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/ THE EFFECT OF SELECTED HEALTH, ENVIRONMENTAL, AND
SOCIOECONOMIC VARIABLES ON ENERGY AND PROTEIN
INTAKE IN THE DOMINICAN REPUBLIC /

by

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INTRODUCTION

"Health is a state of complete physical, mental, and social well-being, and not merely the absence of disease and infirmity."¹ Physical well-being can be defined as the integrated result of constant body changes, while social well-being is the adaption of man to his physical and social environment.¹ These factors influence not only the quality but the quantity of optimal well-being. The environment is made up of air, water, soil, food, plants, and animals. By-products of waste, garbage, sewage, and housing are also a part of the environment. The condition of the environment reflects on the lives of others.

In rural areas of developing countries the environment is not always optimal. Water pollution worldwide is responsible for more human illness than any other environmental influence.² Contaminated water supplies and direct contact with infected individuals transmit diseases due to microorganisms and parasites.² These and other environmental factors contribute to the development of disease which can contribute to malnutrition.

Malnutrition is common throughout the developing countries of the world, especially in tropical areas. Inadequate protein and energy intakes affect a population's nutritional status. Lack of essential proteins or sufficient calories will increase the incidence of malnutrition. Incidence of protein-calorie malnutrition of children is still increasing.^{3,4} Undernutrition may continue throughout their lives.^{3,4} The problem of malnutrition in tropical regions is complicated by overpopulation, poor education, and poverty.

One of the greatest causes of death in the world is the synergistic interaction between infections and nutrition deficiencies.⁵ Both malnutrition and communicable diseases are major health problems of developing countries.⁵ The incidence of infectious disease and malnutrition is greatest among preschool age children.

The Dominican Republic, like many developing countries, have several government projects to improve the standard of living of their population. The Plan Sierra is a rural development project of the Dominican government. The living standards of this area as in other developing countries are influenced by cultural, socioeconomic, physical, and environmental factors. Destruction of the environment will decrease their quality of life. Sanitation systems within the environment can contribute to the developing of disease and malnutrition and prevent an improvement in the quality of life.

Because socioeconomics, environment, and health factors have influenced quality of life in other countries, an examination of the influence of these factors on protein and energy intakes in the Dominican Republic was undertaken. The objectives of this research were:

1. To investigate the effects of selected health and environmental factors on protein and energy intake in rural Dominican Republic.
2. To identify the relationship between malnutrition, health, and household sanitation in this rural area.

REVIEW OF LITERATURE

Geography of the Dominican Republic

The Dominican Republic shares with the Republic of Haiti the island of Hispaniola, the second largest island of the Greater Antilles. Hispaniola lies in the subtropical hurricane belt, bounded on the north by the Atlantic Ocean and the Caribbean Sea on the south.⁶ Occupying the eastern two-thirds of the island, the Dominican Republic covers about 20,000 square miles.

The topography of the Dominican Republic includes fertile valleys, forested mountains, and desert-like plains.⁶ Four major mountain ranges cross the country northwest to southeast. The Cordillera Central is the principal mountain range and is the source of all major rivers. Almost half of the land is suitable for agriculture. The Cibao Valley is the major agriculture region in the north central part.

Climate varies from dry to wet, determined by the topography. Generally the climate is mild and pleasant, although humid with temperatures ranging from 65°F to 85°F in the winter and 73°F to 95°F in the summer. Rainfall varies across the country and with seasons. Annual rainfall averages 55 to 60 inches. The heaviest rainfall extends from May to November in the south and from December through April in northern regions.

The Dominican Republic is one of the smallest countries in Latin America and is reported to be among those with the highest population density.⁶ A fast rate of population growth has been observed recently.⁶

The Dominican Republic population is 5,430,879.⁸ This is an annual increase of 3.0%, one of the highest in the world.⁷ Approximately 49% of the population is under the age of fifteen. In recent years the birth rate, per 1000, has risen to 45, the highest in the Carribean region. Infant mortality is also high for Latin America at 83 per 1000 live births. In the past few years there has been a migration from rural to urban areas. The urban population now exceeds the rural.

The rural farmer is struggling with poor, shallow soils on steep slopes caused by severe soil erosion. The small farmers with simple technology produce the bulk of the food for national consumption.⁷ They produce plantain, red beans, yucca, sweet potatoes, pigeon peas, tomatoes, coffee, and rice. The small farmers are forced to extract as much production as possible from their land. This leads to overutilization, soil degradation, and decreased productivity. Government projects have been started to increase both productivity and the amount of land being used for agricultural use. Farmers are facing underemployment, low income, and increasing poverty.⁷ The Dominican Republic does not produce enough food to feed its population; it is a net food importer. The larger farmers of the Dominican Republic produce the country's export cash products of sugarcane, tobacco, cacao, or beef. Most of the farming is dry-land farming although some farms are irrigated by rivers.

The Yaque del Norte River drains a watershed of 7044 km² through the Cibao Valley.⁷ This river supplies irrigation and hydroelectric power. The steep watershed poses a problem of erosion, massive siltation, and changes in streamflow.⁷ The ground water contributes to domestic and industrial demands. Water quality is good except in the coastal regions.

There are over 4000 wells in the country with depths ranging from less than 25 meters to 200 meters.⁷

Plan Sierra

The Plan Sierra is an integrated rural development program that is trying to improve the quality of life and stabilize the natural resources of rural families in the Dominican Republic. The project was started in 1979. The Plan Sierra covers an area of 2,000 km², about 780 square miles, southwest of Santiago in the mountain area of Cordillera Central.

The population of the Plan Sierra region is about 120,000. The first settlers were Haitian followed by people from the valley. There are three major villages, San Jose de las Matas, Janico, and Monicion, in this area. The rest of the population lives on farms or in very small communities. There are about 50 small communities in this region. Before 1979 medical services were limited and schools were among the worst in the country.⁹ Since the initiation of the project, however, medical services have been greatly extended and the education level of the teachers improved. There are still limited electricity and water services in the small communities. Fourteen rivers including the Yaque del Norte originate in or above the Plan Sierra.⁷ Dams are under construction to expand hydroelectric power and provide a dependable source of water. The soil was considered inadequate for farming due to inadequate depth, low fertility, weak structure, erosion, and occurrence of sediment buildup.^{6,7,9}

The rate of poverty in this area exceeds 40% of the population. Agriculture productivity has not been sufficient to feed the population. The unemployment rate was 30% in 1982. In 1980, research indicated that 12.3% of the Plan Sierra population was suffering malnutrition.¹³

Malnutrition is a major concern in this rural area and other developing countries.

Energy and Protein Requirements

The energy requirement of an individual is determined by physical activity, body size and composition, age, and climate. Infants and children require additional energy for basal metabolism, physical activity, and growth. Women's energy needs increase during pregnancy and lactation.

Energy requirements are based on the Food and Agricultural Organization (FAO) reference man¹⁰ who healthy, age 25, 65 kilograms, moderately active, and therefore requires 3,000 kilocalories per day. The FAO reference female¹⁰ age 25, 55 kilograms, healthy and moderately active and requires 2,200 kilocalories per day. The energy requirement of children and adolescents based on FAO standards are grouped in six age classes: 1-3 (1360 kcal); 4-6 (1830 kcal); 7-9 (2190 kcal); 10-12 boys (2600 kcal) and girls (2350 kcal); ages 13-15 and 16-19 are adjusted according to the weight of the adults in the population group. The averages for these age groups are 13-15 girls (2200 kcal), and boys (2700 kcal); 16-19 girls (2100 kcal), and boys (2800 kcal).¹⁰

Protein requirement is the level of protein considered necessary to meet the physiological needs and maintain health for a specified group.¹⁰ Protein in the diet provides essential amino acids and nitrogen. Nitrogen can be lost through urine, feces, perspiration, hair, skin, and other body excretions. Dietary protein must equal the amount that is lost. Nitrogen equilibrium must be maintained by protein intake equal to protein output. An intake of 0.45 grams of high quality protein per kilogram of body weight per day meets the needs of almost all healthy members of the

population.¹¹ There is increased need for protein during growth periods. Protein need decreases from 2 g/kg of body weight at ages .5-1 year to 0.6 g/kg of body weight at age 18.

The quality of protein depends on the amino acid composition. Those foods containing fewer amino acids are lower quality protein foods. A person would have to consume a greater amount of a low quality protein than of a high quality protein in order to have sufficient amino acids to meet his or her protein requirement. The quality of protein is indicated by a chemical score which is used to determine a protein score. The chemical score is a ratio of the concentration of limiting amino acids in the test protein to that of the reference protein. The value of eggs and human milk are given the chemical score of 100. Net protein utilization (NPU) also can be used to evaluate protein quality. NPU is the proportion of nitrogen intake that is retained in the body for maintenance and/or growth. NPU represents the percent of nitrogen consumed in the diet and retained by the body.

In developing countries most foods are derived from plant sources, so the quality and utilization of the protein becomes more critical. The diet in the Dominican Republic contains vegetable protein primarily and, therefore, only about 60% of the protein is utilized by the body. Whereas, in the United States the diet contains more meat and 80% of the protein is utilized. People in the Dominican Republic and other developing countries must consume a greater amount of the low quality protein to meet their needs.

Malnutrition

In 1973 Klipstein¹² reported that the protein and energy intake of rural residents of the Dominican Republic was less than that of Puerto Ricans living in a similar environment. Three-day dietary recalls collected on 42 adults living in Barrio Cabrata, a rural community north-east of Santo Domingo, showed a mean energy intake per day of 1448 kilocalories compared to 1592 kilocalories for Puerto Ricans. In the Dominican Republic 38% of the sample had energy intakes less than 1500 kilocalories, compared to only 22% in Puerto Rico. The mean daily protein intake was 35 grams in the Dominican Republic and 55 grams in Puerto Rico. Protein intakes of less than 40 grams per day were found in 74% of the Dominican Republic sample but in only 4% of Puerto Rican sample. In the Dominican Republic there were no protein intakes greater than 60 grams per day. The dietary intake of rural Dominican Republic was considered suboptimal while that of Puerto Rico was adequate.

Smith¹³ reported chronic malnutrition existed in the Dominican Republic in 1980, but the incidence of moderate and severe malnutrition was low. She found 12.3% of the children surveyed in rural Dominican Republic were moderately to severely malnourished according to weight/age although half of the children showed some signs of malnutrition. When using height/age measurement for severe malnutrition 15.4% children suffered chronic severe undernutrition.¹³

In the Plan Sierra region rice, beans, bread, spaghetti, eggs, yuca, sweet potato, and plantain were the foods eaten most frequently.¹³ Dairy products were popular and consumed by 36.6% of the population. Animal protein such as meats, sausages, fish, or eggs were consumed two to three

times a week, while fruits were seldom eaten.¹³ The variety of foods available provided an adequate diet. Since availability of foods was not the reason for the incidence of malnutrition, other factors were considered. These factors included family size, family income, environment, sanitation, and other socioeconomic factors.¹³

Nutritional Status Measurements

Nutrition researchers are continually trying to identify better methods of determining nutritional status. The methods used most commonly in field surveys for assessing nutritional status are weight/age, weight/height, and arm circumference. Weight for age is the most useful and widely used single measurement.¹⁶ The accurate age of the subject must be known when using weight/age measurement. Weight charts are effective for monitoring weight in children. A weight curve which falters or levels off is a sensitive measure of impaired nutritional status. In developing countries the prevalence of protein-calorie malnutrition in children appears to be best indicated by weight deficiency and growth failure in all age groups. Weight/height is an excellent indicator of current nutritional status and considered age independent according to Waterlow.¹⁴ Advantages of the weight/height measurement are that it is nearly race and age independent especially between the ages of 1 to 5, and that it can be used to detect nutritional dwarfing, and a marasmus child. Height/age when used in conjunction with weight/height can be used to classify protein-calorie malnutrition according to severity and duration.¹⁴ Disadvantages of the weight/height measurement in field surveys include the need for transporting scales and having trained workers available. In areas where chronic malnutrition is prevalent and stunted growth is likely

to be found both height and weight may be reduced proportionately (nutritional dwarfing) resulting in normal height for weight. Weight for age measurement then would identify a child as protein-calorie malnourished who was malnourished in the past but now is normally nourished.¹⁶

Burgess and Burgess in a 1969 study considered a mid-upper arm circumference measurement of 16.5 cm as a constant for children ages 1 to 5 years.¹⁸ Although the constant for arm circumference of healthy children was 16.5 cm, Shakir¹⁷ found any measurement greater than 14.0 cm fell within the normal range (green). Arm circumference between 12.5 to 14.0 cm (yellow) identified mild to moderate protein-calorie malnutrition, while any measurement under 12.5 cm (red) was classified as severe malnutrition.¹⁷ Using these measurements with a color coded string or plastic strip (Shakir strip), the arm circumference measurement can be taken with ease in field surveys.

Shakir in 1975 used arm circumference to assess the nutritional status of children. He verified that this measurement is both valid and simple to obtain.¹⁷ Shakir used the mid-upper arm circumference measurement as a measure to determine milder degrees of malnutrition and growth failure.¹⁷ In a study of 777 Baghdad, Iraq children ages 1 to 6 years, he found a correlation of 0.92 between weight for age and mid-upper arm circumference.

In many developing countries records are not always kept and weight charts are not used as a national document. The age of the child may not be known or may be inaccurate. The Shakir strip is a simplified instrument for measuring the mid-upper arm circumference and is practical for children ages 1 to 5.¹⁷ In field studies the mid-upper arm circumference is easy to measure, easy to record, the equipment is easy to transport,

and each child can be measured.¹⁸ Since children are more sensitive indicators of poor nutrition than are adults, the children reflect the nutritional status of the population. The arm circumference measure, a crude measure suited for group evaluation, gives an indication of malnutrition in a population.¹⁷

Jelliffe¹⁸ also recommended measuring upper arm circumference to determine protein-calorie malnutrition. In Wolanski's survey of healthy Polish children ages 1 to 5, there was very little difference between the sexes in arm circumference measurement.¹⁸ Little change was seen between the ages of 1 through 5. Mean mid-upper arm circumference of children, aged 1 to 2 years was 16.06 cm and 16.67 cm for those in age group 4 to 5. Burgess¹⁸ suggested that in communities where accurate birth dates are not obtainable that arm circumference measurement would be most useful.

In 1974 Frisancho¹⁹ showed that measurement of arm circumference of muscle mass of children is an indirect indicator of protein reserve. A decrease in muscle mass or smaller arm circumference during malnutrition was highly associated with a greater loss of body weight. In the same report he indicated that in a Central American sample greater muscularity of children was related to greater stature during growth. Measuring muscularity of children in underdeveloped countries serves as a general index of nutritional status and growth in size.¹⁹

Malnutrition and Infection

In addition to malnutrition, poor health impairs the quality of life. Fevers, colds, diarrhea, vomiting, parasites, and skin infection are frequently found.^{5,13,15} Infection is an important cause of weight loss, physical growth retardation, death, and impaired nutritional status.

Smith¹³ found that 93% of the children in the Plan Sierra had had colds during the previous week of her study. Colds were the most frequently reported illness, along with other conditions usually associated with unsanitary conditions.^{13,15,20}

Infections are related also to protein and energy intakes. Scrimshaw²¹ first described the synergistic effect between infection and malnutrition. In a Guatemalan field study of children conducted between 1959 and 1964, he found that two-fifths of 109 deaths were associated with clinical signs of kwashiorkor.⁵ All of the subjects had episodes of diarrhea, measles, chickenpox, whooping cough or other infectious diseases. One-fourth of the deaths were attributed to diarrheal diseases and the remainder to respiratory complications.

Mata reported that mortality was a good index of the magnitude of malnutrition-infection interactions.²² Infants who survive the first year fared well thereafter.²² The cohort children of his Santa Maria Cauqua study showed that diarrhea and upper respiratory illnesses (mainly the common cold) had the highest morbidity rates. Diarrheal disease was responsible for 43% of the total cases of illness. Morbidity rates of diarrheal and upper respiratory illness were most frequent during the weaning period, 12-29 months of age, and then decreased.²² Diarrhea and intestinal disorders reached a peak of 87/100 persons per month in children aged 18-23 months. Upper respiratory illness was less common, reaching a peak of 31/100 persons during this same period.

Signs and symptoms of fever, vomiting, and anorexia were examined also by Mata in relation to their impact on nutritional status.²² Prevalence of both the signs and symptoms were high. The highest illness rates were seen during the weaning period. Anorexia reached a peak

of 73/100 persons-month, a fever of 39.5+°C at 11/100 persons-month, and vomiting had a rate of 26/100 persons-month. Weight loss and growth retardation were found concurrent with diarrheal disease, measles, whooping cough, and acute respiratory disease. A high rate of infections began early in life with Entamoeba histolytica and Shigella infections occurring at about 18 months.²² The greatest deterioration of nutritional status was observed during the weaning period and during illness. The main deficiency was energy which resulted from the custom of food restriction during illness. Growth improved at age three when children became immunized to many of the prevailing infectious pathogens and were able to consume more food.²²

Health Care Services

Primary health care in developing countries is inadequate in rural areas. Rural clinics are available in some countries but the distance to the clinic is usually several miles. Bertrand reported a strong relationship between the quality of health services utilized and nutritional status of mothers and newborns.²³ Children who attended hospitals and health centers, or who saw doctors or nurses fared better than those who attended dispensaries or saw midwives. Customs in some developing countries limit the use of modern medicine. Many people depend on the medicine man from the local village for all health services. Other customs include doing without food or medical help when they are sick.^{6,23}

Environment

Environmental conditions are a key to the health status of the people in developing countries. Housing, water source, and climate

influence people's health.⁶ In the Plan Sierra sanitation was related to the quality of floor material of the house.¹³ The poorer the floor quality the greater the inadequacy of sanitary facilities. Smith¹³ reported that most houses in rural Dominican Republic were well constructed. The housing material included wood siding walls (92.8%), metal (52.9%), or thatch (35.8%) roofs, and cement (61.0%), dirt (21.2%), or wood (17.2%) floors. One-fourth of the houses had running water, while 70% obtained water from a spring or river. Of all of the households: 87.3% used latrines, 1.7% used enclosed trenches, 10.6% had no facilities, and one family had an indoor toilet. Inadequate facilities were found most frequently in houses with dirt floors.

In Guatemala, Mata reported that garbage and animal waste was thrown away indiscriminately, buried, or used as fertilizer.²² The living quarters of the households were considered unkept, but the floors and yards were neatly swept and free of garbage. Among this population only one-third used latrines and two-thirds were considered indiscriminate squatters. This population was described as having deficient household and environmental hygiene. Few households had running water. Waste water from cooking or washing was discarded in the yards or street. The warm humid climate let flies breed year round, a hazard for transmitting diseases.

Land dumps used by overcrowded populations are potential sources of disease carried by flies and rats. Rainfall will carry microorganisms downstream polluting the ground water and the wells used by people for drinking water. Burying or destroying garbage reduces health problems associated with refuse accumulation. The classic epidemiologic model illustrates how environmental factors can affect nutritional disease in

three different ways: availability of nutrients; the nutritional requirements of the host; and the intake of the nutrients.⁵ The environmental factors that affect nutritional diseases include soil and climate, high temperatures, sunshine, humidity, pathogens, parasites, other biological factors, and socioeconomic factors.

The climate in the tropics allows insects and microorganisms to breed easily and transmit disease. Guatemala and other tropical countries with humid climate are ideal the year round for survival of flies which transmit infectious disease.²⁴ Infectious diseases impairs the nutritional status of the population involved.

Summary

The Dominican Republic like many developing countries is struggling for a better life style. Through government sponsored projects optimum health could be reached in the near future. Nutrition, personal hygiene, and environmental conditions are influenced greatly by the customs and culture of the region. Dietary data indicates that in the Dominican Republic protein and energy intakes are not being met.

Malnutrition is seen in varying degrees among all age groups. Preschool age children are the most vulnerable group. Malnutrition and infection have a synergistic relationship in many developing countries. Malnutrition, ranging from 12% to 66%, has been reported and field studies have produced some discrepancies in nutritional assessments. The measurement of mid-upper arm circumference, which is an indirect indicator of protein reserve, is an easy and rapid method of identifying moderate to severe malnutrition.

Health and environmental factors influence nutritional status. Studies have shown that as illnesses and environmental problems increase or conditions deteriorate, there is a decrease in nutrient intake. The total surroundings of the people affect their nutrient intake. Houses in most areas of the Dominican Republic are constructed of substantial material although the conditions of the house may have decreased. Water is obtained mainly from rivers or springs in the rural areas and can be contaminated as it travels downstream. Unless the water is treated, which it often is not, illness can increase. Latrines are available, but not always used.

Treatment of illness depends on the customs of the people. In the Dominican Republic as well as in other developing countries the use of modern medicine is limited and either treat the ill through medicine men or do not treat the illness at all. Rural clinics are available in some regions but the distance to and from is generally too far to walk. More regional hospitals are being built in the rural areas of developing countries. Other factors which affect life style in developing countries include large household size, low income, small landholdings, poor agricultural technology, and little education. All of these environmental, health, and socioeconomic factors can exert an effect on the nutritional status of the population in the Dominican Republic.

METHODOLOGY

Data Collection

The Plan Sierra conducted a survey of the influence of poverty on the quality of life in the Dominican Republic in 1983. The data collection included a sample population of 1,103 families, 1% of the total population, of the Plan Sierra region.⁹ Three distinct geographic regions were represented; dry, semi-humid, and humid. Families were randomly selected from 41 communities and rural areas. Trained Dominicans interviewed the families and completed a questionnaire. Interviewers also measured the mid-upper arm circumference of all children ages 1 to 5 years of the households using the Shakir strip, a non-elastic band, color coded to indicate degrees of malnutrition (Figure 1). The red area (7 to 12.5 cm) identifies severe malnutrition; yellow (12.5 to 14.0 cm) reveals mild to moderate malnutrition; or green (greater than 14.0 cm) indicates normal nutrition^{16,18} of the children measured. Data relating to food intake during the previous twenty-four hours, socioeconomic factors, health, environment, sanitation, and the interviewer's perception of poverty were obtained. The socioeconomic factors included education, income, occupation, and land holdings. The health, sanitation, and environmental factors recorded included illnesses, treatments, and health care services; malnutrition; water source and treatment; disposal of garbage; housing material and cleanliness; children's clothing; and latrine facilities.

All foods consumed by the entire household during the previous 24 hours were recorded. The interviewers were trained to estimate the

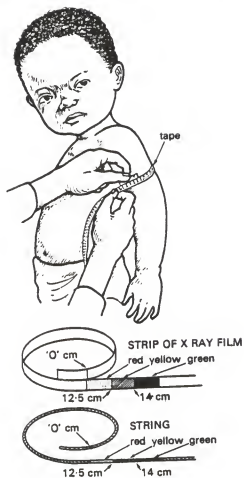


FIGURE 1--Measuring the mid-upper arm circumference using the Shakir strip.*

* King M, King F, Soebagio M: Measuring Arm Circumference. In: Primary Child Care A manual for health workers Book One. Oxford University Press, Oxford, 1978.

quantities of food consumed. Food intake of all household members was summed and household intakes of protein and energy were determined. The Institute of Central America and Panama (INCAP)²⁵ and the United States Department of Agriculture (USDA)²⁶ Food Composition Tables²⁶ (1963, 1976) were used to determine the amounts of protein and energy in the foods consumed. A Dominican Republic cookbook was used to identify ingredients of any food mixture not listed in the food composition tables.²⁷ Intakes of protein and energy were compared to the Food and Agriculture Organization (FAO) standards.¹⁰ Protein values for 60% utilization were used. This level of utilization is appropriate when there is only a small amount of animal protein in the diet.¹¹ FAO values were used to determine individual requirements. Household protein and energy requirements were determined by summing the individual requirements.

Data Management

The raw data from the survey were coded in the Dominican Republic by the interviewers and transferred to large paper sheets. A graduate student from Kansas State University reviewed the sheets for inconsistencies and legibility. The data were then taken to Kansas State University in January 1984 for computer analysis.

The data set consisted of 119 variables from 1103 households. The raw data were entered in the computer and checked for discrepancies, errors, and ambiguous responses which were then eliminated. A code was developed for rank-order questions with multiple answers. Of the original 1103 households interviewed, data from 27 were eliminated because of a lack of 24 hour dietary data and 3 because of unreliably high amounts of food consumption. The final data set included 1073 households.

Dependent Variables

The amount of food consumed by the household during the previous 24 hours was recorded in ounces by the interviewer and later converted to grams. The energy (kcal) and protein (g) values of each food were calculated using the INCAP and USDA tables and summed for each household.

The Food and Agricultural Organization (FAO) dietary allowances recommended by the Oficina Nacional de Planificación were used to determine recommended values for each age and sex group. Because the sex distribution of the household was unknown, the recommendations for energy and protein for both sexes were averaged for each age group. The age distribution was ages 0-1, 2-3, 4-6, 7-9, 10-12, 13-15, 16-19, and greater than 20 years. According to the 1982 Demographic Census Data there was approximately a 50:50 male:female distribution for the adolescent and adult age group of the Dominican Republic.⁸ Household recommended intakes of protein and energy were obtained by summing the protein and energy needs of all household members.

The household's Nutrient Adequacy Ratios (NAR) for protein and energy were obtained as follows:

$$\text{NAR} = \frac{\text{amount of nutrient in household food intake}}{\text{household recommendation for nutrient}} \times 100$$

Independent Variables

The variable COLOR was created to be used in further statistical analysis. This variable included all three of the Shakir strip measurements for malnutrition, indicating the degree of malnutrition by household. Each family was classified according to the greatest number of malnourished children. Several variables pertaining to the health and environment

categorical questions were collapsed for the chi-square tests. The health variables were examined according to two age groups; 1) children less than or equal to 9 years of age and 2) adults greater than 9 years of age. Persons 10 years of age or older were classified as adults because they were not usually in school but were contributing to the economy of the household. Variables were ranked in ascending order from the poorest to the best, the highest value was the best. Table 1 illustrates how these variables were collapsed. Health care services included no health care, medicine man, rural clinic, health subcenter, and regional hospital. These were collapsed to no health care, traditional health care, and formal health care services. All illnesses were recorded as the actual number reported in the previous 15 days. Housing materials were reported as roof, wall, and floor materials used by the household. Roof materials included yagua, cana, wood, zinc, and cement. Wall materials were carton, yagua, wooden poles, wood siding, cement, wood, and cement blocks. The floor materials were earthen, cement, wood, and terrazo. Water was either treated with clorox, boiled, or another type of treatment. Garbage disposal included open air, thrown in the river, given to animals, buried, or burned. The relationship between the variables are illustrated in Figure 2.

Other variables included household size, mortality, income, land-holdings, education, source of water supply, and sanitary facilities. Education of the male and female head of the household were classified according to the highest grade completed. A final variable, which indicated whether the child was nude and/or barefoot, also was included in the analysis.

TABLE 1--Collapsed health and environmental variables of the data set,
Plan Sierra, Dominican Republic, 1983.

New Variable	Variable Classes	Original Variable Included
Health Care Service	<ol style="list-style-type: none"> 1. Nothing 2. Traditional 3. Formal 	<ol style="list-style-type: none"> 1. No health care 2. Medicine man 3. Rural clinic 4. Health subcenter 5. Regional hospital
Illness	<ol style="list-style-type: none"> 1. Actual number 	<ol style="list-style-type: none"> 1. Record of all illnesses in the previous 15 days including; fever, diarrhea, vomiting, parasites, skin infections, colds, and decayed teeth.
Roof Material	<ol style="list-style-type: none"> 1. Wood products 2. Cement and zinc 	<ol style="list-style-type: none"> 1. Yagua 2. Cana 3. Wood 4. Zinc 5. Cement
Wall Material	<ol style="list-style-type: none"> 1. Wood products 2. Wood siding 3. Cement and/or wood 	<ol style="list-style-type: none"> 1. Carton 2. Yagua 3. Wooden poles 4. Wood siding 5. Cement 6. Wood 7. Cement blocks
Floor Material	<ol style="list-style-type: none"> 1. Earthen 2. Cement products and wood 	<ol style="list-style-type: none"> 1. Earthen 2. Wood 3. Cement 4. Terrazo
Treatment of Water	<ol style="list-style-type: none"> 1. Not treated 2. Treated 	<ol style="list-style-type: none"> 1. Nothing 2. Other 3. Add Clorox 4. Boil
Disposal of Garbage	<ol style="list-style-type: none"> 1. Not destroyed/ contaminated 2. Destroyed 	<ol style="list-style-type: none"> 1. Open air 2. Throw in the river 3. Give to animals 4. Bury 5. Burn

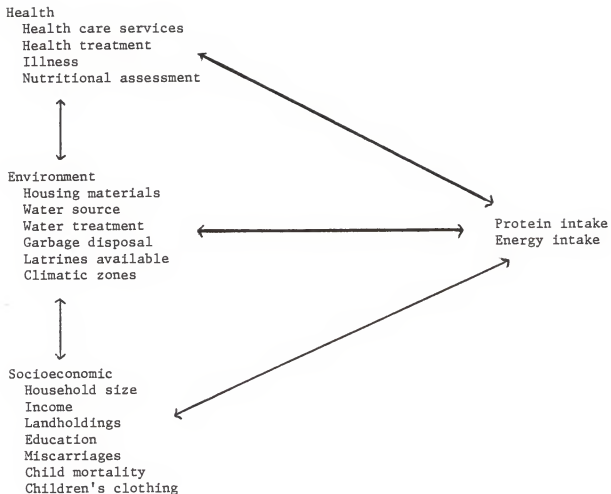


FIGURE 2--The relationships between independent and dependent variables.

Statistical Analysis of Data

The data analysis was conducted at Kansas State University by the Departments of Foods and Nutrition and Statistics. The Statistical Analysis System (SAS) was used to describe the sample population and to show relationships among the variables. Statistical procedures included frequencies, means, standard deviations, percentages, chi-square, regression, Spearman rank order correlation, and stepwise regression. Significant differences among the climate zones, between malnutrition and dietary intake, and between nutrient intake and health, and environmental variables were examined using the chi-square test. The chi-square statistic tests the association of the variables. Spearman rank order correlation was used to show the relationship among all variables. The regression analysis was used to analyze the influence of the continuous independent health and environmental variables on the dependent dietary intake variables.

The inferential analysis consisted of stepwise regression and Spearman correlation. Stepwise regression identifies the set of independent variables that will explain the greatest amount of variance in the dependent variables. The independent variables enter the equation according to their importance, the strength of influence on the dependent variables. Spearman rank order correlation identifies the strength and direction of the association among the variables. The original, not the collapsed values were used in the correlation and regression procedures.

RESULTS AND DISCUSSION

The results of the statistical analysis of the data will be discussed in the following section. The sample will be described and then significant associations between the variables will be discussed.

Descriptive Findings

The sample population included 1073 households with 6686 persons of the Plan Sierra project. The average household consisted of 6.2 persons of which 3.6 members were less than or equal to 14 years of age and 2.6 members were greater than 14 years of age. One in ten women had suffered a miscarriage and one out of every three families had lost a child. Landholdings per household were small. A little over one-third of the sample, 35.7%, owned 6.3 to 31.5 hectares, while 25.6% owned less than 6.3 hectares. About one-fourth (22.1%) of the families in the sample had an average annual income of 1,000-1,500 pesos* while 43.4% of the families had less income. Education levels were low; 34.4% of the population was illiterate. The mean education level for household heads was 2.2 years of schooling completed. There were no significant differences between the sexes in education level (Table 2).

Houses were fairly substantial and most were made of permanent materials (Table 3). Zinc or cement roofing was observed on 60.4% of the houses and terrazo, wood or cement floors in 75.3%; 79.5% had walls made of wood siding, while 16.9% of the household walls were cement blocks.

* The official exchange rate at the time of the study was \$1.00 = 1 pesos.

TABLE 2--Socioeconomic and demographic findings of households in the Plan Sierra, Dominican Republic, 1983.

Variables	Mean
Household size	6.2
Persons \leq 14 years	3.6
Persons $>$ 14 years	2.6
Number of miscarriages	.10
Child mortality	.36
Landholdings (hectares)	31.5
Income (pesos)	1450
Number of persons who can read	1.14
Education level of the male household head	2.2
Education level of the female household head	2.2

TABLE 3--Housing construction in the Plan Sierra, Dominican Republic,
1983 (N = 1076).

Housing materials	%	(N)
Roof material $\chi^2 = 203.7$; $p < .001$.		
Wood products	39.59	(426)
Zinc/Cement	60.41	(650)
Floor material $\chi^2 = 45.6$; $p < .001$.		
Earthen	24.72	(266)
Terrazo/Cement/Wood	75.28	(810)
Wall material $\chi^2 = 30.69$; $p < .001$.		
Wooden poles, yagua, carton	3.53	(38)
Wood siding	79.55	(856)
Cement/Wood	16.91	(182)

These findings were similar to those previously reported by Smith¹³ but the materials had changed slightly, and were more substantial. Fewer households were using thatch roofs and dirt floors. This indicated improved housing which had previously been associated with sanitary environment.¹³ Fewer insects, parasites, and microorganisms would be found in houses of more substantial materials.

The sanitary methods used in the households were inadequate (Table 4). Only one-fourth of the households destroyed their garbage by burning or burying. The rest of the households disposed of their garbage by scattering it outdoors, throwing it in the river, or giving it to animals. These garbage disposal practices were not adequate. Mata,²² described unkept households where garbage and waste were indiscriminately thrown away, buried or used as fertilizer. Many of these same practices were seen in the Sierra. Garbage was not completely destroyed, a practice that could foster disease and contaminate the environment. Most of the households had latrines (88.7%). The availability of latrines had not increased from earlier reports in this area. Smith's findings in 1980¹³ were similar to these (87.3%), which were higher than the number of latrines Mata²² found in Guatemala in 1972. Water source for the households varied: 35.26% carried water from the river, 23.0% was from pipes, 12.5% used wells, and 29.01% used another water source, mostly from a spring or bottle. Usually the water was not treated, only 26.22% of the households did so. Well water had increased from 5% to 12.5% over the past ten years. About one-third of the households obtained water from rivers and one-fourth had running water similar to earlier findings by Smith¹³ and Mata.²² Because they did not treat their water, the respondents were in danger of consuming harmful microorganisms.

TABLE 4--Sanitation practices in the Plan Sierra, Dominican Republic, 1983.

Sanitation practices	%	(N)	χ^2	p-value
Garbage disposal (N = 1075)			51.44	.0001
Not destroyed, contaminated	74.7	(803)		
Destroyed	25.3	(272)		
Latrines available (N = 1071)			13.6	.0011
No	11.3	(121)		
Yes	88.7	(950)		
Source of water (N = 1072)			344.55	.0001
River	35.26	(378)		
Well	12.5	(134)		
Pipes	23.23	(249)		
Other	29.01	(311)		
Treatment of water (N = 1076)			52.65	.0001
Not treated	73.88	(795)		
Treated	26.12	(281)		

Household energy and protein intakes were somewhat lower than the FAO recommendations (Table 5). The mean energy and protein consumption per household was 11,522 kcal and 268 g, respectively compared to the calculated average recommended intakes of 14,547 kilocalories and 306 grams of protein. The mean Nutrient Adequacy Ratios (NARs) were 86.3 for energy and 95.3 for protein, indicating that the households were meeting 95.3% of their protein needs but only 86.3% of their energy needs. FAO standards for 60% utilization of protein were used because less than one-fourth (24.3%) of the protein came from animal sources. Over 34% of the households consumed more than 100% of their protein needs, while only 26% of the households met more than 100% of their energy needs (Table 6). Thirty-nine percent of the households had protein intakes of less than 66% of their recommended needs and the energy intakes of 37% of the households also were below two-thirds of the standards (Tables 7 and 8). In 1973 Klipstein reported the Dominican Republic mean energy intake was 1448 kilocalories per capita. By 1983 kilocalories per capita had increased to 1858 calories in the same area and protein intakes had increased from 35 grams to 49 grams. Protein intake was still lower than that of Puerto Ricans which Klipstein found to be 55 grams per day. The 1983 Plan Sierra sample could have consumed additional calories or protein that were not reported due to under reporting of foods such as fruits which resulted in the lower energy NAR value.

Protein-calorie malnutrition findings were similar but slightly higher than previous studies^{13,15,20} in this region. Seventy-one percent of the households had no malnourished children, while 18.9% had one or more moderately malnourished children, and 9.5% had one or more severely malnourished children using the Shakir strip measurement (Table 9). In

TABLE 5--Household protein and energy intakes of families in the Plan Sierra, Dominican Republic, 1983 (N = 1079).

Variable	Mean Household Consumption	Recommended Household Intake	Mean Consumption per Capita	Recommended Intake per Capita	NAR
Protein (g)	236	306	43.2	49.3	95.3
Energy (kcal)	11,522	14,547	1,858.4	2,346.3	86.3

TABLE 6--Mean percentage of the FAO requirements for protein and energy intake for households in the Plan Sierra, Dominican Republic, 1983.¹

	Percentage of FAO requirements		
	<66%	66-100%	>100%
Protein intake	39.0	26.4	34.6
Energy intake	37.4	36.4	26.2

¹ N = 1079 households.

TABLE 7--Effect of household size on the percentage of FAO protein requirement consumed in the Plan Sierra, Dominican Republic, 1983.¹

Percentage of FAO Requirement for Households	Household Size (N = 1079)					
	<6 Members		>6 Members		Total	
	%	(N)	%	(N)	%	(N)
≤66	45.8	(193)	54.2	(228)	39.0	(421)
66-100	61.7	(176)	38.3	(109)	26.4	(285)
>100	68.9	(257)	31.1	(116)	34.5	(373)

¹ $\chi^2 = 45.39$; $p < .001$.

TABLE 8--Effect of household size on the percentage of FAO energy requirement consumed in the Plan Sierra, Dominican Republic, 1983.¹

Percentage of FAO Requirement for Households	Household Size (N = 1079)					
	<6 Members		>6 Members		Total	
	%	(N)	%	(N)	%	(N)
≤66	43.6	(176)	56.4	(228)	37.4	(404)
66-100	60.8	(238)	39.2	(158)	36.2	(391)
>100	74.7	(212)	25.3	(72)	26.3	(284)

¹ $\chi^2 = 68.20$; $p = .0001$.

TABLE 9--Percentage of households in the Plan Sierra, Dominican Republic, classified as malnourished using the Shakir strip (N = 503).¹

Nutrition Classification	%	(N)
Severely malnourished (RED)	9.5	(48)
Moderately malnourished (YELLOW)	18.9	(95)
Normal (GREEN)	71.6	(360)

¹ $\chi^2 = 17.03$; $p < .01$.

1980 Smith¹³ reported 12% of the Plan Sierra children as being moderately to severely malnourished, 18% mildly to moderately malnourished, and 9% severely malnourished.

Health findings were examined according to age. Over half (55.7%) of the children less than 9 years of age had been ill during the previous 15 days. Of the adults (persons greater than 10 years of age), 63.58% had been ill during the same period. Health care treatment for children was highly significant at .0001, and adult health care treatment at .01 level (Table 10). Prescription medication was the leading treatment for illness in both age groups; 30% of the adults and 23% of the children used prescription medication. The other treatments were similar in both age groups. Almost the same proportion of children were treated with household remedies or received no treatment (21.59% each). Adults were more likely to use household remedies (23.32%) than to receive no treatment (17.93%). Health care services were divided into formal (modern medicine), traditional (medicine man), or no services (Table 11). A total of 38% of both adults and children used the formal health services. Traditional health care services were used by 66.28% of the adults and 4.29% of the children. Children less than 9 years of age (78%) usually were not taken anywhere for health care, while 12.32% adults did not use any health care services.

Differences by Climatic Zones

All of the findings in this section were collected using the chi-square statistic. Some differences in household characteristics were observed among the dry, semi-humid, and humid climate zones (Table 12). Household size in the dry zone was significantly smaller, with 5.8 members versus 6.3 members in the semi-humid zone and 6.5 in the humid zone. Women in

TABLE 10--Health care treatment received by children and adults in the Plan Sierra, Dominican Republic, 1983.

Source	Children		Adult	
	%	(N)	%	(N)
Prescription	23.0	(110)	30.5	(209)
Household remedy	21.6	(103)	23.3	(160)
Over-the-counter medication	16.9	(81)	13.9	(95)
Nothing	21.6	(103)	17.9	(123)
Two or more combinations	16.8	(80)	14.4	(99)
Total	100.0	(477)	100.0	(686)
χ^2	35.94		21.29	
p-value	.0001		.0064	

TABLE 11--Sources of health care received by children and adults in the Plan Sierra, Dominican Republic, 1983.

Source	Children		Adult	
	%	(N)	%	(N)
Formal (regional hospital, health subcenter, rural clinic)	17.2	(82)	21.4	(146)
Traditional (medicine man)	4.3	(21)	66.3	(452)
Nothing (no treatment)	78.5	(375)	12.3	(84)
Total	100.0	(478)	100.0	(682)
χ^2	13.15		50.88	
p-value	.0106		.0001	

TABLE 12--Socioeconomic and demographic findings of households by climatic zones in the Plan Sierra, Dominican Republic, 1983.

Variable	Mean			χ^2	p-value
	Dry	Semi-humid	Humid		
Household size	5.8	6.3	6.5	9.55	.0084
Number of miscarriages	.03	.10	.16	14.93	.0006
Landholdings (hectares)	50	51-100	100	45.08	.0001
Income (pesos)	1450	1430	1470	60.88	.0001
Education level of the male household head	2.29	2.16	2.01	9.1	.0575
Education level of the female household head	2.34	2.10	2.04	4.75	.3137

the humid zone had significantly more miscarriages than women in either of the other zones, but child mortality was higher in the dry zone. Landholdings were smaller in the dry and semi-humid zones, which had more small farms of less than 31.5 hectares than in the humid zone. There were significantly greater number of families in the dry and humid zones than in the semi-humid zone with incomes between 1000 and 1500 pesos. Educational level among the zones did not differ significantly, but the male heads of household were likely to have fewer years of education than the female heads of household in all zones. The housing materials in the dry and humid zones consisted of zinc roofs, cement floors, and wood siding. Houses in the semi-humid zone had wood product roofs, cement floors and wood siding walls. Households in all three zones were more likely to dispose of their garbage in a way that would contaminate the area instead of completely destroying their garbage. There was no significant difference in the number of latrines available in the three zones. The water source for dry and semi-humid zones was a river or other untreated source. The humid zone reported untreated piped water most frequently.

Protein intakes did not differ significantly among the zones (Table 13). More families in the dry and semi-humid zones had energy intakes less than 66% of the recommended levels (Table 14). Households in the humid zones were more likely to meet their protein needs with greater than 100% of the recommended level than households in the other two zones. There were no significant zonal differences in nutritional status of the children as measured by the Shakir strip, although the humid zone had more moderate or severely malnourished children than did the other two zones (Table 15). A possible explanation for the poorer conditions in the semi-humid zone is that this is somewhat of a transitional area between

TABLE 13--Effects of geographical zone on percentage of FAO protein requirement for households consumed by families in the Plan Sierra, Dominican Republic, 1983.^{1,2}

Level of FAO Requirement	Zones							
	Dry		Semi-humid		Humid		Total	
	%	(N)	%	(N)	%	(N)	%	(N)
<66	40.9	(140)	41.8	(155)	34.4	(126)	39.0	(421)
66-100	24.8	(85)	27.8	(103)	26.5	(97)	26.4	(285)
>100	34.2	(117)	30.5	(113)	39.0	(143)	34.6	(373)

¹ N = 1079 households.

² $\chi^2 = 7.57$; $p < .1$ (NS).

TABLE 14--Effects of geographical zone on percentage of FAO energy requirement for households consumed by families in the Plan Sierra, Dominican Republic, 1983.^{1,2}

Level of FAO Requirement	Zone							
	Dry		Semi-humid		Humid		Total	
	%	(N)	%	(N)	%	(N)	%	(N)
<66	43.2	(148)	43.3	(161)	25.9	(95)	37.4	(404)
66-100	36.3	(124)	33.9	(126)	38.5	(141)	36.2	(391)
>100	20.4	(70)	22.6	(84)	35.7	(130)	26.3	(284)

¹ N = 1079 households.

² $\chi^2 = 38.69$; $p < .001$.

TABLE 15--Effect of geographical zone on malnutrition of children ages 1 to 5 using the Shakir strip in the Plan Sierra, Dominican Republic, 1983.¹

Nutrition Classification	Zone							
	Dry		Semi-humid		Humid		Total	
	%	(N)	%	(N)	%	(N)	%	(N)
Severely malnourished (Red)	4.9	(7)	6.8	(11)	15.3	(30)	9.5	(48)
Moderately malnourished (Yellow)	18.7	(27)	15.3	(25)	21.9	(43)	18.9	(95)
Normal nourished (Green)	76.4	(110)	77.9	(127)	62.8	(123)	71.6	(360)

¹ $\chi^2 = 17.03$; $p < .01$.

the extremes of humid and dry areas. The people in the humid and dry zones have adapted to the climatic conditions whereas the semi-humid zone have not. Once inhabitants in this semi-humid zone adapt their protein and energy intakes should increase as well as their health and sanitation. Since the significant differences between the zones were related to economic variables rather than health and environment factors the data were pooled for further analysis.

Differences in Protein and Energy Intakes

The chi-square statistic was used to point out the significant differences in protein and energy intakes in the three climate zones and are listed in Tables 13 and 14. Protein and energy intakes were higher in the humid zone than the dry and semi-humid zones. The semi-humid zone was significantly lower than the other two zones for protein and energy intake. The size of the household was related significantly to protein and energy intake ($p < .0001$). The larger the household size the lower the consumption of protein and energy. The greater the amount of land or the larger the income level of the household the greater the protein and energy intake, an expected correlation.

Household materials that were associated with increased intake of protein and energy were zinc roofs, wood sidings and cement or wood floors. Households which used well water had higher energy consumption. The treatment of water supply also was associated with protein and energy intakes. Those households which treated their water had a greater protein and/or energy intake. About 70% of the households which treated their water consumed greater than 66% of their recommended protein and energy

intakes. No other health or environmental variables significantly effected protein or energy intake.

Inferential Analysis

Spearman Rank Order Correlation

All appropriate variables were included in the correlation matrix. Correlation coefficients are considered to be strong when they exceed 0.8. In large samples such as this one, correlations of 0.4 are excellent and even those of 0.2 may be significant. Caution should be taken in using low correlation coefficients. Although they are significant they may cause an investigator to overstate the findings. Significant correlation coefficients for all variables are listed in Table 16.

The highest Spearman correlation coefficient was between the NARs for energy and protein (.770). As energy intake increased so did protein intake. Education related correlations were found as expected between household size and the number of persons in school (.690); number of children attending school and the number of school age children (.641); and household size and the number of school age children (.565). Another expected correlation was found between nude and barefoot children (.528). Barefoot children correlated with normal nutrition (.505), indicating that going without shoes did not affect nutritional status. Moderate malnutrition was correlated slightly with nude (.238) and barefoot (.232) children. Being barefoot also correlated with illness of the children (.492). Barefoot or nude children was associated with an increase in illness. Nude children and illness was less strongly correlated (.330). A child who was barefoot was more likely to be ill than a nude child

TABLE 16.--Correlation coefficients between proteins and calorie intake and other variables.

	(1) Local	(2) Prot	(3) Illiterate	(4) Illiterate	(5) Adult Illiterate	(6) Yellow	(7) Green	(8) Mule	(9) Barefoot	(10) Bread	(11) School	(12) Ed. level	(13) School	(14) School	(15) Income	(16) Land	(17) Illiterate	(18) Illiterate	(19) Years	(20) Years	(21) Years	(22) Floor
(1) Energy Intake	.770 ^a	-.359 ^a	-.086 ^b	-.055	-.021	-.023	-.129 ^a	-.115 ^a	-.036	-.257 ^a	.017	-.011	-.233 ^a	.065	.141 ^a	-.013	-.003	.058	-.007	.017	-.043	
(2) Protein Intake		-.234 ^a	-.105 ^a	-.039	-.052	-.033	-.135 ^a	-.142 ^a	-.068 ^b	-.147 ^a	.263	-.047	-.162 ^a	.180 ^a	.192 ^a	.004	.068	.118 ^a	.069	.065 ^b	-.124 ^a	
(3) Household Size			.314 ^a	.082 ^b	.164 ^a	.288 ^a	.246 ^a	.323 ^a	.055	.689 ^a	.043	.127 ^a	.565 ^a	.194 ^a	.133 ^a	.083	-.006	.005	.018	.125 ^a	-.066 ^a	
(4) Ill Children				.283 ^a	.293 ^a	.375 ^a	.330 ^a	.492 ^a	-.047	.190 ^a	.093 ^b	.126 ^a	.265 ^a	-.005	-.058	.235 ^a	-.048	.282 ^a	-.058	-.101 ^b	.044	
(5) Ill Adults					.109 ^a	-.065 ^b	-.016	.080 ^b	.092 ^b	.069 ^b	-.058	-.079 ^b	.075	-.075	.102 ^b	.063	.083 ^a	-.105 ^b	.047	-.006	-.021 ^a	
(6) Moderately Malnourished					-.035	.237 ^a	.231 ^a	.005	.065	.007	-.001	-.079 ^b	-.077 ^a	-.065	.020	-.037	-.006	-.068	-.065 ^a	.111 ^a		
(7) Normally nourished						.402 ^a	.505 ^a	-.038	.012	.140 ^a	.151 ^a	.087 ^b	.066 ^b	-.057	-.012	-.025	.136 ^a	.003	-.059	.014		
(8) Mule Children							.528 ^a	.076 ^b	.029	.007	-.002	.062 ^a	-.040	-.141 ^a	-.001	-.048	.131 ^a	-.000	-.158 ^a	.153 ^a		
(9) Barefoot Children								-.065 ^b	.128 ^a	.071 ^a	.061 ^a	.217 ^a	-.050	-.109 ^a	.055	.008	.141 ^a	-.046	-.123 ^a	.136 ^a		
(10) Literate Persons									-.079 ^b	-.530 ^a	.488 ^a	-.050	-.109 ^a	.049	-.082 ^a	-.078 ^a	-.115 ^a	.003	-.065 ^a	.107 ^a		
(11) Persons in School										.079	.136	.641 ^a	.201 ^a	.168 ^a	.102 ^a	.055	.034	.103	.157 ^a	-.136 ^a		
(12) Education Level of Household Head										.377 ^a	.074 ^a	.086 ^b	-.062	.004	.075	.105	.045	.005	-.039			
(13) Education Level of Household Mother										.088 ^b	.174 ^a	.007	-.046	.088 ^a	.111 ^a	.043	.043	.043	.043	.106 ^a		
(14) Persons School Age											.070 ^a	.056	-.065	.048	-.011	.018	.069 ^a	-.024				
(15) Income Level											.275 ^a	-.059	.099 ^a	.007	.066	.073 ^a	.168 ^a					
(16) Landholdings											-.006	.086 ^a	.014	.138 ^b	.087 ^a	.119 ^a						
(17) Health Care Services for Children												.127 ^a	.362 ^a	.107 ^a	.037	-.061						
(18) Health Care Services for Adults													.353 ^a	.568 ^a	.005	-.027						
(19) Treatment of Children														.169 ^a	-.004	.055						
(20) Treatment of Adults															.020	-.061						
(21) Literates Available																						

^a Correlation significant $p < .05$

^b Correlation significant $p < .01$

^c Correlation significant $p < .001$

(.492). Not wearing clothes did not increase the number of illnesses but going without shoes illnesses increased. Mata²¹ indicated that the incidence of illness was high among children until they had adapted to their environment which was generally after the age of three. Treatment of ill children was correlated with health care services (.415). Most children were not treated for illness. Children who were treated at the health clinics also used prescription medications (.342). There was no correlation between treatment of illness and health care service for adults. Other expected positive correlations included household size with barefoot and nude children; landholdings with income; and number attending school with income level.

There was an unexpected negative correlation between educational level of the heads of households and the number of household members who could read (female head .488 and male head .530). This correlation could of been an error in coding the data or the sample could have included a large number of preschool age children. As the level of education of the household heads increased the number of literate household members decreased. One would expect the number of literate members to increase with the increase in the education of the heads of the household. Household size was associated negatively with energy and protein intakes. That is, as the household size increased, protein and energy intakes decreased. The number of school age persons was correlated negatively (.257) with energy intake. Having a latrine was correlated negatively with floor material (.266). The families which had latrines also had poorer floor material. This was an unexpected correlation, the poorer the floor quality was associated with poor sanitary facilities in earlier studies.¹³ Having a latrine and having a dirt floor indicates the sample was trying to improve

sanitary conditions but not improving living conditions. The sample may not understand the importance of permanent floors and sanitation in alleviating insects and pathogens which cause disease. Another possibility for this negative correlation would have been new latrines built in this area. Similar correlations among variables were found in all three zones.

Stepwise Regression

Protein and energy intakes were used as the dependent variables. All health and environmental variables suitable for the analysis were used as the independent variables. Health and environmental variables included in these equations were: illness, Shakir strip, number of miscarriages, infant mortality, health care services, health care treatment, roof material, wall material, floor material, water source, water treatment, garbage disposal and latrine facilities. Socioeconomic variables included were: household size, children's clothing condition, illiterate persons, schooling, education level of household heads, income, and landholdings.

The energy intake variable was most appropriate for determining nutrient intake status. The energy intake equations produced higher R^2 's than the protein intake equations indicating that the health, socioeconomic, and environmental variables had a greater cumulative effect on energy than on protein intake.

All health, environmental, and socioeconomic variables were entered into the stepwise equations shown in Table 17. In stepwise regression analysis the independent variables enter the equation according to their importance. The beta coefficients in the regression equations also can predict the direction and magnitude of the change in the dependent variable. A significance level of .15 was used both to enter and stay in

TABLE 17--Regression equation with socioeconomic and health related variables used to establish percent energy intake.

1.	Percent Energy Intake = 110.87 - 4.01 (Household size) ²	R ² = .086
2.	Percent Energy Intake = 96.99 - 4.58 (Household size) ² + 7.1 (Landholdings) ²	R ² = .162
3.	Percent Energy Intake = 101.29 - 4.04 (Household size) ² - 3.56 (Adult illnesses) ¹ + 7.43 (Landholding) ²	R ² = .192
4.	Percent Energy Intake = 96.31 - 2.32 (Household size) - 3.39 (Adult illnesses) ¹ - 3.53 (Persons attending school) ¹ + 7.8 (Landholdings) ²	R ² = .216
5.	Percent Energy Intake = 92.06 - 2.36 (Household size) - 3.26 (Adult illnesses) ¹ - 3.87 (Persons attending school) ¹ + 2.56 (Income) ¹ + 6.4 (Landholdings) ²	R ² = .235
6.	Percent Energy Intake = 130.27 - 2.39 (Household size) - 3.46 (Adult illnesses) ¹ - 3.86 (Persons attending school) ¹ + 2.61 (Income) + 6.66 (Landholdings) ² - 9.05 (Wall material)	R ² = .248
7.	Percent Energy Intake = 124.59 - 2.36 (Household size) - 3.22 (Adult illnesses) ¹ - 3.95 (Persons attending school) + 2.54 (Income) ² + 6.7 (Landholding) - 10.18 (Wall material) + 3.17 (Source of water)	R ² = .262
8.	Percent Energy Intake = 122.42 - 2.38 (Household size) - 3.15 (Adult illnesses) ¹ + 6.71 (Red) - 3.9 (Persons attending school) ¹ + 2.66 (Income) ¹ + 6.87 (Landholding) ² - 10.08 (Wall material) ¹ + 3.12 (Source of water)	R ² = .269
9.	Percent Energy Intake = 113.78 - 2.4 (Household size) - 3.25 (Adult illnesses) ¹ + 6.81 (Red) - 4.07 (Persons attending school) ² + 2.54 (Income) + 6.7 (Landholdings) ² - 9.98 (Wall material) + 3.11 (Source of water) + 10.86 (Latrines)	R ² = .277

¹ Significant at p < .01

² Significant at p < .001

all equations. In equation 1 household size explained the greatest amount of variance in energy intake and entered first. The R^2 of .086 indicated that household size explained 8.6% of the variance in energy intake of the households. In equation 2, landholdings in conjunction with household size explained 16.2% of the variance. For example, in equation 3, if household size and landholdings are held constant, a one unit change in the number of illnesses of adults decreased energy intake by 3.56%. Illness had a greater effect than landholdings on energy intake because illness entered the equation before landholdings. These three variables together; household size, landholdings, and adult illnesses also explained 19.2% of the variance in energy intake. The most significant variables were adult illnesses and income at the .01 and .001 level. Household size, persons attending school, wall materials and source of water contributed to the variance but were not significant.

Protein intake was affected slightly differently than energy intake. In the first step of analysis (Table 18) income entered the equation first by increasing protein intake by 8.07% with an R^2 of .086. The most significant variables for protein intake were income and landholdings at the .001 and .01 level. Household size, persons attending school, adult medical treatment and source of water contributed and explained 24.2% of the variance but were not significant. Household size, landholdings, persons attending school, and source of water all affected protein and energy intakes. Adult illnesses and treatments affected protein intake more significantly than energy intake.

TABLE 18--Regression equation with socioeconomic and health related variables used to establish percent protein intake.

1.	Percent Protein Intake = 60.68 + 8.07 (Income) ²	R ² = .086
2.	Percent Protein Intake = 104.14 - 6.36 (Household size) ² + 9.23 (Income) ²	R ² = .17
3.	Percent Protein Intake = 94.78 - 6.72 (Household size) ² + 7.47 (Income) ² + 7.03 (Landholding)	R ² = .195
4.	Percent Protein Intake = 87.88 - 4.44 (Household size) ¹ - 4.66 (Persons attending school) + 7.89 (Income) ² + 7.31 (Landholding) ¹	R ² = .211
5.	Percent Protein Intake = 70.13 - 4.34 (Household size) ¹ - 4.8 (Persons attending school) + 7.73 (Income) ² + 7.38 (Landholding) ¹ + 5.59 (Source of water)	R ² = .228
6.	Percent Protein Intake = 44.9 - 3.88 (Household size) - 5.54 (Persons attending school) ¹ + 7.54 (Income) ² + 7.08 (Landholding) ¹ + 5.24 (Adult medical treatment) + 5.75 (Source of water)	R ² = .242
7.	Percent Protein Intake = 51.9 - 3.54 (Household size) - 3.08 (Adult illnesses) - 5.29 (Persons attending school) ¹ + 7.44 (Income) ² + 7.42 (Landholdings) ¹ + 4.96 (Adult medical treatment) + 5.28 (Source of water)	R ² = .252
8.	Percent Protein Intake = 41.68 - 3.31 (Household size) - 3.03 (Adult illnesses) - 5.68 (Persons attending school) ¹ + 7.34 (Income) ² + 7.6 (Landholdings) + 5.35 (Adult medical treatment) + 5.55 (Source of water) + 3.90 (Garbage disposal)	R ² = .258

¹ Significant at p < .01

² Significant at p < .001

CONCLUSION

The Plan Sierra survey of protein and energy intakes as related to selected health and environmental factors included 1073 randomly selected households with 6686 members. The average household size was 6.2 members. The dry zone was significantly smaller in size than the semi-humid and humid zones. Most landholdings were small farms with less than 31.5 hectares.

Mean energy intake for households had increased to 11,522 kcals and protein to 268 grams over the past ten years, but over one-third of the population still were not meeting their recommended needs for protein and energy. The NAR values for energy intake were 86.3 kcal and for protein 95.3 grams. The humid zone had significantly higher NAR values than the other two zones. The protein and energy intakes in the Dominican Republic were below the FAO recommendations except in the humid zone.

Household size, landholdings, and income were related significantly to protein and energy intakes. Protein and energy intakes increased with an increase in land or income, and decreased with larger household size. Energy consumption appeared to be affected by water source, water treatment, and housing materials more than protein intake.

Health care treatment and services were similar in the three climate zones. There were no significant relationships between health care and protein and energy intake. Adult illnesses were associated more with energy intake than with protein intake. There was some relationship between treatment of illnesses and services for both adults and children.

Housing materials were most likely to be permanent, such as zinc roofs, wood siding, and wood or cement floors. Housing materials were related to energy intake, especially wall materials. As wall materials improved, energy consumption increased.

Energy intake had a greater influence on health, environment, and socioeconomic variables of the population in the Plan Sierra than did protein intake. Household size, economics, and other socioeconomic factors were more important than the selected health and environmental variables in predicting malnutrition. The health and environmental variables which affected protein and energy intakes were source of water, treatment of water, illness, and housing materials. A high incidence of malnutrition in children existed as measured by the Shakir strip. Household size and economic variables influenced protein and energy intake more than health and environmental variables. Children's clothing was related to protein and energy intakes more than illness or child mortality were. These socioeconomic variables influenced the amount and degree of malnutrition in this rural area.

Adults mainly used traditional medicine provided by local healers. Children usually were not treated. Only about 20% of the sample used formal health care services. The most frequent medical treatment for adults and children was prescription medication, which indicates that those who used formal health care services bought and used the prescribed medicines. A greater percentage of the sample used prescription medications than sought medical treatment which suggests that they may have been using prescriptions without seeing a doctor. The prescription may have been prescribed for another family member or for a different illness. When the prescription does not alleviate their illness, their skepticism

about modern medicine may increase. This population may be reluctant to change to modern medicines. Availability of medical care was not thought to be a factor because of the number of new health clinics which have been built in this area. Adult illnesses were highly related to energy and protein intakes which indicated that malnutrition may be present in the adult population. When the adult population is ill, agricultural production falters. An increase in illness will decrease productivity, thus producing a cycle that is difficult to break. Increased agricultural productivity would increase the consumption of foods, and decrease malnutrition. Further studies are needed to examine the effect of adult health care, illness and productivity on malnutrition.

Recommendations for further research include an examination of adult and child health care practices and how they relate to agricultural production. Questions that need to be answered are: 1) why are the adults and children not taking advantage of the health care services; 2) why are children not being treated for illness; and 3) why are adults still using traditional healers. This information is crucial because 63.6% of the adults had been ill during the prior 15 days. These illnesses, if not treated properly, will have a detrimental impact on the adults' ability to work in the fields and care for their families.

Protein and energy intakes can be increased through increased agricultural production. However, future programs in this rural area should consider the impact of health on agricultural production. Health and sanitation education programs are needed to improve personal health, environmental conditions, and nutrient intake. This education would help families understand the relationship between infection, malnutrition, and food consumption.

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THE EFFECT OF SELECTED HEALTH, ENVIRONMENTAL, AND
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INTAKE IN THE DOMINICAN REPUBLIC

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Abstract: Data from 1,073 randomly selected households in the Dominican Republic were analyzed to investigate the effects of selected health and environmental factors on protein and energy intakes. The survey was conducted in the three climatic zones, dry, semi-humid, and humid, of an integrated rural development project, the Plan Sierra. Twenty-four hour dietary recalls indicated a mean household energy intake of 11,522 kilocalories and 268 grams of protein, both of which were below FAO recommendations. Differences among the climatic zones were minimal except for a few findings in the semi-humid zone. There was a high incidence of malnourished children as measured by the Shakir strip. Over 25% of the children were considered moderately to severely malnourished. Analysis of the data revealed that household size, landholdings, and income were related significantly to protein and energy intakes. Energy consumption was affected more by water source, water treatment, and housing materials than was protein intake. There was no significant effect of health care on either protein or calorie intake. Positive correlations were observed between protein and energy intakes, and between adult health care and adult medical treatment of illnesses. Further research is recommended to examine the relationship between adult health practices and agricultural production of sufficient protein and energy to meet household requirements.