	51.5	21.2	12.1	-
Boys	14	7.1	64.2	21.4	7.1	-
Girls	19	21.1	42.1	21.7	15.7	-
6-12 years	27	-	7.4	18.5	74.0	-
Boys	12	-	16.7	25.0	58.3	-
Girls	15	-	-	13.3	86.7	-
13-18 years	40	-	-	-	100.0	-
Boys	20	-	-	-	100.0	-
Girls	20	-	-	-	100.0	-

*N = 251

The pattern was different, however, for children under 6 years of age. Only 12 percent of the children aged 2 to 5 were around 100 percent of the standard, while 20 percent were between 80 and 90 percent of the standard. The rest of the children were below the 80 percent of the standard. Almost 86 percent of the children under 2 years of age were below 60 percent of the standard, and only 15 percent of them were between 60 and 80 percent of the standard.

Based on a weight for height criterion, 73, 70, and 93 percent of the Bolivian children of the age groups 2 to 5, 6 to 12, 13 to 18 years sampled were normally developed (Table 30). Approximately 15 percent, 7.4 percent, and 7.5 percent of the same age groups, respectively, were over the 110 percent of the standard. Most of the children under 2 years of age were below the 60 percent of the standard. About 19 percent of children aged 6 to 12 years were also below the 60 percent of the standard.

Based on these three indices, it would appear that Bolivian children were of smaller sizes than those of their North American counterparts. The use of the norms developed for the North Americans may not, however, be appropriate for use in Bolivia. Norms developed for Bolivian children may give a better picture of the growth pattern of these children.

Table 30

Percent Frequencies for Weight/Height

by Age and Sex*

Age & Sex	Total individuals	Percent of NCHS 50th percentile < 60	60 - 79	80 - 89	90 - 110	> 110
<12 months	2	100.0	-	-	-	-
Boys	-	-	-	-	-	-
Girls	2	100.0	-	-	-	-
12-23 months	5	80.0	-	-	20.0	-
Boys	1	100.0	-	-	-	-
Girls	4	75.0	-	-	25.0	-
2-5 years	33	3.0	3.0	6.1	72.7	15.2
Boys	14	-	-	-	92.8	7.2
Girls	19	5.3	5.3	10.5	57.9	21.0
6-12 years	27	18.5	-	3.7	70.4	7.4
Boys	12	16.7	-	-	75.0	8.3
Girls	15	20.0	-	6.7	66.7	6.7
13-18 years	40	-	-	-	92.5	7.5
Boys	20	-	-	-	85.0	15.0
Girls	20	-	-	-	100.0	-

*N = 251

While weight and height indices are the most direct measures of body mass and growth, they do not give indication of the relative sizes of muscle mass and fat in the body. The skeletal muscles can be used as a source of amino acids which may be needed to provide maintenance of vital body protein if the diet is deficient in protein. These amino acids can be mobilized from muscles early in a protein deficiency state and the muscle mass can be reduced in bulk up to two-thirds (Gurney, 1969). A major caloric reserve is subcutaneous fat deposits. In the healthy non-obese adult, up to 90 percent of the subcutaneous fat can be used up without ill effect. The most frequently used measurement of both reserves is the arm circumference. However, the arm circumference will only indicate the total reduction or increase in both reserves.

Measurements of arm muscle sizes are generally used to examine the changes in skeletal muscle, while measurements of the subcutaneous fat are suitable for studying the changes in body fat deposits. The triceps skinfold is the most frequently used measurement for determining subcutaneous fat.

Only two of the girls under two years of age had normal arm circumference for age measurements, while the rest of the children in this age group had below the 90 percent of the standard (Table 31). Approximately 52 percent of the children 2 to 5 years were around the 100 percent of the standard, while 43 percent of the boys and 32 percent of the girls were between 80 and 90 percent of the standard. Twenty-one percent of the girls were between 60 and 80 percent of the standard.

Table 31

Percent Frequencies for Arm Circumference/Age

by Age and Sex*

Age & sex	Total Individuals	Percent of Frisancho 50th percentile < 60	60 - 79	80 - 89	90 - 110	> 110
<12 months	2	-	-	100.0	-	-
Boys	-	-	-	-	-	-
Girls	2	-	-	100.0	-	-
12-23 months	5	-	20.0	40.0	40.0	-
Boys	1	-	-	100.0	-	-
Girls	4	-	25.0	25.0	50.0	-
2-5 years	33	-	12.1	36.4	51.5	-
Boys	14	-	-	42.9	57.1	-
Girls	19	-	21.1	31.6	47.3	-
6-12 years	27	-	-	3.7	70.4	25.9
Boys	12	-	-	-	91.7	8.3
Girls	15	-	-	6.7	53.3	40.0
13-18 years	40	-	-	-	-	100.0
Boys	20	-	-	-	-	100.0
Girls	20	-	-	-	-	100.0
>18 years	144	0.7	-	-	0.7	98.6
Male	63	1.7	-	-	-	98.3
Female	81	-	-	-	1.2	98.8

*N = 251

Only about 7 percent of the girls aged 6 to 12 were below 90 percent of the standard. Almost all the boys of this age group were around 100 percent of the standard with the exception of 8 percent who were over the 110 percent of the standard. The girls, on the other hand, showed a greater percentage over 110 percent level, while 53 percent of them were in the normal range. None of the children in the age group 13 to 18 years were below 110 percent of the standard. Furthermore, approximately 99 percent of the individuals over 18 years of age were over 110 percent of the standard. Only one male of this age group was below 60 percent of the standard, and one female was in the 90 to 110 range.

Table 32 shows the distribution of the individuals for the triceps skinfold for age index. The indices of all children under two years of age were below 90 percent of the standard, and two of the girls had indices below 60 percent of the standard. Of the age group 2 to 5 years, 72 percent of the boys had index values over 110 percent level, while only 5 percent of the girls had indices above that level. The indices of approximately 47 percent of the girls were in the normal range, while the indices of only 7 percent of the boys were in that range. About 14 percent of the boys and 26 percent of the girls had indices in the range of 80 to 90 percent of the standard, and 15 percent of children in this age group had indices below the 80 percent level.

Table 32

Percent Frequencies for Triceps Skinfold/Age

by Age and Sex*

Age & sex	Total Individuals	< 60	60 - 79	80 - 89	90 - 110	> 110
		Percent of Frisancho 50th percentile				
<12 months	2	50.0	50.0	-	-	-
Boys	-	-	-	-	-	-
Girls	2	50.0	50.0	-	-	-
12-23 months	5	-	20.0	80.0	-	-
Boys	1	-	-	100.0	-	-
Girls	4	-	25.0	75.0	-	-
2-5 years	33	3.0	12.1	21.2	30.3	33.3
Boys	14	-	7.1	14.3	7.1	71.5
Girls	19	5.3	15.9	26.3	47.2	5.3
6-12 years	27	14.8	33.3	11.1	22.2	18.5
Boys	12	-	25.0	25.0	25.0	25.0
Girls	15	26.7	40.0	-	20.0	13.3
13-18 years	40	2.5	20.0	7.5	10.0	60.0
Boys	20	5.0	35.0	15.0	5.0	40.0
Girls	20	-	5.0	-	15.0	80.0
>18 years	144	4.9	9.0	7.6	11.8	66.7
Male	63	11.1	19.0	12.7	11.1	46.0
Female	81	-	1.2	3.7	12.3	82.7

*N = 251

The indices of the boys in the age group 6 to 12 years were equally distributed among four levels of the standard, over 110 percent, 90 to 110 percent, 80 to 90 percent, and 60 to 80 percent. The girls, however, showed a different pattern with 13 percent being above the 110 percent level, 20 percent being within the normal range, 40 percent in the range of 60 to 80 percent, and 27 percent being below that level. On the average, about 60 percent of the children of both sexes were below the 90 percent level.

As age increased over 12 years, the number of females having indices beyond the 110 percent level doubled that of the males. On the average, 80 percent of the females over 12 years of age were over the 110 percent level. About 35 percent of the males 13 to 18 years and 19 percent of those over 18 years were between 60 and 80 percent of the standard. Also, about 5 percent of the males 13 to 18 years of age and 11 percent of those over 18 were below 60 percent of the standard. None of the females 12 years or older were below the 60 percent level, and only 2 females were in the range 60 to 80 percent of the standard.

Distribution of the arm muscle area for age measurements of the sample are shown in Table 33 and reveal a pattern similar to that of the arm circumference for age. On the average, 80 percent of children under 6 years of age had measurements below 90 percent of the standard. Approximately 99 percent of the children over 13 years, however, had measurements above the 110 percent level. Children under two years of age showed the same pattern by having measurements below the normal range except for one girl who was in the normal range. About 43 percent

Table 33

Percent Frequencies for Arm Muscle Area/Age

by Age and Sex*

Age & sex	Total Individuals	Percent of Frisancho 50th percentile < 60	60 - 79	80 - 89	90 - 110	> 110
<12 months	2	-	50.0	50.0	-	-
Boys	-	-	-	-	-	-
Girls	2	-	50.0	50.0	-	-
12-23 months	5	-	40.0	40.0	20.0	-
Boys	1	-	100.0	-	-	-
Girls	4	-	25.0	50.0	25.0	-
2-5 years	33	9.0	36.4	36.4	18.2	-
Boys	14	-	42.9	42.9	14.2	-
Girls	19	15.8	31.6	31.6	21.0	-
6-12 years	27	-	-	18.5	14.8	66.7
Boys	12	-	-	33.3	25.0	41.7
Girls	15	-	-	6.7	6.7	86.6
13-18 years	40	-	-	-	-	100.0
Boys	20	-	-	-	-	100.0
Girls	20	-	-	-	-	100.0
>18 years	144	0.7	-	-	-	99.3
Male	63	1.6	-	-	-	98.4
Female	81	-	-	-	-	100.0

*N = 251

of the boys ages 2 to 5 years were between 80 from 90 percent and the same number were between 60 and 80 percent of the standard, while 32 percent of the girls were in each of the 60 to 80 percent and 80 to 90 percent range, and 16 percent of them were below the 60 percent level. Only 6.7 percent of the girls aged 6 to 12 were below the 90 percent level, while one-third of the boys of the same age were in the range of 80 to 90 percent. None of the children aged 13 to 18 was below the 110 percent level, while only one male over 18 years of age was below the 60 percent level.

When the classifications of Gomez et al. (1956) were used to identify the degree of malnutrition among the children surveyed, it was found that 9.3 percent of the children of all ages and sex groups had 3rd-degree malnutrition. Approximately 15.9 percent suffered from 2nd-degree malnutrition, and 10.3 percent were classified as 1st-degree malnutrition (Table 34). Of the children under two years of age, 71 percent had 3rd-degree malnutrition, and 29 percent had 2nd-degree malnutrition. Approximately 15 percent of the children 2 to 5 years were in the 3rd-degree class, 46 percent in the 2nd-degree class, and 27 percent in 1st-degree class. Only 12 percent of the children 2 to 5 years old were classified as having a normal nutritional status. Seven percent of children 6 to 12 years of age were mildly malnourished, while children 13 to 18 years of age were of normal nutritional status.

Table 34

Distribution of the Bolivian Children

by the Gomez Classification

Age	Total individuals	Percent frequencies* 3rd Degree	2nd Degree	1st Degree	Normal
< 2 years	7	71.4	28.6	-	-
2 - 5 years	33	15.2	45.5	27.3	12.0
6 - 12 years	27	-	-	7.4	92.6
13 - 18 years	40	-	-	-	100.0
Total	107	9.3	15.9	10.3	64.5

*Percent of total individuals in each age group

When the Waterlow classification (1972) was used to identify degrees of malnutrition, a different pattern was observed (Table 35). Approximately 22 percent of the children demonstrated stunted and wasted growth, regardless of age and sex. Forty-two percent of the sample was identified as stunted growth, and only about one percent had acute malnutrition as characterized by wasting. Almost 86 percent of the children under two years of age were severely malnourished with stunted and wasted growth while the other 14 percent suffered from chronic malnutrition and stunted growth. A greater percentage of children from 2 to 5 years of age were classified as normal than with the Gomez classification, 55 percent of the malnourished children suffered stunted growth while 15 percent suffered stunted and wasted growth. The percentage of children aged 6 to 12 years who were classified as normal was lower than that of the Gomez classification. Forty-eight, 4, and 22 percent of the malnourished children aged 6 to 12 were classified according to their growth pattern as stunted and wasted, wasted, and stunted, respectively, according to the Waterlow criteria. Moreover, 50 percent of the adolescents were classified as stunted in growth pattern.

Results of this study indicated that the Gomez classification was satisfactory for identifying the degree of malnutrition in young children under the age of five. The Waterlow classification, however, appeared to be better for detecting the degree of malnutrition and its effect on the growth pattern in young children and also for identifying the long term effect of malnutrition on the growth pattern of children of all ages at various stages of growth.

Table 35

Distribution of the Bolivian Children

by the Waterlow Classification

Age	Total individuals	Percent frequencies* Stunted & wasted	Wasted	Stunted	Normal
< 2 years	7	85.7	-	14.3	-
2 - 5 years	33	15.2	-	54.5	30.3
6 - 12 years	27	48.2	3.7	22.2	25.9
13 - 18 years	40	-	-	50.0	50.0
Total	107	22.4	0.9	42.1	43.6

*Percent of total individuals in each age group

Hemoglobin and Hematocrit Evaluation

Hemoglobin and hematocrit average values seemed to be normal except for the girls aged 12 to 23 months whose average levels of hemoglobin and hematocrit were low (Table 36). However, when the WHO criteria (1968) were applied to individual values of hemoglobin and hematocrit, anemia existed in 18.7 percent of the total sample according to the hemoglobin levels and in 36.6 percent according to the hematocrit levels (Table 37). Approximately 20 percent of children under 7 years of age and individuals over 15 years of age were anemic according to their hemoglobin levels. Hematocrit values indicated that only 7 percent of the children under 7 years, and 53 percent of persons over 15 years were anemic. Hematocrit values for children 7 to 15 years of age were normal, but their corresponding hemoglobin values indicated that 7 percent of them were anemic. A greater percentage of females than males of all ages were classified as anemic by both indicators. Hematocrit levels below the standards seemed to exist only in females. Low hemoglobin values, however, were found in both the male and the female populations of all ages. According to hematocrit levels, 96.7 percent of the females over the age of 15 were anemic, while low hemoglobin levels existed in only 22.8 percent of them. On the other hand, low hemoglobin values were detected in 20 percent of the girls under 7 years, while 12 percent had low hematocrit levels.

Table 36

Average Hemoglobin and Hematocrit

by Age and Sex

Age	Total* individuals	Hemoglobin Male	Hemoglobin Female	Hematocrit Male	Hematocrit Female
<12 months	2	-	6.6 ± 9.1	-	21.5 ± 30.4
12-23 months	5	13.0 ± 0.0	10.0 ± 6.6	39.0 ± 0.0	30.24 ± 20.2
2-3 years	17	13.3 ± 1.3	13.1 ± 0.9	38.7 ± 3.3	37.9 ± 1.9
4-6 years	18	13.9 ± 1.1	13.6 ± 1.3	39.3 ± 2.3	39.6 ± 3.9
7-9 years	11	14.6 ± 0.9	14.3 ± 0.8	40.8 ± 2.8	41.5 ± 2.1
10-12 years	14	15.3 ± 0.8	15.2 ± 1.2	41.7 ± 2.0	43.3 ± 2.6
13-15 years	17	15.4 ± 1.1	15.6 ± 1.0	45.2 ± 2.7	44.8 ± 2.2
16-19 years	26	15.1 ± 0.9	14.7 ± 1.0	44.3 ± 3.3	43.1 ± 3.1
20-50 years	109	16.5 ± 1.4	15.2 ± 1.4	48.2 ± 4.0	44.0 ± 2.9
>50 years	32	16.7 ± 1.3	15.4 ± 1.4	48.9 ± 3.4	44.9 ± 4.0

*N = 251

Table 37

Prevalence of Anemia Among the

Bolivians by Age and Sex

Age	Total individuals	Hemoglobin Deficient	Hemoglobin Acceptable	Hematocrit Deficient	Hematocrit Acceptable
< 7 years	42	19.0*	81.0	7.1	92.9
Boys	17	17.6	82.4	-	100.0
Girls	25	20.0	80.0	12.0	88.0
7 - 15 years	42	7.1	92.9	-	100.0
Boys	18	5.6	94.4	-	100.0
Girls	24	8.3	91.7	-	100.0
> 15 years	167	21.6	78.4	53.3	46.7
Males	75	20.0	80.0	-	100.0
Females	92	22.8	77.1	96.7	3.3
Total	251	18.7	81.3	36.6	63.4

*Each value is a percentage of total number of individuals in each age and sex group

The Partial Correlation Study

The simple correlation coefficients between daily intake of iron, hemoglobin, and daily energy intake are presented in Table 38. There was no significant correlation between daily intake of iron and hemoglobin level. There was a significant negative correlation ($p \leq .05$) between daily intake of iron and daily intake of energy, suggesting that the dietary level of iron tended to decrease as the energy content of the diet increased. The correlation between daily intake of energy and hemoglobin level was not significant.

Table 38

Zero Order Partials of Daily Iron, Hemoglobin, and Daily Energy

	Daily iron	Hemoglobin	Daily energy
Daily iron	1.000	-.0054	-0.1316
		P = 0.466	P = 0.018
Hemoglobin		1.000	0.0289
			P = 0.323

When the partial correlation between daily iron intake and hemoglobin level holding constant energy intake was computed, it yielded a correlation coefficient of -0.0016 which was not significant. These results indicated that hemoglobin levels were not functions of daily iron intake.

The zero order partials for daily iron intake, hematocrit level, and daily energy intake revealed a nonsignificant correlation between daily iron intake and hematocrit level (Table 39). A highly significant correlation ($P \leq .01$), however, between hematocrit level and daily energy intake was observed. When the daily energy intake was held constant the partial correlation coefficient between daily iron intake and hematocrit level was 0.488, a significant correlation ($P \leq 0.05$). These results indicated that hematocrit levels were functions of daily iron intake rather than total daily energy intake.

Table 39

Zero Order Partials of Daily Iron,

Hematocrit, and Daily Energy

	Daily iron	Hematocrit	Daily energy
Daily iron	1.000	0.0807	-0.1316
		P = 0.100	P = 0.018
Hematocrit		1.000	0.2489
			P = 0.000

Multiple Regression Study

The multiple regression technique was used to study the effect of sex, age, household size, place of residence, and years of education on the overall nutritional adequacy of diets of Bolivians surveyed as indicated by the nutrient sum index. The multiple correlation coefficient was 0.168 with a coefficient of determination of 0.028. Interpretation of the data suggest that the five demographic variables accounted for only 2.8 percent of the variability in nutritional adequacy of the diets. The amount of variability in the nutritional adequacy of the Bolivians' diets explained by the five demographic variables, while small, was highly significant ($P \leq 0.01$).

Multiple regression analysis revealed that both age and household size had significant effects on the nutritional adequacy of the diets (Table 40). Both variables were positively correlated with the overall nutritional adequacy of the diet.

Table 40

Estimated Regression Coefficients and F Values

For Selected Demographic Variables

And Nutrient Sum Index

Variable	Regression coefficient	F
Sex		
Males	0.135	0.500
Females	omitted	
Age	0.118	6.890*
Household size	0.205	13.709*
Place of residence		
Dispersed centers	omitted	
Populated centers	-0.224	1.043
Urban centers	0.181	0.461
Years of education	-0.924	0.108

$R^2 = 0.028$

$F = 3.331$*

*Significant at $P \leq 0.01$

CHAPTER V

DISCUSSION

Protein-Energy Nutriture

Comparison of the results of the present study and those of the Us Department of Defense (1964) with regard to protein-energy nutriture indicated that the proportion of individuals with inadequate intake of protein and energy found in this study was considerably larger than that of the 1964 study. Moreover, the range of intake from both substances extended below 33 percent of the standards. In the 1964 study the range of intake of energy was between 83 and 88 percent of the standard, and protein intake on the average was adequate. These differences in results may be due to differences in the characteristics of the populations studied. While the present study was concerned primarily with a rural population, the population studied in 1964 represented mainly the urban population of the largest cities in Bolivia.

The protein energy intake pattern of the Bolivians, however, was merely a reflection of the pattern that exists in the developing countries in general. While protein intake was not severely restricted, the total caloric intake was severely deficient, especially in the groups whose need for protein and caloric materials are high. Waterlow and Payne (1975) reported that young children from Ghana, Guatemala, Jamaica, Polynesia, and Uganda had adequate protein intake but intake of energy were less than 75 percent of FAO/WHO recommended daily intake. Horner et al. (1977), reported that protein and caloric intake of

Nicaraguan children was low, but energy deprivation was severe. Plail & Young (1977) also reported that diets of Chilean children were not severely deficient in protein. However, it was observed that small quantities of food were consumed. These results were similar to studies which showed that rural Nigerian diets were found to be adequate in protein and low in total calories (Uyanga, 1979). Sadasivam et al. (1980) reported that over 50 percent of rural Indian families had adequate protein intake, and only 16 percent of those surveyed had adequate energy intakes.

Although the protein intake of the Bolivians was not severely deficient, most of the protein consumed came from vegetable sources, a finding which is typical in countries such as Chile, El Salvador, the Middle East, Nepal, Puerto Rico, and Tanzania (Brown et al., 1968; McLaren & Pellet, 1970; Fernadez et al., 1972; Kreysler & Mndeme, 1973; Horner et al., 1977; Plail & Young, 1977; and Valverde et al., 1980). Typical plant protein sources utilized in these countries include bread, rice, beans, pasta, sugar, vegetables, fruits, potatoes, red kidney beans, bananas, cassava, plantains, breadfruits (vegetables), cocoyam (root vegetable), and wheat tortillas.

Many of these vegetable proteins are limited in one or more essential amino acids. If any of these amino acids is present in a less than adequate amount, the utilization of the food is limited to the extent to which the amino acid is limited in a particular foodstuff.

The amount of protein that will be required from this foodstuff will be greater than protein from animal sources in order to satisfy individual needs.

Much of the protein ingested by the Bolivians was of poor quality, and the most limited amino acids were found to be methionine and cystine. According to McLaren & Pellet (1970), proteins consumed by populations in the Middle East were deficient in the sulfur containing amino acids rather than in lysine even though cereals constituted a major portion of the diets. Pike & Brown (1975) stated that the most limited amino acids in the developing countries were usually methionine and cystine, phenylalanine and tyrosine, and lysine. Oke (1975) stated that in most developing countries where grain, legumes and roots represent the staple foods, the quantity of protein consumed was adequate but was generally deficient in the sulfur-containing amino acids.

Although the deficiency in any of the essential amino acids will reduce the quality of the protein, reports have suggested that individuals can adapt to some degree to amino acid deficiencies by decreasing the rates of catabolism of the deficient amino acids and conserving them for reutilization (Said & Hegsted, 1970, Hegsted, 1974). Waterlow (1975), however, pointed out that such adaptation mechanisms can not operate if there is a deficit in energy intake.

Thus, it can be concluded from the protein and energy intake patterns of the Bolivians and the quality of the protein ingested that protein-energy malnutrition posed a problem especially among children and adolescents. The problem was due in large to a deficit in total energy intake and the ingestion of low quality protein rather than a deficit in the total quantity of the protein.

However, the degree and severity of the protein-energy malnutrition cannot be projected from the dietary intakes alone because of the wide variability of individual requirements, the varied ability of the individual to adapt to various levels of intakes, and the inherent problems in methods of collecting and analyzing dietary data. Most investigations of the nutritional status of populations, therefore include additional criteria such as clinical, biochemical, and anthropometric evaluations.

Although clinical examination of an individual was one of the earliest means used to evaluate nutritional status, it is one of the most subjective areas in the determination of nutritional status (Miller, 1979). Some examiners often detect or assume deficiency symptoms that others may overlook or not recognize as symptoms. Marginal deficiencies are particularly difficult to recognize and evaluate with some of the clinical methods.

Biochemical analyses in dietary surveys are generally limited to blood and urine tests. Serum total proteins and albumin, and urinary urea, creatinine, and hydroxyproline are measurements used in nutritional studies in developing countries. However, collection of urine samples presents a problem, and 24-hour samples are rarely obtained. In addition, sensitivity of the measurements used and the ability to detect changes in cases of marginal deficiencies is questionable (Pike and Brown, 1975). Delpeuch et al., (1980) indicated that a hydroxyproline index, transferrin concentration, albumin/globulin ratio, and prealbumin concentration were satisfactory biochemical parameters for detecting marginal protein-energy malnutrition. Difficulties are encountered, however, in choosing appropriate standards to be used for comparative purposes, particularly if such standards have not been established for a country under study.

Anthropometric information is generally thought to be the most definitive indicator of nutritional status. In developing countries anthropometry has been reported to be the principal means used to assess nutritional status (Whitehead et al., 1976). Miller (1979) stated that simple measurements of height, weight, and skinfold thickness were by far the most cost-objective methods for identifying both under- and over-nutrition. Anthropometry is widely used for assessment of protein-energy malnutrition in humans since growth inhibition generally is a characteristic of the deficiency state. Keller et al. (1976), however, pointed out that genetic and disease factors that are not yet quantifiable may influence growth.

Procedures for appropriate measurements in nutritional anthropometry are fairly standard with various research laboratories. Problems are generally encountered in determining which measurements and age groups are appropriate and in the interpretation of the collected data. Although the relative importance of the various anthropometric measurements have been examined by many investigators, there is no agreement that one parameter is better than another in evaluating nutritional status of the populations. Rao (1970) indicated that weight, weight/height, and calf circumference were highly correlated with protein-energy malnutrition. Whitehead et al. (1976) reported that weight/age gave the better information about protein-energy malnutrition. Trowbridge (1979), however, stated that weight/age did not distinguish between acute and chronic malnutrition. Some investigators have reported good correlations between weight/height and weight/age in identifying protein-energy malnutrition in children while others have reported that protein intake was highly correlated with height/age and caloric intake correlated best with weight/age (Anderson, 1979; Graham et al., 1981). Cole et al. (1981) suggested that the weight/height index was slightly biased because it did not take into account age. They also indicated that children of the same height weighed more the older they got and further suggested that weight-/height/age was a better indicator of protein-energy malnutrition than weight/height.

Frisancho (1974) suggested that measurements of subcutaneous fat in populations characterized by a low degree of fatness may not be a sensitive indicator of nutritional status. He believed that arm muscle size served as an adequate general index of nutritional status and growth. Talwar (1975) reported that weight and height/age were appropriate measurements for children, while weight, height, arm circumference and skinfold thickness were appropriate for adult women. Roche et al. (1981) suggested that the triceps skinfold was the best indicator for total body fat in children and women, and weight/height was the best indicator for body fat in girls and adults. In men, weight/height was the best indicator for percentage body fat, while the subscapular skinfold was the best indicator for total body fat in boys.

In general, there appears to be no single parameter of anthropometric measurements that is superior or the best to use. However, there is an agreement between various investigators that anthropometry serves as a direct, simple, and indicative means of evaluating nutritional status of populations. This study, therefore, included an evaluation of the various anthropometric measurements taken on the Bolivians studied in the survey.

Evaluation of weight/age indicated that 3rd-degree, protein-energy malnutrition was found in 9.3 percent of the children under 18 years of age. Second-degree malnutrition was noted in 15.9 percent, and 10.3 percent of the children suffered from 1st-degree malnutrition. The pattern of the degree of weight deficit found in the Bolivians was similar to that of most of the developing countries. Trowbridge (1974) stated that 72.7 percent of the children from rural El Salvador had 3rd degree malnutrition. Kreysler & Mndeme (1975) reported that severe protein-energy deficiency of the 3rd degree was found in 9 percent of the Tanzanian children. Thirty-nine percent of the children examined in Nicaragua showed 1st- or 2nd-degree malnutrition (Horner et al., 1977). Plail & Young (1977) indicated that 41.5 percent, 11.4 percent, and 1.0 percent of the children surveyed in Chile had 3rd-, 2nd-, and 1st-degree malnutrition, respectively. Ferro-Luzzi et al. (1978) found 3rd-, 2nd-, and 1st-degree protein-energy malnutrition in 5, 62, and 27 percent, respectively, in Guinean children. Anderson (1979) compared weights for ages of children from Colombia, Costa Rica, the Dominican Republic, India, and Pakistan, and found that 11.5 percent, 9 percent, 10.6 percent, 55.1 percent, and 34.1 percent of the children from these countries, respectively, had less than 75 percent of the standard weight/age. An examination of Jamaican children revealed that 44.5 percent, 6.7 percent, and 2.5 percent of the children had 1st-, 2nd-, and 3rd-degree malnutrition, respectively (Marchione & Prior, 1980).

It is apparent from the results of the various studies that there were differences, as well as similarities, in the estimated proportions of children with the various degrees of malnutrition. These differences may be due to differences in the prevalence of protein-energy malnutrition among the population studied or may be due to the problems inherent in the weight/age indices. The weight/age index had two major disadvantages. First, edema may partly compensate for deficit weight in severely malnourished children, and children may not be classified as severely malnourished. A second disadvantage is that differences in heights may exist between a population surveyed and the reference population. The population studied may be of smaller size, and since weight/age does not take into consideration the height of the children, undernutrition may be overestimated (Keller, 1976).

Therefore, a second criterion based on height/age and weight/height was used in this study to evaluate the degree of malnutrition among the Bolivians. Recommended by the WHO, this is known as the Waterlow criterion. The Waterlow criterion has the advantage of measuring the degree of thinness that is weight for height and the growth performance which is the height for age. The Waterlow criterion eliminates the influence of height when comparing weight with a reference standard and takes into account the age of the population studied.

Results of the anthropometric measurements of the Bolivians by the Waterlow criterion indicated that 22.4 percent of the population were classified as wasted and stunted, while 42.1 percent were classified as stunted. Only 0.9 percent were classified as wasted. Results from a study by Ferro-Luzzi et al. (1977) in Guinea indicated that 46 percent of the children under 14 years of age were stunted while less than 2 percent of them suffered wasted growth. Furthermore, the Arab Republic of Egypt nutrition status survey (1978) revealed that 21.2 percent of preschool children suffered from long-term stunted growth. Acute undernutrition, manifested by wasting, prevailed in 0.6 percent of the children. Anderson (1979) classified the growth of children under 5 years of age from Colombia, Costa Rica, Dominican Republic, India, and Pakistan using Waterlow classification. It was found that 28.9 percent of Colombian children were stunted and 0.5 percent were wasted; of the Costa Rican children 9.6 percent were stunted and 3.6 percent were wasted; of the children from the Dominican Republic 18.8 percent were stunted and 1.6 percent were wasted; in India 47.6 percent of the children were stunted and 15.1 percent were wasted; and 29.7 percent of Pakistanian children suffered stunted growth while 8.2 had wasted growth. Trowbridge (1979) reported that 37.8 percent of children under 7 years of age from El Salvador were wasted, while 51.8 percent were stunted and 11.1 percent were wasted and stunted. The degree and severity of protein malnutrition that exists in the Bolivians studied were similar to those of most developing countries where a large proportion of the children of various age groups suffer from long-term stunted growth characteristic of chronic undernutrition. Acute malnutrition prevails only in a very small proportion of the children, and severe protein-energy malnutrition reflected in stunted and wasted growth may or may not exist in a population. In this study, severe protein-energy malnutrition resulting from deficits in energy and protein quality existed in 22.4 percent of the Bolivians, while 42.1 percent of individuals examined suffered from chronic protein-energy malnutrition. The age groups at risk were children under 2 years of age, school-age children, and preschool children, respectively.

Vitamin Deficiencies

About 70 percent of the Bolivians studied had inadequate intake of vitamin A, and approximately 40 percent had low intake of thiamin, riboflavin, and niacin. Inadequate vitamin C intake were found in about 20 percent of the Bolivians.

In the USDOD study in Bolivia (1964) vitamin A intake ranged from 35 percent to 80 percent of the USRDA and thiamin intake was also below the standards (48 to 88 percent). Riboflavin intake was the most deficient of all nutrients studied, and niacin intake was slightly below the RDA, between 69 to 94 percent of the standards. Vitamin C intake, however, was well above the USRDA. These patterns, with the exception of vitamin C intake were similar to those observed in this study. The difference in the vitamin C pattern may have been due to the difference in the composition of the sample in the two studies. The sample of this study was mostly rural, while the sample of the 1964 study was predominately urban. Food sources of vitamin C may have been more available to urban populations than to those in rural areas.

Low intake of vitamin A is not only limited to the developing countries, but is also found in the developed countries. Reports from various countries around the world indicated low intake of vitamin A in various groups of the population (Brown et al. 1968; Varela, 1971; Fernadez et al. 1972; USDHEW, 1972; Sabry et al., 1974; Guzman et al., 1976; Horner et al., 1977; Uyanga, 1979; Tavakoli & Zafar-Ali, 1980).

Low dietary intake of riboflavin has been noted in several countries including Egypt, India, Nepal, Nigeria, the Philippines, Puerto Rico, and Spain (Brown et al., 1968; Varela, 1971; Fernadez et al., 1972; Guzman, 1976; ARE, 1978; Uyanga, 1979; Tavakoli & Zafar-Ali, 1980). Based on these reports, one could conclude that riboflavin deficiency is rather a universal problem.

Inadequate intake of thiamin and niacin by populations has not generally been observed worldwide; however, Fernadez et al. (1972) reported thiamin and niacin deficiencies in 7 percent of the urban families in Puerto Rico. A moderate thiamin deficiency was observed in 30 percent of the adult males and 12 percent of the adult females in Canada (Sabry et al., 1974). Thiamin deficiency was also found in the Philippines where rice or corn was the staple (Guzman et al., 1976). In addition, there was biochemical evidence of thiamin deficiency in young Ghanian children (Neumann et al., 1979). Also, Sadasivam et al. (1980) found thiamin deficiency among the rural population in India.

Vitamin C deficiency was reported in several areas of the world where consumption of fresh fruits and vegetables was low (Brown et al., 1968; Fernadez et al., 1972; Ferber, 1973; Hejda & Masek, 1973; Guzman et al., 1976; Freedman, 1978). Low intake of vitamin C, however, appears to be related to those seasons of the year when fresh sources of vitamin C are limited.

In addition to the diets consumed by many Bolivians being deficient in various vitamins, there is the possibility that the absorption of low dietary levels of vitamins may be less. Foods most frequently consumed by the Bolivians suggest that the main sources of these vitamins are plant foods. Marks (1975) pointed out that riboflavin from vegetable sources was poorly absorbed. Absorption of plant precursors of vitamin A was less than 60 percent of the intake (Olsen, 1975).

Low niacin intake may not be a serious problem since the human body is able to synthesize niacin from tryptophan (Pike & Brown, 1975). Considering that protein intakes of the Bolivians were not severely impaired and tryptophan was not a limiting amino acid in most Bolivian diets, the nutritional adequacy of niacin may have been underestimated.

Mineral Deficiencies

Inadequate intake of calcium was found in over 60 percent of the Bolivians. More than 40 percent of the sample had intake below one-third of the FAO standard. The calcium consumption of the Bolivians (USDOD, 1964) was far below the standards for all population groups in the three altitude zones. Reports from several investigations indicated low intake of calcium in various areas of the world. In Nepal, Brown et al. (1968) stated that calcium intake was uniformly low among the Nepalese from various geographical locations. Low intake of calcium was also found among the Yugoslavians (Ferber, 1973). Sabry et al. (1974) found a shortage of calcium in Canadian infants, children, and adolescents. In the Netherlands, 13 percent of school age children had a low intake of calcium (Hartog, 1975); low intake of calcium was common among the communities where sweet potatoes and coconuts were the staple foods in the Philippines (Guzman, 1976). About 37 percent of the Nicaraguan children had low intake of calcium (Horner et al., 1977), and 20.5 percent of the population of Peking, China showed mild signs of rickets (Freedman, 1978). Low intake of calcium was also reported in Nigerians (Uyanga, 1979).

Evaluation of calcium status among a population cannot be determined solely from calcium intake, because of the effect of other factors in the diet on calcium bioavailability. Calcium absorption can vary from 15 percent to 35 percent of intake in individuals under normal conditions (Pike & Brown, 1975). Several studies have also shown that fiber impairs calcium absorption. Kelsay et al. (1979) observed that adding fruits and vegetables to a normal diet caused calcium balance to fall from +72 to -122 mg/day, even though there was an increase in calcium intake from 1070 to 1166 mg/day. Salvin and Marlett (1980) measured the effect of adding 16 g of refined cellulose, an amount normally found in 200 g bran or 600 g whole meal flour, to bread on calcium balance. The average calcium balance dropped from -16 to -199 mg/day on the average, and it was indicated that the drop in calcium balance may be due to the hemicellulose fraction and not to cellulose per se. James et al. (1978) pointed out that uronic acid found in the noncellulosic fraction of the fiber was a major factor in binding of calcium to fiber, thus decreasing its absorption. According to Allen (1982) fiber and uronic acid content may be 50 to 150 g and 30 to 110 mmol, respectively, in high fiber diets similar to those consumed in developing countries. Most of the calcium in such diets may be bound and unavailable. However, over 80 percent of dietary uronic acid is fermented in the human intestine, and calcium is released and becomes available for absorption.

From the previous discussion and examination of the Bolivians' average intake of fiber, their low intake of calcium may be further reduced up to 20 percent by the relatively high intake of fiber. Such low calcium intake, however, may not be indicative of a calcium deficiency. Pike and Brown (1975) pointed out that there was no conclusive evidence that low calcium intake significantly reduces growth rate or results in altered structure or composition of bone. The authors indicated that this may be due to the ability of the humans to adapt to low intake of calcium or to the great individual variation in calcium balance. Anand & Linkswiler (1974) reported increases in calcium retention of adult males when the diets were low in both protein and calcium. As the protein in the diet increased, calcium retention decreased.

Inadequate intakes of iron were found among 20 percent of the Bolivians, and hemoglobin levels below the WHO standards existed in 18.7 percent of them. Hematocrit levels below the WHO standards, however, were detected in 36.6 percent of all the Bolivians. A similar pattern was found in Puerto Rico (Fernadez et al., 1972) where only 7.2 percent of the population studied had low hemoglobin values and 14 percent had low hematocrit values.

The proportion with low hemoglobin values found among the Bolivians in the present study was lower than that of the USDOD study (1964), while the proportion of those with low hematocrit values was higher. In the 1964 study, 44.3 percent had low hemoglobin values, and 23.9 percent had low hematocrit values. However, iron intake was adequate for the three altitude groups. Therefore, anemia was attributed to either unavailability of iron ingested or to other factors that may contribute to the development of anemia. Differences between the results obtained by the hematological analysis of the present study and those that were obtained in 1964 may be due to differences in the techniques used in estimating both hemoglobin and hematocrit levels.

Nevertheless, the anemia, as indicated by the proportion of individuals with hemoglobin values below the WHO standards, was as prevalent as in other countries. In Canada, Sabry et al. (1974) stated that over 33 percent of the infants and toddlers, about 25 percent of the children 5 to 9 years, and 30 percent of adolescents and adult females were anemic. Horner et al. (1977) found that approximately 36 percent of the children under 5 years of age had hemoglobin values below the standards. Also, 46.1 percent of Chilean children under 5 years of age were reported to be anemic (Plail & Young, 1977). Approximately 30 percent of Egyptian preschool-age children were estimated to have low hemoglobin levels (ARE, 1978).

The prevalence of anemia was even greater in Guyana where 50 percent of the population were found to have low hemoglobin levels (Johnson et al., 1982). Moreover, 69.1 percent of preschool-age children in Jamaica were reported to be anemic (Simmons et al., 1982).

The main hemopoietic nutrients are iron, folate, and vitamin B12. Although there is experimental evidence that some trace elements and other vitamins are necessary for hemopoiesis, anemia due to deficiencies of these nutrients are presumed to be so rare that, from the public health point of view, they may be ignored (Baker & DeMaeyer, 1979). Vilter (1975) indicated that protein deficiency may contribute to the anemia of the children with protein-energy malnutrition. It has not yet been demonstrated that less severe forms of protein deficiency will result in anemia in humans (Baker & DeMaeyer, 1979). Cook & Finch (1979) reported that iron deficiency was identified in most nutritional surveys as the major cause of anemia. However, in the developing countries, other factors such as folate deficiency and chronic infections may cause or enhance anemia. Vilter (1975) stated that multiple deficiencies which are often found in populations of developing countries complicate any hematological study and may explain the great variations in hematological results.

Because this study was limited only to evaluation of iron intake and hemoglobin and hematocrit levels in the blood, a definite conclusion about iron intake and the prevalence of anemia could not be reached. There is the posibility that low iron intake may have contributed significantly to the prevalence of anemia in the Bolivians studied.

Relation between Dietary Iron and Energy and Hematological Status

The hematological evaluation of the Bolivians revealed the existence of anemia among a significant proportion of the population. The relationship between state of anemia and intake of iron was not clear; further investigation of the correlation between iron intake and hemoglobin and hematocrit levels was undertaken.

Vilter (1975) reported that protein-energy malnutrition often masked the deficiency of other nutrients and complicated the interpretations of hematological analyses. In addition, Baker and DeMaeyer (1979) indicated that moderate deficiency of protein has not yet been proven to be associated with anemia in man. Burroughs and Huenemann (1970) suggested that low blood levels of hemoglobin and hematocrit were associated with low intake of energy in children with protein-energy malnutrition.

The zero-order correlation coefficients between daily intake of iron, daily intake of energy, and hemoglobin level showed that both daily intake of iron and energy were significantly correlated ($P \leq 0.05$). These correlations, however, were negative suggesting that there was a decrease in iron intake as the energy intake increased in the diet. This may be due to the fact that food sources rich in energy are generally poor in iron content. There was no significant relationship between iron intake and hemoglobin levels even when control of energy intake was maintained.

Similar results were found by Pearson et al. (1967), who suggested that the apparent noncorrelation between iron intake and hemoglobin may be due to the different chronologies in the sequence of the development of nutritional deficiency signs associated with the biochemical lesions. Crumine and Fryer (1970) studying blood components and dietary intake of preschool children found no relationship between iron intakes and hemoglobin concentration. Johnson et al. (1982), however, found significant correlations between iron deficiencies in the diets of the population in Guyana and hemoglobin levels. These differences in the results of the various studies may be due to the varied degree of severity in dietary iron deficiency or the lack of sensitivity of the hemoglobin index as a measure of iron deficiency anemia. Graitcer et al. (1981) stated that using only hemoglobin tests to detect iron deficiency resulted in an over-diagnosis of 0.5 to 5 percent and a failure in diagnosis by 25 to 57 percent.

When the partial correlation technique was used to examine the correlations between daily iron intake, daily energy intake, and hematocrit values, a highly significant correlation ($P \leq 0.01$) between daily energy intake and hematocrit value was found, while no significant correlation between iron intake and hematocrit values existed. However, when energy intake was controlled for, a significant correlation ($P \leq 0.05$) between daily iron intake and hematocrit was found.

Plough and Bridgforth (1960) also found no relationship between iron intake and hematocrit level in their study of the relationship between nutritional, clinical, and biochemical measures of nutritional status. Beal (1970) indicated that analysis of the longitudinal data of the subjects studied in the Research Council research showed no clear relationship between dietary intakes of iron and levels of hematocrit.

The significant correlation ($P \leq 0.05$) found between daily iron intake and hematocrit values when energy intake was held constant suggested that hematocrit levels were a function of daily iron intake. This was supported by the finding of low hematocrit values only in the Bolivian females. Furthermore, the results also indicated that energy intake masked the relationship between hematocrit values and iron intakes. This may explain the differences between the results of the present study where partial correlation technique was used and the results of other studies where Pearson's correlation technique was used.

Regression Analysis

The results of the regression analysis suggested that sex had no significant effect on the overall nutritional quality of the Bolivian diets as indicated by the nutritional sum index (NS). However, Hass (1980) reported that males born and raised in the high altitude zones of Bolivia were significantly smaller and slower in growth than the females. Beall et al. (1977) also found that the growth of male adolescents was slower than that of the females in the high altitude areas of Peru. Thus, sex may not be related to the nutritional quality of the diet, but may have an effect on the growth patterns of the children living in high altitude zones of Latin America.

Age, on the other hand, had a positive and highly significant effect ($P \leq 0.05$) on the nutritional quality of the diet indicating an increase in nutritional quality as age increased. Jalso et al. (1965), examining the relationship between age, education, socioeconomic level, and personality rigidity on nutritional practices, also found a significant positive correlation between age and valid nutritional practices. Age, however, was reported to be negatively correlated to nutritional adequacy in other investigations (Young et al., 1956; Abdel-Ghany, 1974).

In the developing countries, nutritional practices are influenced by social beliefs and cultural child-rearing attitudes (Greene and Johnston, 1980), and the picture becomes more complicated by the increased needs of nutrients for growth. Thus, it is conceivable that as people grow older and their needs of nutrients are reduced, diets that were not adequate during the early stages of development may become adequate to support maintenance of the adult system.

Household size was also found to have a highly significant positive effect ($P \leq 0.01$) on the nutritional adequacy of the Bolivian diet. Similar results were found by Abdel-Ghany (1978) in a study of the effects of various socioeconomic factors on the nutritional quality of diets consumed by North Carolinians. Valverde et al., (1980), also concluded that the nutritional quality of the rural populations in El Salvador increased as the household size increased.

The effect of household size on the nutritional quality of the Bolivian diets may be attributed to the economies of family size. In rural areas of the developing countries, an increase in family members generally results in an increase in working capacity and income.

Although place of residence did not have a significant effect on the overall nutritional adequacy of the diet, the regression coefficient for the population in the urban centers indicated a positive difference between dispersed and rural populations. Similar differences were found between rural and urban groups in the United States, India, and Ecuador (Abdel-Ghany, 1974; Rao & Satyanarayana, 1976; & Borsotti, 1978). Abdel-Ghany (1978), however, reported that regression coefficients of urban households of North Carolina were negative and significantly different from those of rural households with regard to the nutritional quality of the diet.

The regression coefficient for the populated centers, however, was negative and indicated a better quality of diet was consumed by individuals in the dispersed population. The differences between the three population groups may have been a reflection of the differences in economic status and variability in available foods.

Years of education did not have a significant effect on the nutritional quality of the Bolivian diets, but there was a negative correlation between the years of education and the adequacy of the diet. Education of the female homemaker in the United States, however, was positively correlated to diet adequacy (Abdel-Ghany, 1974). Likewise, children whose mothers had the highest level of schooling in Lebanon had diets of better quality than those of illiterate mothers (Al-Isi et al., 1975). The authors indicated that the educated mothers had better nutritional knowledge than those who did not attend schools. Moreover, Abdel-Ghany (1978) reported that nutritional knowledge of the homemaker proved to have a significant positive effect on the quality of the diet.

In Zambia, educational attainment of the parents was found to be positively correlated to the nutritional status of their children (Wenlock, 1979). Similar findings were reported by Johnston et al. (1980) in a study of the environmental factors associated with growth pattern in rural Mexicans.

Although years of eduction were reported to be positively correlated to nutritional adequacy of the diets, nutrition knowledge was in fact the underlying explanation of such a relationship and not education level per se. In the developing countries, where the incorporation of nutrition education programs in the school curricula is recent, and where there is a great deal of confusion about valid nutritional practices, education may very well be negatively correlated to nutritional adequacy of the diet.

The effect of the five demographic variables on the nutritional quality of the Bolivian diets as indicated by the nutrient sum index was highly significant ($P \leq 0.01$). Nevertheless, they contributed to a relatively small amount of variability in the nutritional adequacy of the diets.

Implications of the Study

Studies of the nutritional status of the population can provide useful information about existing nutritional problems, and can serve as a basis for nutritional interventions. Evaluation of dietary adequacy, coupled with anthropometry, can elucidate information about certain components of nutritional status, and it is strongly suggested that these measures be utilized in future studies in the developing countries.

Interpretation of dietary data without the support of biochemical analyses, particularly those related to vitamin and mineral deficiencies, is rather difficult. Newly developed microtechniques provide a practical and reliable tool for biochemical evaluations of populations. The use of such techniques would certainly aid in evaluating degrees and severities of nutritional problems in populations under consideration.

Furthermore, the etiology and development of the nutritional problems in a population should be considered in relation to the biological, social, and environmental factors specific to this population. The demographic factors considered in the present study did not provide sufficient information pertaining to those factors that may have an influence on nutritional status of the Bolivians. Therefore, future studies of the nutritional problems existing in Bolivia in relation to other environmental factors are needed.

CHAPTER VI

SUMMARY

The purpose of this study was to evaluate the nutritional status of Bolivians residing in three provinces in the State of Cochabamba. The relationships between various demographic variables and the nutritional status of the Bolivians were also examined.

A project sponsored by the United States Agency for International Development aimed at the promotion of soybeans consumption by the Bolivians provided the source of data for the study. The data included dietary information collected by the 24-hour dietary recall, anthropometric data, values of hemoglobin determinants and hematocrits, and demographic background on the Bolivians sampled in the study. The sample consisted of 117 urban and 593 rural Bolivians.

The dietary adequacy of eight nutrients and energy was evaluated relative to the FAO Recommended Dietary Intake, while the quality of the protein ingested by the Bolivians was evaluated by comparison to the FAO amino acid reference pattern. The anthropometric evaluation utilized the NCHS 50th percentiles for weight and height for age, and the Frisancho 50th percentile for arm measurements for age. The Gomez and Waterlow classifications for protein-energy malnutrition were applied in order to identify the prevalence and severity of protein-energy malnutrition among the Bolivians. The WHO criterion was used in evaluating hemoglobin and hematocrit data, and the partial correlation

technique was used to examine the relationship of dietary iron to both of these blood components. The relationship of five demographic factors to the overall adequacy of Bolivians' diet was examined by the multiple regression technique.

The findings of this study can be summarized as follows:

1. Energy and protein intake were below the 67 percent of the standard in 50 percent, and 17 percent of the Bolivians, respectively.

2. Thiamin and riboflavin intake were below the 67 percent level in one-third of the Bolivians, while more than two-thirds had vitamin A intake below the 67 percent level. Approximately, 44 percent and 20 percent of the Bolivians had intake below the 67 percent of the standard for niacin and ascorbic acid, respectively.

3. Intake below the 67 percent level of iron and calcium were found in 23 percent and 63 percent, respectively, of the Bolivians surveyed.

4. Approximately, 50 percent of the sample had inadequate diets in 4 or more nutrients or energy, while only 6 percent had diets adequate in all eight nutrients and energy considered in the study.

5. The protein ingested was of low quality, and the rate limiting amino acids were methionine and cystine.

6. Based on the Gomez classification, 9.3 percent, 15.9 percent, and 10.3 percent of the population had 3rd-, 2nd-, and 1st-degree malnutrition, respectively. According to the Waterlow classification, 22.9 percent, 0.9 percent, and 42.1 percent were stunted and wasted, wasted, and stunted.

7. Almost 19 percent of the Bolivians had hemoglobin levels and 37 percent had hematocrit levels below the standards used for comparison.

8. There was no significant relationship between daily iron intake and hemoglobin values, but daily iron intake was significantly correlated ($P \leq 0.05$) with hematocrit levels.

9. The age groups identified by the study as risk groups were children under the age of two years, school-age children, and preschool-age children, respectively.

10. Sex, age, household size, place of residence, and years of schooling had highly significant effects ($P \leq 0.01$) on variation in the diet adequacy. The most significant variables were age and household size. However, these five variables contributed to only 2.8 percent of the variation in the adequacy of the diet. Thus, a great deal of the variation in the Bolivians' dietary adequacy is still unexplained.

The above findings suggested the existence of some serious nutritional problems among this group of Bolivians. Further investigations of the ecology and development of such problems are needed.

BIBLIOGRAPHY

Abdel-Ghany, M. Influences of US urban household characteristics on nutritive intakes and quality of food consumption (Doctoral dissertation, University of Missouri at Columbia, 1974). (University Microfilm No. 75-16, 957)

Abdel-Ghany, M. Evaluation of household diets by index of nutrition quality. Journal of Nutrition Education, 1978, 10, 79-81.

Al-Isi, I., Kanawati, A. A., & McLauren, D. S. Formal education of mothers and their nutritional behavior. Journal of Nutrition Education, 1975, 7, 22-24.

Anand, C. R., & Linkswiler, H. Effect of protein intake on calcium balance of young men given 500 mg calcium daily. Journal of Nutrition, 1974, 104, 695-700.

Anderson, M. A. Comparison of anthropometric measures of nutritional status in preschool children in five developing countries. American Journal of Clinical Nutrition, 1979, 32, 2339-2345.

Arab Republic of Egypt, Ministry of Health, Nutrition Institute. Arab Republic of Egypt nutrition status survey. Cairo: ARE Ministry of Health, 1978.

Baker, S. J., & DeMaeyer, E. M. Nutritional anemia: Its understanding and control with special reference to the work of the World Health Organization. American Journal of Clinical Nutrition, 1979, 32, 368-417.

Beal, V. A. & Meyers, A. J. Iron nutriture from infancy to adolescence. American Journal of Public Health, 1970, 60, 666-678.

Beall, C. M., Baker, P. T., Baker, S. T., Hass, J. D. The effects of high altitude on adolescent growth in Southern Peruvian Amerindians. Human Biology, 1977, 49, 109-124.

Black, F. L., Hierholzer, W. J., Black, D. D., Lamm, S. H., & Lucas, L. Nutritional status of Brazilian kayapo Indians. Human Biology, 1977, 49, 139-153.

Branch, W. J., Southgate, D. A. T., & James, W. P. T. Binding of calcium by dietary fibers: Its relationship to unsubstituted uronic acids. Proceedings of the Nutrition Society, 1975, 34, 120A.

Brown, M. L., Worth, R. M. & Shah, N. K. Health survey of Nepal: Diet and nutritional status of the Nepalese people. American Journal of Clinical Nutrition, 1968, 21, 875-881.

Burroughs, A. L., & Huenemann, R. L. Iron deficiency in rural infants and children: Caloric, nutrients, and milk intake. Journal of the American Dietic Association, 1970, 57, 122-128.

Caliendo, M. A. Nutrition and the world crisis. New York: Macmillan, 1979.

Cast, M. M., & Kies, C. Food patterns and physical characteristics of Moroccan and American adolescents. Nutrition Reports International, 1980, 22(6), 915-923.

Christakis, G. Nutritional assessment in health programs. Washington, D.C.: American Public Health Association, Inc., 1973.

Cole, T. J., Donnent, M. L. & Stanfield, J. P. weight for height indices to assess nutritional status: A new index on a slide rule. American Journal of Clinical Nutrition, 1981, 34, 1935-1943.

Cook, J. D., & Finch, C. A. Assessing iron status of a population, American Journal of Clinical Nutrition, 1979, 32, 2115-2119.

Crumine, J. L., & Fryer, B. A. Protein components of blood and dietary intake of preschool children. Journal of the American Dietetic Association, 1970, 57(6), 509-512.

Davidson, S., Passmore, R., Broock, J. F., & Truswell, A. S. Human nutrition and dietetics. New York: Churchill Livingstone, 1975.

Delpeuch, F., Corna, A. & Chevalier, P. H. The effect of moderate protein-energy malnutrition on several biochemical parameters in preschool children. In W. Santos, N. Lopes, J.J. Barbosa, & C. Dagoberto (Eds.), Nutrition and Food Science. New York: Plenum Press, 1980.

Ferber, E. Nutritional conditions in Yugoslavia and their reflection on health. World Review of Nutrition and Dietetics, 1973, 18, 263-274.

Fernadez, N. A., Burgos, J. C., Asenjo, C. F. & Rosa, I. Nutritional status of the Puerto Rican population: Master sample survey. American Journal of Clinical Nutrition, 1972, 24, 952-965.

Ferro-Luzzi, A., Norgan, N. G., & Durnin, J. V. G. A. The nutritional status of some New Guinean children as assessed by anthropometric, biochemical, and other indices. Ecology of Food and Nutrition, 1978, 7, 115-128.

Flores, M. Dietary studies for assessment of the nutritional status of populations in nonmodernized societies. American Journal of Clinical Nutrition, 1962, 11, 344-355.

Freedman, R. L. Review of recently published work dealing with nutrition research in mainland China. World Review of Nutrition and Dietetics, 1978, 30, 1-22.

Frisancho, A. R. Triceps skinfold and upper arm muscle size norms for assessment of nutritional status. American Journal of Clinical Nutrition, 1974, 27, 1052-1058.

Garn, S. M., Larkin, F. A., & Cole, P. The real problem with 1-day records. American Journal of Clinical Nutrition, 1978, 31, 1114-1116.

Gomez, F. R., Ramos, R., Frenk, S., Crafioto, J., Chavez, R., & Vazquez, J. Mortality in second- and third-degree malnutrition. Journal of Tropical Pediatrics, 1956, 2, 77-83.

Gordon, A. M. Nutritional status of Cuban refugees: A field study on the health and nutriture of refugees processed at Opa Locka, Florida. American Journal of Clinical Nutrition, 1982, 35, 582-590.

Graham, G. G., Creed, H. M., Maclean, W. C., Kallman, C. H., Rabold, J., & Millets, E. D. Determinants of growth among children: Nutrient intake - achieved growth relationships. American Journal of Clinical Nutrition, 1981, 34, 539-554.

Graitcer, P. L., Goldsby, J., & Nichaman, M. Z. Hemoglobin and hematocrits: Are they equally sensitive in detecting anemias? American Journal of Clinical Nutrition, 1981, 31, 61-64.

Greene, L. S., & Johnston, F. E. Social and biological predictors of nutritional status, physical growth, and neurological development. New York: Academic Press, 1980.

Gurney, J. D. The arm circumference as a public health index of protein-calorie malnutrition in early childhood. Journal of Tropical Pediatrics, 1969, 15, 225-232.

Guthrie, H. A. Introductory nutrition (2nd ed.). St. Louis, Mo: Mosby Co., 1971.

Guzman, V., Guthrie, H. A., & Guthrie, G. M. Physical and intellectual development in Philippine children fed five different dietary staples. American Journal of CLinical Nutrition, 1976, 29, 1242-1251.

Harper, A. E. Methods for assessing amino acid requirements and the effectiveness of α-keto acid analogs as substitutes for amino acids. American Journal of Clinical Nutrition, 1978, 31, 1678-1687.

Hartog, C. D. Food and nutrition in the Netherlands. World Review of Nutrition and Dietetics, 1975, 22,1-39.

Hass, J. D. Maternal adaptation and fetal growth at high altitudes. In L. S. Greene, & F. S. Johnston (Eds.), Social and biological predictors of nutritional status, physical growth, and neurological development. New York: Academic Press, 1980.

Hass, J. D., Frangillo, E. A., Stepick, C. D., Beard, J. L., & Hurtado, L. G. Altitude, ethnic, and sex difference in birth-weight and length in Bolivia. Human Biology, 1980, 52, 459-477.

Hegsted, D. M. Assessment of protein quality. In National Academy of Sciences, Improvement of protein nutriture. Washington, D.C., USGPO, 1974.

Hejba, S., & Masek, J. Nutritional surveillance in Czechoslovakia. In D. Hollingsworth & M. Russell (Eds.), Nutritional problems in a changing world. New York: John Wiley & Sons, Inc., 1973.

Horner, M. R., Harris, W. S., Brownlee, B. J., Goldstone, R. S., & Taylor, A. K. Anthropometric and dietary study of Miskito Indian children in rural Nicaragua. Ecology of food and nutrition, 1977, 6, 137-146.

Irwin, M. I., & Hegsted, D. M. Amino acid requirements of man. Journal of Nutrition, 1970, 101, 539-566.

Jalso, B., Burns, M., & Rivers, J. Nutritional beliefs and practices. Journal of the American Dietetic Association, 1965, 47, 263-268.

James, W. P. T., Branch W. J., & Southgate, D. A. T. Calcium binding by dietary fiber. Lancet, 1978, 1, 638-639.

Johnson, A. A., Latham, M. C., & Roe, D. A. The prevalence and the etiology of the nutritional anemias in Guyana. American Journal of Clinical Nutrition, 1982, 35 309-318.

Johnston, F. E., Scholl, T. O., Newman, B. C., Cravita, J., & DeLicardie, E. R. An analysis of environmental variables and factors associated with growth failure in a Mexican village. Human Biology, 1980, 52, 627-637.

Keller, W., Donoso, G., & DeMaeyer, E. M. Anthropometry in nutritional surveillance: A review based on results of the WHO collaborative study on nutritional anthropometry. Nutrition Abstract Reviews, 1976, 46, 591-609.

Kelsay, J. L., Behall, K. M., & Prather, E. S. Effect of fiber from fruits and vegetables on metabolic responses of human subjects: II. Calcium, magnesium, iron, & silicon balances. American Journal of Clinical Nutrition, 1979, 32, 1876-1880.

Kerlinger, F. N., & Pedhazur, E. L. Multiple regression in behavioral research. New York: Holt, Rinehart, and Winston, Inc. 1973.

Krehl, W. A., & Hodges, R. E. The interpretation of nutrition survey data. American Journal of Clinical Nutrition, 1965, 17, 191-199.

Kreysler, J., & Mndeme, M. The nutritional status of preschool village children in Tanzania: Observations in Lushoto District. Ecology of Food and Nutrition, 1975, 4, 15-26.

Lee, J., Kolonel, L. N., & Hinds, M. W. Relative merits of weight-corrected-for-height indices. American Journal of Clinical Nutrition, 1981, 13, 2521-2529.

Marks, J. A guide to the vitamins: Their role in health and disease. Baltimore: University Park Press, 1975.

Marr, J. W. Individual dietary surveys: Purposes and methods. World Review of Nutrition and Dietetics, 1971, 13, 105-158.

Marchione, T. J., & Prior, F. W. The dynamics of malnutrition in Jamaica. In L.S. Greene, & F. E. Johnston (Eds.), Social and biological predictors of nutritional status, physical growth, and neurological development. New York: Academic Press, 1980.

McLaren, D. S., & Pellet, P. L. Nutrition in the Middle East. World Review of Nutrition and Dietetics, 1970, 22, 43-127.

Miller, D. S. Prevalence of nutritional problems in the world. Proceedings of the Nutrition Society, 1979, 30, 197-205.

Neumann, C. G., Swendseid, M. E., Jacob, M., Stiehm, E. R., & Dirige, O. U. Biochemical evidence of thiamin deficiency in young Ghanian children. American Journal of Clinical Nutrition, 1979, 32, 99-104.

Oke, O. L. A case for vegetable proteins in developing countries. World Review of Nutrition and dietetics, 23, 259-295, 1975.

Olsen, J. A. Factors affecting the bioavailability and metabolism of vitamin A and its precursors. In W. Santos, N. Lopes, J. J. Barbosa, D. Chaves, & J. C. Valente (Eds.), Nutrition and food science. New York: Plenum Press, 1980.

Ortiz, W., & Borotti, M. Ecologic study of nutritional status of Ecuadorean children. Journal of Pediatric Research, 1978, 12, 1028. (Abstract)

Pearson, H. A., Abrams, I., Fernbach, D. J., Gyland, S. D., & Lahn, D. A. Anemia in preschool children in the United States of America. Journal of Pediatric Research, 1967, 1, 169-172.

Pekkarinen, M. Methodology in the collection of food consumption data. World Review of Nutrition and Dietetic, 1970, 12, 145-170.

Pike, R. L., & Brown, M. L. Nutrition: An integrated approach. New York: John Wiley and Sons, Inc., 1975.

Plail, R. O., & Young, J. M. S. A nutritional, hematological and sociology study of a group of Chilean children under the age of 5 years. Journal of Biosocial Science, 1977, 9, 353-369.

Plough, I. C., & Bridgforth, E. Relations of clinical and dietary findings in nutrition surveys. Public Health Reports, 1960, 75(8), 699-706.

Rao, D. H. & Satyanarayana, K. Nutritional status of people of different socio-economic groups in a rural area with special reference to pre-school children. Ecology of Food and Nutrition, 1976, 4, 237-242.

Rao, K. V., & Singh, D. An evaluation of the relationship between nutritional status and anthropometric measurements. American Journal of Clinical Nutrition, 1970, 23, 83-93.

Roche, A. E., Siervogel, R. M., Chumlea, C., & Webb, P. Grading body fatness from limited anthropometric data. American Journal of Clinical Nutrition, 1981, 34, 2831-2838.

Rummel, R. J. Applied factor analysis. Evanston: Northwestern University Press, 1970.

Sabry, Z. I., Campbell, E., Campbell, J. A., & Forbes, A. L. Nutrition Canada: A national nutrition survey. Nutrition Reviews, 1974, 32, 105-111.

Sadasivam, S., Kasthuri, R., & Subramaniam, S. Nutritional survey in a village of Tamil Nadu. The Indian Journal of Nutrition and Dietetics, 1980, 17, 245-250.

Said, A. K., Hegsted, D. M. Response of adult rats to low dietary levels of essential amino acids. Journal of Nutrition, 1970, 100, 1363-1375.

Salvin, J. L., & Marlett, J. A. Influence of refined cellulose on human small bowel function and calcium and magnesium balance. Amercan Journal of Clinical Nutrition, 1980,33, 1932-1939.

Sauberlich, H. E., Dowdy, R. P., & Skala, J. H. Laboratory tests for the nutrition status. Boca Raton, Florida: CRC Press, Inc., 1974.

Sebrell, W. H. Nutritional survey of children in the Dominican Republic with attention to deficits in water soluble vitamins. In R.E. Olsen (Ed.), Protein-calorie malnutrition. New York: Academic Press, 1975.

Simmons, W. K., Jutsum, P. J., Fox, K., Spence, M., Gueri, M., Paradis, R., Gurney, J. M. A survey of the anemia status of preschool age children and pregnant and lactating women in Jamaica. American Journal of Clinical Nutrition, 1982, 35, 319-326.

Table de Composicion de Alimentos (Area Proyecto, Cochabamba) Bolivia, 1977.

Talwar, P. P. Developing indicies of nutritional levels from anthropometric measurements on women and young children. American Journal of Public Health, 1975, 65, 1170-1174.

Trowbridge, F. L. Clinical and biochemical characteristics associated with anthropometric nutritional categories. American Journal of Clinical Nutrition, 1979, 32, 758-766.

Trowbridge, F. L., & Staehling, N. Sensitivity and specificity of arm circumference indicators in identifying malnourished children. American Journal of Clinical Nutrition, 1980, 33, 687-696.

Trulson, M. Panel discussion: Appraisal of food intake. American Journal of Clinical Nutrition, 1962, 11, 362-367.

United Nations Food and Agriculture Organization. Amino-Acid content of foods and biological data on protein. Rome: United Nations Food and Agriculture Organization, 1970.

United Nations Food and Agriculture Organization. Handbook on human nutritional requirements. Rome: United Nations Food and Agriculture Organization, 1974. (a)

United Nations Food and Agriculture Organization. The state of food and agriculture, 1973. Rome: United Nations Food and Agricultural Organization, 1974. (b)

United Nations World Health Organization. Nutritional anemias (WHO Technical Report Series 405). Geneva: United Nations World Health Organization, 1968.

United Nations World Health Organization. Conquest of deficiency disease (WHO Basic Study No. 24). Geneva: United Nations World Health Organization, 1970.

United States Department of Defense. Committee on Nutrition for National Defense. Bolivia nutrition survey. Washington, D.C.: United States Department of Defense, 1964.

United States Department of Health, Education, and Welfare. Ten state survey 1968 - 1970 USDHEW Publication No. (HSM) 72-8134). Atlanta: United States Department of Health, Education, and Welfare, 1972.

United States Department of States, Bureau of Public Affairs. Bolivia: Background notes. Washington, D.C.: United States Department of States, 1981.

Uyanga, J. Food habits and nutritional status in Southern Nigeria. The Journal of Tropical Geography, 1979, 49, 86-91.

Valverde, V., Nieves, I., Sloan, N., Pillet B., Trowbridge, F., Farrell, T., Beghin, I., & Klein, R. E. Life styles and nutritional status of children from different ecological areas of El Salvador. Ecology of Food and Nutrition, 1980, 9, 167-177.

Varela, G. Nutritive state of the population in Spain. World Review of Nutrition and Dietetics, 1971, 13, 86-104.

Vilter, R. W. The anemia of protein-calorie malnutrition. In R. E. Olsen (Ed.), Protein-calorie malnutrition. New York: Academic Press, 1975.

Waterlow, J. C. Classification and definition of protein-calorie malnutrition. British Medical Journal, 1972, 3, 566-569.

Waterlow, J. C. Adaptation to low-protein intakes. In R. E. Olsen (Ed.), Protein-calorie malnutrition. New York: Academic Press, 1975.

Waterlow, J. C., & Payne, P. R. The protein gap. Nature, 1975, 258, 113-117.

Weil, T. E., Black, J. K., Blutstein, H. J., Hoyer, H. J., Johnston, K. T., & McMorris, D .S. Area handbook for Bolivia (DA Pamphlet No. 550-66). Washington, D.C.: U.S. Government Printing Office, 1974.

Wenlock, R. W . Social factors, nutrition, and child mortality in a rural subsistence economy. Ecology of Food and Nutrition, 1979, 8, 227-240.

Whitehead, R. G., Rowland, M. G. M., & Cole, T. J. Infection, nutrition, & growth in a rural African environment. Proceedings of the Nutritional Society, 1976, 35, 369-375.

Williams, H. H., Harper, A. E., Hegsted, D. M., Arroyave, G., & Holt, L. E.. Jr. Nitrogen and amino acid requirements. In National Research Center, Improvement of protein nutriture. Washington, D.C.: National Academy of Science, 1974.

Woolf, B. Statistical aspects of dietary surveys. Proceedings of the Nutrition Society, 1954, 13, 82-93.

Young, C. M., Franklin, R. E., Foster, W. D., & Steele, B. F. Weekly variation in nutrient intake of young adults. Journal of the American Dietetic Association, 1953, 29, 459-463.

Young, C. M., Waldner, M., Greer, B., & Berres, K. What the homemaker knows about nutrition. Journal of the American Dietetic Association, 1956, 32, 218-222.

APPENDIX A

BOLIVIA: BRIEF BACKGROUND

Often called the "Tibet of South America," landlocked Bolivia extends over some 424,000 square miles which makes the country fifth in size in South America. The country is bordered by Brazil on the north and the east, Paraguay on the southeast, Argentina on the south, and Chile and Peru on the west (Figure 1). Bolivia is divided into three areas of different altitudes. The high altitude region, approximately 13,000 feet above sea level, is called Altiplano. This region is about 500 miles long and 80 miles wide, level, and includes the states of La Paz, Oruro, Potosi, and part of Cochabamba. The Altiplano cradles famed Lake Titicaca, which at 12,500 feet is the world's highest navigable lake. The high altitude gives the plateau a clear atmosphere and cool climate with an average temperature of 50 degrees Fahrenheit. The Yungas, an area sloping from the Andes mountains to the lowlands, includes valleys and semitropical forests, and includes parts of La Paz, Cochabamba, Chuquisaca and Tarija, and western Santa Cruz. This area varies in altitude from 1,600 - 9,000 feet. The temperature averages about 70 degrees Fahrenheit, and the atmosphere is humid. The low altitude region or the Llanos comprises about two-thirds of the area and extends over the Amazon River Basin. The states of Pando, Beni, and Santa Cruz are found in the Llanos region. This plain contains the tropical forests and dense vegetation with open savannas (US Department of State (DOS), 1981).

Bolivia was named in honor of Simon Bolivar who liberated the country from Spain in 1825. Since that time, the political situation of Bolivia has been unsettled, and the country has experienced over 100 internal and external revolutions. Thus, the country is considered one of the most unstable nations in the world (Weil et al., 1974).

The population of Bolivia is about 6 million according to the 1980 census estimate (US DOS, 1981). Bolivia's ethnic distribution is estimated to be about 60 percent Indian, 5 percent to 15 percent European (primarily Spanish), and 25 percent to 30 percent mixed Indian and Spanish. Population density ranges from less than one person per square kilometer in the southeastern plains to 9.6 persons per square kilometer in the northern regions. Bolivia's high infant mortality rate (158/1,000) prevents the annual population growth rate from exceeding 2.6 percent.

Bolivia's capital, La Paz, has the highest elevation (11,600 feet) of any city in the world. The fastest growing city is Santa Cruz which is the commercial and industrial center of the eastern lowlands.

The official language is the Spanish. The Indians, however, speak two different languages, Aymara and Quechua, with several dialects. The recognized religion is Catholicism, but freedom of worship is extended to other faiths.

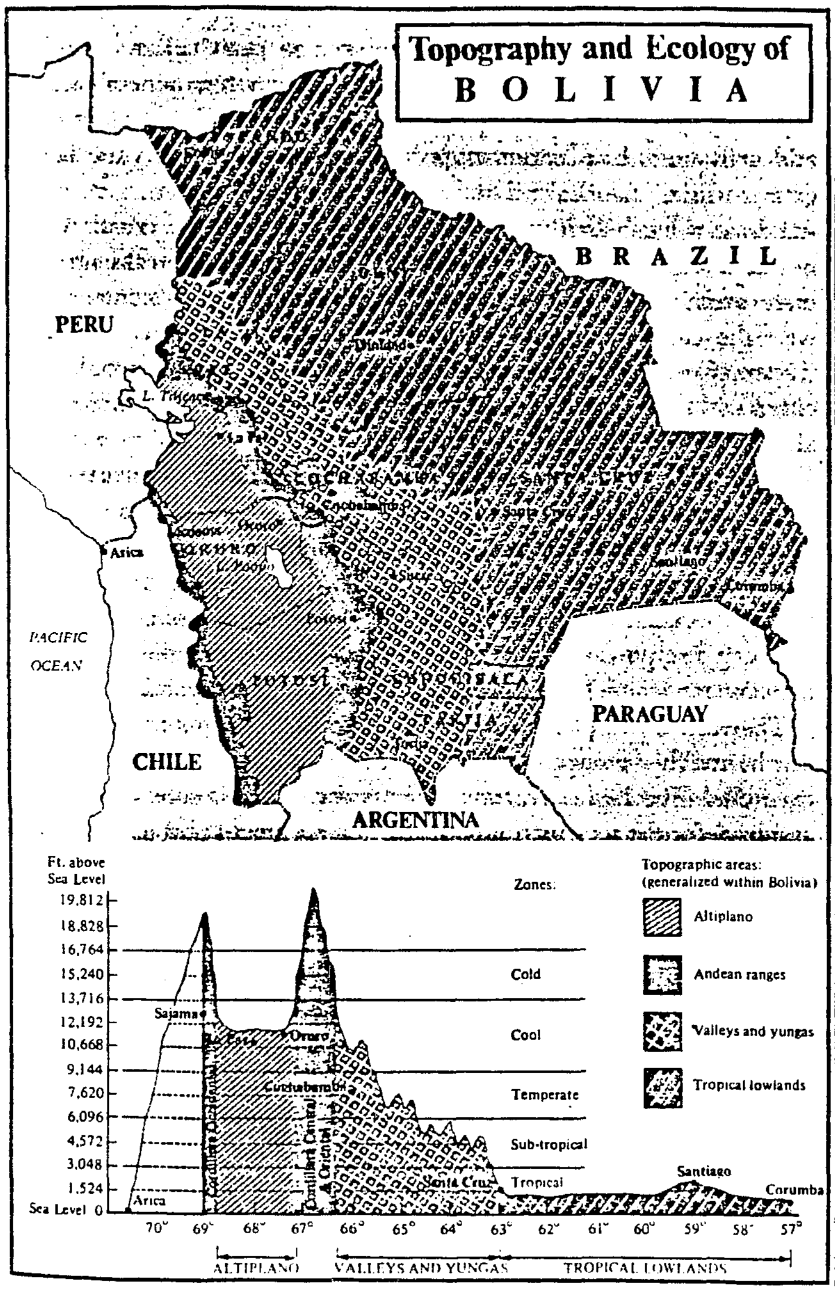

Figure 1. Map of Bolivia

Education is compulsory between the ages of 7 and 14. At the secondary level there is a 4 year general course followed by an advanced curriculum of two years to prepare students for university education. The 4 year course may be followed by advanced vocational training. Bolivia has 7 large universities. These include the Universities of San Francisco Xavier at Sucre, San Andrés at La Paz, Cochabamba, Gabriel Rene´ Moreno, Tomás Frias, Miseal Saracho, and the Universidad Téchnica at Oruro. According to the US DOS estimates (1981) literacy rate was 63 percent.

The main occupations in Bolivia are agriculture and mining. The major agriculture produce grown in the Altiplano zone are cereals such as wheat and barley. Coca leaves, coffee, cocao fruits, yuca, and rice are produced in the Yungas and the valley zones, and rubber, lumber, brazil nuts, cotton and sugar cane are important crops in the Llanos zone. Meat production includes sheep and llamas raised in the Altiplano, and cattle raised in the Llanos region. Tin, silver, and lead are the most valuable minerals with tin accounting for almost three quarters of the value of the nation´s mineral exports. Bolivia is considered a world leader in the production of silver. There is speculation that a sub-Andean petroleum bearing belt running from the Peruvian to the Argentine border lies beneath the country.

Bolivia has very little manufacturing industry and is dependent on imports for over one-third of its food supply and materials for other industries. The mining exports provide the source of pay for such imports. However, Bolivia is among the poorest countries in Latin

America and has a gross national product (890 billion dollars) which is the lowest in South America. Thus, it appears that foreign aid is indispensible to the well-being and survival of the country.

APPENDIX B

SURVEY SITE

The three adjacent provinces of Punata, Jordan, and Esteban Arce in the state of Cochabamba were selected as the survey site. The combined population of these three provinces was 98,884. The populations of Punata, Jordan, Esteban Arce, were 45,324, 25,646 and 27,914 respectively. The location of the three provinces within Cochabamba is illustrated in Figure 2.

The area was divided into distinctly different areas of disperse population, population centers, and urban centers. Areas of disperse population included the inhabitants who lived mainly on the farms outside of the main centers of population. Populated centers were classified on the basis of 50 or more households for which the inhabitants have a common name. The land of the household was not used for agriculture activities but was used for small types of family gardening. The community had a public square, a church, and a store or some kind of commercial place. Also, there was a distance of at least 1000 meters between the last house in a populated center and the next house in a neighboring community. Urban centers were used for towns having a population of 2000 or more.

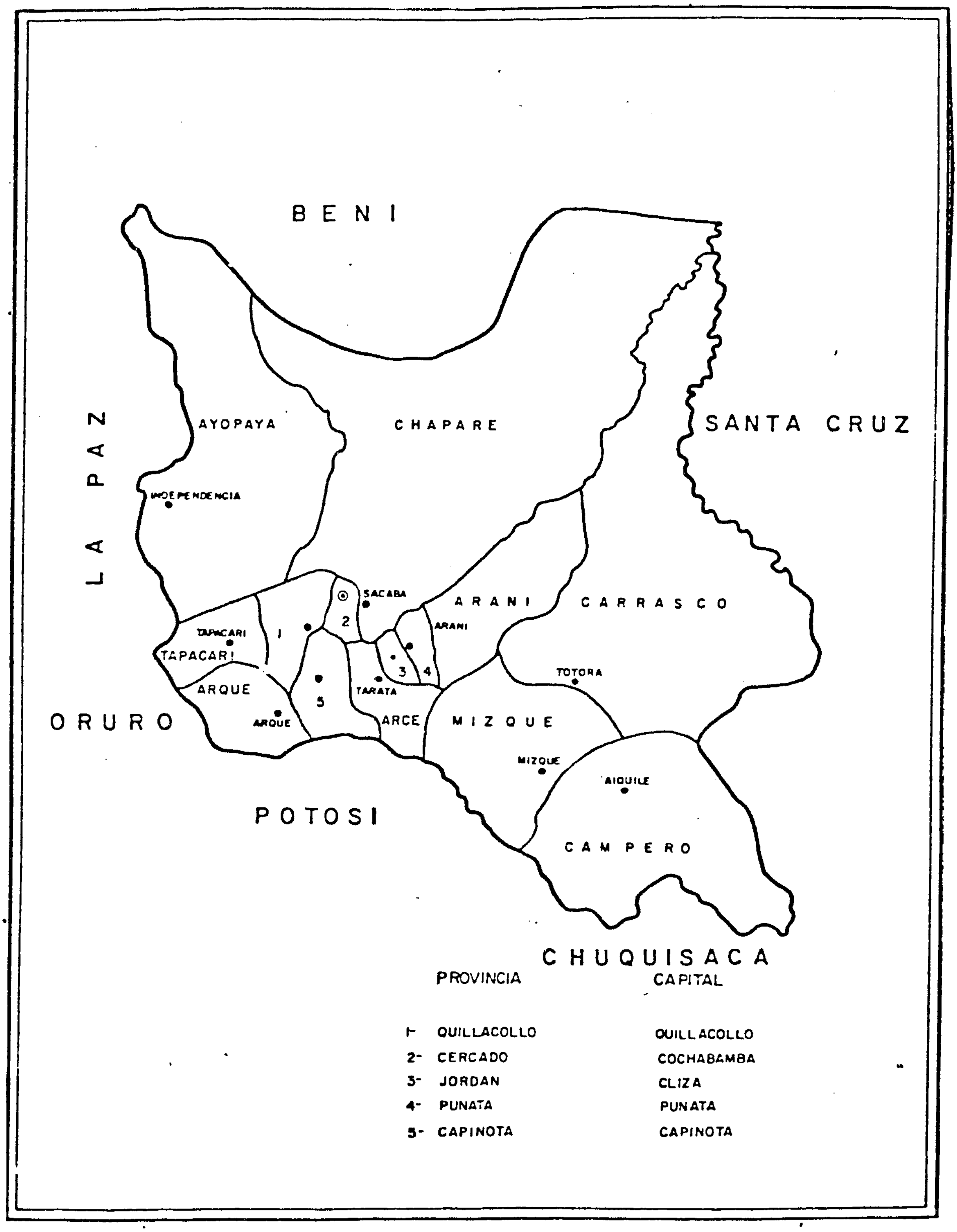

Figure 2. Project Site

The percentage distribution of the population in these three provinces is shown in Figure 3. The area was mostly rural but included an urban population of 39,626.

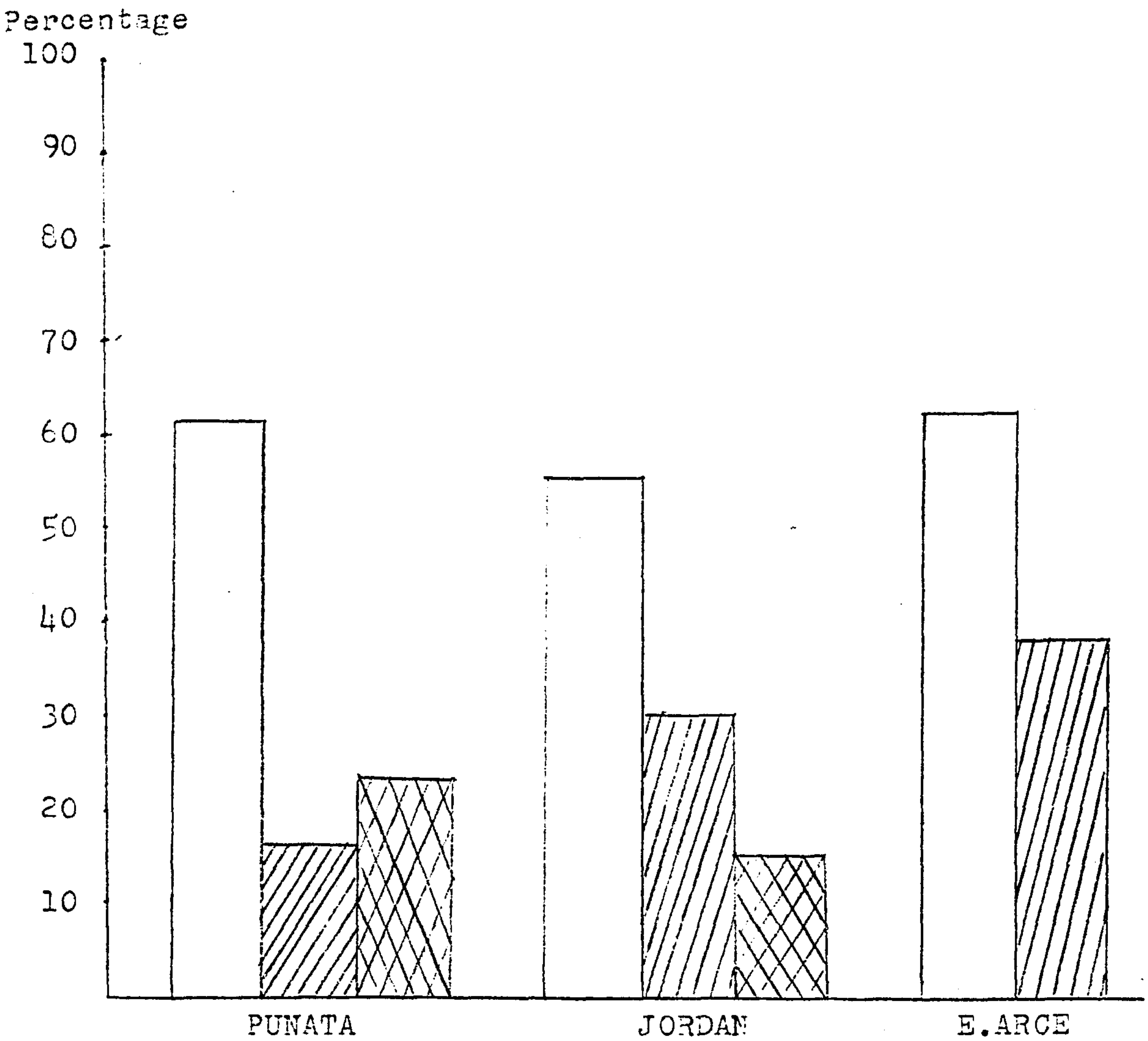

Figure 3. Distribution of the Bolivians in the selected areas.

Disperse population

Populated centers

Urban centers

APPENDIX C

STANDARDS USED FOR THE EVALUATION OF THE DATA

FAO Recommended Dietary Intakes

The FAO Recommended Dietary Intakes for the eight nutrients and energy included in the study are presented in Appendix Table 1. With the exception of those for protein and energy, the standards are defined as "recommended intakes or the amount considered sufficient for the maintenance of health in nearly all people." The protein standards are referred to as safe levels of intake or the amount of protein considered necessary to meet the physiological needs and maintain the health of nearly all persons in a specified group. The energy allowance is defined as the energy intake that is considered adequate to meet the energy needs of the average healthy person in a specified category.

Thus, energy requirements represent average requirements that are based on a reference man and woman between the ages 20 and 39 years who are moderately active and weigh 65 kg and 55 kg, respectively. Protein allowances, however, were determined by using a reference high quality protein, namely eggs or milk. The obligatory losses of nitrogen when a protein-free diet is eaten was first determined. Second, the amounts of nitrogen retained during growth or pregnancy or secreted in the milk during lactation was calculated. Then values obtained in these two

Appendix Table 1

FAO Recommended Intakes

Age (years)	Energy Calory	Protein g	Vit.A. mcg	Thiamine mg	Riboflavin mg	Niacin mg	Vit.C mg	Calcium mg	Iron mg
Children									
< 1	820	14	300	0.3	0.5	5.4	20	500	5-10
1 - 3	1360	16	250	0.5	0.8	9.0	20	400	5-10
4 - 6	1830	20	300	0.7	1.1	12.1	20	400	5-10
7 - 9	2190	25	400	0.9	1.3	14.5	20	400	5-10
Male adolescents									
10 - 12	2600	30	575	1.0	1.6	17.2	20	600	5-10
13 - 15	2900	37	725	1.2	1.7	19.1	30	600	9-18
16 - 19	3070	38	750	1.2	1.8	20.3	30	500	5-9
Female adolescents									
10 - 12	2350	29	575	0.9	1.4	15.5	20	600	5-10
13 - 15	2490	31	725	1.0	1.5	16.4	30	600	12-24
16 - 19	2310	30	750	0.9	1.4	15.2	30	500	14-28
Adult man	3000	37	750	1.2	1.8	19.8	30	400	5-9
Adult woman	2200	29	750	0.9	1.3	14.5	30	400	14-28

Note: Adapted From The Food and Agriculture Organization "Handbook on Human Requirement". Rome, 1974.

steps were added and increased by 30 percent to account for utilization. This value was further increased by another 30 percent to correct for individual variation. These final values are considered to be safe levels of intakes. A further correction for safe level of intake may be necessary, because neither all foods nor mixed diets approach the quality of egg or milk protein.

Vitamin allowances were based on available research data. However, because individual vitamin intakes were not always available for the same age categories, an arbitrary regrouping has been made. Thiamin, riboflavin, and niacin intakes were based on caloric intakes.

Calcium needs were estimated in terms of dietary intakes known to be compatible with health and attainable in many areas of the world, and they are considerably lower than those of the USRDA. Recommended intakes of iron were derived from estimates of maximum iron absorption diets containing three levels of protein, less than 10 percent, 10 - 25 percent, and more than 25 percent of calories from animal sources. The recommended intakes were intended to maintain iron stores at 500 mg and cover iron losses and needs for growth.

FAO Amino-Acid Reference Pattern

Appendix Table 2 shows the amino-acid reference pattern proposed by FAO/WHO for use in the evaluation of the quality of protein in the diet. The standards were based on available data on amino acid requirements for man. The suggested levels were determined to provide for nitrogen equilibrium maintenance plus a safety factor to correct for individual variations.

Appendix Table 2

Provisional Amino Acid Scoring Pattern

Amino acid	Suggested level (mg/g protein)
Isoleucine	40
Leucine	70
Lysine	55
Methionine + cystine	35
Phenylalanine + tyrosine	60
Threonine	40
Tryptophan	10
Valine	50
Total	360

Note: Adapted from Energy and Protein Requirements. World Health Organization Technical Report Series No. 522, Geneva, 1973.

Anthropometric 50th Percentile

The smoothed 50th percentiles for the various anthropometric measurements are found in Appendix Tables 3, 4, and 5. The 50th percentiles for weight/height, height/age, head circumference/age, and weight/height are those developed by the National Center for Health Statistics (1976). These were based on data collected during several cycles, each lasting for several years, of the Health Examination Survey (HES) and Health and Nutrition Examination Survey (HANES).

Collectively, the examinations occurred between 1963 and 1975. These examinations involved a nationwide probability sample, and the examination and measurement processes were highly standardized and closely controlled. A least square-cubic-spline technique was used to smooth the curves. The feasibility of duplicating the curves by utilizing the documented coefficients at various ages supplied by NCHS has been demonstrated. Although developed for the United States population, the efficiency and accuracy by which the percentiles are characterized suggest its use as a reference standard for simplifying comparative interpretation of growth data from differing populations of children around the world.

The arm circumference/age, triceps skinfold/age, and arm muscle area/age are those developed by Frisancho (1974). The data collected from the Ten State Nutrition Survey of 1968-1970 provide the base for these percentiles. This survey was also based on a stratified probability sample, and the measuring processes were standardized. The arm muscle area calculation utilized Gurney's formula (1969). As it is indicated by the triceps skinfold the development of subcutaneous fat in males is characterized by slow apposition, while in females, is continuous throughout childhood, adolescence, and adulthood. The muscle area during childhood exhibits considerable changes. Generally, the amount of subcutaneous fat and degree of muscularity in children reflect the individual calorie and protein reserves.

Appendix Table 3

Males Smoothed 50th Percentiles

Age group years	Age midpoint years	Weight kg	Height cm	Arm circumference cm	Triceps skinfold mm	Arm muscle area sqmm
0.0-0.4	0.3	7.85	67.8	13.4	8	892
0.5-1.4	1	10.15	76.1	15.2	9	1,201
1.5-2.4	2	12.34	86.8	15.7	10	1,284
2.5-3.4	3	14.62	94.9	16.1	9	1,384
3.5-4.4	4	16.69	102.9	16.5	9	1,451
4.5-5.4	5	18.67	109.9	16.9	8	1,579
5.5-6.4	6	20.69	116.1	17.2	8	1,700
6.5-7.4	7	22.85	121.7	17.6	8	1,815
7.5-8.4	8	25.30	127.0	18.5	8	1,987
8.5-9.4	9	28.13	132.2	19.0	9	2,074
9.5-10.4	10	31.44	137.5	20.0	10	2,239
10.5-11.4	11	35.30	143.3	20.8	10	2,406
11.5-12.4	12	39.78	149.7	21.6	11	2,603
12.5-13.4	13	44.95	156.5	23.0	10	3,013
13.5-14.4	14	50.71	163.0	24.3	10	3,544
14.5-15.4	15	56.71	169.0	25.3	9	3,867
15.5-16.4	16	62.10	173.5	26.2	9	4,184
16.5-17.4	17	66.31	176.2	27.5	8	4,771
17.5-24.4	21	-	-	29.2	10	5,315
24.5-34.4	30	-	-	31.0	11	5,802
34.5-44.4	40	-	-	31.2	12	5,820

Note: Adapted from National Center for Health Statistics (NCHS) Growth charts, 1976. Monthly Vital Statistics Report, Vol. 25, No. 3, Suppl. (HRA) 76-1120, Rockville, Md., 1976.

Appendix Table 4

Females Smoothed 50th Percentiles

Age group years	Age midpoint years	Weight kg	Height cm	Arm circumference cm	Triceps skinfold mm	Arm muscle area sqmm
0.0-0.4	0.3	7.21	65.9	12.7	8	866
0.5-1.4	1	9.53	74.3	14.6	9	1,084
1.5-2.4	2	11.80	86.8	15.5	10	1,241
2.5-3.4	3	14.10	94.1	15.7	10	1,298
3.5-4.4	4	15.96	101.6	16.2	10	1,390
4.5-5.4	5	17.66	108.4	16.9	10	1,516
5.5-6.4	6	19.52	114.6	17.0	10	1,563
6.5-7.4	7	21.84	120.6	17.8	10	1,700
7.5-8.4	8	24.84	126.4	18.3	10	1,818
8.5-9.4	9	28.46	132.2	19.2	11	1,955
9.5-10.4	10	32.25	138.3	20.3	12	2,115
10.5-11.4	11	36.95	144.8	21.0	12	2,335
11.5-12.4	12	41.53	151.5	22.0	13	2,558
12.5-13.4	13	46.10	157.1	23.0	14	2,711
13.5-14.4	14	50.28	160.4	24.0	15	2,952
14.5-15.4	15	53.68	161.8	24.5	16	3,031
15.5-16.4	16	55.89	162.4	24.9	15	3,198
16.5-17.4	17	56.69	163.1	25.0	16	3,058
17.5-24.4	21	-	-	26.0	17	3,341
24.5-34.4	30	-	-	27.5	19	3,606
34.5-44.4	40	-	-	26.6	22	3,724

Note: Adapted from National Center for Health Statistics (NCHS) Growth charts, 1976. Monthly Vital Statistics Report, Vol. 25, No. 3, Suppl. (HRA) 76-1120, Rockville, Md., 1976.

Appendix Table 5

Smoothed 50th Percentile of Weight/Height

Height	Weight Male	Weight Female	Height	Weight Male	Weight Female
cm	kg	kg	kg	kg	kg
48 - 50	3.15	3.29	76 - 78	10.27	10.02
50 - 52	3.48	3.55	78 - 80	10.70	10.41
52 - 54	3.88	3.89	80 - 82	11.12	10.10
54 - 56	4.34	4.29	82 - 84	11.53	11.18
56 - 58	4.84	4.76	84 - 86	11.93	11.56
58 - 60	5.38	5.27	86 - 88	12.34	11.95
60 - 62	5.94	5.82	88 - 90	12.76	12.36
62 - 64	6.52	6.39	90 - 92	13.20	12.80
64 - 66	7.11	6.97	92 - 94	13.65	13.27
66 - 68	7.70	7.55	94 - 96	14.14	13.77
68 - 70	8.27	8.11	96 - 98	14.66	14.31
70 - 72	8.82	8.64	98 - 100	15.21	14.87
72 - 74	9.33	9.14	100 - 102	15.81	15.46
74 - 76	9.81	9.59	102 - 104	16.45	-

Note: Adapted from National Center for Health Statistics (NCHS) Growth charts, 1976. Monthly Vital Statistics Report, Vol. 25, No. 3, Suppl. (HRA) 76-1120, Rockville, Md., 1976.

APPENDIX D

Average Daily Intakes of Amino Acids

Amino acid	Intake in mg
Isoleucine	1657.6 ± 71.5
Leucine	2335.6 ± 100.6
Lysine	1625.4 ± 66.6
Methionine	709.8 ± 28.8
Cystine	498.6 ± 20.3
Phenylalanine	1415.3 ± 58.8
Tyrosine	1157.4 ± 48.8
Threonine	1571.6 ± 73.0
Tryptophan	625.9 ± 31.0
Valine	1613.2 ± 61.9
Arginine	1496.8 ± 61.9
Histidine	752.0 ± 31.7
Alanine	1461.1 ± 60.2
Aspartic acid	2750.5 ± 117.9
Glutamic acid	5479.8 ± 234.9
Glycine	1318.2 ± 51.9
Proline	2204.9 ± 89.7
Serine	1437.4 ± 57.9

Of the essential amino acids, average intake of tryptophan and methionine were the lowest. However, comparison between the amino acid pattern of the protein ingested by the sample and the FAO reference pattern revealed that tryptophan was not a limiting amino acid.