PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND THEIR IMPACT ON THE NUTRITIONAL STATUS OF PRESCHOOL CHILDREN IN SAN PEDRO DE MACORIS DOMINICAN REPUBLIC

By

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CHAPTER I

INTRODUCTION

Intestinal parasitic infections are widespread around the world. Although these infections are more prevalent in tropical and subtropical regions, temperate and cold regions are not spared. By 1977-1978 global estimates, major infections are prevalent in Africa, Asia, and Latin America (Walsh and Warren,1979) where malnutrition, poor sanitation and/or an inadequate supply of safe water coexist. Most of the infections are due to *Ascaris lumbricoides*, *Trichuris trichura* and Hookworm.

According to studies by Pawlowski (1984) ascariasis and hookworm infections have been estimated to rank second only to diarrheal diseases and tuberculosis in prevalence in Africa, Asia and Latin America. Trichuriasis and schistomiasis are also among the 11 most common infections. In terms of morbidity and mortality, schistomiasis, hookworm infections and ascariasis rank among the top 17 infections worldwide. Children are more heavily infected than adults, therefore, they are more likely to suffer from the pathologic consequences of these infections.

Even though antihelminthic drugs are available, inexpensive, effective and safe to use and improvements have been made in the control measures used against intestinal parasites, prevalence of parasitosis in developing countries is still high. Low standards of living and the poor environmental sanitation conditions prevailing among many of the people in low income countries, lead to reinfection and perpetuation of the epidemiological transmission cycle. Intestinal parasitic infections usually do not cause acute and serious debilitations. However, studies show that these infections have an important impact on nutritional status. Intestinal parasitic infections may be associated with a reduction in food intake, malabsorption, endogenous nutrient loss, and anemia (Tomkins and Watson, 1989). Ascariasis contributes to poor growth and malnutrition (Stephenson et al., 1980). Iron deficiency anemia due to infection by hookworm is well known and trichuriasis may cause anemia and weight loss (Cooper and Bundy, 1986).

In the last three decades socio-economic development in Latin America and the Caribbean has been characterized by broad ecological changes. Many countries have achieved unprecedented rates of economic growth. This progress has been accompanied by improvement in health and nutritional status of the population, as indicated by declining mortality, increases of life expectancy and decreased morbidity particularly from those infectious diseases which have been successfully combated by vaccines and antibiotics. Evidence shows, however, that good health and nutrition still elude large sectors of the populations.

By 1984, studies conducted in the Dominican Republic showed that 85% of children between 6-10 years old had intestinal parasites (Aquasciati, 1984). Also research completed by SESPAS (Department of Public Health and Social Assistance - Division of Epidemiology) indicated that 62% of the general population were affected by parasites, the most prevalent were Trichuris trichura, 36%; Ascaris lumbricoides, 23%; and hookworm 19% (CENESMI, 1987).

Nutritional surveys at a national level conducted by the Consejo Nacional de Poblacion y Familia (CONAPOFA, 1986) and by the Centro Nacional de Investigaciones en Salud Materno-Infantil (CENESMI, 1987) uncovered an infant malnutrition prevalence of 37.5% and 28.9% respectively. Data were analyzed by comparison of results to the standards of the Pan American Health Organization (PAHO) and the World Health Organization (WHO). A study showed a national prevalence of 8% chronic diarrhea in the general population and 18% in the malnourished children. The prevalence of intestinal parasites in these two groups was 60% and 74% respectively (CENESMI, 1987). These findings were identified as important contributing factors to the protein calorie malnutrition in the country. Very few studies have examined the impact of intestinal parasitosis on the nutritional status (growth and development) of children in the Dominican Republic.

The infant mortality rate has tended to decrease in the Dominican Republic during the last two decades. Some studies report about 64 per 1000 live births in the period 1985-90 (IDAN, 1991). Even though a considerable decrease in the infant mortality rate has been observed, when a comparison is made with other countries in the region the level continues to be high. Twenty-five percent of childhood mortality in the Dominican Republic is considered to be associated with malnutrition.

General Profile of the Dominican Republic

Location

The Dominican Republic is located in the Caribbean basin. The Caribbean is a unique region embracing some 27 coastal and island territories, four linguistic groups and a kaleidoscope of races, cultures and histories (see map of the region in Appendix A).

The "Island of Hispaniola", or "Island of Santo Domingo" as it came to be known, and which the native Taino Indians called "Haiti", is the second largest of the greater Antilles, second only to Cuba in size. The Island is shared by the Republic of Haiti (in the western portion) and by the Dominican Republic, with the latter occupying two-thirds of the total land mass with a surface area of 48,482 square miles. The official language is Spanish.

According to David Barret (1982) the ethnolinguistic groups in the country of just some 7 million people are as follows: 71% mulato, (Spanish/Black), 16% Dominican caucasians (Spanish), 11% black (African negros, including Haitians and West Indians), 2% Asian and other European. The per capita gross national product (GNP) for 1990 was $820, with a rate of inflation of 22% (UNICEF, 1993). National literacy stands at 85% for men and 82% for women. Urban dwellers represent approximately 59% of the population with the rate of annual urban growth at 4%. The life expectancy was estimated at 67 years in 1991 (UNICEF, 1993).

Health Indicators

The Dominican Republic is classified by UNICEF among the countries with a high Under-5 Infant Mortality Rate which in 1991 was 76 deaths per 1000 live births. While the Infant Mortality Rate was 59 per 1000 live births (UNICEF, 1993), according to a survey by Tufts/USAID, malnutrition affects nearly 43% of children in the Dominican Republic, of which 8% suffer from second and third degree malnutrition. Infant malnutrition reaches 38.5% in urban areas and is even higher in rural areas.

Almost two-thirds of the infant mortality is caused directly or indirectly by malnutrition and infectious intestinal diseases (Sappho, 1993). The maternal mortality is estimated asn 10-20 per 100 births (CENESMI, 1991), the prevalence of the use of contraceptive was 50%, and the percentage of births attended by trained health personnel by 1991 was 92% (UNICEF, 1993).

Brief Description of the Health System

As in most Third World countries, the Dominican Republic health care is oriented towards therapeutic care. A disproportionately small amount of resources is given to preventive care such as immunization, prenatal care, health education, and family planning, and even less to broad public health programs, such as nutrition, sanitation, and occupational safety. However, preventive care is gradually becoming more of a priority. For example, during the last few years the health authorities have given special attention to immunization programs of all children against the preventable child diseases. Such campaigns have been very successful due to the support received from UNICEF.

In addition to traditional healers, there are three broad providers of health care services in the Dominican Republic: government services, the social security system, and the private sector. Because health care is considered a universal right in the Dominican Republic, everyone is eligible to receive care at government public health facilities. However, most of the population is also covered by the social security health system, and a portion of the remainder uses private health services. Generally, it is the poorest who use the government facilities. In general both of these providers offer the same services (general medicine, infant and maternal health care, surgery, etc.). However, the social security health system has more financial and medical resources. It can only be accessed by individuals who are employed and hold a social security card.

Health Care Services

Government. The Secretaría de Estado de Salud Pública y Asistencia Social (SESPAS) is the government health facilities open to all Dominicans. The SESPAS facility (general hospitals, specialty hospitals and clinics) are managed by the Secretaria of Health and Social Assistance Ministry

Social Security The Instituto Dominicano de Seguro Social (IDSS) health facilitates serve about 56% of Dominicans who are employed by the government or private companies (industrial and professional workers). This social security secretariat runs its own general and specialty hospitals and clinics. The Armed Forces Personnel are served through the armed forces private hospital system run by the national government. A large proportion of the population are not served by the government providers.

Private Sector. The private health sector serves those who are not covered by the social security system or do not want to use the government facilities. Generally, these are wealthier people, although a surprising number of poor people also seek services in private clinics, because medications are very seldom available in the other facilities.

The international aid for the health sector in the country is provided mainly by the World Health Organization and the Pan American Health Organization. Their assistance is directed primarily for the development of health programs. UNICEF also offers international aid in the country mainly in immunization and nutrition programs. Other international agencies that offer health and nutritional aid in the country are CARE (Cooperative for American Relief Everywhere) and CARITAS(Charity program of the Roman Catholic Church). CARE offers supplementary feeding programs in different communities in the country supported in part by USAID. CARITAS runs health programs in certain communities especially in the rural areas where no other services of this type are available. There are others religious and lay organizations at the national, regional and local levels in the Dominican Republic that have developed and maintained health and nutrition programs. These programs seek to fill the voids caused by the limited availability of medicines and of medical services in the government facilities. For example, The Dominican Episcopal Church through the Order of the Transfiguration, offers one feeding and medical program in San Pedro de Macoris. The researcher used this program as a referral for the study undertaken in the present thesis.

The budget that supports the health and nutrition governmental programs in the Dominican Republic is uncertain. The Dominican Medical Association (AMD) estimated that 6% of the national budget is assigned to this area. This is not a reliable estimate since there are no recent data published by the government. Even though health care is considered a universal right in the Dominican Republic, the cruel reality is that its health care and nutrition programs need enormous improvement in order to address properly the needs of the country's population.

Purpose

The purpose of this research was to assess the prevalence of intestinal parasitosis in two communities and its impact on the nutritional status of preschool children by using anthropometric measurements and clinical examination.

Research Objectives

The objectives of this study were as follows:

1. To determine if intestinal parasitism affects the nutritional status (weight for age, height for age and weight for height) of preschool children in the community.
2. To identify the most frequent type of parasites in this age group of the community.
3. To determine if the prevalence of intestinal parasitism is related to the monthly family income.
4. To identify the sanitary conditions within the community.
5. To determine if the sanitary conditions within the community affect the nutritional status of preschool children in the community.
6. To evaluate if the relationship between the education of parents or their nutritional practices affect the prevalence of intestinal parasitism.

CHAPTER II

REVIEW OF LITERATURE

The following review of literature will focus on the description of the intestinal parasites most frequently identified in the communities studied and on the research concerning the effects of those parasites on the nutritional status of preschool children. Because, the determination of the nutritional status of the children is based on anthropometric measurement in this study, the literature related to anthropometric measures used in this research also is reviewed.

Parasitic infections are caused by a great number of protozoa and helminths that are either specific zoonotic parasites or which affect both man and animals. Over 50 different species of intestinal parasites can infect human beings.

Infections with protozoal and helminthic parasites represent the most prevalent endemic condition in the world. Intestinal helminths are so identified because a part of their life history includes a period of obligatory residence in the human alimentary tract, or because they induce pathologic changes in that site. Nutritional impairment is often associated with chronic intestinal parasites. Many factors determine the influence of parasitic infection on the host's nutrition.

Ascaris Lumbricoides

Infection with *Ascaris lumbricoides* is the most prevalent human helminthiasis with an estimated 1 billion cases world wide. These infections are more commonly found in preschool age children. Ascariasis in humans has a varied distribution and maintains a dominance in tropical and sub-tropical climates and also in temperate climates. In areas where there are predisposing factors such as poverty, inadequate sanitation, and high population density blended with favorable climatic conditions, *Ascaris lumbricoides* find its most favorable habitat (Stephenson, 1987).

Worldwide infections from *Ascaris lumbricoides* are found in higher percentages in Asia (73%), Africa (12%) and Latin America (8%)(Peters, 1978). However, in Latin America prevalence can go above 45%. During the last 50 years the prevalence of the major intestinal parasites such as *Ascaris lumbricoides*, has shown very little change (Botero, 1981).

Being a soil-transmitted infection, ascariasis depends on the dissemination of eggs under suitable environmental conditions. Humans become infected by the ingestion of embryonated eggs commonly through fecal contamination of food, water or other beverages, or eating utensils. Even though cooked food is usually safe, it can become contaminated after cooking. Young children may become infected by the consumption of clay, or by putting in their mouths objects contaminated with fecal material (Stephenson, 1987).

The enormous output of worms and their abilities to survive in unfavorable environmental conditions contribute to the endemnicity of Ascaris lumbricoides. Eggs have the capacity of remaining infective in soil for long periods and may survive temperatures of 5 to 10 degrees Celsius. Therefore, the transmission of the infection can occur throughout the year depending on suitable soil conditions (Nelson et al., 1983).

Life cycle and Development. Ascaris lumbricoides has a simple life cycle progressing from the egg to four larvae stages, then to immature worms, and finally to adult worms of both sexes (Stepheson, 1987). Within two or three weeks, the eggs develop in the soil. Each egg develops into a larval worm in the small intestine. The hepatic portal system allows the larvae to migrate to the liver and lungs where they further develop. Then they return to the small intestine and become sexually mature (WHO, 1987).

Clinical manifestations The symptoms of Ascaris lumbricoides infection include: debility, abdominal pain, persistent cough, pulmonary reaction, loss of appetite and weight, intestinal and biliary obstruction, and malnutrition. Several types of complication are associated with ascariasis. Intestinal obstruction may be produced by the bolus of worms, or adult worms may migrate from the small intestine into the bile and pancreatic ducts, respiratory passages, or appendix. These conditions may cause medical or surgical emergencies (WHO, 1987). *Ascaris lumbricoides* releases powerful allergens. Anti-ascaris IgE may induce hypersensitivity reactions, including respiratory symptoms, (asthma has been associated, but the relationship is not clear), skin rashes, and gastrointestinal disorders. Some patients have pulmonary manifestations (pneumonitis, Loffler's syndrome) caused by larva migration. The diagnosis of the infection is made by identifying eggs in feces or adult worms passed through the anus, mouth or nose.

Ascaris lumbricoides and malnutrition. Among the pathogenic effects attributed to *Ascaris lumbricoides* is the ability to cause nutritional disturbance in the host. Heavy infections in the tropical countries have been associated with kwashiorkor, stunting of growth, general undernutrition, and avitaminosis (WHO, 1987). Experiments with pigs infected with *Ascaris suum* showed that infection caused a significant reduction in food intake and rate of body weight gain, with impaired nitrogen balance and fat absorption and some degree of carbohydrate malabsorption including lactose intolerance. These results suggest that the nutritional status of children may be adversely affected during ascariasis particularly if their food intake is marginal in quantity or quality (WHO, 1987).

Clinical studies of *Ascaris lumbricoides* infection in humans, primarily in children, have shown increased loss of nitrogen in feces, decreased absorption of fat, carbohydrate, and nitrogen, and accompanying villous atrophy and impaired absorption of vitamin A. The first of these studies found that deworming of nine hospitalized infected Indian children, who harbored a mean of 26 adult worms, significantly reduced fecal nitrogen excretion in the children from a mean of 1.32 to 0.70 grams per day (Venkatachalam and Patwardhan, 1953). The authors also showed that neither the improved hospital diet, nor the eggs excreted, nor the effects of drugs used in deworming could have accounted for the decrease in nitrogen excretion. They concluded that even moderate burdens of *Ascaris lumbricoides* could be responsible for nutritionally significant losses of dietary protein in children receiving diets marginal in protein content.

A study conducted to assess nitrogen loss in five hospitalized Colombian children (Tripathy et al., 1972) who harbored a mean of 30 adult *Ascaris lumbricoides* and who were fed relatively low levels of dietary protein, found that fecal nitrogen after de-worming decreased by a mean of 6.5% of dietary nitrogen. Before deworming, four of five children exhibited mild to moderate steatorrhea. Three of the five children also had impaired D-xylose absorption which improved slightly in two cases immediately after de-worming. D-xylose is used as an index of carbohydrate absorption because it is rapidly absorbed by the small intestine and it is excreted unmetabolized in the urine.

A malabsorption syndrome also has been described in Ascariasis in a study by Tripathy et al., (1972). They stated that malabsorption associated with the adult ascariasis infection is accompanied by demonstrable intestinal mucosal abnormalities and that the lesion tended to disappear rather rapidly upon deworming. Not all studies agree, and some have found no significant relationship (Freij et al., 1979).

A study conducted in an agricultural area of south-central Louisiana (Blumenthal and Schultz, 1976) compared the nutritional status of 30 children infected with Ascaris lumbricoides with that of 30 uninfected controls matched for age, race, sex, and family income. Statistically significant evidence of an adverse effect of ascariasis on serum albumin levels and plasma vitamin C levels was found. Suggestive evidence of an adverse effect of the infection on weight for height and on riboflavin nutritive was also found.

Lactose is the only commonly consumed carbohydrate which has been conclusively shown to be affected by Ascaris lumbricoides infection in children. Studies in Panama of ascaris-infected preschool age children have shown a markedly decreased digestion of lactose, measured by breath hydrogen concentration. The decreased lactose digestion was related to the log of worm burden and was not present in age and sex-matched uninfected controls from the same community (Carrera et al., 1984).

Clinical studies show that ascariasis interferes with vitamin A absorption. Vitamin A absorption was studied in 28

Ascaris lumbricoides infected adults and 12 healthy controls (Mahalanabis et al., 1976). Over 70% of infected patients had malabsorption of vitamin A, also 70% of 23 infected patients who received a D-xylose absorption test had abnormally low values. Immediately after deworming, vitamin A absorption improved in 13 of the 14 patients re-tested, and D-xylose absorption increased in all five patients re-tested. Likewise studies in Panama have reported significantly lower plasma vitamin A concentrations in Ascaris infected compared with uninfected children (Taren et al., 1987).

Sivakumar and Reddy (1975), found that six *Ascaris lumbricoides* infected children absorbed significantly less of a test dose of vitamin A from the gut than did five control children (80% vs. 99% absorption). The percentage of the radioactive label excreted in the urine did not differ between groups, hence the infected children retained significantly less vitamin A than did controls (68% vs. 82%). None of the children had steatorrhea since stool fat content was less than five grams per 24 hours. Two of the infected children were re-tested two months after de-worming; vitamin A absorption improved from 83-86% to 95-96%. Only trace amounts of vitamin A label were found in excreted worms, indicating that sequestering of vitamin by the worms could not have caused the defect in absorption. The authors concluded that ascariasis may be aggravating vitamin A deficiency in areas where xerophthalmia is common.

Many studies have been conducted in relation to effects of ascariasis on growth and weight. Preschool children were studied in four villages in Uttar Padresh, where ascariasis and protein malnutrition were prevalent (Gupta et al., 1977). Infected children who took anthelmintic drugs showed a significant improvement in body weight gain after 8 months, ($p < 0.01$), when compared with similar children given a placebo. Willet and coworkers (1979) working in Tanzania with preschool age children known to be infected with Ascaris lumbricoides observed that the rate of weight gain in those given doses of Levimosole® every three months, over a period of a year, was 21% greater ($p < 0.03$) than weight gain in children given a placebo.

In a longitudinal study of growth in ascaris-infected and uninfected children conducted in Kenya, Stephenson et al., (1980), demonstrated a significant improvement in the children's nutritional status with deworming. Skinfold thickness increased ($p < 0.0005$) in previously infected children versus control. They concluded that even relatively light Ascaris lumbricoides infection may adversely influence nutritional status and that deworming might enhance growth in a similar community.

A study was conducted to assess the effects of ascariasis on the nutritional status of children in Brazil (Gupta, 1990). One hundred children, ages 24 to 72 months, who had a history of passing roundworms during the preceding 12 months, were compared with 100 children without such history. The two groups were matched by birth date, age, sex, and economic status. Children who had Ascaris lumbricoides were 2.1 cm shorter, 0.6 cm smaller for mid-arm circumference and 0.38 kg lighter in weight compared to children who did not pass Ascaris lumbricoides. The first two differences were statically significant ($p < 0.005$). Gupta concluded that ascariasis contributes significantly to malnutrition in communities where both co-exist and that periodic deworming should form part of community nutrition programs in areas where ascariasis is common.

The mechanisms underlying these improvements in growth and weight still are not fully understood. Other studies have not demonstrated a significant effect of deworming and growth. In Guatemala (Gupta and Urrutia, 1982), the use of Metronidazole® for the control of giardiasis was evaluated. A significant increase in the growth of undernourished preschool aged children was seen whereas antiascaris treatment had no effect. Also Greenberg et al., (1981), dewormed children in Bangladesh against Ascaris lumbricoides and reported no statistically significant differences between the treated and placebo groups. In Papua, New Guinea, preschool age children were treated with Pyrantel® each month and monitored for gain in weight, length, arm circumference and skinfolds for one year (Pust et al., 1985). Although the weight gain at the end of three months was greater for the 81 children receiving Pyrantel® compared with 222 control untreated children, these differences were not statistically significant.

There could be various factors that account for the failure of some deworming studies to provide positive growth results. These factors include sample size, the severity of malnutrition and ascaris infection in the population chosen, the experimental design, the data analysis, and the rate of successful drug treatment (Stephenson, 1987). It is not possible to attribute malnutrition to *Ascaris lumbricoides* alone; therefore, these findings should not be considered surprising. Many other variables exist like poly-parasitosis. Also communities have different economic and nutritional status, climates, cultural practices and availability of health care. Furthermore, in different regions of the world *Ascaris lumbricoides* may vary in pathogenicity.

Apart from the nutritional side effects, ascariasis could have other manifestations. Some of then have been tracked especially at the class room level such as nervousness and lack of attention and interest in classes. Statistically significant differences in the performance of children infected were found in a limited number of tests (Collis and James, 1968).

Trichuris trichura

This parasite is the cause of one of the most common worm infections in humans. Worldwide five hundred million cases are estimated to occur every year. Warm climates are very attractive for these infections even though they are also common in North America (Nelson et al.1983). Tropical and subtropical regions of Asia account for around 63% of the infected persons, while about 14% are found in the Americas, and 11% in Africa (Pawlowski, 1984). Even though infections have been reported in pigs, lemurs and monkeys, the principal host for Trichuris trichura infections are humans (Wolfe, 1978).

According to Bundy et al., (1987) the prevalence of Trichuris trichura infections in St. Lucia increased rapidly with age in early childhood, and staying relatively constant and high through adulthood. They also found on the island that the average worm burden suffered a significant decline in adults. In urban areas infection tended to be less common than in rural areas. This has also true for overcrowded and agricultural regions. Trichuris trichura infections are frequently found in multiple infections with other parasites such as Ascaris lumbricoides, hookworm and Entamoeba histolytica (Stephenson et al., 1980).

Life cycle and Development Because of its characteristic shape, the Trichuris trichura commonly is called "whipworm". It has a life cycle very similar to that of Ascaris lumbricoides, except that Trichuris trichura does not migrate through the bloodstream but is a hand to mouth disease. That is, in order for infection to take place, the infective eggs from the soil must be swallowed. Infections result from the ingestion of embryonated ova from contaminated hands, objects such as toys or sticks which have been contaminated by infected soil, or from food and drink contaminated directly or indirectly through domestic animals or flies (Malnutrition and parasite project, 1973).

Trichuris trichura eggs hatch in the intestine after man has ingested them. Then the larvae will normally penetrate the small intestine remaining there for about three to ten days and slowly moving down the bowel to mature into adult worms. The cecum becomes the final habitat (Nelson et al., 1983). In heavy infections, worms can often be found in the wall of the appendix, colon or the most posterior level of the ileum. Worms feed on the enterocyst syncytium, but may also ingest erythrocytes, leucocytes, mucosal tissue fluids and cells when they occasionally penetrate below the basic membranes of the enterocytes (Pawlowski, 1984). Diagnosis of the infection is made by identifying eggs in the feces or by sigmoidoscopic observation of the worms attached to the wall of the lower colon in some infections.

Clinical manifestations Children from 5-15 years of age have the highest rate of infections. Even when most of the persons infected are asymptomatic, there are some abdominal complaints. Colic and distension have been associated with the infections. An adult Trichuris trichura sucks an estimated 0.005 ml of blood/worm/day which means that a child heavily infected may develop anemia, bloody diarrhea and in some rare cases rectal prolapse (Nelson et al ,1983). In any case, the severity of the disease depends on the health status of the host, and not only on the intensity of the infection or its location in the gastrointestinal tract, and experience with past infections (Pawlowski, 1984). Trichuriasis syndrome has been associated with loads that exceed 500 worms; however, a severe disease could be initiated with a couple of hundred worms (Cooper and Bundy, 1986). When the infections are moderate, diarrhea, abdominal pain, nausea, and vomiting may cause lower food intake and higher loss of nutrients, therefore making children more prone to illness especially if they are malnourished (Holland, 1987).

Rectal prolapse which has been described in trichuriasis may be a consequence of either straining at defecation in the presence of massive numbers of worms and/or the possible irritation of nerve endings with increased peristalsis (Ramirez-Weise, 1971). Massive infections may lead to degeneration and coagulation necrosis of the mucosal cells nearest to the worms, inflammation and sub epithelial hemorrhages, and at times extensive infiltration of lymphocytes, plasmocytes and eosinophils into the area (Wolfe, 1978). Also there may be various allergic reactions to the presence of whipworm in the body due to toxic secretions from the worm itself. The penetration of whipworm may facilitate invasion of the intestinal mucosa by bacteria and parasitic protozoa, such as Entamoeba histolytica which also may lead to peritonitis as well as other secondary infections (Malnutrition and parasite project, 1973). Many worms matted together may block the lumen of the appendix or cause inflammation and irritation of the epithelium of the cecum, appendix and colon leading to appendicitis, colitis and proctitis. These conditions may contribute to further diarrhea.

The parasite derives nourishment from the infected individual either by liquefying the cells of the mucosa with its secretions or by sucking blood or blood-letting by hemorrhage from the intestinal lining. In moderate to severe infection with the Trichuris trichura parasite, this blood loss may lead to anemia (Holland, 1987). It is not clear how much blood is sucked by the worm and how much loss occurs as a consequence of bleeding lesions in the colonic mucosa.

Trichuriasis and Malnutrition. An association has been described between heavy infection with Trichuris trichura and anemia, protein-energy malnutrition and chronic diarrhea and dysentery. When diarrhea, hypoalbuminemia and iron deficiency anemia are observed in association with the presence of parasites, it is very possible that there would be a chronic impairment of the nutritional status of the person (WHO, 1981).

Getz (1945) described trichuriasis in four children who died with severe anemia. The numbers of Trichuris trichura found at autopsy were 1100, 1700, 1100 and 400; 140 hookworms were also found in one of the children. It was stated that trichuriasis could be responsible for the anemia in at least 3 cases. A comparison between the degree of anemia and the degree of infection with Trichuris trichura was made by Otto (1935), who performed blood tests and eggs counts on 550 children from 5 to 14 years of age. Otto found no difference in the blood hemoglobin concentrations among the group with negative stool examinations (11.2 g/dl), the group having infection from 1 to 2,500 eggs per g of feces (11.4%), and the group which he considered heavily infected with more than 2,500 eggs (11.5 g/dl).

Wong and Tan (1961) studied 20 heavily infected children in Singapore. They reported that all children were severely anemic: 10 had a hemoglobin level less than 8.8 g/dl, 7 were below 6 g/dl, and 3 below 3 g/dl. The anemia was apparently due primarily to bleeding from the rectum since sigmoidoscopy demonstrated that 19 of the 20 children had bleeding ulcers in the rectal mucosa. In more recent studies, fecal blood loss was measured with Cr in nine children with various degrees of infections with Trichuris trichura. The children were found to lose about 0.0005 ml of blood per worm per day, about 6 to 10 times less than from Necator americanus, and 30 to 50 times less than loss from Ancylostoma duodenale. Patients infected with Trichuris trichura lose about 0.8 ml of blood per million eggs per day and about 0.25 ml per thousand eggs per gram of feces. Infections of over 800 parasites producing more than 5 million eggs per day apparently induce anemia in children (Layrisee et al., 1967).

Greenberg and Cline (1979) studied 86 relatively lightly infected and 27 uninfected Puerto Rican children. They concluded that Trichuris trichura was not associated with iron deficiency anemia, even though they observed a significant inverse relationship between hemoglobin levels and egg counts

($p < 0.05$). Their conclusion was based on the fact that serum iron and transferrin saturation were not correlated with egg counts. Dietary information for 24-hour recalls showed that the mean dietary intake of iron, (13.6 mg per day), was reasonably adequate. Therefore it does seem reasonable to conclude that trichuriasis was not associated with anemia in this study.

In light infections, blood loss from Trichuris trichura can be considered practically negligible in terms of iron loss. Nevertheless, in heavy infection (more than 5 million eggs per day and more than 800 parasites), blood loss may reach 4 ml per day, which represents more than 1.5 mg of hemoglobin iron loss, when the hemoglobin in the peripheral blood is more than 12 g/dl. Nonetheless, the amount of daily hemoglobin iron loss due to trichuriasis that could induce iron deficiency anemia would vary from one person to another according to diet, physiologic blood loss (such as menstruation), and requirement for growth and hemoglobin formation (Layrisee et al., 1967). Given these results, it is natural to conclude that more studies are needed to provide adequate answers to all the questions related to anemia and trichuriasis, especially well-designed longitudinal studies.

Studies show that heavy infections with Trichuris trichura contribute to protein-energy malnutrition in children and that growth rate improves following treatment. The association between heavy Trichuris trichura infection and Entamoeba histolytica infection was studied (Gilman et al., 1976). Serum albumin was significantly low in both infected groups. Trichuris trichura infection was responsible for the complex severe diarrhea, anemia, malnutrition, clubbing of the fingers, rectal prolapse and coexistent infections. In a study of three groups of children in Malaysia, aged 8-12 years, 39 were heavily infected with Trichuris trichura, 33 had Entamoeba histolytica, and 44 were healthy controls. Children with severe trichuriasis had a significant number of previous hospitalizations because of diarrhea and rectal prolapse, and their hematocrits were significantly lower. It is the chronicity of heavy Trichuriasis infections and diarrhea that provoke the syndrome as opposed to the more acute symptomatology associated with Entamoeba histolytica (Gilman et al., !976).

Bowie et al., (1978) treated ten children aged 2 1/2-10 years with moderate infections of Trichuris trichura and reported increases in weight gain and regression of clubbing after treatment. The authors concluded that generalized malabsorption was not a major factor in the infections and that the weight gain on treatment was likely due to the more nutritive diet in the hospital, to improvements in appetite following treatment for iron deficiency, and to the cessation of diarrhea.

Protein energy malnutrition and the symptoms associated with trichuriasis and growth stunting were studied in a village of St.Lucia (Bundy et al, 1987). The children who were most heavily infected exhibited significant increases in stool frequency, presence of blood and mucus in the stool, and greater growth deficits compared with the rest of the population. Low height-for-age was more strongly associated with trichuriasis than was low weight-for-age. Of course these results are not conclusive, and more research is needed in relation to trichuriasis and growth stunting. The impact of Trichuris trichura on the health and nutrition of children needs to be more deeply evaluated, especially because of the high prevalence of the parasite in areas of the world where malnutrition is also prevalent.

Hookworm infections

Two species of hookworms which infect man are Ancylostoma duodenale and Necator americanus. Ancylostoma ceylomicum, Ancylostoma Brazilense and Ancylostoma caninum are rarely found in humans. Infection is endemic in temperate, subtropical and tropical areas of the world. Although there are no recent estimates of their prevalence, hookworms are thought to infect more than 900 million people (Nelson et al., 1983).

The most common human hookworms are the Ancylostoma duodenale and the Necator americanus. Europe and areas bordering the Mediterranean, the Middle East, North Africa, the West Coast of North America, parts of Pakistan, and Northern India are the places where Ancylostoma duodenale is most predominant. Necator americanus is the only human hookworm which is exclusively found in North America, Central Africa, Southern India, Indonesia and the South Pacific. Both species have been found in certain parts of Brazil, parts of India, Africa and all over South-Asia (Holland, 1987).

Man is the primary host for the three species of hookworms. Endemnicity of infection in any specific geographic location depends on suitability of environmental conditions for hatching of eggs and maturation of larvae, on fecal contamination of soil, and on human contact with contaminated soil. The optimal conditions for survival of hookworm larvae in soil include good aeration, moderate moisture, and temperature ranging from 23-33 degrees Celsius. These conditions are found in many parts of agrarian tropical countries and also in the southeastern part of the United States.

Infections with hookworm affect children more frequently than adults. In a study made in an endemic area, half of the children were infected before age 5, and 90% were infected by age 9. Intensity increases up to age 6-7, then stabilizes for a few years. Newly infected children acquire a mean of two female worms and have a net gain of 2.7 parasites/year (Nelson et al.,1983).

Men have higher levels of infection than women. This difference may be caused by women's reduced exposure to infected soil. According to a household survey done in southeastern Georgia, USA, hookworm was present in males twice as frequently as in females (Martin, 1972). Furthermore, southern white males have significantly higher levels of parasites than their black socio-economic counterparts. The reason for this difference is unknown.

Life cycle and development. Hookworm eggs which have been deposited in the soil with the stools of infected individuals incubate in the warm, moist soil and develop into first-stage (rhabdetiform) larvae. These larvae continue to develop through a second stage (strongylaform) into a third stage (filariform) which is infective. These infective larvae which can survive in the soil for several weeks have the capacity to penetrate human skin (especially the soft skin between fingers and toes). The larvae penetrate the body through the skin and invade the tiny blood vessels close to the skin surface. If certain bacteria enter the body with the larvae, an irritation called "ground itch" may occur. From there, the larvae go straight into the blood stream and migrate through the lungs to the final destination the small intestine. There the grayish yellow adult worm attaches itself to the intestinal lining through the buccal capsules and begins to digest away the tissue. This digestion of the infected person's tissue may cause bleeding, ulcers, and in the case of heavy infection, anemia. The worm secretes an anticoagulant which prevents the clotting of blood and makes it easier for them to suck blood from the intestinal tissue. Each adult worm is said to cause the loss of approximately one milliliter of blood per day. The hookworm has a life span of four to five years inside the human body.

Ingestion of contaminated water also causes infection. A person can swallow Ancylostoma duodenale larvae along with uncooked vegetables. The larvae's development takes place in the gastrointestinal tract. Necator americanus behaves differently since a percutaneous entry as well as a phase in the lung is essential for its development. Diagnosis is made through the examination of feces to identify the eggs.

From Japan there is some evidence of transmammary transmission of Ancylostoma duodenale (Banwell and Shchad, 1978). The low level of occurrence of transmammary transmission reported may be because of a lack of research on this topic (Holland, 1987).

Clinical manifestations Cutaneous invasion which is the first stage of the infection results in symptoms such as a dermatitis of short duration and other nonspecific symptoms, known as "ground itch". There is a varied number of symptoms that have been associated or attributed to the intestinal phase of hookworm infection. Among these are loss of appetite, indigestion, diarrhea and abdominal pain. These association are primarily based on observations or experimental analysis of infections in persons with heavy worm loads. However, no adequate controlled community studies have been undertaken to document the occurrence of specific abdominal symptoms in natural hookworm infections. Chronic hookworm infection has some significant consequences including edema, anemia and hypoalbuminemia. Statistically there is a significant inverse correlation between intensity of the infection and the hematologic values (Nelson et al.,1983).

Hookworm and Malnutrition The most important nutritional impact of the infection on the host is anemia, due to the presence of adult worms in the small intestine and the blood and iron loss that the worms cause. The symptoms and clinical signs are those of iron deficiency anemia, and include lassitude, breathlessness, palpitations, tinnitus, headache, mental apathy and depression. Gastrointestinal symptoms are reported to be relatively rare. In addition to a low hemoglobin level, iron deficiency anemia is accompanied by low mean corpuscular volume, elevated free erythrocyte protoporphyrin, low transferrin saturation, and low ferritin levels. Cardiological symptoms can develop from severe anaemia and include dyspnea, palpitations and cardiac pain and edema. It is not clear if these conditions are related primarily to inadequate intake of protein or to the protein-losing state as a consequences of blood loss and damage to the intestinal mucosa.

There have been several studies that have measured intestinal blood loss in chronic hookworm infestation. These indicate general positive correlation between worm load and blood loss, but other factors appear to have some influence. Four important factors need to be taken into account (Roche and Layrisse, 1966). First, the sample size needs to be large due to high individual variations; second, the individuals studied need to include those with both light and heavy infections; third, detailed statistical analysis is needed, and fourth, quantitative determinations need to be made both of hemoglobin levels and either worm loads or egg counts. Other anemia-producing factors such as dietary deficiencies also must be taken into account so that they do not obscure the picture.

Martinez-Torres et al., (1967) suggested that blood loss may increase in the presence of markedly low hemoglobin level. Even small hookworm burdens may be sufficient to lower hemoglobin in a vulnerable group in which iron losses or requirements are high and the reserves low. They studied 54 subjects infected with Necator americanus and suffering iron deficiency anemia. All were free of other hematological disorders. Daily fecal blood loss was estimated to be 0.0031 ± 0.0015 ml. The correlation between fecal blood loss and eggs per gram of feces was highly significant in the 34 subjects.

It is now clear that an individual with a high dietary intake of utilizable iron and good iron stores can harbor a relatively high hookworm load for some time before becoming anemic. In contrast, a person with a diet marginal in its iron content and who has low iron stores may rapidly become anemic with a relatively small hookworm load (Holland,1987). Anemia associated with hookworm infection usually responds rapidly and dramatically to the administration of ferrous sulfate or other suitable iron therapy by mouth.

Estimates of intestinal blood and iron loss occurring in hookworm-infections are for Necator americanus approximately 0.03 ml of blood per day and for A. duodenale as much as 0.15 ml per worm per day. Because only about 10 percent of iron consumed in food typically is absorbed into the body, in tropical areas a person with a light hookworm infection must consume at least 13 mg of extra iron per day if affected with *Necator americanus* infection.

Some studies have analyzed the absorption of fat, carbohydrate, vitamin A, vitamin B12, and folic acid in hookworm infected patients. The study of 14 anemic hookworm infected patients in Puerto Rico showed evidence of a causal link between hookworm and malabsorption syndrome (Sheehy et al., 1962) Malabsorption syndrome of fat, carbohydrate, and vitamin A was detected in most patients. Biopsies showed that villi were usually shorter and broader than normal with widening at the tips, and the natural convolutions on the side were lost. All specimens exhibited chronic inflammation of the lamina propia. After treatment most biopsy specimens were normal. In contrast to these results, ten studies from Egypt, Uganda, Nigeria, India, Pakistan, Venezuela and Puerto Rico found little or no evidence for malabsorption of fat or carbohydrate in patients with hookworm infection of varying intensities (Holland, 1987).

Mayoral et al., (1967) studied 15 Colombian subjects and illustrated that regression of intestinal mucosa abnormalities occurred after protein repletion but without treatment for the parasites. It has been found that the majority of the studies show that infection with hookworm is not usually associated with a malabsorption syndrome (Holland, 1987).

Protein loss in hookworm infection could occur because of decreased intake, decreased absorption, increased excretion or a combination of these. Intestinal protein loss in hookworm infection has been measured using fecal nitrogen excretion and also isotopic tracer techniques, in which albumin or plasma are labelled with ^{125}I, ^{131}I, ^{51}Cr or ^{95}Nb. Gupta and co-workers (1974) using ^{51}Cr labelled proteins, found that albumin loss in eight Indian patients with light infections did not differ significantly from two uninfected controls but that protein loss was elevated in one more heavily infected individual.

Some studies have found that albumin and protein loss increased with increasing worm burden or egg count; but the extent to which the albumin losses are due to blood loss itself or to abnormal leakage of plasma as part of protein-losing enteropathy is not clear and cannot be established until double labelling techniques of serum protein and red cells respectively are used to measure the proportion of each component lost (Miller, 1979). This topic deserves further study.

The relation of growth-stunting and hookworm infection is unknown. Stephenson et al., (1985), working in Kenya, reported significant improvements in the growth rate of children following treatment with Metrifonate® for schistosoma and hookworm. The degree of growth improvement correlated positively with the decreases in hookworm egg counts after treatment. If iron deficiency anemia by itself causes anorexia, then hookworm anemia which is mainly due to iron deficiency could easily lead to anorexia and poor growth. In addition, since mental performance has been found to be much lower in anemic school children and to improve following iron therapy, hookworm anemia may have a substantial effect on children's learning ability and hence, on their functional capabilities as adults in endemic areas. Also the ability to perform work and the earning capacity of male and female rural workers is seriously reduced by even moderate anemia (Wolgemuth et al., 1982).

Entamoeba histolytica

This is a parasite that can be found all over the world. Entamoeba histolytica, a protozoa can results in a disease commonly knwons as "amoebiasis". The parasite exists in two forms: the infective cyst and the trophozoite form. In Latin America, especially Mexico and in others parts of the world including South-East, China, Eastern and South Africa, invasive amoebiases is considered a serious health and social problem. The presence of poor sanitary conditions in these areas combined with the presence of highly virulent strains of Entamoeba histolytica may account for the high level of incidence of amoebiasis and amoebic liver abscess (WHO, 1985). This infection has been ranked on a global scale among the top three most important cause of morbidity and mortality, second only to malaria and schistomiasis. Walsh reported that in 1982, 480 million persons were infected every year, which is around 10 percent of the world's population. Roughly 50 million are thought to develop symptoms of amoebic dysentery or of hepatic amoebiasis, the latter being asymptomatic.

The percentage of amoebic infections varies in different parts of the world from 5% to 81%. The outcome of the infections also varies in different parts of the world. Clinical complications due to the infections are less common in children than in adults (Nelson et al., 1983).

Man is the natural host and reservoir of Entamoeba histolytica; primates and laboratory animals may be infected. The outcome of amoebic infection varies in different parts of the world. For example, infection acquired in India, Mexico, or South Africa is more virulent than that from other locations. The definition of virulence, geographic strains, and pathogenicity of different amoeba, however, is not clear (Nelson et al., 1983).

Infections by Entamoeba histolytica in the Dominican Republic prevail since the colonial times. This dysenteric agent was found in 14% of people who underwent medical examination in Santo Domingo and had an incidence of 8% in patients with dysenteric diarrhea as well as patients with acute diarrhea (Mendoza et al., 1981). Studies in the bordering provinces in the south east of the country found a frequency of Entamoeba histolytica of 25% (Mendoza et al., 1981). Some investigators found an average prevalence of 13% among all the studies reviewed (Mendoza et al.,1981).

The incidence of Entamoeba histolytica infection is higher in rural than in urban areas. The lower socio-economic classes show a greater incidence of infection than higher classes, probably because of malnutrition diseases, overcrowding and unsanitary conditions. Malnutrition, particularly vitamin C deficiency, leads to increased susceptibility and severity of the disease (Malnutrition and parasite project, 1973). Amoebiasis is more closely related to sanitation and socio-economic status than to climate.

Most evidence points to contaminated water as the main vehicle of transmission of amoebiasis. Water supplies, which in small communities are often exposed to contamination by sewage, may serve to spread the infection. The distribution of amoebiasis is also related to contamination of food. Infection may be acquired by eating raw vegetables which may have been contaminated by night soil used as fertilizer. Flies have been shown to carry cysts in their legs or deposit these cysts in their own fecal material. Thus food left uncovered may be contaminated by these insect vectors. In general, the rate of infection is higher in areas with poor sanitation, such as parts of the tropics, in mental institutions and among sexually promiscuous homosexuals. In areas with good sanitation, amoebic infections tend to cluster in households or institutions.

Life cycle and Development. There are two stages in the life cycle of the Entamoeba histolytica, the parasitic trophozoite stage and the infective stage. Entamoeba histolytica invades the intestinal mucosa while in its trophozoite stage. Tissue damage is produced with little inflammatory response within the local area. Under the intestinal epithelium, the organism can multiply spreading to the sides and producing flat shaped ulcers. The damage can be seen in the cecum, transverse and sigmoid colon. The same lesions can be produced in the liver. Entamoeba histolytica occasionally disseminates to other extra-intestinal sites such as the lungs, liver and brain. The contrast between the extent of tissue destruction by the parasites, the absence of a local host inflammatory response, and the demonstration of systematic humoral antibodies against the organism is still unknown (Nelson et al., 1983). Diagnosis is made by the examinations of fresh feces for trophozites or cysts. In case of invasive intestinal amoebiasis the indirect hemagglutination test is recommended.

Clinical manifestations. Most infected individuals are asymptomatic with the only evidence of infection being the cysts found in their feces. Invasion of the host occurs in 2 to 8% of infected individuals and may be related to the strain of parasite. The major host factors contributing to the unpredictability of amoebic infections in man are: the physico-chemical environment in the gut under the influence of, for example, the bacterial flora, mucus secretions and intestinal mobility, and the degree of immunological resistance/specificity. Antiamoebic antibodies are produced when tissue invasion occurs. Immune serum produces rapid lysis of Entamoeba histolytica trophozoids in vitro. Accumulated experimental evidence strongly suggests that cellular immunity plays an important part in controlling the recurrence of invasive amoebiasis (Sepulveda and Martinez-Palomo, 1982).

The most common clinical manifestations of amoebiasis are due to local invasion of the intestinal epithelium and dissemination to the liver. For intestinal amoebiasis the onset is usually gradual with colicky abdominal pains and frequent bowel movements. Diarrhea is frequently associated with tenesmus, dysentery with bloody and mucous stool with few leukocytes, and alterning episodes of diarrhea and constipation to severe invasive disease producing necrotic ulcerations throughout the colon, abdominal tenderness and even colonic perforation and peritonitis. In general, there are no fevers or other systemic manifestations and the symptoms disappear after a few days of treatment or even spontaneously. The existence of chronic intestinal amoebiasis, as a clinical entity characterized by a prolonged course, or tendency to recur, non-specific bowel or general symptoms and associated cellular infiltrations of intestinal mucosa, still require confirmation.

There are three forms of clinical severe intestinal amoebiasis: 1) fulminating amoebic colitis, 2) amoeba of the colon, and 3) amoebic appendicitis, all more common in adults than in children. The most common extra-intestinal form of invasive amoebiasis is amoebic liver. Hepatic amoebiasis is a very serious manifestation of disseminated infections. It occurs in fewer than one percent of infected individuals and may appear in patients with no clear history of intestinal disease. In children fever is the hallmark of amoebic liver abscess. It is frequently associated with abdominal pain, distension, and an enlarged tender liver. The less common extraintestinal forms of invasive amoebiasis are cerebral abscess and skin amoebiasis.

In many regions amoebiasis is an important cause of diarrhea and dysentery. In Mexico City up to 15% of cases of acute diarrhea and dysentery in children requiring hospitalizations were found to be associated with Entamoeba histolytica. In women amoebiasis may be more severe during pregnancy and lactation (WHO,1987).

Entamoeba and malnutrition. Entamoeba histolytica, like all parasites, absorbs and engulfs nourishment from its host. It also ingests red blood cells, hemoglobin, bilirubin, fragments of tissues, and bacteria by encircling and engulfing them. (Malnutrition and parasite project, 1973). Studies in humans indicated that malnutrition may be a factor predisposing to amoebic disease. In addition, some evidence suggests that individuals taking diets poor in protein and relatively high in energy content are particularly susceptible. Interpretation of these findings is somewhat difficult since the disease itself may lead to impaired nutritional status.

In animal studies protein deficient rats were more susceptible to amoebic infection and carbohydrate supplementation enhanced this effect. In guinea pigs diet also alters susceptibility to infection. Deficiency of vitamin C and nicotinic acid also increase susceptibility to infections in animal models (Sadun et al.,1952).

Faust's (1938) study of malnourished individuals in Colombia suggested that a combination of protein deficiency and carbohydrate malabsorption permitted colonization by Entamoeba histolytica without manifestation of clinical disease. Amoebic infection may also be inhibited in the presence of iron deficiency. The lack of available iron in the host may directly affect parasite growth since Entamoeba histolytica has a substantial iron requirement. These studies indicate that amoebic infection and nutritional deficiencies may interact in an antagonistic way. The results of the different studies showing the relationships among parasites and nutritional status discussed in this chapter are summarized and presented in Table I.

Anthropometric Measurements

In the nineteenth century a technique known as "anthropometry" was developed by anthropologists to quantify human differences in form by using simple measuring devices. The anthropometric methods for assessing nutritional status were first done by Richer in the latter part of the nineteenth century. He used skinfold thickness as an index of fatness. During World War I the modern era of nutritional anthropometry was begun by Matiegka who developed anthropometric methods dividing the human body into muscle, fat and bone (Heynsfield et al., 1994).

TABLE I
SUMMARY OF NUTRITION AND PARASITE STUDIES IN CHILDREN*

Ascaris

Authors	Year	Location	Study Population	Methods	Conclusions
Venkatachalam and Patwardham	1953	India	9 hospitalized children	Clinical Studies	Even moderate burdens of A. lumbricoides could be responsible for nutritionally significant losses of dietary protein in children receiving marginal diets in protein content.
Tripathy et al.	1972	Colombia	5 hospitalized children	Clinical Studies	Fecal nitrogen after deworming decreased.
Freij at al.	1979	Ethiopia	6 piperazine treated and 7 placebo treated children	Clinical Studies	No significant differences between groups in relation to nitrogen, fat, and xylose absorption.
Blumenthal and Shultz	1976	South Central Louisiana	30 infected children with A. lumbricoides and 30 uninfected	Clinical Studies	Statistically significant evidence of an adverse effect of Ascaris on serum albumin levels and plasma vitamin C
Carrera et al. Taren et al.	1984	Panama	Ascaris infected preschool age children and age-sex-matched uninfected controls	Clinical Studies	Markedly decreased in digestion of lactose
Mahalanabis et al.	1976	India	28 Ascaris infected adults, and 12 healthy controls	Clinical Studies	Infected patients had malabsorption of Vitamin A, which improved immediately after deworming
Sivakumar and Reddy	1975		6 ascaris-infected children and 5 control	Clinical Studies	Infected children absorbed significantly less vitamin A
Gupta et al.	1977	India	154 undernourished pre-school children	Longitudinal Clinical Studies	Increased in weight for age after deworming
Willet et al.	1979	Tanzania	341 pre-school children	Intervention Studies	Ascaris infected children showed weight gain and an increase in skinfold thickness after deworming
Stephenson et al.	1980	Kenya	186 pre-school children	Intervention Studies	Ascaris infected children showed weight gain and an increase in skinfold thickness after deworming
Gupta	1980	Brasil	100 infected pre-school	Clinical	Ascaris contributes significantly to malnutrition in

Cont. Table I

			children and 100 uninfected children	Studies	communities where both co-exist
Gupta and Urrutia	1982	Guatemala	159 pre-school children	Clinical Studies	No significant increase in height and weight gain in children receiving piperazine
Greenberg et al.	1981	Bangladesh	182 children	Clinical Studies	No statistically significant differences between treatment and placebo group in growth rate
Pust et al.	1985	Papua, New Guinea	81 infected pre-school children 222 control untreated children	Clinical Studies	No statistically significant differences between groups in weight gain
T. trichura					
Getz	1945	Panama	4 dead children	Retrospective	Trichuriasis could be responsible for the anemia at least in 3 cases
Otto	1935	Louisiana	550 children aged 5-14 years	Clinical Study	No association of trichuriasis with anemia
Wong and Tan	1961	Singapore	20 parasited children	Clinical Studies	All children were severely anemic
Layrissee	1967	Venezuela	9 infected children	Clinical Studies	Heavy infection of over 800 worms can cause iron deficiency anemia in children
Greenberg and Cline	1979	Puerto Rico	80 infected children 27 uninfected	Clinical Studies	Trichuriasis was not associated with iron deficiency
Giliman et al.	1976	Malaysia	39 infected with Trichuris 33 infected with E. histolytica 44 healthy controls	Clinical Studies	T. Trichura is responsible for the complex of severe diarrhea, anemia, malnutrition, clubbing of the fingers and rectal prolapse
Bowie et al.	1978		10 children aged 2.5 to 10 years	Clinical Studies	Generalized malabsorption was not a major factor in the infection
Cooper and Bundy	1984	St. Lucia	260 children	Clinical Studies	The results imply that trichuriasis and the associated dysentery led to the observed growth stunting

Cont.Table I

Hookworms

Sheehy et al.	1962	Puerto Rico	14 anemic children	Clinical Studies	Strong evidence between hookworm and with hookworm malabsorption syndrome, of carbohydrate, fat and vitamin A
Mayoral et al	1967	Colombia	15 subjects	Intervention Studies	Regression of intestinal mucosal abnormalities occurred after protein repletion but without treatment for the parasites
Gupta et al.	1974	India	8 patients 2 uninfected controls	Clinical Studies	Albumin loss did not differ significantly from control but protein loss was elevated in most heavily infected individuals
Stephenson et al.	1985	Kenya			Significant improvement in growth rates of children following treatment with metroifonale

* Compiled by Dr. Digna de la Cruz-Ibert

In the evaluation of physical growth, anthropometry is presently widely accepted, as it is also used for evaluating the nutritional status of individuals and population groups. The advantage of anthropometry is that the available methods are simple, inexpensive and noninvasive. Nutritional anthropometry was first used in young people to estimate the body composition. However, it has also been used for the same purpose in other age groups. Of these, infants and preschool age children have been given priority attention since protein calorie malnutrition is more prevalent and more severe at this age. Anthropometric measurements are also used for the surveillance and monitoring of the nutritional situation in a country or a community.

Workers at various stage have introduced a number of indices. The most commonly known are based on weight, height, arm circumference and skinfold thickness. These measurements can be combined to form useful indicators of nutritional status, usually used along with sex and age, as in weight for age or height for age, and sometimes in combination with each other as in weight for height. The following discussion will be limited to those anthropometric indices which were used for research in this thesis.

Age. Where there is general registration of births and ages are known, the recording of age is a straightforward procedure. When age is not known, different techniques have been used to estimate ages. The technique chosen will influence the presentation of the nutritional status data on population groups.

The importance of age of the individual for the interpretation and use of anthropometric measures has been emphasized in some research. The causes of growth failure are generally age-specific and the required intervention often depends upon age. The method of reporting results should take into account the purpose of the survey and be sensitive to the impact of age interpretation. The decision on age ranges must reflect both the intended uses of the data and the resources available to collect and analyze it.

Height and weight. These are the two simplest measurements that can be taken to assess the nutritional status of a population. However, they need to be adequately standardized to avoid bias and errors in their recording. The appropriate training of health workers in the use of measuring apparatus and scales has been part of the measures taken to address error. Even when the health workers are properly trained, it is advisable whenever possible to rotate them among groups of subjects to be measured to reduce the effects of individual bias (WHO, 1983). It is recommended that infants and children under 2 years of age, be measured while lying down, since the measurement of standing height is inaccurate with an uncooperative child.

Weight-for-age The measurement of body weight is a simple and a common assessment of growth. In the past, nutritional acute and chronic or present and past malnutrition. Height-for-age can be used as an indicator of past and chronic malnutrition. The primary disadvantages of height for age are 1) the deficits in height take some time to develop, 2) deficits may not be manifest in acute infant malnutrition, and 3) deficits found in infants or young children may be the consequence of small size at birth rather than indication of postnatal malnutrition (Keller, 1976).

For children under two years of age, length-for-age is used. Genetically determined differences are partly responsible for the differences in height found in age groups in any population, even though it is accepted that differences in height are more due to environmental than genetic causes.

Weight-for-Height. Weight-for-height is an index of current nutritional status. Also it is a measure of body proportions and should be relatively free from genetic differences in absolute body size, particularly for children age 1-5 years. For the evaluation of benefits in intervention programs, weight-for-height is also useful since this index is more sensitive to changes than the height for age index. The disadvantage of this index is that it may classify children with poor linear growth as "normal." This index is frequently used as well in nutritional assessment of hospital patients for the identification of malnutrition. Seoane and Latham (1971), suggested that it was important to distinguish different types of protein energy malnutrition (PEM) on the basis of weight and height measurements of children. They identified three categories: a) acute, current, short-duration malnutrition: weight-for-age and weight-for-height are low, but height-for-age is normal; b) past chronic malnutrition: weight-for-age and height-for-age are low, but weight-for-height is normal; and c) acute and chronic, or current long-duration malnutrition: weight-for-age, height-for-age, and weight-for-height are all low.

Arm circumference. Arm circumference was introduced as an index of malnutrition by Jelliffe and co-workers in 1969. They developed it for use in evaluating undernourished children in field research. Arm circumference is reduced in severe malnutrition and it identifies effectively cases of severe malnutrition in a population. Arm circumference is considered to be age independent. In a population of children between the age of one and four years it shows little increase. However, the measurement is not strictly independent of age. There is no need to know the exact age but an approximate categorization is required. Retardation refers to the relation that exists between a given value and age, therefore an age-independent estimate of retardation is not possible. However, more or less valid age-independent estimates can be obtained by ratios of two measurements other than age. Weight-for-height is the most clear example (Waterlow, 1972).

The method for the assessment of arm circumferences is fast, simple and requires no sophisticated equipment. However, the right measurements of arm circumference require not only the careful training of the field workers but also repeated standardization (United Nations, 1972).

Arm circumference measurements have been used as an indicator in several areas. For instance, the Quack Stick index was used in Nigeria and Bangladesh in relief operations for a quick classification of malnourished children, and studies in Bangladesh showed that it can be used to predict mortality (Shakir, 1974).

The ratio of arm circumference to head circumference has been proposed as a measure of malnutrition probably independent of age (Shakir, 1974). It has been agreed that the ratio of arm circumference to skinfolds thickness provides information that cannot be gotten in any other way. It distinguishes between a thin muscular child and an apparently well-nourished but flabby one.

<u>Triceps Skinfold</u> This measurement is called "fatfold" thickness, because it represents the thicknesses of double folds of skin and subcutaneous adipose tissue at specific sites of the body. The measurements of skinfold thickness will normally provide an estimate of the size of the subcutaneous fat depot, which in turn provides an estimate of the total body fat.

It is important to note that not all outer fat sites are equally good for measuring; there are around half a dozen sites usually selected. The triceps and biceps skinfolds are popular because the sites ordinarily protrude from the usual clothing.

Age changes, sex differences and individual compressibility at each site and their meaning are but some of the technical problems that need to be considered when using skinfold measurements. In some cases the skinfolds measurements at a single site are used to evaluate the total body fat or the percentage of body fat. Roche et al.,(1981) emphasized that the most appropriate skinfolds sites also depend on whether total body fat or percentage of body fat is the parameter of interest.

In general the triceps skinfold thickness has been the site most frequently selected for a single skinfold to assess total body fat. The triceps skinfold appears to be especially suitable for the assessment of percentages of body fat in women and children. The measurement of triceps skinfold has been used successfully in field projects to evaluate response to nutrition intervention programs or any health intervention programs. For example, it has been used to evaluate the effect of deworming in preschool children (Stephenson et. al, 1980).

<u>References Standards</u> The nutritional status of a population, particularly infants and young children, has been evaluated by using nutritional anthropometry as a tool. However, there is no agreement upon the point of cut-off to be used in assessing the prevalence of malnutrition in a population survey. Indicators can be established based on the

local growth reference population or international growth references. No matter what reference population is used, it will serve as an indicator against which an individual nutritional status measures can be compared to the references median. Such measures can be expressed in at least three ways: as a percentage of the reference median, as percentile and as proportion of the standard deviation.

Based on studies that have been conducted, it is agreed that ethnic differences play an insignificant role in the actual growth performance of populations when compared to the much greater influences of nutrition and diseases. The growth status of children can be compared to a reference population; it is also advantageous to evaluate anthropometric status in both population studies and surveillance program.

In 1977 the World Health Organization made a recommendation to adapt the NCHS (National Center of Health Statistics) population as a reference for international uses. Then in 1978 WHO recommended that a single anthropometric growth reference be used both for individual child growth monitoring and for assessing the nutritional status of populations (WHO, 1978). The international reference provides a common basis for evaluating child growth by primary health workers. It also provides nutrition investigators with a common external reference derived from a well documented data base. Moreover, its use has promoted standardization of the analysis of anthropometric data and the development of computer programs (Jordan, 1986).

The method is based on comparing the distribution of the indicator with that of the normalized NCHS reference population. It is assumed that the distribution of the indicator and that of the normalized NCHS are nearly normal. The proportion of cases in the observed that is outside the normal distribution of the references values are defined as "standardized prevalence". These can be estimated by the means and the standard deviation of the so called standardized Z-score of the population. The formula used for this is based on the mathematical properties of the normal probability curve (Mora, 1989).

Three biological considerations have a major impact upon the use and interpretation of anthropometric indices. First the interpretation of length varies with the age of the subject. Second, the indices of weight in relation to length reflect current under- or overnutrition regardless of age. And the third principles is that achieved size in children may be seen as a marker of relationship of the environment in which growth failure occurred and as such, a indicator of other risk associated with environment (Beaton et al, 1990). There are two factors to be taken into consideration in the selection of an anthropometric index. First, the index must fit the decision to be made, that is, ensuring that the researchers are measuring the right things. Second, the interpretation of the index will depend on whether the goal is describing a population or diagnosing individuals for direct intervention. Each particular purpose should have a stated reason for its choice and also the cut-off point chosen should be the most appropriate for the purpose (Beaton et al., 1990).

In summary, it is important to note that anthropometric information per se is non-specific and does not identify the causes of growth failure nor the specific solution. Anthropometry's usefulness stems from its close correlation with multiple dimensions of individual health and development, as well as their socio-economic and environmental determinants.

CHAPTER III

MATERIALS AND METHODS

This chapter provides an explanation of each activity involved in the development of the research and a physical description of the studied communities. The study protocol was reviewed and approved by the Oklahoma State University Institutional Review Board (IRB) for the protection of human subjects (Appendix B).

The study was undertaken in Barrio Las Flores and Barrio Miramar, two communities of San Pedro de Macoris. The city of San Pedro de Macoris is 47 miles east of the capital city, Santo Domingo. Barrio Las Flores is inhabited mainly by persons who have emigrated from the nearby rural areas in search of jobs available in the factories established in the Free-Trade Industrial Zone. Barrio Miramar is a well established urban community of the city of San Pedro de Macoris. Since the purpose of this research was to assess the prevalence of intestinal parasitosis in two communities and its impact on the nutritional status of preschool children, causal comparative descriptive analysis was used. Nutritional status was measured by anthropometric measurements and clinical exams.

Description of the physical structure of the communities

Barrio Las Flores (Community I) is a relatively new community made up of recent arrivals from rural areas in search of jobs, and who were sheltered on empty lots on the northeast outskirts of the city. There was no community organization or planning; therefore, no schools, nor streets nor basic services were provided. Community I is a typical shanty town, with a main access street (a pothole road), unpainted shanties and unpaved broken streets. The houses are poorly constructed with different materials from cartons to bricks and most have earth floors. Community I has no permanent running water, no disposal facilities, and no indoor plumbing. There are inadequate latrines which are usually shared by more than two households. Garbage is collected by the inhabitants and burned or thrown into empty lots. The community is bordered by the old city sewage system. Its population is estimated at 5000 inhabitants. The only available health and educational services are provided by the Sisters of the Order of Transfiguration. They established and operate an out-patient health care clinic which is served by three medical doctors on a permanent daily basis, and a day care center with a capacity of 150 children. They also provide an education program from preschool through third grade. The sisters use both centers to provide a food program to some malnourished children. However, this program depends on charity and chance of access, and not the implementation of a consistent supplementary feeding program.

Barrio Miramar, on the other hand, is an old barrio of this centennial city of San Pedro de Macoris. Therefore it is an organized community in terms of having appropriate running water and plumbing systems, electric energy facilities both in the community and the households, and a sewage system, even though this displays some serious deterioration.

A very high percentage of economic activity in this city of San Pedro de Macoris is exercised around factories established in the "Free Zone". An Industrial Free-Zone is an area where foreign owned factories are set-up under tax exemption and non union conditions.

Sample and Population

The unit sample was the house. First, a map of the Community I (Barrio Las Flores) was drawn (Appendix C). A number was assigned to each of the houses. From this sample 100 randomly selected houses were identified. If at the house selected there were no pre-school children (6 months to 5 years old), the next house was chosen. These children were compared with 100 preschool children chosen in the same way from Community II (Barrio Miramar) which was believed to be a somewhat economically more advanced community of the same town.

The parents or guardians of the children were interviewed in their home by the researcher. A description of the activities of the project was explained to them and they were asked to sign a consent form which is included in the Appendix D.

Questionnaire Content

The questionnaire was developed from samples of other surveys and also followed the guidelines found in Community Nutritional Assessment with Special Reference to Less Technically Developed Countries (Jellife and Jellife 1989). Adaptations were made based on the author's knowledge of the community. As a medical doctor, the author has worked as a volunteer in these communities. The questionnaire was administered to the parents or guardians of each child. Each parent was asked to indicate the average monthly family income, education, the number of persons in the household, and the type of domestic sanitation. They were also asked about factors related to the child's present nutritional and health status, consumption of food intake and type of milk that the child drinks, any history of food allergies or intolerance, the child's appetite, and history of any diseases that the child has had (Appendix E).

Anthropometry. Height, weight, upper arm circumference and triceps skinfolds thickness were measured by the researcher assisted by a trained nurse of the community. Weight was recorded for each child who was either lightly clothed or nude and barefoot. The children were weighed to the nearest 0.1 kg on a portable Salter spring balance with a 25 kg capacity. Scale calibration was checked each day. Length was measured for children under two years old of age and height was measured for older children with a nonstrechable, polyvinyl, tape measure placed against the wall. The measurements were converted, according to the World Health Organization standards, to percentiles for height-for-age and weight-for-age and weight-for-height. Mid-upper arm circumference was measured to the nearest 0.1 cm on the left arm. Triceps skinfold was measured with a caliper to the nearest 0.5 mm on the left arm where the midpoint had been marked for the arm circumference measurements. Arm muscle area (AMA) was calculated using the following formula:

$AMA = [C- (\pi \times \text{triceps skinfold})]^2 / (4\times\pi)$ (Frisancho, 1991)

Physical Examination. The researcher performed the physical examination of each child to detect clinical signs associated with malnutrition. The examination began with observation and inspection of the general appearance of the children. Then a careful review was conducted of each organ: hair, face, eye, ear, mouth, tongue, teeth, skin, nails and system: cardiovascular system, muscular and skeletal system, gastrointestinal system and nervous system. Especial attention was paid to signs of nutritional deficiency (The form used for physical examination is enclosed in the questionnarie in Appendix E).

Stool Samples. Single stool specimens were collected from most children and examined using a 10% formalin ether concentration technique (WHO, 1980) for the presence of the following parasites: Ascaris lumbricoides, Trichura trichuris, Entamoeba histolytic, Necator americanus and Ancylostoma duodenale. Stool samples were collected at home, brought to the laboratory on the same day, and analysed by a certified laboratory assisstant.

Analysis of Data

Hypotheses. The hypotheses postulated for this study were as follows:

H_1: There will be no significant differences between the two communities

H_2: There will be no significant relationship between the nutritional status (weight-for-age, height-for-age, and weight-for-height) of preschool children and the prevalence of intestinal parasites.

H_3: There will be no significant relationship between family income and the prevalence of intestinal parasites.

H_4: There will be no significant relationship between the education of parents and the prevalence of intestinal parasites.

H_5: There will be no significant relationship between the sanitary conditions within the communities and the nutritional status of preschool children.

Each of the above hypotheses was tested separately using different statistical analyses which included the chi-square test, paired t-test, analysis of variance, Pearson correlation coefficients and stepwise multiple regression. A significance level was established as $p < 0.05$. PC-SAS® software was used for the statistical analyses (SAS Institute, Inc, Cary, N.C.).

Assumptions and Limitations

The researcher assumed that the study methodology would be applicable to subjects of this age group. The researcher acknowledges the following limitations.

The data accumulated can not be generalized to the entire population of preschool children since the sample was representative only of the two specific communities. The sample size, even though representative of the communities, was small due to time and financial limitations.

Anthropometric measurements and physical exams were the basis for classifying the nutritional status of the children and these also pose some limitations. Clinical examinations do not diagnose malnutrition in the early stage, but rather when there is an advanced stage of nutritional depletion. Also many of the physical signs observed in malnutrition may be caused by non-nutritional factors. Other physical signs are non-specific and must be interpreted in conjunction with other laboratory tests. Furthermore some signs may occur during the deficiency as well during the recovery phase.

Anthropometric measurements are frequently used to determine nutritional status of populations in field research because they are noninvasive, inexpensive and safe. On the other hand, these measurements can not detect disturbances in the nutritional status of children over a short period of time. Also the training of the researcher on the proper use of the equipment and the technique may affect the reliability and validity of the measurements.

A single stool sample was collected versus two or three consecutive-day samples to estimate the prevalence of intestinal parasites. This decision was based on results which suggest that a single stool examination provides valid estimates of the prevalence of intestinal parasites (Gyorkios et al., 1989). Also, only prevalence and not load of parasites was being estimated.

In addition, the completion of the survey depended upon the memory of the child's caretaker. Information may not be reliable due to the amount of time that had passed, change in caretaker, reluctance to cooperate, low educational level of some of the interviewees or other factors affecting the interview.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the research will be examined in this chapter. Results will be presented by the comparison of the two previously identified communities. Emphasis will be placed on data which show statistically significant differences. As was already presented in Chapter III, Barrio Las Flores(Community I) is a suburban community and Barrio Miramar(Community II) is an urban community of San Pedro de Macoris. These communites were found to be differents in many aspect such as education, income and their physical infrastructure. However, for part of the discussion the researcher has pooled the data from both communities to assess the effects on socio-economic factors and parasite prevalence on malnutrition in a larger, more diverse population.

Demographic Data

The profile of the population studied is described in terms of education, occupation, marital status, income and number of children in the households (Table II). The percentage of persons with no schooling as shown for Community I (17.3%) is higher than in Community II (5.0 %). Most of the interviewees in Community I were women who have

TABLE II

DEMOGRAPHIC DATA OF THE PARENTS OR GUARDIAN OF THE PRESCHOOL CHILDREN OF COMMUNITIES I AND II (PERCENTAGES)

Variables	Community I n=98	Community II n=100	Both Communities n=198
Education*			
no schooling	17.3	5.0	11.1
primary school	38.8	19.0	28.8
secondary school	36.7	50.0	43.4
college	3.1	12.0	7.6
vocational/technical	4.1	14.0	9.1
Occupation			
factory workers	45.9	30.0	37.9
seasonal workers	15.0	8.5	11.7
mechanic	4.1	3.0	3.5
drivers	5.1	1.0	3.0
house wife	6.0	15.3	10.6
maid	7.1	3.0	5.0
teachers	2.3	7.0	4.6
others	14.5	32.2	23.3
Marital status			
single	87.8	68.0	77.8
married	8.2	27.0	17.7
other	4.1	5.0	4.5
Income[1]**			
less than RD$750.00	9.1	0.0	4.5
RD$751.00 -RD$2.000	86.7	67.0	76.8
more than RD$2.000	4.1	33.0	18.7
Number of children in the household			
one	20.4	30.0	25.2
two	32.7	30.0	31.3
three	25.5	19.0	22.2
four or more	21.4	21.0	21.2
Sanitation*			
unacceptable	98.9	0.0	49.4
fair	1.0	5.0	3.0
acceptable	0.0	94.9	47.4

1 US$1 dollar = RD$12.50 pesos (Central Bank of the Dominican Republic,1994); exchange rate may fluctuate
Community I is statistically significant different from Community II by Chi-square analysis, * p<0.05 ** p<0.001

migrated during the last years from rural communities where there either are no schools at all or just seasonal schools. Women in this community are given less opportunity than men to attend school. The illiteracy rate in the country is 5.2% according to the report of the Ministry of Education (Periodico Ultima Hora, 1994). In Community I is found the highest percentage of interviewees (38.8%) who completed the primary schools, while in Community II, 50% completed secondary school. Only 3.1% in Community I have college education but 12% have completed this level of education in Community II. Also those with any vocational or technical education is higher in Community II (14.0%) than in Community I (4.1%). When we look at both communities together, 43.4% of the interviwees have attended secondary school. In general the level of education is statistically higher in Community II ($p<0.0001$) than in Community I.

Most of the interviewees work in the Free Zone factories. In Community I, 45.9% work in the Free Zone compared to 30.0% in Community II. Women who are not directly employed find employment, for instance by cooking meals at home and selling lunches at the factories. Other women earn income by babysitting for working parents. A significant percentage (15%) of the interviewees reported being seasonal workers. Thus, many of the interviewees do not have a specific job, but work at whatever jobs are avaible to them. In Community II, 15.3% of women reported being housewives, while in Community I only 6% identified themselves as housewife. Other job categories identified include those of university graduates (lawyers, engineer etc.), found in Community II, as well as other non-professional jobs in Community I such as construction workers, assistant nurses, etc. However, the number of professionals interviewed and their percentage in relation to the total population were at a level not considered sufficient to assign them a category.

In terms of marital status a very high percentage of interviewees in both communities (77.8%) reported themselves to be single, 87.8% in Community I and 68% in Community II. In addition some of the women live with their companeros (spouses) without going through a legal marriage. Instead they live in a "free union", or common law marriage, as it is called in the Dominican Republic. This type of arrangement is very common and accepted by this culture, and it is done under a verbal agreement between both parties. There is also the reality that the trend in family structure is changing and more women have the responsibility for supporting their family.

According to Young (1993), more than 30% of women in Latin America and the Caribbean are economically active and almost 30% of the households are headed by women. In the Dominican Republic one out of every three households is headed by a woman. This phenomenon is more common in the urban than in rural areas (Cordero, 1994). Only 17.7% of the interviewees were legally married. Being formally married is a practice which is more prevalent among the middle class or more educated persons; so obviously it was more frequent in Community II (27%).

In analyzing the level of income identified in Table II, it was observed that for Community I, 86.7%, and for Community II, 67% of those interviewed reported a monthly income between RD$751.00 and RD$2,000. This level of income is considered inadequate to meet the energy requirements of those interviewed. The minimum wage in the country is set at RD$ 915.00 per month. The estimated cost of living for basic food, housing and health for a family of 2 to 4 persons is RD$ 5,000 per month. The low income situation in these communities is enhanced by the fact that some of these workers, especially women, are seasonal workers which means that they are not guaranteed year round employment. In Community II 33% reported to have a monthly income of more than RD$ 2,000, thus in terms of economical level community II is significantly different ($p < 0.001$) than community I.

The number of children per couple in the country has tended lately to decrease. In Community I 20.4% reported having only one child while in Community II 30% had one child. The highest percentage of families surveyed both in Community I (32.7%) and in Community II (30.0%) had two children. Three children were more common in Community I (25.5%) than in Community II (19%). When the data of both communities are combined there is still a high percentage of families (21.2%) with four or more children. The typical rural extended family ranges from four to six children. An explanation for the decrease in the number of children per family may be that when women become pregnant their employment is normally terminated. Often they do not want to risk unemployment, so they limit their number of children.

In Community I, 98.9% of the housing sanitation was considered substandard; that is to say, houses in this community do not have a proper disposal of human waste nor of household waste and sewage. They also have both no plumbing system and inadequate water storage. This situation is made worse by a significant number of domestic pets, such as dogs and cats, and farm animals, such as pigs and goats, that live in close contact with the families. On the other hand, 94% of the housing in Community II was considered to have an adequate sanitation (see description of the communities in Chapter III). The level of sanitation was evaluated using a scale according to various characteristics of the household construction and practices such as disposal of human waste, disposal of waste/sewage, type of plumbing system, storage of water and the presence of animals around the house. To each of these indicators a number was assigned to each answer (see Questionaire, Appendix C). If the addition of this number was greater than 10, then the sanitation was considered unacceptable; if it was less than 10 and greater than 6, it was considered fair; and if it was less than 6 it was considered acceptable (This scale was developed by the researcher and has not been tested for validity).

Dietary Intake Data

In Table III food intake data of the sample of children is shown. Time and financial limitations for this research did not allow for the gathering of more detailed information. However, an effort was made to draw a picture of the dietary situation by asking the parents some general questions. Example of these questions included: type of milk more commonly used, breastfeeding practices, number of milk servings and meals a day, child's appetite and the use of vitamins/minerals.

Very few data are available in Dominican Republic concerning infant feeding practices. It is generally stated that children begin to eat solid foods between 3 to 6 months of age. Very little published data are available which describe what children are eating in the different regions of the country. However, more infant commercial food is available presently in the market than ever before, which suggests more of their use by mothers.

It was not surprising, then, to discover that powdered whole milk was by far the most commonly used in both communities, 65.3% in Community I and 73% in Community II, even though these communities are close to rural areas where cow's milk production and distribution is very common. A possible explanation may be that cow's milk needs refrigeration and the country has an electric energy deficit which is especially accentuated in poor communities such as the ones studied. This

TABLE III

CHILD'S DIETARY DATA OF COMMUNITIES I AND II (PERCENTAGES)

Variables	Community I n=98	Community II n=100	Both Communities n=198
Type of milk used*			
no milk	19.4	10.0	14.6
breast milk	3.1	5.0	4.0
cow's milk	10.2	3.0	6.6
powdered whole milk	65.3	73.0	69.2
other	2.0	9.0	5.5
How often drink milk			
never	4.8	4.3	4.5
once a day	7.2	4.3	5.6
twice a day	24.1	18.1	20.9
thrice a day	31.3	30.9	31.1
more than thrice	32.5	42.6	37.9
Number of meals per day*			
three to five	31.6	1.0	16.2
four to six	62.2	72.0	67.2
five to seven	6.1	27.0	16.7
Child's appetite			
good	70.4	63.0	66.7
bad	4.1	5.0	4.5
poor	25.5	32.0	28.8
Use of vitamins/minerals			
yes	22.4	16.0	19.2
no	77.6	84.0	80.8

Community I is statistically significant different from Community II by Chi-square analysis, * $p<0.05$

energy deficit forces mothers to buy powdered whole milk which is expensive.

It should be noted in Table III that breastmilk is used less than other types of infant feeding, in both Community I (3.1%) and in Community II (5.0%). A possible explanation could be that data were collected from children aged 6 months and up. This is precisely the time when some mothers who breastfeed may stop. Some mothers may discontinue breastfeeding because they need to return to employment where no facilities are offered to assist them in breastfeeding. According to reports available, 93% of mothers in the Dominican Republic begin breastfeeding immediately after birth, but at least 40% stop breastfeeding when the child is 4 to 6 months of age (CENESMI, 1990).

The percentages of children given no milk at all in Community I (19.4%) as well as in Community II (10%) are cause for concern. When the mothers were questioned about the reason for this, they only stated that they did not like it. Chocolate, tea or juice were reported to be given to the child instead of milk. It was not clear if the motive was financial (that the mothers could not afford to buy milk) or if there were any gastrointestinal problems such as lactose intolerance. *Ascaris lumbricoides*, the most common parasite identified in these communities, is associated with lactose intolerance. Carrera et al., (1982) showed that lactose utilization in ascaris-infected children may be depressed compared to uninfected children. However, this area of research is in need of further study.

Three servings of whole milk per day were received by 31.3% of the children in Community I and 30.9% in Community II. Also only 32.5% of the children in Community I received more than three servings of milk while in Community II, 42.6% received that amount. On the other hand the highest percent of children in Community I (62.2%) as well as in Community II (72%) received from 4 to 6 meals per day. This may reveal an adequate pattern of feeding for children at this age. However, mothers reported that food intake depends on the availability of funds to purchase the goods. Thus on certain days children receive the amount stated above, but on other days they do not.

Most mothers reported that their children's appetites were good, 70.4% in Community I and 63% in Community II. However, this information represents subjective reponses and may not be reliable. Mothers often stated that their children want to eat more than they can offer. Thus, it is not clear whether these responses represent accurately the adequacy of the children's food intake.

The percentage of children using any supplements of vitamins/minerals was relatively low in both communities (Community I, 22.4% and Community II, 6%). From the author's experience in this country, mothers strongly request to be prescribed supplements because there is a general perception that their childrens' diets are inadequate and some supplementation is needed. These data were collected, however at one point on time, so it is difficult to conclude that the use of vitamin/mineral supplements has changed.

Medical Data

The medical data (Table IV) show that 11.2% of children in Community I were reported as having an illness at the time of the interview and 18.2% in Community II. Most of the cases of illness reported in both communities were diarrhea, upper respiratory tract infections, and amoebiasis. Entamoeba hystolitica was reported by mothers to be a frequent cause of disease in Community I, even though in this research few cases of amoebiasis were identified by laboratory test.

When parents were asked if their children had suffered any serious illness, 29.6% in Community I and 27.3% in Community II responded positively. Again these were most frequently related to diarrhea, amoebiasis and pneumonia which gives us a picture of the environmental, social and economic standards of the communities. Diarrhea and respiratory diseases continue to be the main reason for seeking medical assistance and the most prevalent causes of infant mortality in the country. This shows the deterioration which still persists in the basic sanitary structure of the country. The percentage of children using any medication was 10.2% in Community I, 14.1% in Community II, and 12.2% in both communities. The parents or guardian reported that the medicines were used to treat current illnesses, i.e. medicine for colds, antibiotics and medicine for diarrhea.

The history of vomiting and diarrhea was 10.2% for Community I and 17.2% for Community II. These medical data

TABLE IV

RESULTS OF THE MEDICAL INTERVIEW FOR THE PRESCHOOL CHILDREN OF COMMUNITIES I AND II (PERCENTAGES)

Variables	Community I n=98	Community II n=100	Both Communities n=198
History of current illness			
yes	11.2	18.2	14.7
no	88.8	81.8	85.3
History of serious illness			
yes	29.6	27.3	28.4
no	70.4	72.7	71.6
Usage of any medication			
yes	10.2	14.1	12.2
no	89.8	85.9	87.8
History of vomiting/diarrhea			
yes	10.2	17.2	13.7
no	89.8	82.8	86.3
History of parasite recently			
yes	38.8	36.4	37.6
no	61.2	63.6	62.4
Wearing shoes*			
yes	71.4	57.6	64.5
no	28.6	42.4	35.5
History of pica			
yes	22.4	22.2	22.3
no	77.6	77.8	77.7

Community I is statistically significant different from Community II by Chi-square analysis, * $p<0.05$

suggest that there may be some epidemic cases of diarrhea in Community II which could be explained on the basis that the data were collected in the summer when there is a decrease in the city's water supplies. Those percentages are considered high given the way in which the data were collected at one point in time, but it reflects the general level of sanitation of the communities. As stated by Karl-Erick (1994)," diarrhea is frequent in those lacking education and those who have little or no access to clean water or sanitation. It is indeed the disease of social deprivation, the affliction of those left behind, those most in need".

A high percentage of the interviewees reported that their children have a history of parasites, 38.8% and 36.4% in Community I and Community II respectively. It is suggested that a cycle of infection and re-infection occur in many preschool children in these communities. It is also significant that a high percentage of children in both communities, 71.4% in Community I and 57.6% in Community II, were reported not to wear shoes either inside or outside the house, even though the prevalence of hookworm infestation, which is associated with this practice, was very low in both communities. The statistical differences in the practice of wearing shoes between Community II and Community I ($p < 0.042$) may be due to the higher level of education and monthly income in Community II.

The practice of pica was similar for both communities (22.3%). In most cases the children consumed clay. This behavior of ingestion of nonfood substances is quite common among children under six years of age. The practice of pica may contribute significantly to high parasitic infection.

A clinical examination performed on each child showed frequent signs of anemia, e.g. pallor of the low conjunctiva (38% in Community I and 37% in Community II). Pallor of the nail bed was found in 15% of Community I children and 10% in Community II children. Iron deficiency anemia is reported to be high in the Dominican Republic. Dietary practices seem to be the main cause of anemia in these communities. In general, most of the dietary iron in the country comes from foods of vegetable and cereal origin, which is more poorly absorbed than heme iron in foods of animal origin. The cost of meat is almost prohibitive for the majority of the inhabitants of these poor communities. At the time of the collection of data for the research, there were some epidemic cases of viral conjuctivitis, mainly in the adult population of Community I, but 9 cases were identified also in some preschool children of the community. Also many cases of escabiasis were identified in the children of both communities, 14 cases in Community I and 7 cases in Community II. This skin infection is frequent in children who live in overcrowded houses under poor sanitary conditions. There were other clinical signs identified in both communities, but these were less prevalent. (see appendix F for the summary of the clinical signs identified through the physical examination).

Parasitology Data

The overall prevalence of intestinal parasites for both communities was 44.6%. In Community I, 62.3% of the preschoool children were infected compared to 28% in Community II ($p<0.005$) (Table V). The most common parasitic infection was Ascaris lumbricoides followed by Trichuris trichura. In Community I, 40.9% of the children were infected with Ascaris lumbricoides, 2.2% with hookworm, 24.7% with Trichuris trichura, 4.3% with Entamoeba histolytica and 7.5% with others. In Community II, 19% of the children were infected by Ascaris lumbricoides, 6% with Trichuris trichura, 1% with Entamoeba histolytica, and 4% with others (Fig.1). Differences between communities were tested by Chi-square analysis, As shown in Figure 1, the prevalence of Ascaris lumbricoides is much higher in Community I than in Community II ($p<0.001$). This comparison is true also for the prevalence of Trichuris trichura ($p<0.001$). Examination for other parasites in Community II found only 4 cases of Enterobius vermiculares. In Community I other more dangerous parasites were identified such as 4 cases of Taenia saginate, 2 cases of Strongyloides stercolaris and 1 case of Gardia Lambia.

In children 2 years old and older, parasitic infections were more frequent in both communities. The logical explanation for this is that, at this age, children begin to have closer contact with their environment. It was also noted that 46.2% of the infections in Community I and 26.2% of the infections in

TABLE V

PREVALENCE OF PARASITES IN PRESCHOOL CHILDRENOF COMMUNITIES I AND II (PERCENTAGES)

	Community I	Community II
Presence of parasite	62.3*	28.0
Absence of parasite	37.6	72.0
Total	99.9	100.0

* Community I is statistically different from Community II by Chi-square analysis $p<0.05$

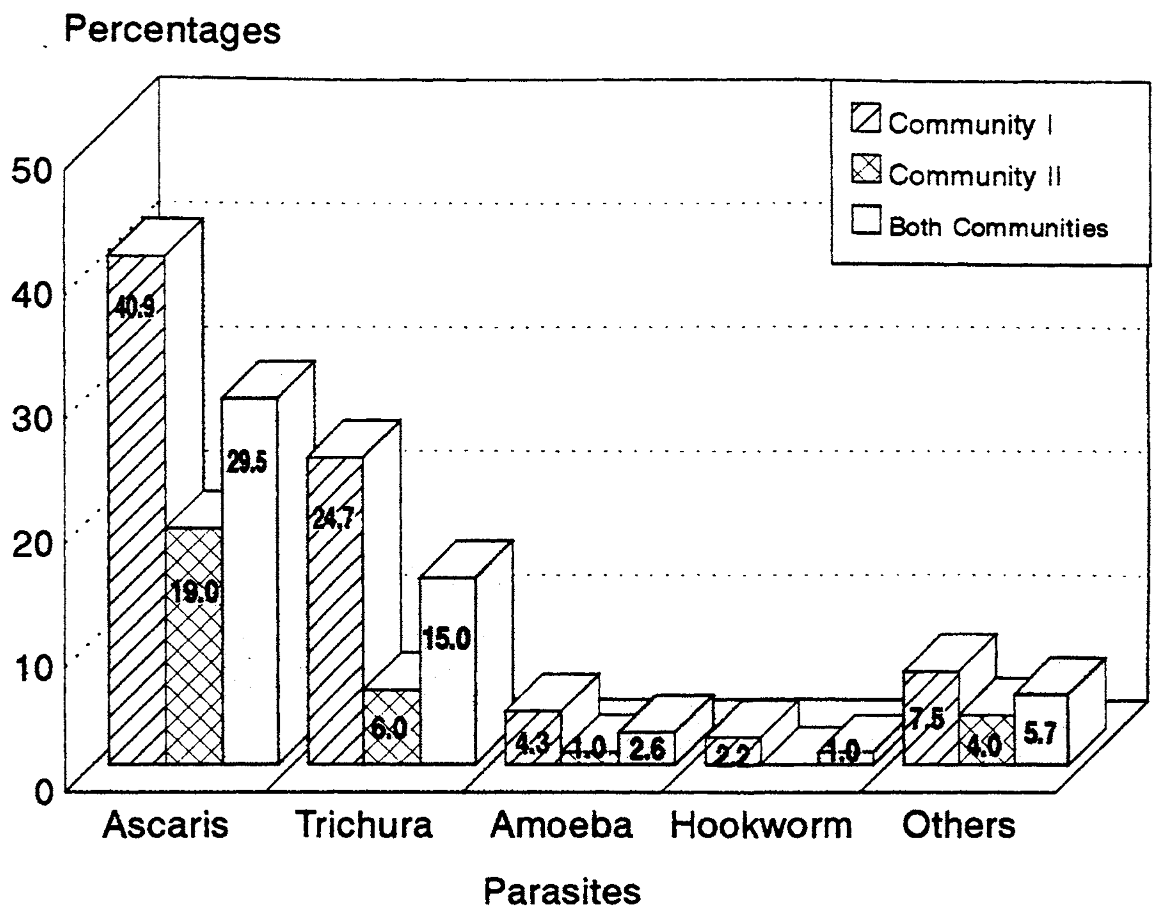


Figure 1. Prevalence of Parasites in Preschool Children of Communities I and II

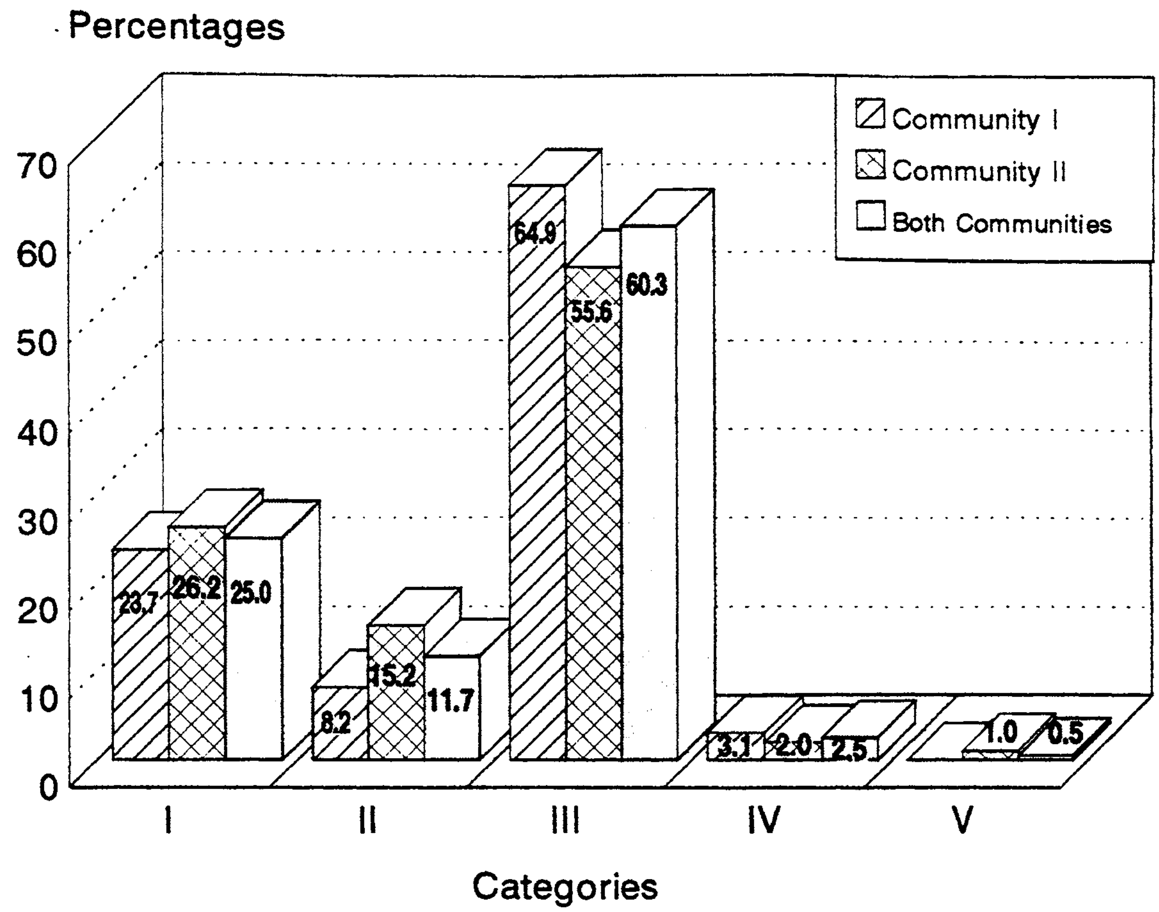
Community II were due to a single parasite (Ascaris lumbricoides).

In Community I, 15.1% of children were affected by two different parasites and 1.1% by three differents parasites. However in Community II only 2.0% of the children were affected by two parasites. When infections were due to more than one parasite, the combination of Ascaris lumbricoides and Trichuris trichura was the most frequent. Due to the similarities in their life cycle, simultaneous exposure to infectious eggs of both parasites may occur.

Anthropometric Data

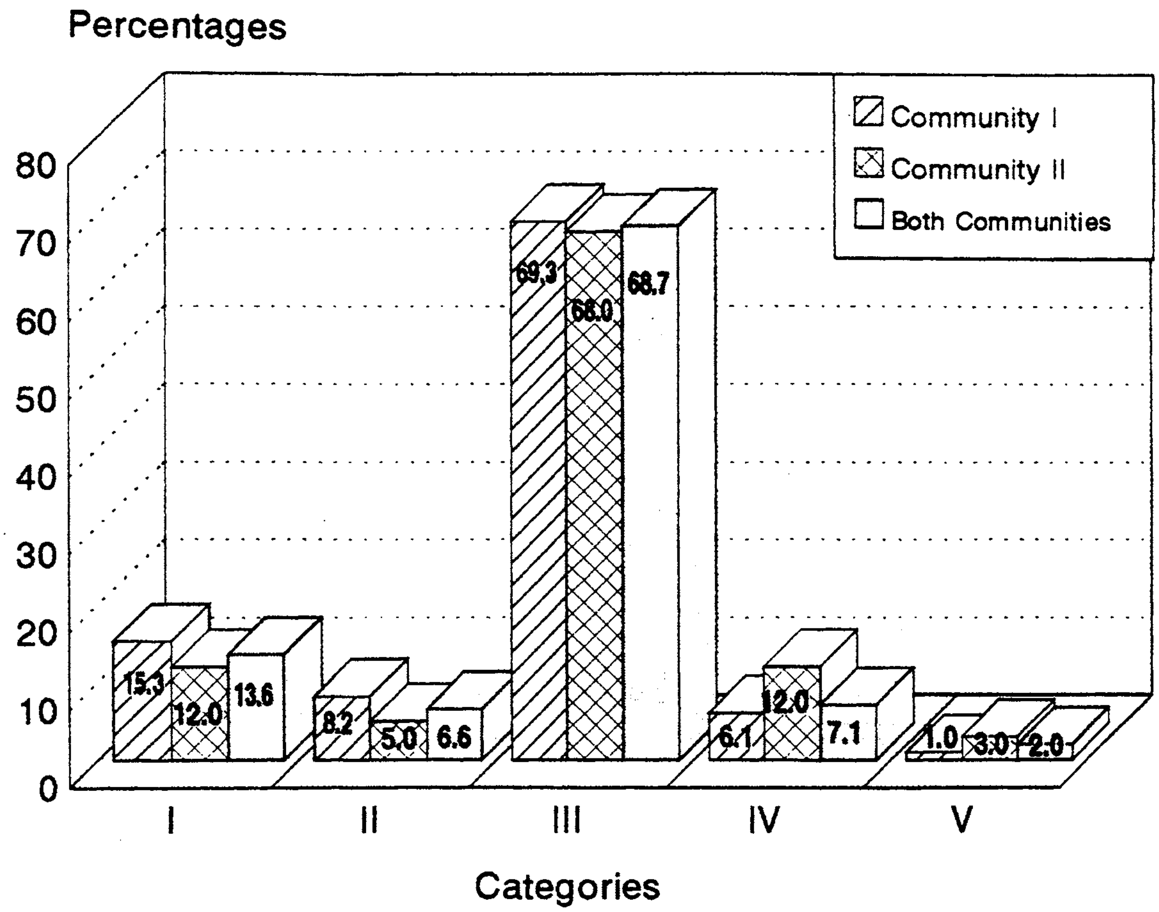
Anthropometric data were assessed using as a basis the USA National Center for Health Statistics standards as recommended by the WHO. A cut-off at the 5th percentile was used to evaluate the nutritional adequacy of the children (Frisancho, 1990). According to these standards, in Community I, 23.7% of the children were underweight and in Community II, 26.2% were underweight (Fig. 2). Also 15.3% of the children in Community I and 12.0% of the children in Community II were identified as being stunted (Fig. 3). In Community I, 23.6% were identified as wasted while in Community II, 29% (Fig. 4).

In the 1992 UNICEF report on the Dominican Republic, 12.5% of the children were said to be underweight, 20.8% showed stunting, and 2.3% were wasted. If these figures are compared with the combined data of both communities, it is evident that



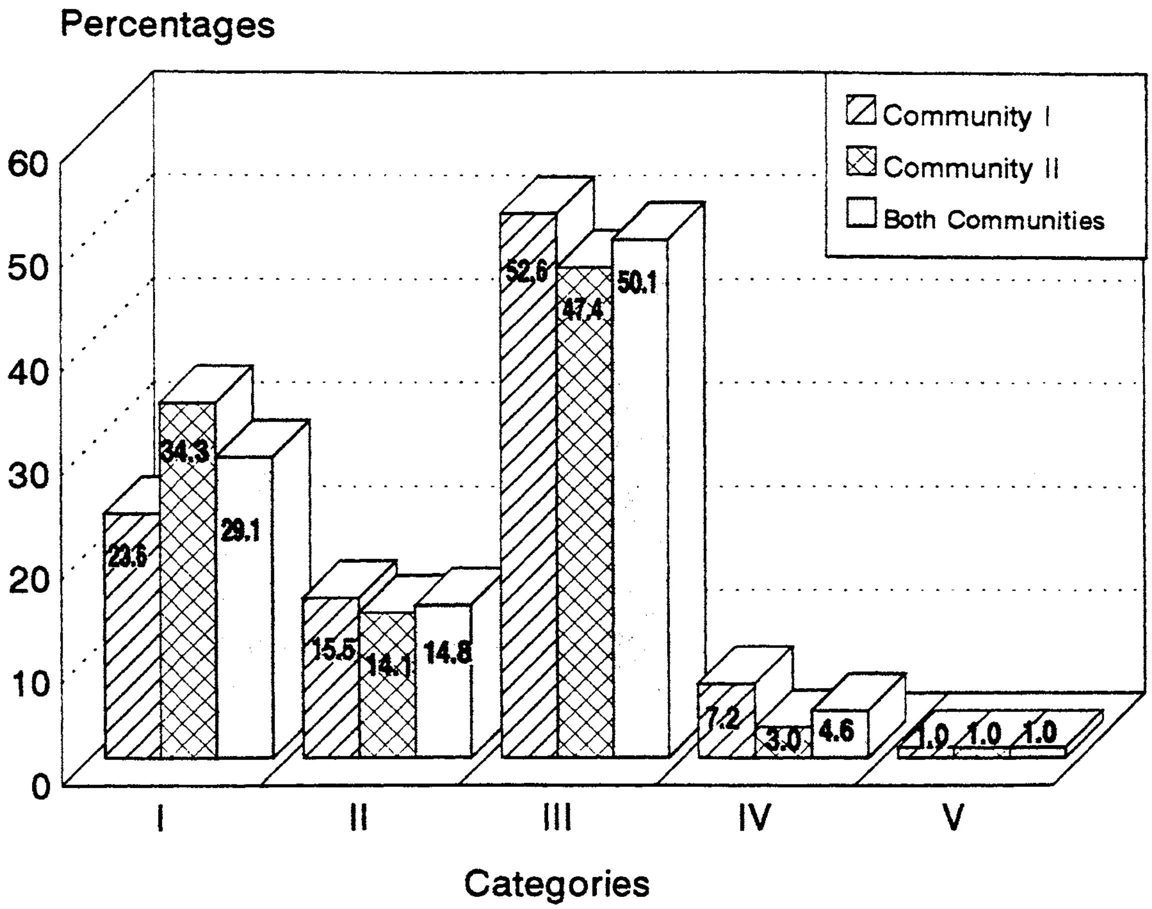
Category I: Low weight: 0.0 to 5.0 percentile; Category II: Below average: 5.1 to 15.0 percentile; Category III: Average: 15.1 to 85.0 percentile; Category IV: Above average: 85.1 to 95.0; Category V: Heavy weight: 95.1 to 100.0

Figure 2. Prevalence of Malnutrition by Weight for Age in Preschool Children of Communities I and II



Category I: Short: 0.0 to 5.0 percentile; Category II: Below average: 5.1 to 15.0 percentile; Category III: Average: 15.1 to 85.0 percentile; Category IV: Above average: 85.1 to 95.0; Category V: Tall: 95.1 to 100.0

Figure 3. Prevalence of Malnutrition by Height for Age in Preschool Children of Communities I and II



Category I: Low muscle wasted: 0.0 to 5.0 percentile; Category II: Below average: 5.1 to 15.0 percentile; Category III: Average: 15.1 to 85.0 percentile; Category IV: Above average: 85.1 to 95.0; Category V: High muscle: 95.1 to 100.0

Figure 4. Prevalence of Malnutrition by Weight for Height in Preschool Children of Communities I and II

the data for sampled communities are higher, especially as related to underweight and wasting. It should be noted that anthropometric indicators can change rapidly for 'at risk' population groups and may show seasonal patterns associated with changes in food availability. Anthropometric indicators may also change as result of the effects of infectious diseases (Carlson et al., 1990). It should be stated, however, that all causes for the high prevalence of wasting and underweight in these communities may not be identified, since that intensity of investigation is out of the scope of this research.

When we compared the anthropometric data from the sampled population with the References Standards (WHO 1983) which are based on the normal distribution, we found that the sampled population did not fit the bell shape curve for normal distribution in either community. The data of the sample population were skewed to the left, which means that a large number of children from the sampled population were below the median. In other words, many children in both communities were identified as malnourished.

The results of a Chi-Square analyses between the observed and the expected values for anthropometric indicators are shown in Table VI. It should be noted that in both communities the statistical analyses showed very significant malnutrition for all anthropometric indicators. After the collapse of the National Nutrition Surveillance System maintained by SESPAS during the 80's and the National Survey in Nutrition carried out by CENESMI in 1987, the reports on child nutritional status

TABLE VI

RESULTS FROM A CHI-SQUARE ANALYSES PERFORMED BETWEEN THE OBSERVED AND THE EXPECTED VALUES FOR ANTHROPOMETRIC INDICATORS IN THE PRESCHOOL CHILDREN OF COMMUNITIES I AND II

Anthropometric Indicators	Community I n=98	Community II n=100	Both Communities n=198
Weight-for-age	X^2=80.3 p<0.0001	X^2=105.1 p<0.0001	X^2=35.9 p<0.0001
Height-for-age	X^2=26.3 p<0.0001	X^2=13.6 p<0.005	X^2=182.0 p<0.0001
Weight-for-height	X^2=80.5 p<0.0001	X^2=188.8 p<0.0001	X^2=256.4 p<0.0001

have been scarce and fragmented, making it impossible to evaluate the conditions adequately. Some observers and participants in child nutrition programs like UNICEF have written about the deterioration of childrens' nutritional status in the country due in part to the worsening of the country's national economy (CENESMI 1990).

Results from the correlation analyis showed that education of parents was positively correlated with monthly income (r=0.31, p=<0.001). Education was also negatively correlated with the number of children in the household (r= -0.15, p=<0.029), was not significant when correlated with the prevalence of parasites (r=-0.13, p<0.071), and was negatively correlated with sanitation (r= -0.32, p<0.001).

Income was not significantly correlated with the number of children in the households. Income was negatively correlated with sanitation (r= -0.41, p<0.001). Income was also negatively correlated with parasites (r=-0.11, p<0.106) but was not statistically significant. Ascaris is more common in areas and countries with low socio-economic status, but within a community, the prevalence of ascariasis is not always inversely related to the socio-economic status (Stephenson et al., 1983).

Results from the correlation analysis between the anthropometric indicators and parasites showed that Ascaris lumbricoides was negatively associated with all the anthropometric indicators (Table VII). Trichuris trichura was negatively associated as well with all the anthropometric

TABLE VII

PEARSON CORRELATIONS COEFFICIENTS BETWEEN
ANTHROPOMETRIC INDICATORS AND PARASITES[1]

Anthropometric Indicators	Parasites			
	Ascaris	Trichura	Hookworm	Amoeba
% W/A	-0.231** (0.001)	-0.124 (0.085)	-0.068 (0.346)	0.154* (0.031)
% H/A	-0.131 (0.068)	-0.093 (0.198)	-0.037 (0.68)	0.039 (0.589)
% W/H	-0.198** (0.005)	-0.113 (0.118)	-0.072 (0.317)	0.13 (0.071)
Arm muscle area	-0.150* (0.037)	-0.261** (0.003)	-0.055 (0.448)	-0.141* (0.050)
Arm circumference	-0.165* (0.021)	-0.270** (0.001)	-0.021 (0.770)	-0.149* (0.037)
Triceps skinfold	-0.097 (0.179)	-0.087 (0.227)	0.084 (0.245)	0.032 (0.651)

* P<.05 ** P<.001
1 P values in parentheses

TABLE VIII

P VALUES FOR ANTHROPOMETRIC INDICATORS TESTED FOR EFFECT OR PRESENCE OF ABSENCE OF PARASITES IN PRESCHOOL CHILDREN[1]

Anthropometric Indicators	Parasites			
	Ascaris	Trichura	Hookworm	Amoeba
% W/A	0.001 (3.28)	0.085 (1.73)	0.346 (0.94)	0.031 (-2.16)
% H/A	0.068 (1.82)	0.019 (1.29)	0.608 (0.51)	0.589 (-0.54)
% W/H	0.005 (2.79)	0.118 (1.57)	0.317 (1.00)	0.071 (-1.81)
Arm Muscle Area	0.037 (2.09)	0.000 (3.73)	-----	0.050 (1.96)

1 t values in parentheses

TABLE IX

CHI-SQUARES DETERMINATION INDICATING ASSOCIATION BETWEEN SELECTED VARIABLES/NUTRITIONAL INDICATORS AND PRESENCE OF PARASITES

Variables	Chi-square values	P values
Income	1.03	0.597
Sanitation	25.90	0.001
Education	3.78	0.436
Number of children in the house	1.08	0.897
% W/A	12.40	0.054
% H/A	5.94	0.430
% W/H	11.69	0.069

TABLE X

RESULTS OF REGRESSION ANALYSES WITH WEIGHT-FOR-AGE AS DEPENDENT VARIABLE FOR PRESCHOOL CHILDREN OF COMMUNITIES I AND II

Variables	Regression Coefficient	Standard Error	F-value
Ascaris	-12.231	3.879	9.94*
Trichura	-6.384	4.979	1.75
Hookworm	-12.497	16.793	0.55
Amoeba	17.019	10.806	2.48
Sanitation	-3.708	1.95	3.62
Education	3.577	2.676	1.79
Number of childrenin the house	0.568	2.14	0.07
Income	-11.643	8.383	1.93
Intercept	41.902		
R2=0.12			

* p<0.001

TABLE XI

RESULTS OF REGRESSION ANALYSES WITH HEIGHT-FOR-AGE AS DEPENDENT VARIABLEFOR PRESCHOOL CHILDREN OF COMMUNITIES I AND II

Variables	Regression Coefficient	Standard Error	F-value
Ascaris	-5.508	4.801	1.32
Trichura	-1.925	6.165	0.10
Hookworm	-1.228	20.793	0.00
Amoeba	9.203	13.379	0.47
Sanitation	4.733	2.412	3.85
Education	4.89	3.312	2.18
Number of children in the house	-0.994	2.647	0.14
Income	-15.636	10.379	2.27
Intercept	51.686		
R2=0.07			

TABLE XII

RESULTS OF REGRESSION ANALYSES WITH WEIGHT-FOR-HEIGHT AS DEPENDENT VARIABLE FOR PRESCHOOL CHILDREN OF COMMUNITIES I AND II

Variables	Regression Coefficient	Standard Error	F-value
Ascaris	-13.031	4.464	8.52*
Trichura	-8.561	5.73	2.23
Hookworm	-18.085	19.325	0.88
Amoeba	14.15	12.435	1.29
Sanitation	-6.544	2.244	8.50*
Education	2.796	3.079	0.82
Number of children in the house	1.166	2.463	0.22
Income	-15.368	9.646	2.54
Intercept	50.287		
$R^2 = 0.13$			

* $p < 0.01$

The effect of intestinal parasites on arm muscle area (AMA) was assessed using analysis of variance. This analysis revealed that the prevalence of parasites affected arm muscle area ($F=9.62$ $p < 0.001$). All the tests performed showed consistently negative results of the effects of ascariasis on the nutritional status of preschool children in this study.

Other researchers have reported similar findings. In a cross-sectional survey of children in Louisiana, Ascaris lumbricoides was associated with low serum albumin and low plasma ascorbic acid levels and was weakly associated with low weight-for-height (Blumenthal,1976).

In a study in Indonesian preschool children, Cerf et al.,(1981) compared fecal ascaris egg counts with weight-for-age. Eggs count were significantly and inversely correlated with weight-for-age, but only in the group of children who had lower protein and energy intake. Results from longitudinal studies conducted in several countries have provided strong evidence that either periodic deworming or the successful cure of ascariasis in preschool children improves growth.

Gupta et al.,(1977) in a study in India, reported an increased weight-for-age in preschool children after periodic deworming. He concluded that periodic deworming improved nutritional status.

Willet et.al, (1979) also reported improved growth in a study of Tanzanian preschool children who received Levamisole® or a placebo. The rate of weight gain was 21% greater for those treated with Levamisole® than in those receiving a placebo (p=0.03). Stephenson et al., (1980) likewise reported a higher percentage of weight gain with deworming in their study with Kenyan children. The authors concluded that even light Ascaris lumbricoides infections might adversely influence nutritional status, and deworming may enhance growth. In a more recent study, Thein Hlaing et al., (1991) demonstrated significant gains in both height and weight ($p<0.001$) following treatment with Levimasole® to expel Ascaris lumbriocoides from children living in rural Myanmar.

Other studies have failed to demonstrate a significant effect of deworming on growth, (Freij et al., 1979, Gupta and Urrutia, 1982 and Greemberg et al., 1981). The extent to which parasitic infections contribute to malnutrition has not been fully determined, and as stated by Cerf et. al, (1981), "the relationship between ascariasis and child malnutrition is conditional and depends upon the interaction of multiple factors". The degree of ascariasis that could interfere with nutritional status in one community may not do so even in a nearby one. Differences in food avilability and medical care provided, for example, explain the contradictory results presented from the various studies. Furthermore, we need to recognize that nutritional status is the result of the interaction between food intake, digestion, absorption needs and loss. There are a variety of factors that influence children's nutritional status, so it cannot be viewed in isolation from the socio-economic, environmental and the socio-cultural situation in which the communities and families live.

These factors produce their effect together with other crucial factors like education, sanitation and health services offered and utilized by the community.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

The prevalence of intestinal parasitic infections and their impact on the nutritional status of preschool age children in San Pedro de Macoris, Dominican Republic was studied using two selected communities. Many variables were studied such as, parents' education, family monthly income, number of children in the households, occupation and marital status of parents, as well as some dietary and child's health data.

Anthropometric measurements were taken and nutritional indicators developed (W/A, H/A, W/H). A physical examination was administered to each child and a single stool sample collected.

A significant percentage of children from both communities were identified as malnourished. Many variables which may affect the nutritional status of children were present but not all of them could be identified in this study. It is evident that the poor environmental and sanitation conditions prevailing in the communities affect significantly the disease process of the community residents. As a result a high incidence of intestinal parasites and diarrheal diseases was identified in the preschool child age group. Contribuiting to the above is the low income of the majority of the inhabitants which lowered the nutritional status of the children. They are more prone to face health and psychosocial problems as a consequence of growing up in unfavorable ambiance.

Increasing urbanization requires different types of child care arrangements than are usually available in rural areas where most the inhabitants of these communities originally lived. Furthermore a number of mothers find it necessary to work. Absent mothers may have a negative impact on the nutritional intake and status of the children. It is important to be aware that the problem of malnutrition in these communities is not only lack of food or poor environmental sanitation; it also may be the constraint in the feeding and care of these children.

All the statistical tests performed between the nutritional indicators and the presence of parasites, especially Ascaris lumbricoides, which was the most frequent, point to a negative association of parasites with the nutritional status of preschool children. A significant negative effect of ascariasis on weight-for-age and weight-for-height, was found.

Summary of Hypotheses

Because of the results of this study we reject the null hypotheses H_1, which stated that there will be no significant differences between the two communities. The communities were found to be different in relation to sanitation, monthly income and education. Also we reject the null hypotheses H_2, which stated that the will be no significant relationship between the nutritional status (weight-for-age, height-for-age and weight-for-height) of preschool children and the prevalence of intestinal parasites. A significant negative effect of parasites on weight-for-age and on weight-for-height was observed. H_2 was not rejected when height-for-age was the index used to evaluate nutritional status.

We failed to reject the null hypotheses H_3, which stated that there will be no significant relationship between family income and the prevalence of intestinal parasites. We also failed to reject the null hypotheses H_4, which stated that there will be no significant relationship between the education of the parents and the prevalence of intestinal parasites.

Furthermore, we failed to rejected the null hypotheses H_5, which stated that there would be no significant relationship between the sanitary conditions within the communities and the nutritional status (weight-for-age, height-or-age and weight-for-height) of preschool children. However, the sanitary condition did show a weak effect on height-for-age.

Conclusion

Intestinal parasitic infections may be a contributing factor to the poor nutritional status of many of the preschool age children in the sampled area. Recognizing the limitations of the research design, the data suggests particularly interesting directions for future research in this area.

Research needs include not only further investigation of the effects of intestinal parasitic infection on the nutritional status of the groups studied, but also the need to update the data on the nutritional status of the children in Dominican Republic in general.

If the country is to improve its health status, it must be established which groups are the most vulnerable and at higher risk. Undoubtedly one of these groups is children, especially those living in communities such as the ones studied in this research as well the low income families that live in a marginal urban setting lacking adequate sanitation,and ready access to services, proper education, and acceptable housing.

Recommendations

Further longitudinal research is needed to identify the extent of intestinal parasitic infections and under what conditions they produced a negative effect on the nutritional status of preschool age children. Future studies should collect more child dietary data and infant feeding practices information to broaden knowledge of the problem.

Periodic deworming should be considered as a part of community nutrition programs in these communities. The control of parasites should include sanitary measures, accessibility to potable water supply and health education because human behavior is of considerable importance in the transmission of intestinal parasitic infection and the success of control programs. The government budget for health prevention and nutrition programs should be revised to accommodate these needs since the basic funding for these programs should come from the health authorities.

Children should be a priority target of specific health policies and strategies for action, taking into account that the health and nutritional status of the child shapes the health of the adults. The basic barrier to accomplish the aforementioned recommendations is the lack of political will to address the health and nutritional problems not only in communities as the ones studied but also for the whole country. Programs which address the health and nutrition needs of women and children have not been considered a priority for the government and other health institutions.

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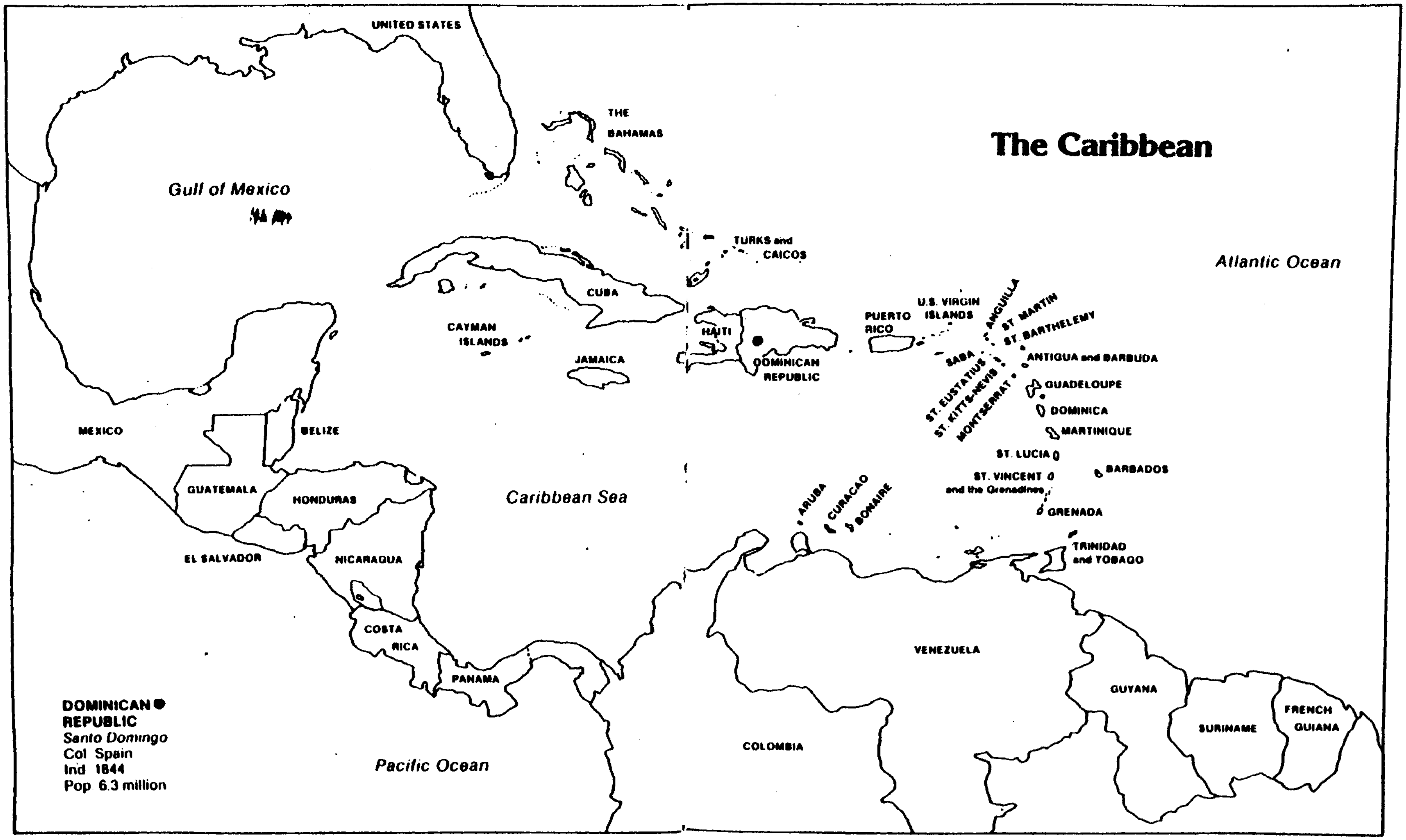
APPENDIXES

APPENDIX A.

MAP OF THE CARIBBEAN REGION


The Caribbean
UNITED STATES
Gulf of Mexico
THE BAHAMAS
TURKS and CAICOS
Atlantic Ocean
CUBA
CAYMAN ISLANDS
JAMAICA
HAITI
DOMINICAN REPUBLIC
PUERTO RICO
U.S. VIRGIN ISLANDS
ANGUILLA
ST. MARTIN
ST. BARTHELEMY
SABA
ST. EUSTATIUS
ST. KITTS-NEVIS
MONTSERRAT
ANTIGUA and BARBUDA
GUADELOUPE
DOMINICA
MARTINIQUE
ST. LUCIA
BARBADOS
ST. VINCENT and the Grenadines
GRENADA
TRINIDAD and TOBAGO
ARUBA
CURACAO
BONAIRE
MEXICO
BELIZE
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
COSTA RICA
PANAMA
Caribbean Sea
VENEZUELA
GUYANA
SURINAME
FRENCH GUIANA
COLOMBIA
Pacific Ocean
DOMINICAN REPUBLIC
Santo Domingo
Col Spain
Ind 1844
Pop 6.3 million

APPENDIX B.

OKLAHOMA STATE UNIVESITY INSTITUTIONAL REVIEW

BOARD FOR HUMAN SUBJECTS RESEARCH

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 04-12-93 **IRB#:** HES-93-027

Proposal Title: INCIDENCE OF INTESTINAL PARASITIC INFECTIONS AND THEIR IMPACT ON THE NUTRITIONAL STATUS OF PRESCHOOL AGE CHILDREN IN THE DOMINICAN REPUBLIC

Principal Investigator(s): June Wolgemuth, Digna del la Cruz

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: Marcia L. Tilley
Chair of Institutional Review Board

Date: April 23, 1993

APPENDIX C.

MAP OF BARRIO LAS FLORES (COMMUNITY I)

(See pocket in the back)

APPENDIX D.

CONSENT FORM USED IN THE RESEARCH

CENTRO MEDICO BUEN PASTOR - OKLAHOMA STATE UNIVERSITY

CONSENT FORM

"I, ____,
hereby authorize Dr. Digna de la Cruz, M.D. and assistant to perform the following:

1.- The completion of a questionnaire concerning the nature of and factors contributing to my attending.

2.- Measurements including height, weight, arm circumference and triceps skinfolds measurements.

3.- The collection of fecal samples from my child. I understand that I will be shown by demonstration how to collect the fecal sample(s).

4.- Medical nutritional screening.

I understand that my participation will likely take about one hour not including the time needed to collect the fecal sample(s).

I understand that all information is of a personal and will be held in strict confidentiality. I understand that there is no known risks to me or my child.

I understand that these procedures are done as part of a research entitled, "Impact of parasitic infection on the nutritional status of preschool children." The purpose of this study and of fecal collection are to identify parasitic infections in children and how this affect their nutritional status.

I understand that: participation is voluntary. I understand that there is no penalty for refusal to participate. I understand that I am free to withdraw my consent and participation in this project at any time after notifying the project director.

I may contact Dr. Digna de la Cruz at
Eusebio Payano #2
San Pedro de Macoris, D.R.
Phone# (809) 529-7154

I have read and fully understood the consent form. I sign it freely and voluntary. A copy has been given to me."

Date: ______________________________ Time: ____________________

Signed: ____
(signature of assisting parent or guardian)

I certify that I have personally explained all elements of this form to the subject or his/her representative before requesting the subject or his/her representative to sign it.

Signed: ____

APPENDIX E.

QUESTIONNAIRE USED IN THE RESEARCH

NUTRITION AND PARASITIC INFECTIONS

CENTRO MEDICO BUEN PASTOR / OKLAHOMA STATE UNIVERSITY

QUESTIONNAIRE # : __________

1. Place of interview :

   a. TOWN : ______________

2. I.D. # : _________

3. Name of the interviewer : ________________

4. Date of the interview : _____/_____/_____

****

5 Name of the parent/custodian : _______________

6. Age : _______ 7.Sex : Female/Male

8. Marital status :

   Single/Separated/Divorced/Married/No response

9. Education :

   a. No formal schooling : ______
   b. Primary school : ______
   c. Secondary school : ______
   d. College : ______
   e. Vocational/Technical school: ______

10. Occupation : ___________________

11. Income per month :

   a. Less than $ 500.00 : _______
   b. $ 501.00 - $ 750.00 : _______
   c. $ 751.00 - $ 1000.00 : _______
   d. $ 1001.00 - $ 2000.00 : _______
   e. More than $ 2000.00 : _______

12. Relationship to child : ____________________

13. Name of the child : ____________________

14. Age of the child : ____

15. Date of birth : ____/ ____/ ____

16. Sex of the child : Female/Male

17. How many children are in the houselhold ? _____

18. What type of milk does your child drink ? __________

19. How often does your child drink milk ?

a. once a day : ________

b. twice a day : ________

c. thrice a day : ________

d. more than thrice : ________

20. a.How many meals does your child eat per day ? _______

b. With whom ? _____________

21. How would you describe your child's appetite ?

a. Good : _______

b. Bad : _______

c. Poor : _______

22. Does your child have any trouble chewing or swallowing ?

a. Yes/No : _______

b. If Yes specify : ______________________

23. Does your child have any food allergies or intolerances ?

a. Yes/No : _______

b. If Yes specify : ______________________

24. Is your child taking any vitamins/minerals supplements ?

a. Yes/No : ______

b. If Yes specify : ____________________

25. Is your child taking any medication ?

a. Yes/No : ______

b. If Yes specify : ____________________

26. Does your child have any current medical illnesses ?

a. Yes/No : ______

b. If Yes specify : ____________________

27. Has your child had any serious illnesses in the past 12 months?

a. Yes/No : ______

b. If Yes specify : ____________________

28. Has your child ever had any serious medical illnesses ?

a. Yes/No : ______

b. If Yes specify : ____________________

29. Has your child had diarrhoea and/or vomitting recently ?

a. Yes/No : ______

30. Has your child had any history of parasites recently ?

a. Yes/No : ______

b. If yes did he/she undergo any treatment or took any medication ?

c. Yes/No : ______

31. Does your child walk or play outside without shoes ?

a. Yes/No : ______

32. Does your child eat anything which is not considered food ?

a. Yes/No : ______

b. If yes specify : ____________________

HOUSING

33. Disposal of human waste :

a. Flush toilets : __________

b. Latrine : __________

c. Latrine shared with other house : ________

d. Others : __________

34. Disposal of waste/sewage :

a. Public sanitation : __________

b. Incineration : __________

c. No disposal system : __________

35. What type of plumbing system do you have at home ?

a. City water

i. Inside the house : ____________

ii. Outside the house : ____________

b. From Cistern : ____________

36. Storage of water :

a. Cistern : __________

b. Clay barrel designed solely for water storage : ______

c. Large clay jar : __________

d. Buckets, tin bails : _________

37. Is there any animals around the house ?

a. Yes/No : _________

b. If Yes, specify : _________

ANTHROPOMETRIC MEASUREMENTS OF THE CHILD

38. Height : ________

39. Weight : ________

40. Tricep skinfold : ________

41. Arm circumference : ________

42. Weight/Age percentile : ________

43. Weight/Height percentile : ________

44. Height/Age percentile : ________

PARASITOLOGY RESULTS

45. Parasitology : ____________

CLINICAL EXAMINATION

46. Eyes

ALL NEG. ______

a. xerosis conjunctivae ________
b. conjuctival wrinkling ________
c. conjunctival pigmentation ________
d. Bitot's Spots ________
e. advanced xerophthalmia ________
f. corneal scarring ________
g. conjuctivitis ________
h. signs of trachoma ________
i. cataract ________
j. pallor of lower lid conjunctiva ________
k. other (specify) ________

47. Ears

ALL NEG. ______

a. discharge ________
b. external inflammantion ________
c. other (specify): ________________________________

48. Mouth

ALL NEG. ______

a. angular stomatitis ________
b. angular scars ________
c. cheilosis of the lips ________
d. spongy bleeding gums ________
e. number of teeth decaying ________
f. number of teeth missing ________
g. number of teeth filled ________
h. mottling of teeth ________
i. gingivitis ________
j. pallor of tongue ________
k. other, specify : ________________________

49. Glands ALL Neg.

a. thyroid goitre: 0 1 2 3
b. parotid enlargement ____
c. gynecomastia ____
d. other (specify): ____

50. Skin ALL NEG. ____

a. pellagrous ____
b. follicular hyperkeratosis ____
c. crazy pavement or mosaic ____
d. scabies ____
e. petechial or subcutaneous hemorrhage ____
f. fungal infection ____
g. scars ____
h. rash ____
j. other (specify): ____

51. Nails ALL NEG. ____

a. pallor of bed ____
b. koilonychia ____
c. other (specify): ____

52. Cvs ALL NEG. ____

a. heart murmur ____
b. dyspnea ____
c. cardiac enlargement ____
d. edema ____
e. arythmia ____
f. other (specify): ____

53. Lungs ALL NEG. ____

a. abnormalities: ____

54. Abdomen ALL NEG. ____

a. splenomegaly ____
b. hepatomegaly ____
c. hernias ____
d. ascites ____
e. other (specify): ____

55. Skeleton ALL NEG. ____

a. knock knees ____
b. bow legs ____
c. other deformities (specify): ____

56. Any other conditions: ____

APPLENDIX F.

SUMMARY OF THE PHYSICAL EXAMINATION PERFORMED TO PRESCHOOL CHILDREN OF COMMUNITY I AND COMMUNITY II

UMMARY OF THE PHYSICAL EXAMINATION PERFORMED
TO PRESCHOOL CHILDREN OF COMMUNITY I
AND COMMUNITY II

Clinical signs	Community I	Community II
Conjunctivitis	7	3
Pallor of the lower lid conjunctiva	39	37
Discharge of the ears	3	1
Cheilosis of the lips	7	3
Angular stomatitis	4	-
Motting of teeth	16	6
Gingivitis	1	1
Pallor of tongue	5	2
Scabies	14	6
Fungal infections	8	2
Rash	10	4
Pallor of bed nail	15	5
Neurological disorders	4	-

VITA

Digna de la Cruz-Ibert

Candidate for the Degree of

Master of Science

Thesis: PREVALENCE OF INTESTINAL PARASITIC INFECTIONS AND THEIR IMPACT ON THE NUTRITIONAL STATUS OF PRESCHOOL CHILDREN IN SAN PEDRO DE MACORIS, DOMINICAN REPUBLIC.

Major field: Nutritional Science

Biographical:

Personal Data: Born in Santo Domingo, Dominican Republic, on September 22, 1959, the daugther of Secundina Ibert and Andres de la Cruz.

Education: Graduated from Liceo Union Pan Americano High School, Santo Domingo, Dominican Republic, in July 1978; received the degree of Doctor in Medicine from the Universidad Autonoma of Santo Domingo, Dominican Republic, in 1986; completed the requirements for the Master in Science in December 1994.

Professional experience: Pasantia medica, Centro nutricional CARITAS Dominicans, 1986-87. Centro Comunidad y Salud, Sabana Perdida, 1987-1990. Centro Medico Sagrada Familia, 1989-1990. Hospital Francisco Moscoso Puello, Santo Domingo, 1989-1991.

Professional Organizations: Association Medica Dominicana.