To the Graduate Council:

We are submitting herewith a dissertation written by Charles Thomas Faulkner entitled "Household Management of Endoparasitic Infection in a Border Community in Tamaulipas, Mexico." We have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Dr. Michael H. Logan, Co-Major Professor

Dr. Sharon Patton, Co-Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of the Graduate School

HOUSEHOLD MANAGEMENT OF ENDOPARASITIC INFECTION IN A BORDER COMMUNITY IN TAMAULIPAS, MEXICO

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Charles Thomas Faulkner
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I met Dr. Logan in 1976 as a student in his introductory Cultural Anthropology course. My decision to pursue a career in Anthropology was made before the midterm examination. It's a decision I have never regretted. However, I could never have predicted the circuitous path I would follow to arrive at this goal. I joined my 1st archaeology project in 1978 on Mike's advice that an anthropologist should have experience in all of the subdisciplinary areas of the field. I found prehistoric archaeology so enthralling

that I ended up pursuing a master's degree under the direction of Walter Klippel. I became interested in the analysis of desiccated human fecal samples from archaeological sites in Middle Tennessee, and eventually developed a thesis project on samples from Big Bone Cave in Van Buren County, TN. Mike innocently suggested that I should consider examining some of the paleofecal material for evidence of endoparasitic infection during one of his seminar classes in ethnobiology. Although my biologic training up to that point had been in ethnobotany, field botany, and palynology, I thought to myself how difficult can it be to learn how to identify parasites. My search for instruction led me to Dr. Sharon Patton's laboratory at the College of Veterinary Medicine. I truly believed that I would only be in her laboratory long enough to learn the skills necessary to write a single chapter in my thesis. I never imagined that the parasitologic analysis of the Big Bone Cave samples would be one of the most interesting aspects of the research, and that my career path was about to take yet another turn.

In Dr. Patton's laboratory, I became hooked on parasites and fascinated with the study of parasitism in all of God's creatures. My colleagues in Parasitology often ask me what organism I study, and I have had to admit that I find all parasites equally interesting and want to study aspects of all of them. Sharon has nurtured my eclectic interest and reminded me that we study the phenomenon of parasitism rather than parasites as the unit of analysis. I believe that this fundamentally different approach to Parasitology is the foundation for my desire to research and understand the cultural beliefs and behaviors that underlie parasitism in human societies. Sharon has been more than a mentor over the 12 years we have known each other. She has also been a close and personal friend whose encouragement, prayers, council, and wisdom have contributed to my success as a scientist, husband, parent, and socially responsible human being.

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ABSTRACT

Fecal samples from 438 children in 217 families were examined for helminth eggs/larvae and protozoan cysts to study the occurrence of parasitic infection and household knowledge of cholera preventive measures in a border community in Tamaulipas, Mexico. The age of the children ranged from 1 month to 16 years. Parasitic infections occurred in 30% of children residing in 79 of 217 households. *Giardia lamblia* accounted for 12.5% of all infections. Other endoparasitic species found in the children were: *Hymenolepis nana* (28/438), *Ascaris lumbricoides* (16/438), *Trichuris trichiura* (6/438), *Enterobius vermicularis* (6/438), *Ancylostoma-Necator* (1/438), *Strongyloides stercoralis* (1/438), *Entamoeba coli* (27/438), *Ent. hartmanni* (24/438), *Ent. histolytica* (1/438), *Endolimax nana* (23/438), and *Iodamoeba büetschlii* (10/438). Infected children were older (mean age 6.32 years, $p = .05$) and often had an infected sibling (odds ratio = 2.88, $p < .01$). Households with ≥ 3 children were also more likely to have an infected child (odds ratio = 4.76, $p < .01$). Household knowledge and attitudes about infection and prevention of endoparasites and cholera was also collected with a structured interview schedule. Knowledge of cholera preventive measures was found in 72% of parasite infected households, and 81% of uninfected households. Parasite infected households were distinguished by their inability to list ≥ 3 cholera prevention measures (odds ratio = 2.19, $p < .01$). Informants from these households were more inclined to accept parasitic infections as a consequence of everyday life and recognize that the adverse effects of parasitism can be controlled with highly effective medicines. In contrast, informants from uninfected households shared a model which regarded parasitic infection in children as a preventable health effect. Public health interventions that emphasize the economic benefits of preventing rather than curing parasitic infections and other hygiene-related diseases can be an important adjunct to existing community health programs aimed at reducing childhood morbidity and mortality. The relatively low frequency of endoparasitism in communities such as the one investigated in this research is encouragement that *higiéne es salud* (hygiene is health) and that achievement of community-wide reductions in parasite-related morbidity is a public health problem for which there is a solution.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BIP	Border Industrialization Program
BNF	Buffered Neutral Formalin
CDR	Crude Death Rate
df	degrees of freedom
DIF	*Sistema Nacional Desarollo Integral de la Familia*
Ent.	*Entamoeba*
FES	Focused Ethnographic Study
HHHQ	Household Health and Hygiene Questionnaire
HLC	*Health Locus of Control*
IMR	Infant Mortality Rate
IMSS	*Instituto de Mexicano del Seguro Social*
ISSTE	*Instituto de Seguridad y Servicos Sociales de los Trabjadores del Estado*
KAP	Knowledge Attitudes and Practice
LIC	*Locus of Illness Control*
Mex$	Mexican pesos
MHPQ	Modified Household Parasite Questionnaire
ml	milliliters
mm	millimeters
NAFTA	North American Free Trade Agreement
ORT	oral rehydration therapy
OTC	over-the-counter (pharmaceutical products)
PC	Primary Caregiver
PI	Principal Investigator
PVA	Poly Vinyl Alcohol
RAP	Rapid Assessment Procedures
SSA	*Servicios Corridinados de Salud Publica*
µl	microliters
µm	micrometers
US$	United States dollars
VHCS	*Centro Salud Suburbano Valle Hermoso del SSA*
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

Project Overview

This research examines infection with endoparasitic helminths and protozoa as a measure of how well public health recommendations for preventing cholera and diarrheal disease have been accepted by residents of Valle Hermoso, a small town in the northeastern state of Tamaulipas, Mexico. Endoparasitic infection was presumed to be an appropriate measure of household compliance because many of the species infecting humans are related to unhygienic behavior, such as drinking contaminated water, eating improperly washed fruits and vegetables, and promiscuous defecation habits. Compliance with government health and hygiene recommendations for cholera prevention was expected to be effective in preventing infections with parasitic helminths and protozoa. This study investigated the hypothesis that households without endoparasitic infection were comparatively more attuned to illness prevention, and health management was based on faithful compliance with the government recommendations. In contrast, households with endoparasitic infection were hypothesized to be less attuned to illness prevention, and health was managed therapeutically with locally available antiparasitic medications and remedies. Behavioral and attitudinal factors associated with increased risk of infection from endoparasitic and infectious enteric agents can be targeted by additional educational efforts to increase compliance with government public health programs.

The objectives of this research were to:

1. describe endoparasitic infections of children in Valle Hermoso with respect to age, gender, household, and neighborhood affiliation,
2. collect information on household knowledge regarding the symptoms, etiologies, treatments, and prevention strategies commonly employed in the diagnosis and management of endoparasitic infections in Valle Hermoso,

3. evaluate the data on household knowledge of parasite acquisition, diagnosis, treatment, and prevention for consistency between household groups based on their endoparasitc infection status,
4. investigate the relationship of endoparasitic infection and household attitudes regarding illness prevention and treatment as measured with the *Locus of Illness Control* standardized interview instrument.

Behavioral and attitudinal factors associated with increased risk of parasitic infection and diarrheal disease could be disseminated to public health authorities in Valle Hermoso and the United States-Mexico border region to assist development of education materials and intervention programs aimed at reduction of morbidity and mortality due to parasitic and other enteric infectious diseases.

Development of the Research Problem

As a medical anthropology student pursuing research in parasitology, the global impact of parasitic disease as a major cause of human suffering prompted my desire to investigate the relationship between peoples' behavior and the culturally defined models used to explain how parasitic infections are acquired, treated, and prevented. In Latin America, for example, 40% of deaths can be traced to parasitic and infectious agents (Hauklinen et al. 1986). The adverse impact is particularly devastating among children where diarrheal disease from malnutrition and concurrent infection with endoparasitic protozoa, helminths, and enteric viral and bacterial agents is a significant cause of death for children less than five years of age (Guerrant et al. 1992; Warren 1988). In 1990 alone, Mexican authorities reported 22,196 deaths from diarrheal disease (Lezama-Basulto and Mota-Hernandez 1993). Children less than five years of age accounted for 63% of the deaths, and within this population 70% of the deaths were in children less than one year old (Lezama-Basulto and Mota-Hernandez 1993).

Previous research by Dunn (1972), Kloos et al. (1981), Buck et al. (1978), Kochar (1976), and other researchers in tropical medicine provided a rich historical background of epidemiologic studies of human parasitism and the cultural-behavioral factors that put people at increased risk for infection and disease. The scope of these studies, however, did not include detailed information about cultural knowledge of parasite-related etiologies, the symptoms used in households to diagnose parasitic infections, the preferred treatment options used by caregivers, and the strategies employed by household members to

prevent the reoccurrence of parasitic infections. Medical anthropologists working collaboratively in international public heath programs to reduce morbidity and mortality associated with childhood diarrheal disease began to collect this type of information throughout the 1980's. Studies by Escobar et al. (1983), Kendall et al. (1984), Kunstader (1991), Mull and Mull (1988), Nations and Rebhun (1988), Nations et al. (1988), Stapelton (1989), and many other researchers demonstrated the usefulness of detailed anthropologic studies of household-level etiologic models of diarrheal disease and treatment seeking behavior for developing effective intervention programs such as the delivery of oral rehydration therapy.

With few exceptions, many anthropological studies of knowledge, attitudes, and perceptions about parasitic and infectious diseases have not been fully integrated with epidemiologic studies of disease patterning conducted in the same populations. For example, information on a mother's explanatory model for how parasites are acquired may have been collected in great detail. However, without data on the occurrence of parasitic infection in those particular households, it is impossible to examine variation in knowledge of etiologies, symptom recognition, and treatment seeking behavior as independent variables that either increased or lowered the household's risk of infection and potential disease. Studies of helminth-related cultural beliefs by Booth (1993), Rousham (1994), and Willams-Blangero (1998) are particularly susceptible to this criticism. In each of these studies, regional scale parasite prevalence data were used as the backdrop for investigation of parasite-related beliefs. Because these data were collected independently of the households and communities interviewed in each study, it is impossible to know if increased risk of parasitic infection plays a role in the knowledge of treatment and prevention options household informants perceive are available to them.

Investigations of the relationship between disease patterning in human populations and their health-related beliefs have been undertaken using the theoretical construct known as *Locus of Illness Control* (Coreil and Marshall 1982; Logan 1991; Patrick 1993). Coreil and Marshall (1982) hypothesized that in areas of highly endemic infectious diseases people would be oriented primarily toward curative medicine because of the inherent difficulties associated with preventing infections with etiologic agents responsible for disease. They suggested that the predominate perception held by people living under these conditions would be that there is little one can do to prevent illness, but once ill there are many available options for curing illness (Coreil and Marshal 1978).

As a medical anthropologist-parasitologist interested in explaining why some households harbored parasitic infections in their children and others did not, the *Locus of Illness Control* had obvious utility as a theoretical construct for exploring this phenomena. It was hypothesized that households without parasitic infections would be comparatively more oriented toward illness prevention. These households were expected to conform to a model in which health was perceived as the outcome of one's actions, choices, and behaviors. Infected households, in contrast, would be less oriented toward illness prevention. The prevailing model for these households was that health was managed, and disease was averted by use of the many therapeutic options available in the private and public health sectors.

I traveled to Mexico in 1993 to perform diagnostic parasitologic examinations on children as a member of the Remote Area Medical team's expedition to the northeastern state of Tamaulipas, Mexico. I was struck by the sharp contrast in the landscape between the United States and Mexico when I crossed the border for the first time. On the U.S. side of the border everything was lush and green, on the Mexican side it was dry, brown, and dusty. In Mexico, I felt as if I had traveled back in time 35 years, when my family drove through the Tennessee countryside on two-lane highways. The Mexican roadside was dotted with isolated one and two room houses illuminated by naked incandescent lights. The faint smell of burning garbage in the evening air brought back memories of assisting my grandfather with his evening chores. The outhouses in the backyards indicated the absence of inside plumbing, a luxury in Mexico that is regarded as a basic household facility in the United States. I was expecting to find a lot of *wormy children* (Croll and Ghadirian 1981), and an overall poor understanding of how children became infected. After all, this expectation was based on everything I had read in the scientific literature about developing countries, and Mexico certainly had the appearance of a developing country even though I was only 45 kilometers from the border.

The results of the parasitologic analyses were quite unexpected. In these preliminary efforts, parasitic infections were detected in only 28% of the children. Infections with *Hymenolepis nana*, a nonpathogenic tapeworm, and *Entamoeba coli*, a nonpathogenic protozoan species were the most predominate parasites found in the samples. Informal discussions with the children's mothers also indicated that the relationship between *infección* (infection) and *higéne* (hygiene) was fairly well understood as a result of the recent cholera prevention initiative promoted by the Mexican government. Preventive

measures like hand-washing before meals and after using the bathroom, consumption of clean well prepared food, and drinking only water that is boiled, filtered, or chemically treated have been disseminated to the public by mass media and personal contact with health department personnel. The objectives of the present research were based on the hypothesis that faithful compliance with these preventive measures should also be effective in preventing infections with endoparasitic helminth and protozoan species transmitted to susceptible hosts through poor hygienic behavior. Infections with the nonpathogenic protozoan species like *Entamoeba coli*, *Ent. hartmanni*, *Endolimax nana*, and *Iodamoeba büetschlii* were presumed to be particularly appropriate indicators of household hygienic practices because they are not associated with clinical illness, and therefore are not targets for chemotherapeutic control.

In the chapters that follow the endoparasitic infections of Valle Hermoso children are described with respect to their age/gender distributions, and occurrence in households and *colonias* (neighborhoods). These data were used to differentiate households according to their parasite infection status to investigate variation in parasite-related knowledge and beliefs about illness prevention. This study provides baseline information on the occurrence of endoparasitic infection and its relationship to illness prevention beliefs in a convenience sample of households from Valle Hermoso *colonias*. Epidemiologic risk factors identified by this study can be targeted for increased attention and surveillance by health department personnel. Household attitudes and behaviors that are at variance with models that emphasize the role of individual health-related behaviors in disease prevention can be targeted with additional educational efforts to increase compliance with government preventive health initiatives.

CHAPTER 2

MATERIALS AND METHODS

Introduction

The materials used in this study include fecal samples collected from 438 children for diagnostic evaluation of endoparasitic infection. Interview data from adult male and female residents of 244 households in 13 *colonias* (neighborhoods) in Valle Hermoso were also obtained to provide information on household hygiene practices and knowledge on the identification and control of parasitic infections in children. Fieldwork to collect these materials was conducted over a three-year period between 1994 and 1997. Nurses assigned to the *Centro de Salud Suburbano Valle Hermoso del SSA* (VHCS), Dr. Benito Borrego, and volunteer neighborhood health care *promotoras* (promoters) assisted with the household interviews and fecal sample collection. Laboratory processing and diagnostic evaluation of the fecal samples, translation and transfer of household interviews into a computerized database format, and analysis of all materials associated with the project was performed by the author who served as Principal Investigator (PI) for this research. Student laboratory personnel employed in the Clinical Parasitology Service Laboratory, Department of Comparative Medicine, University of Tennessee College of Veterinary Medicine assisted with minor aspects of the laboratory work under the direct supervision of the PI. A detailed description of the field and laboratory methods used to collect and analyze the materials used in this research is provided in the following sections.

Colonia Selection and Household Enlistment

The *colonias* included in the study were recommended by the director of the VHCS. These *colonias* were located at the margins of the municipal limits of Valle Hermoso, and were the focus of recent public health education initiatives to reduce childhood morbidity and mortality from cholera and diarrheal disease produced by parasitic and other infectious enteric agents. The public health education effort of the VHCS was carried out in each *colonia* by a local committee of volunteer *promotoras* who are trained and

work under the supervision of a nurse assigned by the VHCS. This organizational structure permitted access to the greatest number of households and provided an expedient method for establishing the rapport necessary to conduct the investigation. The level of bias introduced in the study by using *colonias* with recent public heath education involvement was considered acceptable because the objectives of the research were focused on how well cholera and diarrheal disease prevention measures were accepted and practiced in Valle Hermoso households. Thus, an important characteristic for enrollment in the study was that each household had the opportunity to be exposed to government public health education programs.

Open meetings with the *promotoras* and interested residents of each *colonia* were conducted to enlist households for participation in the study. The project objectives were explained clearly and concisely by a native Spanish speaker (Dr. Borrego). This was required to fulfill the principles of informed consent established by the University of Tennessee Institutional Review Board of all studies involving human subjects in research. Detailed instructions for administering a household health and hygiene questionnaire and collecting fecal specimens from resident children for parasitologic analysis were presented. *Promotoras* and VHCS nurses were also provided with a prepared statement (in Spanish) for obtaining verbal affirmation of informed consent from all participants (Figure A1.1 and A1.2). During 1994 and 1995 *colonia* households were contacted during *door to door* pedestrian surveys and interviewed by small teams which included the PI, Dr. Borrego, *promotoras*, and VHCS nurses. Households were also enlisted in the study during *colonia* wide public health clinics sponsored by the VHCS. In 1996, *promotoras* in each *colonia* collected all fecal specimens and supervised the administration of household health and hygiene questionnaires for a nominal fee. All households that returned household health and hygiene questionnaires and/or provided fecal specimens from their children were included in the study. Household participation in the study was strictly voluntary and economic incentives were not used to stimulate cooperation. A precise estimate of the proportion of households participating in the study was not possible in the absence of a detailed population census of the total number of families and families with children from each *colonia*. Thus, the households participating in the study constitute a convenience sample because their enrollment in the study was not based on systematic population sampling techniques.

Household Health and Hygiene Data Collection

The household health and hygiene questionnaire (HHHQ) was used to systematically collect information from 165 households on beliefs about illness prevention, and the recognition, treatment, and prevention of parasitic infections in children in the 1994 and 1995 field sessions (Figure A2.1). Information used to develop the questionnaire was based on the results of an earlier investigation on the occurrence of the Hispanic folk illness *empacho* and its relation with endoparasitic infection in Tamaulipas communities (Faulkner et al. 1994). Additional ideas for formulating questions on parasite and hygiene related beliefs were taken from published studies by Weller et al. (1993), and Rousham (1994).

The HHHQ was composed of six sections. Information on household characteristics such as age and sex of the informant, number and ages of resident children, source of drinking water, and facilities for disposal of fecal waste were listed in the first section. In 1995, additional information on the occupation of the head of the household, and home ownership was collected to obtain an estimate of household income. Informant knowledge of the government recommendations for cholera prevention was collected in the first section. The prevention measures promulgated through the national program include:

1. Wash hands after defecation and before meals
2. Wash fruits and vegetables before consumption
3. Cook all foods, especially seafood well
4. Only drink water that has been boiled or purified

Each informant was asked to immediately recall these or similar recommendations from memory, and comment on how frequently they were used in their household. Informants were asked if they were used all of the time, some of the time, or never used in their households. Specific information on method and frequency of hand washing was not collected because it was covered under the government cholera prevention measures.

Section two consisted of a series of questions taken from Coreil and Marshall's (1982) *Locus of Illness Control* (LIC) instrument. Beliefs about the population at risk for parasitic infection, and how infections are acquired were elicited in the third section. Section four contained questions about the symptoms and recognition of parasitic infections in children. Beliefs about treatment and prevention of parasitic infections were collected in response to the questions in sections five and six. Questions in each

section were designed to be answered as *yes, no,* or *don't know*. However, for the LIC section *sometimes* was substituted for *don't know* as the third response. The HHHQ was translated into Spanish by a native speaker (Figure A2.2). Dr. Borrego improved the translation with suggestions on phrasing particular concepts and ideas in the local vernacular. The HHHQ was reviewed in detail with VHCS nurses and *promotoras* prior to administration to clarify any problems arising from misunderstanding the questions or their translation from English into local Spanish.

Preliminary analysis of the data collected with the HHHQ indicated that it was desirable to collect detailed information on parasite acquision, treatment, and prevention. This was done with a limited series of open-ended questions in which the informant was encouraged to explain the reasoning behind their answer. The modified household parasite questionnaire (MHPQ) was developed in collaboration with Dr. Borrego, translated into local Spanish, and pre-tested in a single *colonia* with 11 households in July 1995 (Figure A3.1 and A3.2). The success of this effort prompted slight revisions to the MHPQ prior to its use in December 1995 (Figure A4.1 and A4.2), and April 1996 (Figure A5.1 and A5.2). In each case, the basic household characteristic information (section one of the HHHQ) remained comparable between all versions of the MHPQ. Slight differences between versions resulted from the addition and/or expansion of particular questions on parasite-related beliefs as interesting trends emerged during preliminary analysis of data collected in the previous field session. The MHPQ was used to interview 28 households in 4 *colonias* during the December 1995 field session. Fifty-five households in 6 *colonias* were interviewed with the MHPQ during the April 1996 field session.

To summarize, 244 households were interviewed during the course of this research. The HHHQ was administered to 165 households during the 1994 and 1995 field sessions. The MHPQ was administered to 79 additional households during the July 1995, December 1995, and April 1996 field sessions.

Household Fecal Sample Collection and Processing

Fecal samples were collected from 438 children in 217 households. All samples were collected by the primary caregiver (PC) in each household (usually the mother) and submitted for laboratory processing in plastic bags provided to each family during the initial visit when the HHHQ or MHPQs were

administered. The PC in each household was given explicit instructions on how to collect samples from all resident children, and label each plastic bag with the child's name, age, family name (*apellido*), and *colonia*. All fecal samples from participating households in each *colonia* were collected by the PI on a prearranged day (usually one or two days) after the interview session. Samples were taken to a field laboratory established in the clinic of the *Cruz Roja de Valle Hermoso* (Valle Hermoso Red Cross) and processed for diagnostic analysis, and transport to the Clinical Parasitology Laboratory at the University of Tennessee College of Veterinary Medicine.

All fecal samples were macroscopically examined for blood, mucus, spontaneously passed worms, tape worm segments, and fly larvae prior to processing. Each stool specimen was classified according to its morphology as liquid, soft, or formed by the PI according to the criteria of Beaver et al. (1984). Fecal samples were then divided into equal portions and placed in commercially acquired fecal transport vials (Meridian Diagnostics, Cincinnati) containing 10% Buffered Neutral Formalin (BNF) and Poly Vinyl Alcohol (PVA). Each sample was assigned an accession number and all specimen identity information was cataloged accordingly.

Diagnostic Parasite Analysis

Fecal samples were processed for diagnostic parasite analysis by the direct and centrifugal flotation methods using saturated zinc sulfate (specific gravity 1.18) and Sheather's sucrose (specific gravity 1.26) solutions as flotation media (Sloss et al. 1994). These methods levitate the diagnostic products of parasites (eggs, larvae, oocysts, and cysts) from the fecal matrix with the use of a flotation medium that has a higher specific gravity than the parasite products. The flotation method concentrates the parasite products on the surface of the medium because of their lighter density, and results in a cleaner preparation for microscopic examination when compared to sedimentation methods. However, flotation techniques also have the disadvantage that there is no single all-purpose medium capable of concentrating all parasite products equally well. Sheather's sucrose, for example, is too viscous for use without a centrifuge, and zinc sulfate does not reliably float the eggs of *Ascaris lumbricoides* or *Trichuris trichiura*. The eggs of Pseudophyllidian tapeworms like *Diphyllobothrium latum* and various Trematode species are best recovered by the sedimentation technique. Sheather's sucrose and zinc sulfate were chosen as flotation

media for this study because of their superior ability to concentrate particular parasite products for diagnostic analysis. Sucrose flotations were performed on each fecal sample to identify potential infections with *A. lumbricoides, T. trichiura, Hymenolepis nana, Cyclospora cayentisis*, and *Cryptosporidium parvum.* Potential infections with parasitic protozoan species like *Giardia lamblia, Endolimax nana, Iodamoeba büetschlii, Entamoeba coli, Ent. hartmanii*, and *Ent. histolytica*, were targeted for identification with the zinc sulfate flotation technique. The sedimentation technique was not employed because it was too labor intensive, and there was a low prior probability of detecting infections with *Diphyllobothrium latum* or a Trematode species that infects humans. These parasites are generally acquired through consumption of poorly cooked fish and crustaceans. Fish, crustaceans, and other seafood are not common dietary items in Valle Hermoso households.

Fecal samples were analyzed for diagnostic parasite products by the direct zinc sulfate flotation method in Valle Hermoso during the 1994 and 1995 field sessions. The purpose of this preliminary analysis was to identify clinically significant parasitic infections for treatment by the local public health authorities. The direct flotation was performed according to the following procedure (modified after Sloss et al. 1994):

1. Approximately 3 to 4ml of each formalin fixed stool sample was transferred to a 3oz uncoated paper *Dixie* cup.
2. Approximately 5ml of saturated zinc sulfate solution with specific gravity 1.186 was mixed with the fecal-formalin suspension and strained through 2 layers of cotton gauze in to a clean *Dixie* cup to remove excess fecal debris.
3. The strained fecal-formalin-zinc sulfate suspension was transferred to a 15ml conical bottom polystyrene centrifuge tube.
4. Additional zinc sulfate was added to the tube to create a convex meniscus.
5. A 22 x 22mm, No. 1½, glass coverslip was applied to the meniscus at the top of the centrifuge tube and allowed to stand for a minimum of 20 minutes.
6. After 20 minutes, the coverslip was transferred to a labeled glass microscope slide with 1 drop (approximately 25µl) of Lugol's iodine stain to enhance the diagnostic morphologic features and identification of endoparasitic protozoan species.

7. The glass slides from each fecal sample were examined with a compound microscope at magnifications between 200x and 1000x. Endoparasitic helminth and protozoan species were identified based on their characteristic morphology and with the aid of diagnostic reference manuals by Ash and Orhiel (1990), Garcia and Bruckner (1993), and Price (1993).

All fecal samples collected during the study were analyzed for diagnostic parasite products at the University of Tennessee Clinical Parasitology laboratory by the centrifugal flotation method with zinc sulfate and Sheather's sucrose. The purpose of this analysis was to confirm the parasitic infections identified in Valle Hermoso, and provide an accurate assessment of the parasite infection status for each of the households participating in the study. The centrifugal flotation method differs from the previously described direct flotation method in its use of centrifugal force to assist levitation of the parasite products from the fecal matrix. The centrifugal method also incorporates a *water wash step* for the removal of fecal fats and pigments that may interfere with efficient microscopic examination of the fecal sample. The centrifugal flotation method was performed according to the following procedure (modified after Sloss et al. 1994):

1. Approximately 10 to 11ml of formalin fixed stool sample was transferred to a 3oz uncoated paper *Dixie* cup.
2. Approximately 7ml of tap water was mixed with the fecal-formalin suspension and strained through 2 layers of cotton gauze in to a clean *Dixie* cup to remove excess fecal debris.
3. The strained fecal-formalin-water suspension was divided into equal portions by transfer into two 15ml conical bottom polystyrene centrifuge tubes. Water was added to each tube to bring the total volume up to 15ml.
4. The fecal suspension was concentrated by centrifugation for 5 minutes at approximately 1500 RPM in a swinging bucket centrifuge (Dupont-Sorvall, Norwalk, CT).
5. The samples were removed and the supernatant was carefully decanted so that the sediment pellet (approximately 2.8gms) in the bottom of each centrifuge tube remained undisturbed.
6. The undisturbed sediment pellet in each centrifuge tube was resuspended in approximately 10ml of either zinc sulfate (specific gravity 1.18) or Sheather's sucrose (specific gravity 1.26).

7. Additional flotation media was added to each tube bring the total volume up to 15ml and create a convex meniscus.
8. A 22 x 22mm, No. 1½, glass coverslip was applied to the meniscus at the top of each centrifuge tube and the centrifuge run for 5 minutes at 1500 RPM.
9. After centrifugation, each coverslip was transferred to labeled glass microscope slides. A drop (approximately 25µl) of Lugol's iodine stain was added to each of the samples processed with zinc sulfate to enhance the diagnostic morphologic features and identification of endoparasitic protozoan species. Sheather's sucrose processed samples were not stained.
10. The glass slides from each fecal sample were examined with a compound microscope at magnifications between 200x and 1000x. Endoparasitic helminth and protozoan species were identified based on their characteristic morphology and with the aid of diagnostic reference manuals by Ash and Orhiel (1990), Garcia and Bruckner (1993), and Price (1993).

Permanent fecal smears were made from all of the PVA fixed samples collected in the study and stained with the modified trichrome technique initially described by Wheatley (1951). The purpose of this analysis was to confirm identifications of endoparasitic protozoan species recognized from the zinc sulfate flotation processed samples treated with Lugol's iodine stain. Because of the small size of their diagnostic stages, reliable identification of intestinal protozoa is enhanced by examination of their differentially stained morphologic features at the higher magnification of 1000x. The trichrome staining method was performed according to the following procedure (modified after Garcia and Bruckner 1993):

1. A small portion of PVA fixed fecal sample was applied to a labeled 1"x 3" glass microscope slide with a wooden applicator stick. The sample was spread to the edge of the slide so that the resulting film was thin enough that newsprint could be read through the smear.
2. Each slide was allowed to thoroughly dry overnight at room temperature.
3. The dried slides were transferred to glass staining dishes and placed in 70% ethanol-iodine 10 minutes to remove mercuric chloride from the PVA fixative.
4. The ethanol-iodine was rinsed from the slides by placing them in 2 changes of 70% ethanol for 10 minutes each.
5. The fecal smears were stained by immersion in the trichrome stain solution for 12 minutes.

6. The slides were destained with a single dip in 90%-acidified ethanol to differentially stain the nuclear and cytoplasmic material of the protozoan cysts in the fecal smears.
7. The slides were dipped in 100% ethanol 5 to 6 times to remove the acid and stop the destaining activity.
8. Excess stain was removed from the slides in 2 changes of 100% ethanol for 5 minutes each.
9. The slides were placed in carbol-xylene solution to remove excess water molecules remaining in the fecal smear from the ethanol rinse steps.
10. The fecal smears were completely dehydrated by placing the slides in 2 changes of 100% xylene for 10 minutes each.
11. Each stained fecal smear was removed directly from the xylene and a 22x55mm No.1 glass coverslip was immediately affixed to the slide with an organic resinous medium (*Coverbond*, Baxter Scientific, Chicago).
12. The permanently mounted stained fecal smears were examined with a compound microscope under oil immersion at 1000x magnification. Endoparasitic protozoan species were identified based on their characteristic morphology, and with the aid of diagnostic reference manuals by Ash and Orhiel (1990), Garcia and Bruckner (1993) and Price (1993).

Experimental Design, Analytical Units, Data Management, and Statistical Analysis

The experimental design employed for this research was comparable to the cross-sectional study defined in conventional epidemiologic research (Mausner and Kramer 1985). Observations of a study population were made during a cross-sectional slice of time by employing clinical tests, interviews, and other estimated measures of exposure to determine the prevalence of a particular health effect (Mausner and Kramer 1985). The purpose of such studies is to compare the prevalence of a defined health effect among subgroups of a population with varying exposures, age/gender compositions, or personal habits. For this study, the prevalence of endoparasitic infection was compared among subgroups of the Valle Hermoso study population. These subgroups were defined in terms of the age/gender compositions and personal habits of informants and their households, the informant's *colonia* of residence, variation in the immediate recall of cholera prevention measures promulgated by the Mexican government, and differing degrees of knowledge regarding parasite acquision and prevention.

The analytical units of the study were individual persons (n= 438) from whom fecal samples were collected for parasitologic analysis and informants from cooperating households (n= 244) who provided information about beliefs on illness prevention, and the recognition, treatment, and prevention of parasitic infections in children. Patterning in the distribution of parasitic infections by age and sex of the host and relationship with infected siblings sharing the same household was examined using individual persons as the unit of analysis. Comparison of households by infection status and attributes such as income, number of resident children, and variation in parasite-related beliefs measured by the HHHQ and MHPQ was done using households as the unit of analysis. A household unit was operationally defined as all persons residing within the confines of a single dwelling under the leadership of an individual recognized as the head of the household.

Households were classified into analytical groups for comparison using nominal scale attributes based on providing fecal samples from their resident children for parasitologic analysis, and the outcome of the diagnostic analysis for parasitic infection. Households that participated in the interview portion of the study but did not provide fecal samples for analysis served as an outside group for comparing the beliefs about illness prevention, and the recognition, treatment, and prevention of parasitic infections with households that provided fecal samples. No effort was made to contact households that did not provide fecal samples to find out why they declined to participate. It was felt that such an effort would be perceived as coercive and inconsistent with the informal agreement of the informed consent statement previously presented to the PC. Households that provided fecal samples were differentiated by their parasite infection status. Infected households were operationally defined as those in which at least one member was infected with any endoparasitic species. Infected household members were likewise defined as persons harboring at least one endoparasitic species indicated by the occurrence of helminth eggs or larvae, or protozoan trophozoites or cysts in an examined fecal sample. Uninfected households and persons were operationally defined as those in which no evidence of parasitic infection was detected in any of the examined fecal samples. Thus, the interviewed population of this study has been broken down for analytical purposes into three analytical comparison groups: *outside comparison households*, *infected households*, and *uninfected households* (Table 1).

Table 1. Analytical comparison groups defined for Valle Hermoso households participating in the study of household hygienic practices and parasitic infections in children.

Analytical Comparison Group	Defining Characteristics
Outside comparison households	Households that consented to interview but did not provide fecal samples for parasitologic analysis
Infected households	Households that consented to interview, provided fecal samples for parasitologic analysis, and at least 1 person in household was positive for parasitic infection
Uninfected households	Households that consented to interview, provided fecal samples for parasitologic analysis, and no person in household was positive for parasitic infection

Data from the fecal sample collections and household interviews were maintained in computerized databases constructed with Dbase 3+, version 1.1 (Ashton-Tate, Torrance, CA) and EpiInfo, version 5.1 (Centers for Disease Control, Atlanta, GA) software. All fecal samples from individuals were assigned accession numbers when collected and recorded in a Dbase 3+ database. Additional information in the database included the child's name, age, sex, stool form, and fecal examination results. All household interview forms (HHHQ and MPHQ) were translated into English by the PI, and transferred to EpiInfo databases following each field session. Identification numbers were assigned to each household to simplify data management and permit cross-referencing of the household interview data with the parasitologic test results of children residing in the household.

The statistical methods employed for analysis of the data collected during the study were essentially those of descriptive epidemiology in which attributes of the analytical units are summarized by frequencies and proportions. For most analyses the parasite infection status of an individual, or household, was regarded as the dependent variable. Thus, individuals and/or households were differentiated as infected or uninfected according to the operational definitions presented above. Independent variables used for comparing the infection status of individuals included the child's age, sex, and *colonia* of residence, and residence in a household with infected siblings. For this and subsequent analyses the original 13 *colonias* were collapsed into eight analytical units suitable for statistical analysis. This approach was justified

because some of the *colonias* were small in size, sometimes being represented by less than 10 households, or were separated only by a single street. The resulting eight *colonias* are listed in Table 2 according to the pseudonyms used throughout this research for protection of the residents' privacy.

Independent variables used for comparing the infection status of households were: household income, knowledge and use of government cholera prevention measures, the number of resident children in the household, source of household drinking water, the presence/absence of household fecal disposal facilities such as toilets in the house or latrines outside of the house. Information on household income was collected indirectly by asking informants to list the occupation of their spouse or the head of household if they were unmarried. A Valle Hermoso *Cruz Roja* staff member reviewed the list of occupations and provided an estimate of the weekly salary for each occupation. Dr. Borrego confirmed the reasonableness of the salary estimates based on his 20 years experience as a Valle Hermoso businessman. Conversion of the weekly household income estimates, and other economic measures into U.S. dollars (US$) was based on the exchange rate of 7.3 Mexican pesos (Mex$) to 1 US$.

Informant knowledge of the government cholera prevention measures was operationally defined by asking informants to recall from memory all of the preventive measures they were familiar with. For analytical purposes these results were classified into groups consisting of informants able to list 0, 1, 2, ≥ 3 cholera preventive measures. Household use of the cholera prevention measures was based on informants' response that the measures were practiced in the household *all of the time*, *sometimes*, or *never*. For analytical purposes, households were classified into two groups: those who consistently used the preventive measures, and those who used them inconsistently. Households were also classified into analytic groups based on the number of resident children: households with two and fewer children and households with three or more children. Sources of household drinking water were differentiated as follows: bottled, from the faucet without treatment, from the faucet with treatment, and other outside sources such as an irrigation canal, river, or well. Treatments applied to water taken from the faucet include boiling, filtering, or addition of chemicals such as dilute chlorine bleach. Household facilities for disposal of fecal waste included toilets in the house, outside latrines, and no formally defined facilities.

Table 2. Valle Hermoso *colonias* and number of participating households.

Colonia[1]	Total households interviewed
Campo de Sueños	41
El Arbolado	26
Fuente de Suerte	35
La Corona	38
Los Indios	14
La Libertad	10
Los Vecinos	42
Sal Si Puedes[2]	38
Total Households	**244**

[1]All *colonia* names are pseudonyms to protect the privacy of their residents.

[2] The pseudonym *Sal Si Puedes* is used here in recognition of Margaret Clark's (1970) classic study of health in a Mexican-American community.

The responses to questions on the diagnosis, treatment, and prevention of parasitic infections contained in the HHHQ were also used as independent variables for comparing infected and uninfected households. Interview responses of informants in each analytical group: *outside comparison, infected, and uninfected* households were examined for consensus by comparing relative percentages of affirmative and negative answers for each question. Statistical tests of significance were performed whenever directionality in the proportion of affirmative or negative responses was detected. The primary statistical procedure used for comparisons between infected and uninfected individuals and households was the chi-square method. Risk factors for parasitic infection were evaluated for statistical significance using the *odds ratio* (Gillings and Douglas 1985). The odds ratio is a mathematical expression of the chances in favor of being infected with a parasite given the presence of the risk factor versus the chances against being infected given the absence of the risk factor (Mausner and Kramer 1985). For this study a risk factor was operationally defined as any personal, behavioral, or environmental characteristic associated with an increased probability of parasitic infection (Mausener and Kramer 1985). An odds ratio whose 95% confidence intervals does not include 1 is considered statistically significant (Gilling and Douglas 1985:187).

Single Factor ANOVA was used for analysis of normally distributed interval data such as informant age, household income, and number of resident children. Kruskal-Wallis nonparametric ANOVA was used whenever the assumption of a Gaussian distribution or homogenity of variances could not be assumed. For all statistical tests of significance, the probability of falsely rejecting the null hypothesis of no difference (Type 1 error) in the infection status of households relative to the tested independent variables was 0.05.

Locus of Illness Control Analysis

Households informants in 1994 and 1995 were interviewed with a series of statements designed to obtain information about their beliefs on illness prevention and cure. These were taken from a Spanish translation of Coreil and Marshall's (1982) *Locus of Illness Control* (LIC) instrument. The LIC instrument consists of 15 questions aligned on two dimensions, *illness cure* and *illness prevention* (Table 3). Each dimension, or subscale, is composed of several statements that are worded with internal or external

Table 3. *Locus of Illness Control* survey instrument. Items are listed according to their subscale and directionality dimensions. Items with internal directionality are scored: yes = 1, sometimes = 2, no = 3. Items with external directionality are scored: yes = 3, sometimes =2, no =1. The possible range of scores for the total instrument, and subscales are: 15 to 45 (total), 9 to 27 (prevention), 6 to 18 (cure). A high score on the total instrument, and the prevention and cure subscale indicates greater externality, or association with the belief that illness prevention and cure is largely outside of one's own control.

Locus of Illness Control Item	Subscale	Directionality
1. When persons get sick, there is usually much they can do about it	Cure	Internal
2. If you follow a life like God says you will rarely get sick	Prevention	Internal
3. Almost all diseases have a cure	Cure	Internal
4. If God wishes to send you an illness there is nothing you can do about it	Prevention	External
5. There are persons that are sick all of the time and others that are not	Prevention	External
6. The majority of illnesses are cured alone even when they are not treated	Cure	External
7. The people that have good health is from pure luck	Prevention	External
8. If you become ill, it is because you live under a lot of pressure (work too much)	Prevention	External
9. In the future, the doctors will find a cure for all diseases	Cure	Internal
10. The majority of persons are sick because they worry too much	Prevention	Internal
11. When persons eat well and maintain a healthy body, they are rarely sick	Prevention	Internal
12. When persons are sick it all depends on God if they get better	Cure	External
13. There is no reason to worry about illness, you have what comes to pass	Prevention	External
14. When people are sick, it is usually the result of bad luck	Prevention	External
15. The majority of illnesses can be cured by a good doctor with the proper medicines	Cure	Internal

directionality. The *illness cure* subscale is composed of six questions; four internal and two external. The *illness prevention* subscale is composed of nine questions; three internal and six external. Internally worded questions are scored according to the following scheme: yes = 1, sometimes = 2, and no = 3. Externally worded questions are scored in reverse so that yes = 3, sometimes = 2, and no = 1. For analytical purposes the *illness cure* and *illness prevention* subscales are summed separately, and the subscale scores are combined for a total LIC score. Scores for each subscale have a possible range of 6 to 18 for *illness cure*, and 9 to 27 for *illness prevention*. The total score has a possible range of 15 to 45. Higher scores are indicative of greater externality, or a general tendency to accept that the outcomes of events are outside of one's control, and result from fate, luck, chance, or the interventions of powerful others.

The original language of the LIC instrument was slightly modified to permit translation into the colloquial Spanish spoken in Valle Hermoso *colonias*. Item two was changed from the original "if you lead a good life you will rarely get sick" to "if you follow a life like God says you will rarely get sick". Item six was also changed from "most illness will be cured in a matter of time whether or not treatments are used" to "most illnesses are cured alone even when they are not treated". These modifications follow the recommendations of Patrick (1993) who recognized that these statements could be interpreted differently by informants and yield inconsistent results. Additionally, the directionality of item one was changed by rewording the original statement from "when people get sick there is not much (*no es mucho*) you are able to do about it" to "when people get sick there is much (*es mucho*) you are able to do about it". The need for this substitution became apparent during the early part of the 1994 data collection when several informants emphasized their strong disagreement with the statement and insisted that we *pencil in* the necessary changes on the interview form before proceeding to the other statements. Given the potential ambiguity with which this statement was interpreted in its original form, we felt that a formal change of its directionality was a pragmatic solution and more desirable than probing each informant's response and reverse scoring the statement on a case by case basis. This change in directionality also helped to balance the LIC instrument so that item 1 became the polar opposite of item 12 (Table 3).

The LIC scores of cooperating households were analyzed against the independent variables of:

1. household infection status,
2. informant age,
3. relative ability to list cholera preventive measures,
4. *colonia* of residence.

Classification of households into analytical comparison groups and operational definitions for household infection status, knowledge and ability to recall cholera preventive measures, and *colonia* of residence has been previously described. Informant age classes were defined using the cumulative frequency distribution of informant ages to divide the data set into socially meaningful groups according to the following ranges 18 to 25 years, 26 to 32, 33 to 43, and 44 to 70 years. Analytical group mean scores for the *illness prevention* subscale, and the total LIC score were calculated from the raw data collected from household informants using a single factor ANOVA model to test the null hypothesis that variation in the mean LIC scores between analytical groups was not statistically significant. The Kruskal-Wallis nonparametric equivalent to the single factor ANOVA model was used to analyze between group variation for the *illness cure* subscale because these scores did not follow the normal distribution assumed by parametric statistical methods (Zar 1984). For each statistical test, the probability of falsely rejecting the null hypothesis of no difference (Type 1 error) in the mean *illness prevention* and total LIC scores, and the median *illness cure* score relative to each independent variable was 0.05.

The mean scores calculated for each item on the LIC scale were also examined individually to obtain additional insight about the Valle Hermoso informants perceptions of the *illness cure* and *illness prevention* dimensions. Following the work of Coreil and Marshall (1982) and Logan (1991) scores greater than 2 were indicative of an external orientation for particular items on the LIC scale. Statistical analysis of the mean scores for each LIC item was not possible because they did not follow the Gaussian or normal distribution assumed for parametric analyses such as the T test or traditional ANOVA. It was necessary, therefore, to use the Kruskal-Wallis nonparametric single factor ANOVA for all statistical analyses of the LIC items and their relationship with the independent variables described previously. In contrast to the parametric ANOVA model which uses population parameters such as the mean and its variance, the Kruskal-Wallis ANOVA uses the sum of ranked observations, in this case median LIC scores, to compute

the test statistic for evaluating the null hypothesis. The probability of falsely rejecting the null hypothesis of no difference (Type 1 error) in the median LIC item score relative to each independent variable was 0.05. As with the parametric ANOVA, if the null hypothesis is rejected it is necessary to carry out a multiple comparison of the analytical group means, or medians, to determine which one(s) are significantly different from the others. For these analyses, Dunn's posteriori test ($p < .05$) was used to determine if the median scores for particular LIC items and their independent variables were statistically different.

In the discussion of the *item by item analysis* in chapter 7, frequent reference will be made to the *mean score* for each of the LIC items. This is necessary because the mean score is an intuitively less complicated attribute for describing the relationship between the independent variables and their orientation on the internal and external dimensions of the LIC scale. Mean scores and standard deviations are listed in the associated tables in chapter 7 for descriptive purposes only. All statistical tests of significance were based on the rank ordered median score calculated for each LIC item.

The LIC scores were also examined with the multivariate factor analysis method described by Rummel (1967). The objective of this aspect of the research was to describe the patterns of variation in LIC scores that were subtly expressed in the ANOVA results. Factor analysis was well suited to this task because it is a mathematical technique capable of simultaneously managing hundreds of variables, and it is able to compensate for random error and invalidity, and disentangle the complex interrelationships of a data set into major and distinct regularities (Rummel 1967). Because the application of this technique was simply focused on describing regularities in the LIC data, statistical problems like the type of underlying frequency distribution, sample size, and randomness of the data did not necessarily have to be part of the research design (Rummel 1967). Additionally, it was anticipated that the results of this analysis would be comparable to the results published by Coreil and Marshall (1982) and Logan (1991). By using the same methodology as these previous investigators this work contributes an additional reference group for examination of the larger issue of cultural variability in LIC beliefs.

For the factor analysis the LIC data were partitioned into three separate data matrices based on household infection status as defined above. Each matrix was analyzed separately using the factor analysis multivariate procedure with the SAS (Carey, NC) software package for the personal computer. Variation in

household LIC beliefs were analyzed with a six factor model that accounted for most of cumulative variation expressed in the informant's responses on the 15-item LIC instrument. The six factor solution was decided upon *a priori* so that the results of these analyses would be comparable to Logan's (1991) previous investigation of LIC beliefs among Brazilian herbalists. Following calculation of the initial factor matrix, eigenvalues, and percentage of total and cumulative variation accounted for, each of the data matrices were orthogonally rotated using the varimax technique. In factor analysis the rotated matrix is the object of interpretation (Rummel 1967:462). Ideally speaking, the results of the factor analysis of the LIC data were expected to yield 6 distinct clusters of relationships, or factors, between items on the LIC instrument. In contrast to the unrotated factor matrix, each factor in the rotated matrix is independent of the other factors, and no significance is attached to the ordering of the factors (Rummel 1967:466-467). From a theoretical perspective, each factor is assumed to be equally influential in defining the constellation of illness control beliefs shared by the households. Thus, the resulting picture is akin to a six dimensional projection of the important underlying concepts used by Valle Hermoso households to explain the presence and absence of illness, and the options available for the treatment of sick individuals.

CHAPTER 3

LITERATURE REVIEW

Scientific research does not occur within a theoretical vacuum. All research efforts, no matter how brilliant and innovative, have their origins in the historical literature of their respective disciplines. Conducting research on human parasitic infection and health-related behavior in a foreign country such as Mexico is by necessity an interdisciplinary enterprise. The theoretical background and methodological approaches that characterize this research are drawn from seemingly disparate disciplines as anthropology, parasitology, epidemiology, public health education, and statistics. The purpose of this chapter is to recognize the interdisciplinary foundation for this study of human parasitism and its cultural-behavioral context by drawing attention to the relevant literature that has been consulted since the project began. In the first section, a brief review of anthropological involvement in public health intervention programs is presented. These examples demonstrate how anthropological research has been applied to understanding the cultural dimensions of health behavior and the context in which public health programs are accepted or rejected by the populations they are intended to help. A review of relevant literature on the theoretical construct known variously as *Locus of Control, Health Locus of Control, and Locus of Illness Control* is presented as a useful framework for describing the health related beliefs of individuals and population subgroups with respect to preventive and curative medical orientations. Preventive health program planners could benefit by understanding the preventive and curative health dimensions of their target population and potentially achieve greater compliance with specially designed educational materials. Examples of *Knowledge, Attitude, and Practice* (KAP) studies explicitly focused on intestinal parasitic infection in developing countries are also presented. Aspects of this growing body of literature are reflected in the present study of human parasitism in a Mexican border community. Issues of methodological relevance to this research are also reviewed in subsequent sections. These include a brief consideration of the relative merits of population survey versus traditional ethnographic participant-observation techniques for KAP data collection on hygiene behavior and parasitic infection. The validity

of using single stool examinations to diagnose endoparasitic infection in a study population is also discussed. In the final section, a brief review of the literature on school based mass treatment programs for children and their role in the maintenance and improvement of community health is presented. This last topic has important implications for the development of health programs and allocation of resources aimed at reducing childhood morbidity and mortality due to parasitic and other diarrhea producing infectious agents.

Anthropological Involvement in Public Health Programs

Anthropological involvement in public health dates to the early 1950s when international agencies sought advice on sociocultural factors influential in the acceptance and rejection of modern medical programs proposed for traditional societies in developing countries. Health programs initiated during this period were based on the assumptions that:

1. the preventive and curative medical practices of developed nations and the institutional context for delivering these services were unequivocally suitable for all sociocultural and economic settings; and
2. the populations of developing nations would recognize the advantages of these medical practices and readily embrace them (Foster 1977).

According to the prevailing paradigm, health goals in developing countries could be achieved by transplanting western biomedical models of health care delivery. Foster (1977) observed that this expectation was probably based on the successful smallpox immunization campaign because it was a clear case where the efficacy of a medical technique was independent of culture. However, health program planners of this era failed to appreciate that one's willingness to be vaccinated was completely dependent on cultural factors (Foster 1977). Studies by Hanks and Hanks (1955), Hsu (1955), Wellin (1955), and others were carried out in response to this critical observation. These and subsequent studies documented cultural, social, and economic barriers influential in the acceptance of public health initiatives based on the western biomedical model of health care delivery.

Cultural factors which condition the acceptance and rejection of health programs include:

1. models used to explain the origin, occurrence, and prevention of illness; clinical signs and symptoms for illness diagnosis and classification (Foster 1977; Weiss 1988);
2. perceived seriousness of various illnesses patterns of help-seeking; and therapeutic options for treatment and management of illness (Young 1978, 1980).

Health programs initiated in traditional culture settings are often rejected because the models used to explain illness are incongruous with biomedical models based on the *germ theory* and principles of contagion. Explanatory models commonly employed in non-western medical systems have been differentiated by Foster (1976) into two basic types, personalistic and naturalistic. Personalistic models evoke the purposeful actions of a supernatural deity or individual (witch, sorcerer, or magician) as the source of the malady. Affected persons typically ask the questions *"who is responsible"* for sending the illness, and *"why did this happen to me"*. Illness, in these terms, is considered punishment for immorality and other behavioral transgressions, or an unfortunate consequence of offending the wrong person. Naturalistic models explain illness as the result of natural forces or conditions such as heat, cold, winds, and dampness rather than the purposive actions of an angry god. These forces act on individuals to disrupt the natural balance of their bodies/souls. Illness, according to this model, is the result of inadvertent violations of culturally based principles for maintaining health (Foster 1976, 1984). For example, dietary indiscretions such as over-consumption of foods with *hot* or *cold* properties are believed to be responsible for various gastrointestinal illnesses in many different cultural settings (Bently 1988; Kendall et al. 1984; Weller et al. 1993). Hsu (1955) described the local response of a Chinese community to a cholera epidemic. Despite the vigorous efforts of the hospital and schools, the local explanation was that *"epidemic-carrying spirits"* had been sent by the gods as punishment for behavioral transgressions. Hanks and Hanks (1955) likewise described an example of how the Bhuddist explanatory model of illness as a cosmic retribution for past misconduct affected the response of a Thai village to a district health officer's call for immunization during a diphtheria epidemic. Kark and Kark (1962) noted widespread resistance to the use of sanitary latrines by Africans who were reluctant to concentrate their feces for the convenience of witches who might make magic on them. Wellin (1955) found that residents of a community in Peru rejected a *"water boiling"* campaign promoted by the public health authorities because it was incompatible

with the premises of humoral balance. According to these residents, the act of *"cooking the water"* transformed its humoral property to *hot* so that it was unsuitable for drinking by healthy people. *"Cooked water"* was associated with illness, and therefore only suitable for consumption by persons who were very young, very old, chronically ill, delicate, or pregnant (Wellin 1955). The clinical signs and symptoms of affected individuals permit classification of particular illnesses with respect to cause and effect relationships articulated within explanatory models. For these systems, illness is diagnosed and defined by patterns of distress, such as diarrhea, anorexia, and fever. This method of diagnosis is often at variance with western biomedical models based on isolation and identification of etiologic agents. Scrimshaw and Hurtado (1988) described elaborate taxonomies for defining the cause and effect relationships of diarrheal complaint in Costa Rica, Guatemala, and Nicaragua. Similar taxonomic schemes have been reported from Brazil (Nations 1982), Haiti (Coreil and Genece 1988), Honduras (Kendall et al. 1984), India (Bentley 1988), Nepal (Stapelton 1989), and Pakistan (Mull and Mull 1988). These taxonomies qualitatively differentiate diarrhea resulting from organic causes (climatic, dietary, and intestinal worms), physical causes (fallen stomach, fallen fontanel, and blocked stomach/intestine), emotional causes (fear, envy, anger, and sadness), and developmental milestones associated with childhood (weaning, teething, and crawling). Each of these kinds of diarrhea also differs with respect to their perceived seriousness, options for therapeutic management, and patterns of help seeking. Interestingly, of the roughly eight categories of diarrhea noted by Scrimshaw and Hurtado (1988), only one or two were considered serious enough to warrant the attention of a physician, or treatment at a health post. This observation has important implications for public health programs directed at reducing morbidity and mortality due to childhood diarrheal illnesses.

Health programs often fail because the recommended therapeutic measures appear irrational to members of the community and they are at odds with local beliefs and practices (Weiss 1988). For many people "continuing to eat and drink is counterintuitive for an illness characterized by frequent liquid stools" (Weiss 1988). In other cases, biomedical therapies are presumed unsuitable for illnesses perceived to be outside the scope of biomedicine. For example, Kendall et al. (1984) observed that many people did not think oral rehydration therapy (ORT) was suitable for treating diarrhea caused by the Hispanic folk illness *empacho*. The treatment of choice for this illness is a purgative because it is believed to result from having

food or saliva stuck in one's stomach. Thus, any treatment thought to inhibit diarrhea, or interfere with clearing the blockage from the alimentary tract would be unacceptable. In a study of diarrhea concepts among Pakistani mothers', Mull and Mull (1988) noted that certain kinds of diarrhea were regarded as a natural consequence of *growing up* and that these diarrheas should be tolerated. Accordingly, the mothers believed that *teething diarrhea* was caused by excess heat from the activity of teething, and it should be allowed to run its course as a natural way of cooling the body (Mull and Mull 1988). In other cases, the culturally defined treatments for illness may impede recovery or potentially harm the patient. For example, diarrhea in rural Guatemala is often treated by withholding food and liquids under the assumption that it will solidify the feces (M. Logan 1978). This practice actually promotes dehydration, and accounts for the high rates of mortality from diarrheal disease. Lead poisoning is another adverse effect that has been associated with ethnomedical treatment of *empacho* (Baer et al. 1989; Trotter 1985, 1990). Similarly, Trotter et al. (1989) noted that traditional treatments for the Hispanic folk illness *caida de mollera* or fallen fontanel are ineffective for reversing the course of harmful dehydration. Moreover, because the parents of affected children preferentially seek help from knowledgeable relatives or folkhealers rather than medical practitioners, the pattern of help seeking impedes rapid diagnosis and treatment of the illness.

The sociological factors which condition the acceptance and rejection of public health programs include education level, socioeconomic class structure, and political leadership of the community. Rubinstien and Lane (1990) addressed the indirect effect of literacy on human health. Illiterate mothers are unable to read directions on medicine containers, or read brochures containing illness prevention information. They noted a 7 to 9% decrease in infant mortality for every one year increment in mothers' education level. Community schools are also important avenues for disseminating health related information and implementing preventative health programs. Hanks and Hanks (1955) noted that one reason a diphtheria immunization program failed in a Thai community was because residents did not understand why it was not implemented through the local schools, as previous programs were. Compliance with preventative health programs may also be influenced by the socioeconomic class structure of a community. Wellin (1955) noted that *upper class* residents of the Peruvian town were not receptive to a community wide water-boiling program because they perceived that compliance equated them with the residents of lower socioeconomic neighborhoods whom the program was designed for. Support from

political leaders also has important implications for local compliance with public health programs. Hanks and Hanks (1955) attributed differences in compliance with the diphtheria immunization program to personal involvement of local political officials. They noted that low response rates were associated with hamlets in which village leaders had delegated the responsibility of informing residents about the immunization program to children. Wellin (1955) likewise noted that household compliance with the water-boiling campaign may have also been adversely effected because local political leaders did not want to become involved with a program concerning the household routines of community women.

Economic factors which affect the acceptance and rejection of health care programs include such variables as mean household income, availability of electricity and potable water, and resources available for food, hygiene, and health care. Economic costs associated with health care are often cited to account for under utilization of services provided by public health programs. Young (1978, 1980) noted that the perceived severity of an illness, accessibility of care, and likelihood of cure were important factors affecting illness treatment decisions in a Mexican town. He concluded that treatment decisions were primarily based on economic cost for nonserious illnesses, and probability of cure for life threatening illnesses. Oths's (1994) study in a rural Peruvian community likewise demonstrated the relationship between frequency of use and expenditures on healthcare and the availability of economic resources. She found that households in economic crisis were less likely to seek treatment for mild to moderate illnesses. Similar examples can be found in the United States where lack of health insurance encourages many people to only seek medical attention for *serious* life threatening conditions. Even when healthcare services are provided at no expense to the recipient, expenditures associated with transportation, lost time from employment, or household obligations often make visits to *free* medical clinics too costly for the clientele they are intended to serve (Foster 1977). Such patterns of under utilization may have an indirect effect on community health by inhibiting the dissemination of information on preventative health measures. For example, Rousham (1994) found that differences in knowledge of hygiene and helminth infection were correlated with the frequency of visitation to a local clinic in Bangladesh. Other economic barriers to health maintenance include the relative cost of incorporating preventative health measures into routine household activities. Unfortunately, few studies have addressed the household economic impact of adopting hygiene measures such as hand-washing with soap, water-boiling, and consumption of bottled

water to prevent diarrheal disease and parasitic infection. Wellin (1955) described a case where compliance with the Peruvian *water-boiling* program was too costly with respect to fuel (firewood) and disruption of routine household activities. Rousham (1994) also noted that the lack of financial resources for purchasing soap, shoes, and building sanitary latrines were practical obstacles to reducing helminth infections in a Bangladesh community. Clearly, public health planners need to consider the relative cost of compliance as a percentage of household income if their programs are going to achieve their intended health goals.

Although anthropologists have contributed substantially to the success of public health programs in the last decade, preventable sanitation related illnesses are still a major source of excess morbidity and mortality on a global scale (Hakulinen et al. 1986). The primary challenge facing public health in the next century is selling the message of preventive medicine. The advantages of acute care medical services are widely acknowledged and readily utilized wherever they are available in developing countries (Foster 1977). However, the benefits of a prenatal health program, childhood vaccination campaign, or environmental sanitation program, are not readily perceived. This is because the cause and effect relationship of "no disease being followed by the absence of disease" is not as obvious as curing a serious illness like infant dehydration in a few days or hours (Foster 1977). Kendall et al. (1984), and others who have promoted use of ORT in developing countries, suggested that preventive health interventions are more likely to be adopted if they are embedded in curative medicine. This view implicitly assumes that health beliefs in a community are homogeneous, and a single intervention strategy will increase compliance. However, research by Weller (1984[a], 1984[b]), Weller et al. (1993), Trotter (1981), Rubel et al. (1984), and Logan and Morrill (1979) has clearly demonstrated considerable inter and intra-cultural variation in health beliefs. Differences in acculturation and education account for most of this variability. Coreil and Marshall (1982) developed a survey instrument to test perceptions regarding illness prevention vs. illness cure. In short, they suggested that it is possible to differentiate individuals who are predisposed to preventive medicine from those who are oriented toward curative medicine. This technique may be useful for evaluating variability in client compliance with public health program recommendations. Health programs could be promoted by exploiting the curative or preventive dimension of an individual's health beliefs.

Locus of Illness Control

The construct of *Locus of Control* is derived from Rotter's (1954) *Social Learning Theory* and based on the principle of *generalized expectancies* in which individuals intuitively predict the occurrence of particular reinforcements resulting from specific behaviors in various situations and social contexts. The construct predicts that individuals modify their behavior or attitudes according to the expectation that particular reinforcements will occur. Subsequent researchers differentiated two basic personality types, designated as *internal* and *external*. The external orientation is associated with the perception that the consequences (i.e. reinforcement) following an action or behavior is beyond the control of an individual and result from chance, luck, fate, or intervention of powerful others (Rotter 1966). In contrast, the internal orientation is associated with the perception that the outcome of an event is contingent upon one's own actions or behaviors (Rotter 1966). The importance of this conceptual distinction for health related behavior was based on the assumption that internally motivated individuals are more likely to engage in behaviors that prevent illness (Wallston and Wallston 1978). The validity of this assumption was formally tested with the *Health Locus of Control* (HLC) scale developed by Wallston et al. (1976). Subsequent studies of health related behaviors with the HLC instrument were directed primarily at differentiating the internal or external orientations of individuals (e.g. Kaplan and Cowles 1978). The development of treatment regimens tailored to the *generalized expectancies* of individuals was a major goal of this research (Wallston and Wallston 1978). Health educators were also encouraged to develop HLC interview scales for evaluating health programs, and initiate pilot programs for training individuals to become internally oriented (Wallston and Wallston 1978). One goal was to promote health professionals as appropriate resources, and reinforce the belief that personal behaviors were important for maintaining health (Wallston and Wallston 1978). The development of the *Multidimensional Health Locus of Control* scale (Levenson 1973; Wallston et al. 1978) was designed to investigate the relationship of chance, fate, or luck, and intervention of powerful or influential persons in the generalized expectancies of externally motivated individuals. Health behavior was measured by separate subscales for internality, chance, and intervention by powerful others to determine which dimension was the most influential in a particular person's health orientation. This refinement increased the internal consistency, reliability and predictive power of the HLC

because health behavior was measured at a finer scale of resolution. Coreil and Marshall's (1982) *Locus of Illness Control* (LIC) instrument was designed to investigate the internal- external dichotomy in perceptions of illness prevention and illness cure. In contrast to previous versions of the HLC (Wallston et al. 1976), perceptions of control over illness were tested in 2 dimensions: the ability to prevent the occurrence of illness, and the ability to cure or treat illness with therapeutic intervention (Coreil and Marshall 1982). Thus, the HLC measured beliefs about health behavior exclusively, but the LIC measured the general perception of control over health and illness by including items related to illness cure and prevention (Coreil and Marshall 1982).

The LIC was employed to compare inter group differences in perceived control over health and illness between rural Haitians and rural Appalachians (Coreil and Marshall 1982). The results indicated that the two groups had different beliefs in control over illness and health despite similarities in low socioeconomic status, fatalistic worldview, and inaccessible healthcare. Although the Haitian population was significantly more external with respect to illness prevention, it exhibited greater internality on the illness cure dimension when compared to the Kentucky population. This suggested that the prevailing belief among rural Haitians was, *there is little that can be done to prevent illness*, however, *once someone becomes sick there are many therapeutic options available for curing illness.* In contrast, the prevailing perception among the Kentucky population was *most illnesses can be prevented*, however, if one becomes sick the success of a therapeutic regimen is largely a matter of fate, chance or *God's will.* Coreil and Marshall (1982) explained these results accordingly:

> "The major health problems of Haiti are... acute infectious diseases...with which Western scientific medicine is most successful in producing a quick and specific cure. In contrast, the Appalachians face health problems of chronic nonspecific etiology for which Western Medicine provides little therapeutic potential. There are no real cures for degenerative diseases of multiple etiology such as hypertension and cancer" (Coreil and Marshall 1982:136).

The LIC construct was an important contribution to the literature because it related health perceptions to prevailing patterns of illness confronted by populations. Despite the utility of this research tool, it has not been widely applied in anthropological studies of health related behavior.

M. Logan (1991) investigated the health beliefs of Brazilian herbalists with the LIC. Although his instrument was redesigned to collect information on an ordinal scale, the results were similar to those

obtained by Coreil and Marshall (1982). The Brazilians also exhibited marked externality with respect to illness prevention, and internality on the illness cure dimension. He concluded that this was because they were also susceptible to many of the same infectious and parasitic diseases. Again, the point was made that in areas where acute disorders predominate, people will have more confidence in curative, rather than preventive medicine (M. Logan 1991). Logan also suggested that biographical data be collected in addition to responses on the LIC. He predicted that variables such as age, sex, and health history may covary with an individual's score on the instrument. Patrick (1993) addressed many of these variables in a cross-cultural investigation of LIC beliefs among U.S. and Brazilian college students. LIC beliefs were also compared with Brazilian herbalists (M. Logan 1991) and their clients. He found that Brazilian herbalists were more inclined to acknowledge the role of God's will in curing illness than college students from the same community. He suggested that the age difference between the two populations may account for this variation because the older herbalists are more prone to chronic degenerative disorders for which there are few successful cures. There was no appreciable difference in scores of Brazilian and U.S college students with respect to illness prevention. Patrick (1993) hypothesized that increased socioeconomic status of the Brazilian college students may insulate them from the greater disease load of the lower socioeconomic classes. Unfortunately, his data were insufficient to test this hypothesis.

These studies demonstrate that the LIC could be an appropriate theoretical construct for understanding variability in household parasite infection status. Treated as analytical units, households can be differentiated with the LIC according to preventive and curative medical orientations. Variation in LIC beliefs within the same socioeconomic class may be a function of differential risk to illness produced by endoparasitic and enteric infectious agents. Parasitologic analysis of stool samples from households surveyed with the LIC would provide an objective method for relating patterns of compliance with hygiene recommendations to variation in illness beliefs.

KAP Studies of Parasitic Infection

KAP studies of human parasitic infection are increasingly becoming incorporated in the human health and behavior literature. Despite the longstanding interest in the occurrence of parasitic infection in human societies, most studies have been primarily conducted from the perspectives of descriptive

epidemiology, disease ecology, and cultural adaptation (see for example Alland 1978; Chernela and Thatcher 1989; Dunn 1968, 1979; Knightlinger et al. 1996, 1998; Kloos, et al. 1981; Nwosu 1983). Although many of these studies have examined the occurrence of parasitic infection as a product of cultural behaviors in the host population, recent KAP studies also focus on the conceptual framework used by the host population to recognize and manage parasitic infections. From this perspective, health and health seeking behavior as it relates to human parasitism is a matrix of transactions which includes:

1. knowledge and beliefs about the origin of parasitic infections and who is at risk,
2. symptoms by which infections are recognized,
3. available options for treatment or alleviation of symptoms, and
4. the behaviors and practices used to prevent infections or reduce the risk of reinfection (Holland 1989).

KAP studies of human parasitic infection include research on intestinal helminths (Booth et al. 1993; Kamunvi and Ferguson 1993; Rousham 1994; de Silva et al. 1996; Vecchiato 1997; Willams-Blangero et al. 1998), lymphatic filariasis (Eberhard et al. 1996; Gyapong et al. 1996), and malaria transmission and vector control in Guatemala (Ruebush et al. 1992; Klein et al. 1995). The KAP studies of intestinal helminth infection are briefly reviewed below because they are especially relevant to the present research.

Booth et al. (1993) examined the KAPs associated with the self-diagnosis and treatment of perceived helminthiasis in a rural community in Guatemala. Symptoms used for household diagnosis included stomach ache, diarrhea, vomiting, and observation of intestinal roundworms (*Ascaris lumbricoides*) voided in the feces. Changing economic conditions in the region over the one year study period afforded the opportunity to monitor options available to households for treating helminth infections. Approximately 75% of households reported exclusive use of pharmaceutical based anthelminthics at the beginning of the study. The number of households exclusively using pharmaceutical compounds decreased to 33% at the end of the observation period in response to a community-wide economic crisis precipitated by national inflation, poor maize harvest, and low demand for the community's cash crop. Sources of information regarding treatment of helminth infections were family members (30% of all cases), neighbors (22%), and the community health promoter (14%). Only 4% of the 79 self-diagnoses of helminth infection

during the study period were confirmed by medical personnel. This indicates that approximately 96% of the cases were treated outside of formal medical channels. Thus, information regarding preventive measures was not reaching the majority of households for whom parasitic infections are important.

Kamunvi and Ferguson (1993) investigated KAPs of intestinal helminthasis in two East African communities. The prevalence of infection between the communities was comparable. Visual identification of intestinal helminths and symptom recognition was high in the study population. However, understanding of the causes of helminth infection, appropriate treatments, and preventive measures was lower. Observed differences in KAP in the study population were attributed to sex, educational level and age of respondents. Sex related differences in helminth-related knowledge were perhaps due to the increased child rearing responsibilities of female respondents.

Rousham (1994) examined KAPs regarding intestinal helminths among a sample of mothers in two rural communities in Bangladesh. Symptoms used to recognize parasitic infection in children included a large or swollen abdomen, and drooling at night. Approximately 48% of mothers interviewed believed that worms were acquired from eating sugar and sweet foods, and 22% had no idea how individuals become infected. Hygiene related measures for prevention of helminth infections were given by 37% of interviewed mothers, and 38% were unable to list any preventive measures. Differences in parasite related knowledge between the two communities was attributed to the geographic proximity of one community to a regional health center. In the more distant community, the Islamic practice of *purdah* discouraged mothers from traveling to the regional health center. These mothers did not have access to parasite prevention information from the health center, and relied on their husbands to purchase anthelminthics in the larger town where they were employed. Mothers from the community near the regional health center were able to obtain treatment for their children's helminth infections and information essential to prevent reinfection.

The prevalence of helminth infection in children and its association with KAPs in two communities in Sri Lanka was examined by de Silva et al. (1996). Approximately 43% of mothers interviewed believed that all children normally have intestinal worm infections. The majority of mothers thought infections were acquired by eating sweets, and none were aware the relationship between fecal contamination of soil and transmission of infective helminth eggs and larvae to susceptible children. Approximately 50% of all mothers believed that helminth infections in children were preventable.

However, all of them said that prevention was possible with drugs, and none listed any preventive measures associated with hygiene. KAPs apparently did not differ between infected and uninfected households, although decreased prevalence was associated with increasing socioeconomic status.

Vecchiato (1998) described the KAPs of helminthasis among the Sidama people in Ethiopia. Helminth infection was the most frequently diagnosed health complaint among new outpatients at a regional health facility. The prevalence of intestinal roundworm infection was estimated to be about 26% in this population. However, respondents in a community-wide health survey ranked helminth infections 5th among all other recognized illnesses. Follow-up investigations in the community revealed that intestinal helminth infections were viewed positively among the respondents. In fact, many people considered worms to be essential components of *health* and their primary function was to aid the digestive process. The purpose of periodic anthelminthic treatment is to rid the body of excess worms, and maintain the proper numerical balance for good digestive health. This study demonstrates contrasting perspectives regarding helminth infection. Biomedically oriented health planners emphasize the adverse effects of helminth infection on the growth and development of children. On the other hand, according to the Sidama ethnomedical view, intestinal helminth infections are considered essential to good health. Ascarisis control programs implemented in this culture setting will fail to achieve their health goals without full community endorsement and the behavioral modification necessary for breaking the cycle of transmission and reinfection of the host population.

Williams-Blangero et al. (1998) studied the KAPs associated with helminth infection in two Jirel villages in eastern Nepal. The prevalence of helminthasis in the region was widespread, and 65% of the population were infected with at least one species of soil-transmitted helminth. Recognition of helminth infections in the population was high, and 90% of the interviewed women claimed to know people who had worm infections. Many women recognized that fecally-contaminated soil was important in transmission of helminth infections through unwashed food items, and cooking utensils. Consumption of sweet-sugary food items, and the belief that worms were present in children's bodies at birth were also recognized as important explanations for how people became infected. The majority of women (69%) obtained treatment from hospitals or pharmacies for helminth infections after they or their children experienced prolonged abdominal pain. This pattern of self-diagnosis and medication was suspected to undermine confidence in

anthelminthic therapy. The indiscriminate use of anthelminthics based only on abdominal cramping, when other etiologic agents may be involved, often leads individuals to conclude that the medications are not efficacious when adult worms are not immediately passed in the stools. One of the implications of this study was that pharmacists should play a larger role in disseminating information on prevention of intestinal helminth infections.

KAP Data Collection by Population Survey Methods

Medical anthropology is essentially an applied subdiscipline that has become focused on practical issues related to improving the health and health care of people in developed and developing countries (Pelto and Pelto 1990). Participation in the areas of international public health and development has brought about an increased demand for knowledge and understanding of people's perceived health needs, and services for improving health care delivery. The basic data collection methodologies used by medical anthropologists include KAP population surveys, and ethnographic description of health related behavior based on participant-observation. Essentially, these contrasting methodologies produce quantitative and qualitative data. The value of these data for understanding human health behavior has engendered critical debate, with detractors on both sides of the issue. Public health planners require anthropological data on human health related behaviors that is problem oriented, quantifiable, and sufficient for making generalizations applicable to populations and population subgroups (Pelto and Pelto 1990; True 1990). On the other hand, researchers committed to the traditional ethnographic study of human health tend to view this narrowly focused applied style of research as too restrictive, value laden, and theoretically uninteresting for understanding larger issues of how humans, health, and culture interact and shape each other's expression.

KAP surveys use questionnaires, and structured interview schedules, to interview subjects in defined populations for collecting data that is quantifiable and applicable to larger populations. Critics of this methodology recognize that these types of survey instruments are rigid and inflexible. Respondents are typically not allowed to elaborate on the answers they provide to simple *agree-disagree* type questions contained in the survey instrument. This data collection format has been criticized as often producing invalid and misleading results in developing countries (Bhattacharyya 1997; Ebo et al. 1997; Kroger 1983;

Stanton et al. 1987). Invalid and misleading depictions of health related beliefs are often the result of logistical problems with data collection, errors that occur in data recording, and biases that result from interactions between the interviewer and the respondent (Bhattacharyya 1997). KAP population surveys need to be based on statistically valid random samples of the population under study if one is going to make broad-scale generalizations about health behavior. Although considerable effort has been directed at developing statistical sampling techniques for conducting health research in developing countries, these may be too costly, cumbersome, and invasive for application in communities where people are naturally suspicious of foreigners as well as government interference in their lives. Accordingly, many KAP studies are based on convenience samples of individuals and households who are willing to participate for various reasons which range from altruism to purely self-serving materialistic motives. Errors in data recording can occur when the interview forms are translated into the language of the investigator, and entered into a computerized database for analysis (Bhattacharyya 1997). Care must be taken at all stages of data recording to ensure that interview results remain properly collated with the respondent and other analytical units. Oftentimes, the interviewers are strangers in the community and respondent's interactions will be dictated by social norms applicable to guests and outsiders (Bhattacharyya 1997). Surveys are also an unfamiliar way to exchange information in many cultures, and often the outside interviewer is regarded with suspicion. If respondents are uncomfortable with their role, they may either refuse to participate, or provide misleading information in an effort to please the interviewer with the correct answers (Bhattacharyya 1997). Studies of health behaviors where intervention programs have included a health education component are especially susceptible to this form of bias because respondents are afraid they will be scolded for not providing the correct answer (Bhattacharyya 1997). Informant recall and reporting of health effects such as self-diagnoses of helminthiasis, malaria, acute respiratory infection, or diarrheal episodes have been shown to be notoriously underreported (Belcher et al. 1976; Booth 1993; Frerichs 1980; Nations 1986). Mothers and caregivers may not report health effects in their children unless they are perceived to be severe enough to warrant special attention (i.e. accompanied by high fever, prolonged crying fits, etc). Respondents may also be reluctant to report utilization of alternative health care services provided by traditional healers and herbalists lest they appear backward and unsophisticated to the interviewer. Alternatively, caregivers may neglect to mention alternative health care utilization for

particular aliments because it is simply assumed that these patterns of health-seeking behavior are common knowledge (Bhattacharyya 1997).

KAP studies have the advantages of enabling researchers to interview a large number of persons and collect a tremendous amount of data on health behavior in a comparatively short period of time (Bhattacharyya 1997). Interviewers can often be recruited locally and trained to administer the survey instrument fairly easily. Ethnographic approaches to data collection typically involve fewer informants who are interviewed in much greater depth over a longer period of time. Often one or two years of intensive fieldwork and residence in the community under study is required to build sufficient rapport with informants and attain an in-depth understanding of the cultural context in which health is sought and maintained, and illness is treated and prevented. The *yes-no* or *agree-disagree* format of the structured interview instrument, or questionnaire, is quantifiable and therefore suited to analysis with a variety of statistical models. The intensive, informal person to person interview style in ethnographic research is not as easily quantified and statistical analyses of the collected data may not be possible. Ethnographic studies also tend to be focused on general questions of theoretical interest and many lack explicit research designs. Systematic data collection is difficult when the research is not focused on a specific problem, and the results are often highly subjective (True 1990). However, ethnographic studies provide highly detailed descriptive data necessary for placing health behavior in the larger social, cultural, and economic context (Nations 1986). The flexible research style allows the investigator to explore interesting and unexpected findings that develop during the study. The inductive nature of ethnographic research is especially well suited to discovery and generating hypotheses for subsequent testing with explicit research designs and systematic data collection methods (Bhattacharyya 1997).

Focused ethnographic studies (FES) and rapid assessment procedures (RAP) employed in contemporary applied anthropological research combine aspects of both KAP population survey and ethnographic data collection methodologies (Bhattacharyya 1997). With these approaches, a brief period of qualitative data collection using ethnographic methods such as key informant interviewing, free listing attributes of diseases and symptoms, and structured interviews with open-ended sentence frames is conducted prior to execution of a larger population based survey. The qualitative data are used to develop the survey instrument, or questionnaire, which is administered to the survey population for collection of

quantitative data. This juxtaposition of qualitative and quantitative data collection methodologies is often referred to in the applied anthropology literature as triangulation (Bhattacharyya 1997). FES/RAP studies are well suited to health program research because they are relatively inexpensive and can be conducted in a short period of time. Moreover, these studies preserve the qualitative aspects of the cultural context in which human health and illness are defined and managed. The focused methodology of FES/RAP studies also enables the investigator to obtain *hard numbers* amenable to hypothesis testing with statistical models. The inductive nature of the preliminary qualitative data collection phase permits minor modifications to research designs and data collection methods to investigate interesting, but unanticipated, hypotheses (Bhattacharyya 1997). However, like KAP studies, FES/RAP data have limited generalizability, and may be subject to the same reporting biases. The focused nature of the research, however, helps investigators collect data that is necessary and pertinent to generating and testing hypotheses about human health behavior. These data are suitable for development and evaluation of health intervention programs.

Diagnosis of Intestinal Parasitic Infection by Examination of a Single Stool Sample

The ability of a single fecal examination to accurately identify parasite-infected individuals and households has important implications for estimating the prevalence of endoparasitic agents in the population used in this research. Sensitivity and specificity are terms used to describe the accuracy of a diagnostic procedure or test used in clinical practice and epidemiological research. Sensitivity is defined as the proportion of the population with the disease of interest and a positive test result. Specificity refers to the proportion of individuals without the disease or condition of interest and a negative test result (Fletcher et al. 1988). Sensitive tests rarely fail to identify people with the disease of interest, and specific tests rarely misclassify people without the disease as diseased (Fletcher et al. 1988). The diagnosis of endoparasitic infection by stool examination is largely an issue of sensitivity because infected individuals will often test negative for the reproductive products (eggs, larvae, cysts, and oocysts) of various parasite species. As a diagnostic method, stool examinations are virtually 100% specific because the detection of parasite products inevitably means the presence of (or infection with) intestinal parasites. Negative

diagnostic test results may be explained with respect to: lack of sexual maturity in the parasite population, single sex infections, intermittent shedding of parasite progeny, and variations in parasite fecundity.

The sensitivity of a single stool examination for endoparasite diagnosis has recently been discussed in the literature (Kawatu et al. 1993; Nazer et al. 1993; Marti and Koella 1993; McSherry 1989; Montessori and Bischoff 1987; Senay and MacPherson 1989). The origin of this concern can be traced to the work of Sawitz and Faust (1942) who demonstrated that fewer than 50% of *Entamoeba histolytica* were detectable by a single fecal examination. Their work showed that examination of six samples on successive days was required to achieve a 90% recovery rate. Recently, Montessori and Bischoff (1987) reviewed the clinical records of 456 patients who had submitted multiple fecal samples for parasite evaluation. They found 95% of the cases were positive for parasitic infection on the first sample, and the second and third samples accounted for only 3.5% and .9% of the additional diagnoses. These findings were supported in another study of 441 patients where 94% were positive on the first examination (Montessori and Bischoff 1987). Senay and MacPherson (1989) performed a similar study and examined the clinical records for a two year period in which 13,478 stool samples were examined. Their results illustrate the number of particular parasite infections that would not have been detected by a single sample examination. This point is important because the rates at which helminth eggs and larvae, and protozoan cysts are passed in the stools of infected hosts are extremely variable for individual parasite species. For example, egg production in *Trichuris trichiura* has been estimated at 1 to 7000 eggs per day, and contrasts dramatically with the estimated 200,000 eggs per day of *Ascaris lumbricoides* (Schmidt and Roberts 1989). Senay and MacPherson (1989) found that a single fecal examination was sufficient to identify 87% of infections with *Giardia lamblia*, 89% of *Entamoeba* spp. infections, and 92% of unspecified helminth infections. In summary, they concluded that approximately 90% of the endoparasitic infections were accurately diagnosed with a single fecal sample. McSherry (1989) suggested that Senay and MacPherson's (1989) results may have been biased because the samples were submitted from symptomatic patients with a high probability of parasitic infection. In response to this point, Kawatu et al. (1993) initiated a study of endoparasitic infection in an asymptomatic population of residents from an Ontario institution. They found that the prevalence of *Ent. histolytica* (10.2%) estimated by the first sample was substantially lower than the true prevalence (23.8%) based on three successive examinations. However, additional examinations

did not enhance detection of *T. trichiura* infections which were accurately diagnosed with a single stool sample (Kawatu et al. 1993). Nazer et al. (1993) also addressed the need for three stool samples in routine examinations for endoparasitic infection. Samples from 175 patients submitted over a 21 month period were evaluated to determine the risk of false negative results from a single stool examination. Their results indicated that 58% of infected patients were correctly identified based on examination of a single stool specimen. Second and third examinations revealed an additional 21% of the infections, respectively. Recovery rates for individual parasite species were: *A. lumbricoides* 55%, *G. lamblia* 63%, Hookworm species 80%, *Hymenolepis nana* 47%, and *T. trichiura* 50%. Marti and Koella (1993) provided a mathematical model for illustrating the relationship between multiple stool examinations and false negative results. Equations for estimating the prevalence of particular parasites in a population of samples were applied to stool samples obtained from 1,869 patients. The probability of identifying an infected individual by a single sample was: 75 % for *G. lamblia*, 89% for *T. trichiura*, 92% for *A. lumbricoides*, and 77% for hookworms. When three samples were examined, the probability of obtaining a false negative result was less than 2%.

This body of research provides a basis for estimating the sensitivity of a single stool examination for diagnosing endoparasitic infections. These estimates can be used to calculate predictive values for positive and negative test results. The positive predictive value is the probability that an individual with a positive test result is infected with the parasite of interest. Conversely, the negative predictive value expresses the probability that an individual with a negative test result is actually uninfected. Because detection of parasite progeny in a stool sample inevitably means the presence of endoparasitic infection, a primary methodologic concern for this research is assessing the accuracy of a negative test result. In other words, given the poor sensitivity of a single fecal examination *what is the likelihood that an individual with a negative test result is actually uninfected rather than being judged falsely negative?* Predictive values are based on the performance characteristics (sensitivity and specificity) of the diagnostic test, as well as the prevalence of disease in the population under investigation (Fletcher et al. 1988; Mausner and Kramer 1985). High prevalence rates usually lead to high positive predictive values (Fletcher et al. 1988; Mausner and Kramer 1985). As noted above, the specificity of a single fecal examination for detecting an endoparasitic infection is 100%. Sensitivity values for detecting endoparasitic species with a single fecal

exam have been taken from Nazer et al. (1993), and Marti and Koella (1993) (Table 4). These values will be applied to the parasite prevalence data for Valle Hermoso presented in chapter 5 to demonstrate, with a high degree of certainty, that the individuals in this study who test negative on a single fecal exam are actually uninfected.

Community-Wide Helminth Control Programs Based on Targeted Chemotherapy of School-Age Children

Targeted chemotherapy of school aged children has increasingly become an important intervention strategy for achieving community-wide reductions in the morbidity and mortality resulting from intestinal helminth infections (Bundy et al. 1990; Chan 1997; Hall et al. 1997; Holland et al. 1996). This approach to community helminth control has been made possible by the availability of safe, effective, and inexpensive anthelminthic drugs like albendazole and mebendazole which are capable of significantly reducing helminth burdens of individuals in a single dose. This feature makes them particularly attractive for large scale distribution programs.

Targeted chemotherapy programs are based on the recognition that helminth infections are neither evenly nor randomly distributed among all members of a population (Bundy et al. 1992; Croll 1983). The tendency of helminth infections to aggregate in the host population has been described as overdispersion (Croll et al. 1982). Croll and colleagues coined the term *wormy persons* to describe the phenomenon that relatively few individuals harbor most of the helminth infections of a given host population (Croll et al. 1982). It is important to recognize that *wormy persons* are not necessarily predisposed to multiple infections with other parasites, nor are they inherently less healthy or more inclined to clinical disease than other persons in the population (Croll et al. 1982; Knightlinger 1996). Rather, these individuals are an important reservoir of helminth eggs and larvae for infecting the rest of the community (Bundy et al. 1992). Studies have shown that infections with *A. lumbricoides* and *T. trichiura* achieve their peak prevalence (number of infected hosts) and intensity (number of worms per host) in children between the ages of 5 and 10 years (Bundy et al. 1990; Bundy et al. 1992; Halloran et al. 1989). This tendency for helminth infections to be concentrated in children makes them particularly attractive target populations for achieving

Table 4. Sensitivity figures for correctly identifying endoparasitic infections by examination of a single fecal sample. Percent sensitivity figures for each endoparasitic species have been taken from published results of experimental studies by Nazer et al. (1993), and Marti and Koella (1993).

Parasite Species	Percent Sensitivity (Nazer et al. 1993)	Percent Sensitivity (Marti and Koella 1993)
Giardia lamblia	62.8 %	75.0 %
Hymenolepis nana	47.0	
Ascaris lumbricoides	55.0	91.6
Trichuris trichiura	50.0	88.8
Ancylostoma/Necator[a]	80.0	77.4

[a] The eggs of these human hookworm genera are morphologically indistinguishable.

community-wide reductions in helminth related morbidity. (Bundy et al. 1992). Repeated anthelminthic treatments in children are able to reduce the prevalence of helminth infections in the community because there is a cumulative reduction in egg shedding and infective stages transmissible to the adult population over time (Bundy et al. 1990; Chan 1997; Thein-Hang and Lay-Kyin 1991).

Children are also targeted for chemotherapeutic intervention because they are the most susceptible to the adverse effects of chronic helminthasis. Children infected with hookworms, *A. lumbricoides* and *T. trichiura* exhibit poor growth for their age, decreased academic performance, and other clinical expressions of disease such as bowel obstruction, iron deficiency anemia, bloody mucoid diarrhea, and inflammatory colitis (Beaver et al. 1988; Cooper and Bundy 1988; Halloran et al. 1989; Kvalsig 1988; Nokes et al. 1991; Stephenson 1987). Many of these adverse effects are reversible with periodic anthelminthic treatment (Halloran et al. 1989).

Targeted and community-wide mass treatment programs are typically carried out by dispensing an appropriate dose of the anthelminthic to all individuals in the targeted population irrespective of their infection status. Diagnostic screening and selective chemotherapeutic intervention for infected individuals is approximately 17 times more expensive than simple treatment of all persons (Holland et al. 1996). The World Health Organization (WHO) has recommended that diagnostic screening and selective chemotherapy is not necessary for communities where the prevalence of infection is greater than 50% and the risk of adverse drug-related effects is minimal (Chan 1997).

It has been suggested that simple reliance on chemotherapeutic intervention strategies for helminth control without commitment to sustainable preventive measures such as improvements in community hygiene, and childhood nutrition only produce short term health benefits (Evans and Stephenson 1995; Vecchiato 1997). This is especially true when targeted chemotherapy programs are carried out in the absence of periodic intestinal parasite surveillance where it is difficult, if not impossible, to establish if community-wide morbidity reduction goals are being achieved. Transmission of other intestinal parasites such as *G. lamblia,* a flagellate protozoan species associated with diarrheal disease in children, are only moderately impacted by the benzimidazole drugs used in targeted chemotherapy programs because the rate at which people become re-infected is so high. Behavioral modification interventions such as frequent hand-washing and improved sanitation are necessary to achieve community-wide morbidity reductions for

parasites that cannot be controlled by drugs alone. Community-wide surveillance programs can provide information on subgroups within the population that are at increased risk for parasitic infection. These groups could be targeted for additional intervention efforts to reduce morbidity and transmission of particular parasitic species. Moreover, a periodic surveillance program would enable local government health planners to justify reallocation of public health resources to other important community health issues when intestinal parasite morbidity is below detectable levels.

In summary, targeted and community-wide chemotherapeutic helminth control programs will continue to be important and effective methods for reducing the burden of intestinal parasite infection. These approaches are able to achieve short term reductions in numbers of infected persons and numbers of worms per infected person quickly, and often in a single dose. Children infected with hookworms, *A. lumbricoides,* and *T. trichiura* are at greatest risk for poor growth, poor academic achievement, and clinical disease. It has been demonstrated repeatedly, that much of this lost growth and development can be rapidly gained back following appropriate anthelminthic treatment. When targeted programs for school-age children are carried out by government agencies with mass media support they also have the effect of stimulating concern among the children's parents. Infection with intestinal parasites is almost universally regarded as an undesirable health condition for children. The increased parental concern associated with parasitism can be channeled into other primary health care programs like childhood immunization, nutritional supplementation, and promotion of community wide hygiene and sanitation programs (Knightlinger et al. 1996, 1998). Periodic surveillance of targeted subpopulations for intestinal parasitic infections is necessary to establish a baseline for evaluation of community-wide reductions in morbidity. These efforts can also provide government health planners with information necessary to justify intensification of parasite control measures among subpopulations at increased risk, or reallocation of public health resources to address other important community health issues.

CHAPTER 4

BACKGROUND

Description of the Study Area

Valle Hermoso is a thriving business community in the northeastern state of Tamaulipas, Mexico. It is located approximately 45 kilometers south of the United States border and served by the cities of Reynosa and Matamoros on the Mexican side, and Harlingen and Brownsville, Texas, on the United States side (Figure 1). The town is the governmental seat of the *municipio* (county) of Valle Hermoso which includes 28 other communities (25 *eijidos*, 3 *poblanos*) and encompasses an estimated area of 61,000 km^2. Valle Hermoso is a medium size town with an area of approximately 36 km^2. The town is composed of 66 defined neighborhoods, or *colonias*, which range in size from .02 to .25 km^2. The central business district, or *El Centro*, is a four block area developed around a central plaza and the city's principal Roman Catholic church, *El Sagrado Corazon de Jesus* (The Sacred Heart of Jesus). The *centro* is composed of more than 100 individual business which include mercantile, hardware, grocery, clothing, shoe, furniture and appliance, and book and stationary stores. Service industries also located in the *centro* include: hairdressers, photography studios, medical and dentist offices, pharmacies, banks, notary public and insurance offices, restaurants, and movie theaters. The town is served by two government administered hospitals, a university, two business colleges, and several primary and secondary schools. All services located within the *centro* are accessible to Valle Hermoso residents by walking, private automobile, or commercial transportation.

The *colonias* included in this study are located at the margins of Valle Hermoso, approximately 1.0 to 2.6 kilometers from the plaza (Figure 2). All of these *colonias* are less than 20 years old, and have been the focus of recent population growth in Valle Hermoso. Many families residing in the *colonias* have relocated to Valle Hermoso from surrounding communities in the *municipio* because of employment

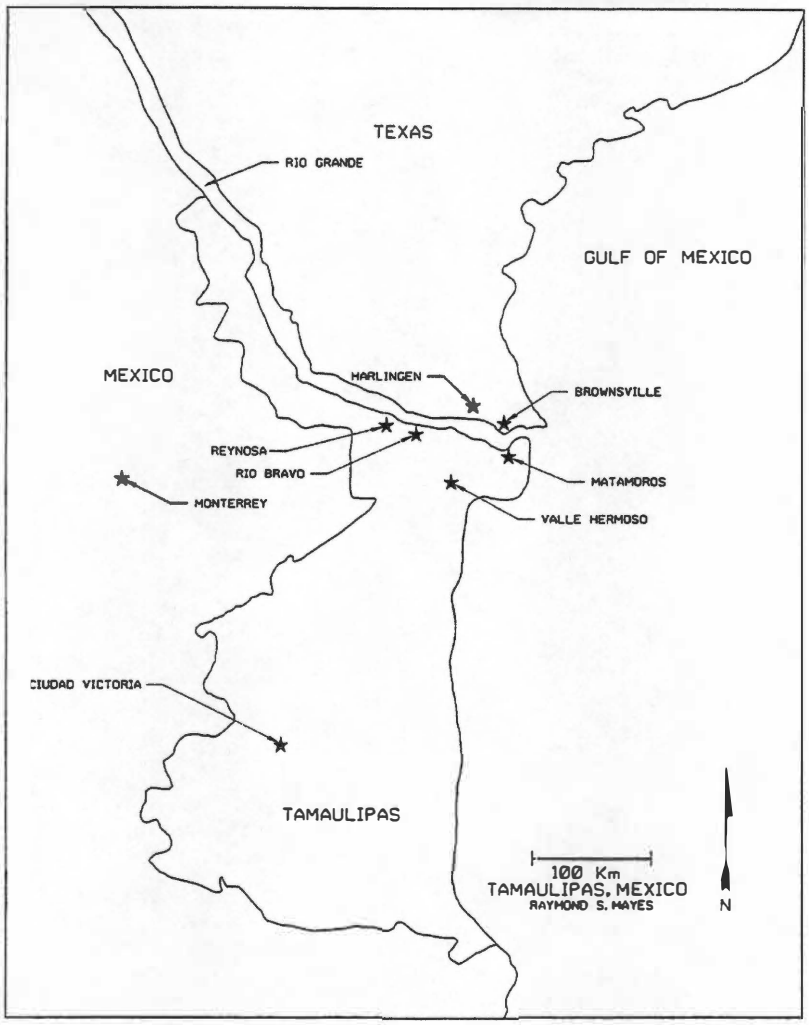


Figure 1. Location of Valle Hermoso relative to the United States-Mexico border and principal cities in the region.

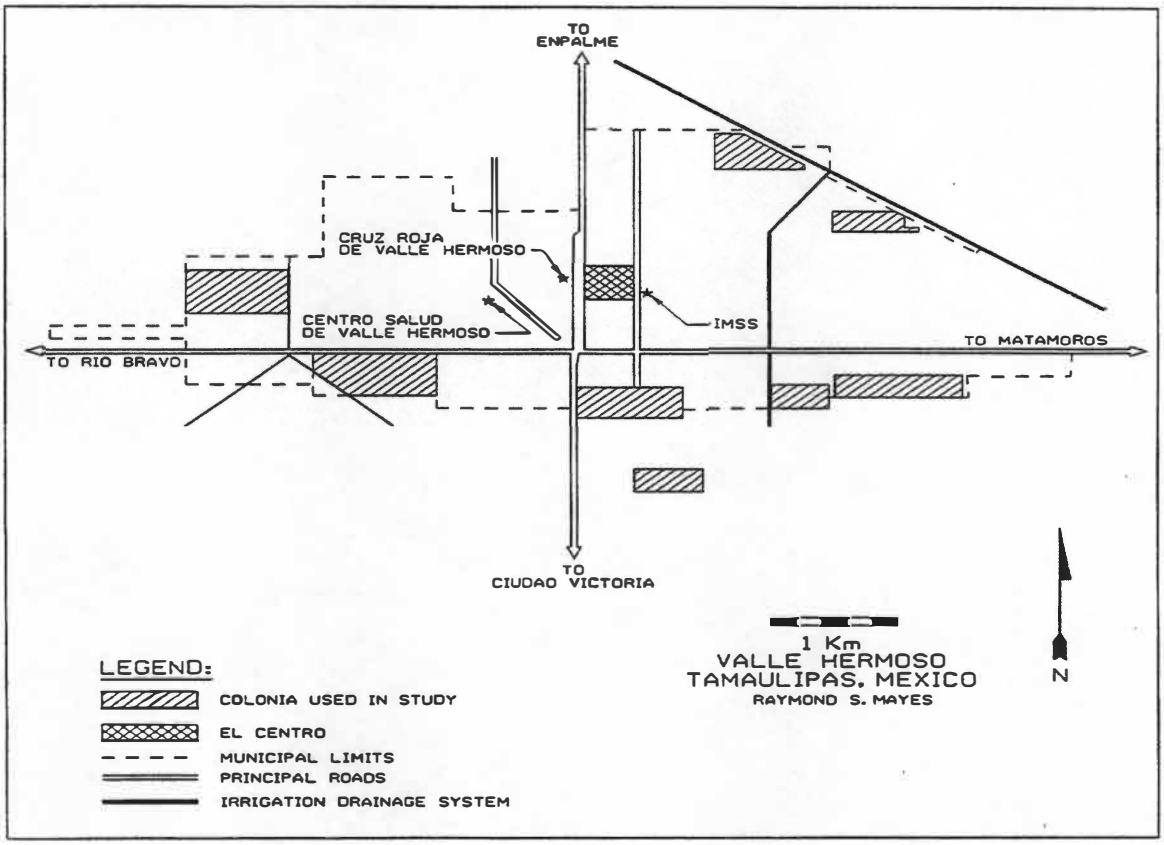


Figure 2. Plan view of Valle Hermoso and *colonias* included in the study.

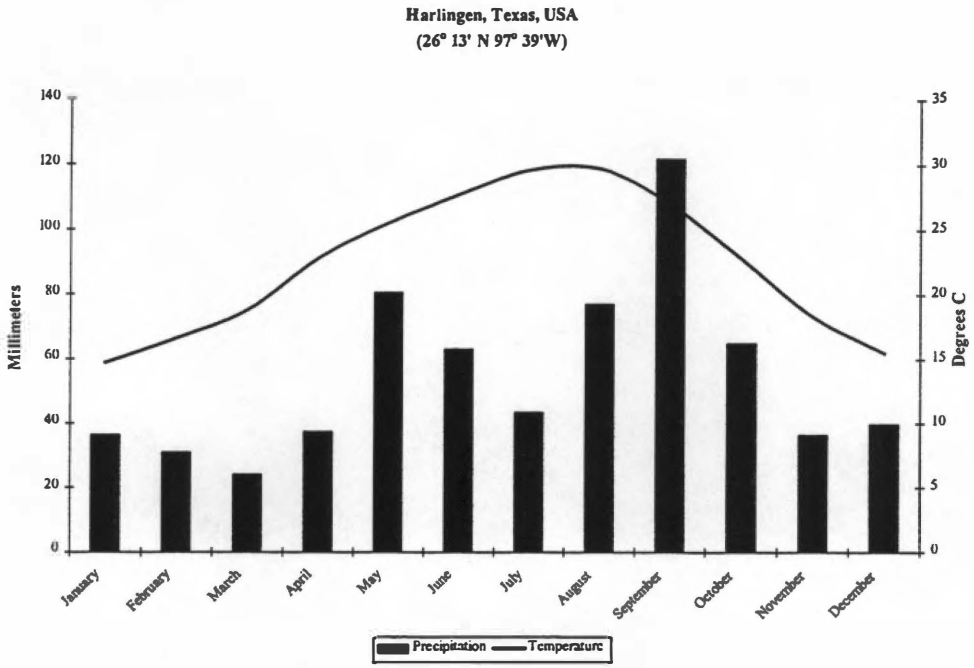
opportunities associated with businesses and service industries in the town or *maquiladoras* (foreign-owned export assembly factories) recently established in the town as a response to the Border Industrialization Program (BIP) and the North American Free Trade Agreement (NAFTA). Houses in the *colonias* are typically one to three room dwellings, approximately 7 x 5 meters in size, and constructed of concrete block, or wood frame with either plywood or flatboard siding. Access to piped water is available in 96% of Valle Hermoso households. Electrical utilities are available in 93% of the households, and 73% of all households have access to sewage disposal (INEGI 1996[a]). Houses in older, more established, *colonias* are generally constructed of concrete block and have inside plumbing. Houses in the younger, developing *colonias* are usually of wood construction, and may lack inside plumbing. In these households, water for cooking and washing is obtained from a spigot in the front yard of the house and outside latrines are used for disposal of fecal waste. Of the households included in this study approximately 89% have running water inside the house. However, only 19% of the households have indoor toilets. The majority of households in these *colonias* dispose of their fecal waste in outside latrines, and fewer than 1% defecate *al aire libre*, or in the open air.

Physical Environment and Climate

The characteristics of the physical environment and regional climate surrounding the municipio of Valle Hermoso are directly relevant to this research because of their relationship with the predominately agricultural economy of the community. Aspects of soil composition, and seasonal variation in rainfall and temperature also play an influential role in the maintenance and transmission of endoparasitic organisms in the human host population. For example, children may be at increased risk of amoebiasis in the summer months when they seek relief from the oppressive heat and swim in irrigation ditches that have been contaminated with human fecal waste. Similarly, the dry saline soils that prevail in the region may be inhospitable to survival and transmission of endoparasitic species which require brief periods of development in the environment prior to infecting a susceptible host.

Valle Hermoso (25° 40' N 97° 48' W) is situated within the North Gulf Costal Plain physiographic province (INEGI 1996c). It is approximately 20 meters (65') above mean sea level. The landscape is characterized by its relatively flat to undulating topography. Areas near rivers and tributary streams are deeply dissected with deep erosional gullies (*arroyos*) extending out of the active floodplain into the adjacent uplands. The lithology of the area is primarily composed of Quaternary age sediments deposited during the Sangamon interglacial period approximately 70,000 years ago (Bernard and LeBlanc 1965). The soils of the region belong to the Solonchak soil family which is characterized by varied degrees of salinity (INEGI 1998[a]). These are comparable to the Harlingen series soils mapped from Cameron County, Texas on the U.S. side of the border (Ramiro Molina, USDA-NRCS, personal communication). The Harlingen series is characterized by deep moderately well drained calcareous soils found on upland landscapes derived from ancient Pliestocene floodplain and delta deposits (USDA-SCS 1978). Water permeability is very slow when the soil is saturated, and high when it is dried and cracked (USDA-SCS 1978). The moisture availablitiy of these soils for agricultural field crops is very low to high depending on the degree of salinity (USDA-SCS 1978). The capability of these soils for agriculture is dramatically improved with irrigation (USDA-SCS 1978). High residue producing crops such as sorghum also improve soil structure and conserve soil moisture (USDA-SCS 1978).

The prevailing climate in Valle Hermoso is characterized as semi-hot sub humid with scarce rainfall throughout the year (INEGI 1996[c]). The annual distribution of temperature and rainfall is depicted graphically with data compiled from the National Weather Service recording station at Harlingen, Texas (26° 13' N 97° 39' W) which is approximately 47 kilometers to the north on the U.S. side of the border and from the San Fernando, Tamaulipas (24° 51' N 98° 9' W) meteorological station which is approximately 110 kilometers south of Valle Hermoso (Figure 3). Because of its proximity between these two stations the average temperature and rainfall values for Valle Hermoso are expected to fall in the middle range of values recorded at these stations. The total annual rainfall for the area is approximately 653mm (25.7"). Most rainfall is associated with thundershowers and sportatically distributed throughout the region seasonally and geographically (Orton 1978). The highest monthly rainfall occurs in September due to the



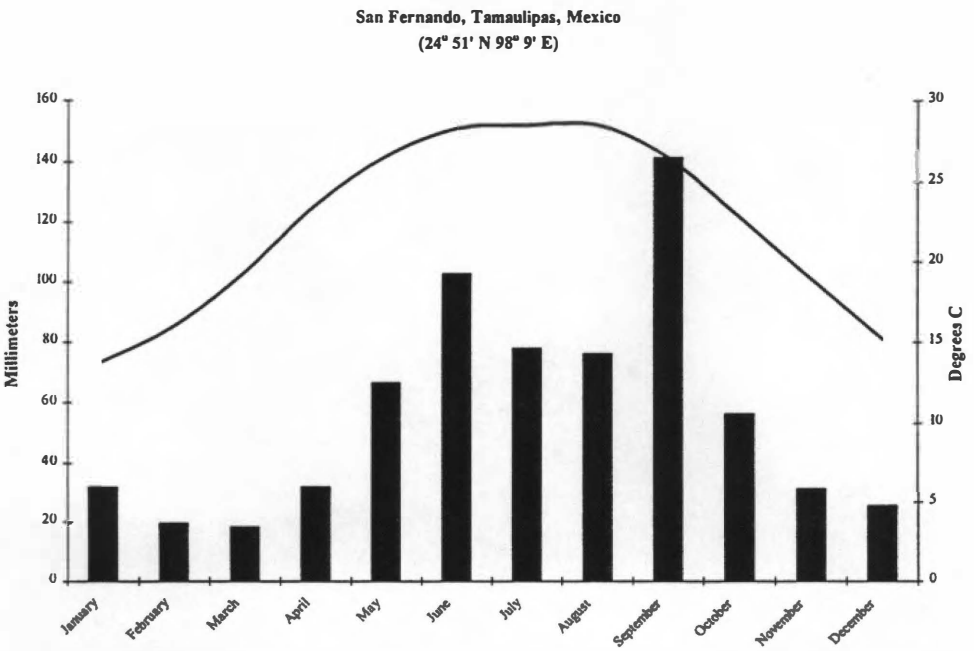


Figure 3. Annual temperature and precipitation data recorded from meteorological stations at Harlingen, Texas USA, and San Fernando, Tamaulipas, Mexico. Meteorological data from Harlingen is based on 30 year normal temperature and precipitation from 1931-1960. Source: Climate of Texas. *In* Climates of the States, Volume 2, National Oceanic and Atmospheric Administration, Gale Research, Detroit (Orton 1978). Meteorological data from San Fernando is based on 30 year average temperature and precipitation from 1960-1994. Source: Anuario Estadistico del Estatado Tamaulipas, Edicon 1996. Instituto Nacional de Estadística, Geografía e Informática, Aguascalientes (INEGI 1996[c]).

increased frequency and strengthening of tropical cyclonic air masses in the Gulf of Mexico. Secondary precipitation maxima occur in May and June. These are associated with squall line thunderstorms which occur earlier (May) in the Harlingen area, and later (June) in the San Fernando area (Orton 1978). The months of October through January are characterized by steady rainfall with monthly averages between 56 (2.2") and 31mm (1.2"). Rainfall during these months is especially important for filling the irrigation reservoirs used during the spring planting season. March is the driest month throughout the region and rainfall averages approximately 21mm (0.82").

The average monthly temperature in Valle Hermoso is moderated by the warm-moist air from the Gulf of Mexico (Orton 1978). The average monthly temperature during the late fall, winter, and spring months is 20° C (68° F), and the days are considered mild and pleasant by visitors from more northern climates. Brief periods of freezing temperatures occur in three of every four years on average. These episodic cold spells are associated with intrusions of arctic air-masses into the region and rarely exceed 72 hours duration (Orton 1978). However, they are poorly tolerated by local residents whose houses typically lack insulation and heating units necessary to maintain comfortable living temperatures in their residences. The highest monthly temperatures occur in July and August and average 29° C (84° F). Daily high temperatures may exceed 38° C (100° F), and coupled with high relative humidity seem oppressive, even to local residents. During these months, it is commonplace to hear Valle Hermsoans comment on the daily temperature with the exclamation *que calor!* (what heat!) to which they respond *bastante!*, or enough!. Diurnal variation in temperature during these months is slight and the range between the daily high and low is approximately 12° C (23° F). Thus, there is little relief at night from the high day time temperatures in the absence of air conditioning.

The climate in Valle Hermoso is also characterized by windy weather conditions derived from the seabreeze circulation of the Gulf of Mexico. Although the constant breeze helps to moderate the humid heat of the summer months, it also aerosolizes the dry sediments which settle out on uncovered food and beverages, and other household items. The *povo* (dust) driven by the wind is popularly regarded as an important mechanical vector for transmitting the infective *huevocitos,* or little eggs of endoparasitic

helminths, to susceptible human hosts (M.L., *Hierbera,* personal communication). The wind is also a constant feature of the winter weather and seen as a hazard to good health (F.G., *Promotora* and *Presidente de Colonia Los Vecinos,* personal communication).

The regional climate permits a growing season of approximately 329 days (Orton 1978). In Valle Hermoso the growing season is divided into two distinct *cosechas* (harvests) which roughly coincide with periods of peak precipitation availability. The primary growing season occurs from about February through May. The secondary *cosecha* begins in late August or September and lasts through November. Employment and capital for purchasing luxury consumer goods and making household improvements is plentiful during the last weeks of each *cosecha* when the crops are taken from the fields and transported to the market.

Population Characteristics

According to the 1995 census the total number of persons residing in the town of Valle Hermoso was 39,004 (INEGI 1996[a]:368). This population represents 9,059 individual households with an average of 4.3 persons per household (INEGI 1996[a]:368). Individuals under 20 years of age account for approximately 46% of all persons in the population (Figure 4). The essentially triangular, broad based population pyramid is typical of developing countries, and resembles the age distribution for the entire country of Mexico and the state of Tamaulipas (INEGI 1996[b]:40, 79). The crude birth rate for the municipio of Valle Hermoso was 25 per 1000 persons in 1995 (INEGI 1996[c]:91). Comparable birth rates for Tamaulipas and Mexico were 22.7 per 1000 and 25.1 per 1000, respectively (Secretaría de Salud 1995[a,b]). The estimated life expectancy at birth in 1995 for Tamaulipas was 74.1 years, which is slightly higher than the 72 years estimated for all of Mexico (Secretaría de Salud 1995[a,b]). *Municipio* specific data are not available for determining the age of mothers giving birth in 1995. However, in Tamaulipas *municipios* with populations comparable to Valle Hermoso (>50,000 and < 75,00) women between the ages of 20 and 29 accounted for 59% of all births in 1994-95 (INEGI1996[c]:93). In 1995, the average number of children per woman was 2.4 for Tamaulipas, and 2.8 for Mexico (Secretaría de Salud 1995[a,b]).

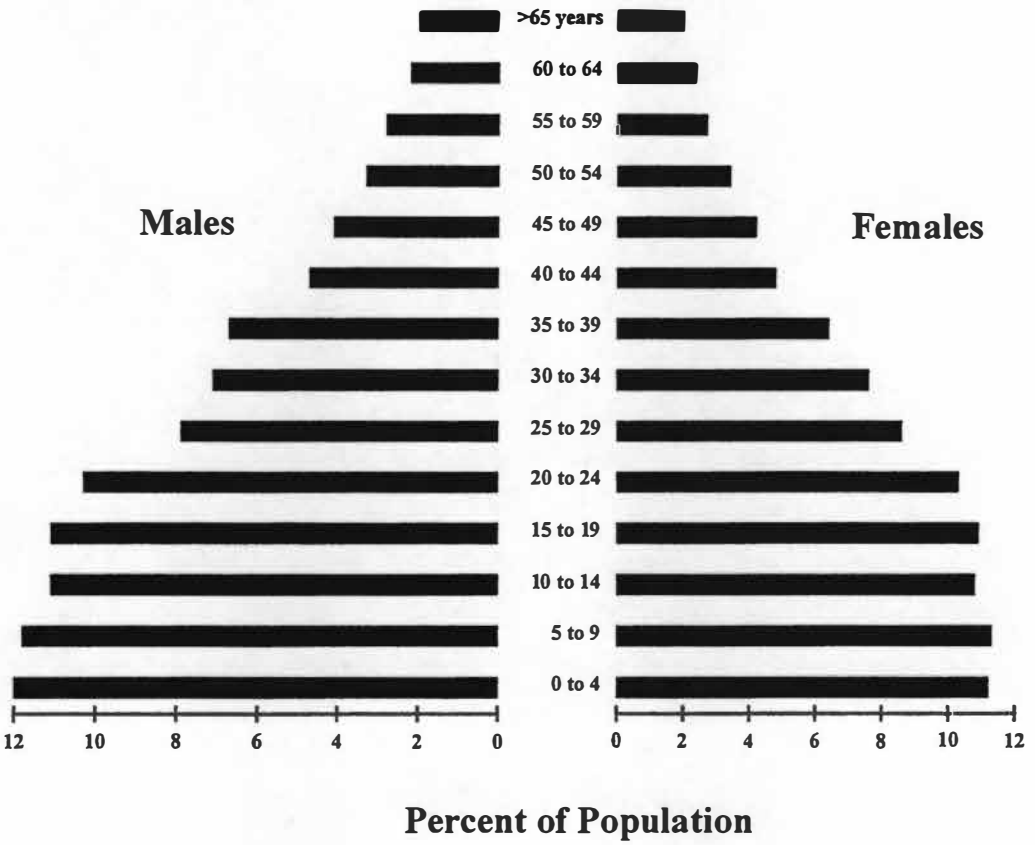


Figure 4. Population pyramid for Valle Hermoso according to the 1995 census. Source: *Tamaulipas Contento de Poblacion y Vivienda 1995 Resultados Definitivos Tabulados Basicos* (INEGI 1996[a]).

Literacy is high among Valle Hermoso residents. In the population 15 years and older, 95% of males and 94% of females are functionally literate (INEGI 1996[a]:191). Less than 1% of the people residing in the *municipio* speak an Indian language (INEGI 1996[a]:161). All individuals who speak an Indian language also speak Spanish (INEGI 1996[a]:161).

Patterns of Mortality and Morbidity

The 1995 crude death rate (CDR) for Valle Hermoso was 4.3 per 1000 persons. This is equivalent to the CDR of 4.3 per 1000 population for Tamaulipas, and slightly lower than the national CDR of 4.7 per 1000 population (INEGI 1996[c]:87-88, Secretaría de Salud 1995[a,b]). The principal causes of mortality in Tamaulipas were heart disease, malignant tumors, diabetes mellitus, and stroke. Although cause specific infant mortality data are not available for the *municipio* of Valle Hermoso, the infant mortality rate (IMR) was 6.4 of 1,610 registered births during 1994-95 (INEGI 1996[c]:91,102). Infant mortality for Tamaulipas was 10 per 1000 registered births in 1995. The Valle Hermoso IMR is lower than that reported for Tamaulipas as a whole, and considerably lower than the IMR of 17.5 calculated for Mexico (Secretaría de Salud 1995[a,b]). Principal causes of death for infants less than one year of age in Tamaulipas were complications arising during delivery and during the perinatal period (45% of all deaths), congenital anomalies (19%), pneumonia and influenza (8%), intestinal infections (7%), malnutrition (3%), transportation related accidents (2%), and all other causes (16%) (INEGI 1996[c]:103). This pattern of mortality was similar for the nation as a whole (Secretaría de Salud 1995[b]).

Morbidity due to infectious agents in Tamaulipas resulted in 1,059,467 new cases during 1995. Respiratory causes were the most frequent and accounted for 66% of all cases reported to government health authorities. Other causes of morbidity included unspecified intestinal infections (13%), parasitic infections (6%), otitis media (2%), and chicken pox, measles, and rubella (1%) (INEGI 1996c:186-188). Principal causes of morbidity in 1995 among children reported by the *Hospital Infantil de Tamaulipas* were respiratory infections (66%), unspecified intestinal infections (15%), parasitic infections (2%), otitis media (1%), and chicken pox, measles and, rubella (<1%) (INEGI 1996[c]:188). Morbidity due to diarrhea

producing infectious agents for 1993 through 1997 has been summarized in Figure 5. This graph is based on total number of reported cases of amoebasis, shigellosis, typhoid fever, salmonellosis, enterotoxgenic alimentary bacterial infections, and other unspecified intestinal infections summarized for Tamaulipas by the epidemiologic surveillance program of the *Secretaría de Salud* (INEGI 1996[d]; Secretaría de Salud 1994[a], 1998). In 1994, 110 cases of cholera were reported by Tamaulipas health authorities. The calculated incidence of 4.35 cases per 100,000 inhabitants was equivalent to the national average and contrasts dramatically with incidence rates from Chiapas (19.36), Tabasco (18.70), Veracruz (15.73), and Campeche (13.70) (Secretaría de Salud 1994[b]). These are among the most impoverished states in Mexico and have the highest percentage of indigenous peoples in their respective populations (INEGI 1996[b]:154-170).

The incidence of endoparasitic helminth and protozoan infections reported by health authorities in Tamaulipas for 1991, 1992, and 1993 has been summarized in Table 5. The incidence of *Trichuris trichiura* infection ranges from 10.26 to 9.90 cases per 100,000 inhabitants. Human roundworm infections, *Ascaris lumbricoides*, ranged from 416 to 464 cases per 100,000 inhabitants. The incidence of hookworm (*Ancylostoma duodenale* and/or *Necator americanus*) infections decreased from 24.53 to 9.98 cases per 100,000. Infections with the enteric flagellate protozoan *Giardia lamblia* ranged from 202 to 243 cases per 100,000. Children under 14 years of age were the primary population at risk for infection with these parasites. Approximately 70% of all parasitic infections were concentrated in this age group. In general, the incidence of parasitic infections with *T. trichiura* and *A. lumbricoides* for Tamaulipas were comparable with the average incidence figures reported for Mexico, and considerably lower than many other states. However, the incidence of infection with hookworms and *G. lamblia* was approximately 250 to 300% greater than the national average during this time period.

Access and Utilization of Health Care Resources

All Mexican citizens are guaranteed access to health care as a basic human right advanced in Article 4 of the national constitution ratified in 1983 (Barry 1991). Health care for Mexican workers and their families

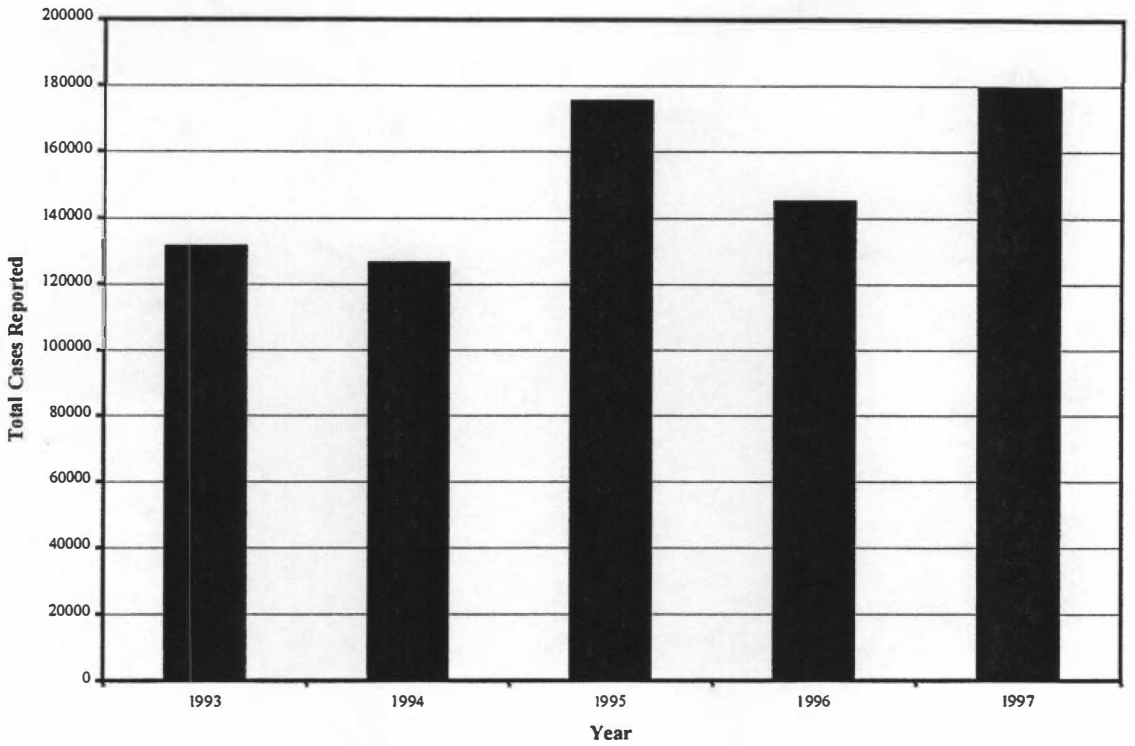


Figure 5. Morbidity from infectious enteric agents associated with diarrheal disease in Tamaulipas from 1993 through 1997. Data in the graph are based on the total reported cases of amoebasis, shigellosis, typhoid fever, salmonellois, enterotoxgenic bacterial infection, and other unspecified intestinal infections summarized by the epidemiologic surveillance program of the *Secretaría de Salud.* Source: Informe Semanal Epidemiología a la semana 49 del 4 al 10 Dicembre 1994, Boletín Epidemiológico, Vigilancia Epidemiológica Semana 2: Del 11 al 17 Enero de 1998. Document available on the World Wide Web at http://www.ssa.gob.mx/pop/estadis. Accessed January 1998.

Table 5. Incidence of intestinal parasitic infections per population 100,000 for Tamaulipas, Mexico from 1991 through 1993. These data are compared with the national average incidence of parasitic infections reported from all Mexican states from 1991-1993. Source: *Dirección General de Epidemiología, Secretaría de Salud,* SS-EPI-1-85 (Secretaría de Salud 1991, 1992, 1993).

	1991	1992	1993	NationalAverage 1991-1993
Trichuris trichiura	10.26	17.56	9.90	15.41
Ascaris lumbricoides	415.95	410.96	464.45	530.46
Ancylostoma duodenale/ Necator americanus	24.53	8.18	9.98	4.83
Giardia lamblia	202.08	240.83	195.65	86.10

is coordinated primarily through the *Instituto Mexicano del Seguro Social* (IMSS), and the *Instituto de Seguridad y Servicos Sociales de los Trabjadores del Estado* (ISSTE). The IMSS is financed by employee, employer, and government contributions to provide health care insurance for members of the general workforce. In reality, only individuals with steady employment in formally defined occupations like service industries and *maquilladoras* have health coverage through the IMSS. The ISSTE is a similar heath care bureaucracy for government workers with stable employment. Approximately 70% of the Mexican population receive health care through the social security systems. The remainder of the population includes individuals who are generally the most impoverished. They are excluded from this healthcare system because of unstable employment. Most are employed as unskilled day laborers. These individuals and their families obtain health care from government social assistance bureaucracies administered by the *Servicios Corrdinados de Salud Publica* (SSA), *Secretaría de Salud del Gobierno del Estado*, and the *Sistema Nacional Desarrollo Integral de la Familia* (DIF). Private charities like the *Cruz Roja* (Red Cross) also operate small clinics for emergency care and provide ambulance services. An estimated 5 to 10% of the population has access to the private health care sector (Barry 1991). Health care facilities available in the private sector range from the simple store front *consultarios* (offices) of individual practitioners to highly specialized multi-bed hospitals with fully equipped laboratories and surgical suites.

Government coordinated health care facilities available in the municipio of Valle Hermoso include the *Hospital General* under the direction of the *Secretaría de Salud del Gobierno del Estado,* the *Centro de Salud Suburbano Valle Hermoso del SSA* (VHCS), eight outpatient clinics operated by the IMSS, IMSSTE, IMSS-Solidaridad, and nine *Casas de Salud* (houses of health) administered by the SSA (INEGI 1996c). The IMSS-Solidaridad clinics have their origins in earlier programs that extend health care service to marginal areas and segments of the population (Barry 1991). One IMSS-Solidaridad outpatient clinic is located within walking distance of the Valle Hermoso *centro*. The SSA administers nine *Casas de Salud* located in outlying, *colonias*, *eijidos*, and *poblanos* throughout the municipio. These are staffed primarily by nurses and neighborhood volunteer health *promotoras* with an attending physician available

during designated office hours (usually a four hour shift in the morning or afternoon) one or two days each week. The *Cruz Roja* also operates a three bed clinic suitable for short-term (overnight-weekend) hospitalization and outpatient care, and an emergency ambulance service. Medical services of the *Cruz Roja* are provided at a nominal cost, or *gratis* to individuals who are unable to pay for service. In 1995, 119,274 outpatient cases, or approximately 2.15 outpatient visits per municipio resident, were documented for Valle Hermoso government health care facilities. Approximately 80% of these cases were for routine health care including prenatal examinations, treatment of colds, vaccinations, and other non-critical conditions. Emergency care accounted for 13% of the cases, with the remainder of the cases being divided between conditions that required the services of medical specialists including dentists (INEGI 1996[c]:178).

Health care facilities in the private sector include seven clinics equipped with laboratories, surgical suites; and 8 to 10 beds suitable for short-term hospitalization, and approximately 50 to 75 storefront doctor/dentist *consultarios*. *Over-the-counter* (OTC) medications and prescription drugs are available for purchase in any of 12 to 20 pharmacies or *boticas* located in the *centro* and nearby *colonias*. In Mexico, OTC medications are not limited to cold and allergy relief medicines as they are in the United States. Rather, OTCs include a wide variety of pharmaceutical compounds such as anthelminthics for the treatment of endoparasites, and antibiotic and antiprotozoal compounds for the treatment of infections with bacteria and diarrhea producing protozoan parasites such as *G. lamblia* and *Entamoeba histolytica*. Anthelminthics such as albendazole (tradename *Zentel*) and mebendazole (tradenames *Vermox, Revapol*) range in cost from Mex$ 7.30 to 12.50 (US$ 1.00 to 1.71). Antiprotozoal compounds such as metronitozole (tradename *Flagyl*) cost approximately Mex$ 8 to 17 (US$ 1.09 to 2.32). Herbal based *remedios caseros* (household remedies) for the treatment and management of a wide spectrum of health complaints are available in five *herberias* (shops primarily devoted to selling medicinal herb preparations), one health food store, and in a national-chainstore pharmacy. These shops provide an alternative venue for clients seeking relief from mostly chronic illnesses such as diabetes, arthritis, gastritis, constipation, urinary tract complications, and hypertension. The *herberias* also sell *remedios* for the expulsion of parasites. These preparations are available in various forms as dried herbs for brewing teas, in capsule form, and as

distilled elixirs. They range in cost from approximately Mex$ 8 to 15 (US$ 1.09 to 2.05) depending on the preference of the vendor. Some *herberias* also sell small individual doses of pharmaceutical anthelminthic compounds under the tradename *Lombrisaca* (mebendazole). The *herberias* also provide a brisk trade in special candles, oils, incense, and amulets (*milagres*) for treating illnesses of a spiritual nature which are presumed to be outside of the scope of formal biomedicine.

Public Health Issues in Valle Hermoso

Several public heath issues are actively promoted in Valle Hermoso. These are identified as locally relevant health priorities derived from the national health promotion efforts of the *Secretaría de Salud*. All public health promotion programs are carried out locally by the collaborative association of the previously described health care bureaucracies. Women of reproductive age are targeted for programs designed to promote awareness and prevention of sexually transmitted diseases like AIDS, as well as family planning, birth control, and teenage pregnancy prevention. Expectant mothers receive instruction on the importance of prenatal nutrition and health care. Mothers of infants are encouraged to participate in the national childhood vaccination program for protection of their children against infectious diseases such as poliomyelitis, diphtheria, whooping cough, tetanus, measles, and tuberculosis. Mothers of infants and children are also instructed in the principal warning signs of dehydration resulting from infectious diarrhea, and the preparation and administration of oral rehydration therapy (ORT). Prevention of foodborne infectious diseases like salmonella, amoebasis, and *Taenia solium* cysticercosis are also actively promoted by public health agencies at national, regional, and local levels.

The public health programs for promotion of household hygiene and prevention of diarrheal disease are of particular relevance to this research. The impetus for these efforts is derived from the national program for cholera prevention initiated by the *Secretaría de Salud*. Cholera prevention efforts in Mexico began in 1991 when the first cases of the El Tor biotype of *Vibrio cholera 01* were detected (Valdespino-Gomez et al 1993). This biotype is responsible for the global pandemic which originated from an endemic focus in Sulawesi, Indonesia, in 1961. It has spread throughout Asia, Africa, Oceania,

and Latin America over the last 30 years (Centers for Disease Control 1991). The prevention phase of the national program includes health promotion and diffusion of information through mass media campaigns.

Activities of the national promotion program are primarily directed toward building awareness and encouraging:

1. basic sanitary and personal hygiene measures such as hand washing before meals and after using the bathroom,
2. adequate stool and garbage disposal (occasionally supporting construction of latrine and sewage disposal facilities),
3. adequate management, preparation, and preservation of meals consumed in the household,
4. adequate treatment of water used for human consumption through clorination, filtration, or boiling,
5. avoidance of consumption of beverages and foods from unregulated street vendors, particularly in food stands with poor hygienic conditions.

Activities of the health promotion program are diffused to the public through mass media presentations on local radio and television stations, news media coverage of educational programs, posters, leaflets, and lectures and demonstrations to diverse audiences. Mass media diffusion of the anti-cholera-diarrheal disease message is intensified during May through August, when the risk of infection is highest. Messages about cholera prevention, childhood diarrhea, amebasis, and dehydration assessment are broadcast on all television channels approximately every 20 minutes during the middle of the day when women are the primary television viewers (D.A., *Enfermera*, VHCS, personal communication). Although, the presence/absence of a television was not recorded for individual households, personal communication with *promotoras* indicated that they are widespread and most households have them. In the words of one *promotora* "they [the family] will sleep on the floor if necessary to be able to afford a television" (F.G., *Promotora* and *Presidente de Colonia Los Vecinos,* personal communication). Mass media health promotion broadcasts change seasonally as the threat of different disease producing agents change in importance. Summer months stress the importance of preventing diarrheal diseases, dehydration, and skin cancer. Winter months feature diseases and illnesses like flu, pneumonia, measles, and other infectious

diseases likely to be acquired in schools (I.W., *Enfermera*, VHCS, personal communication). Childhood vaccination against infectious diseases are also heavily promoted by the mass media during the school year.

In Valle Hermoso, e*nfermeras* (staff nurses) of the VHCS have the primary responsibility for coordinating the health promotion program of the national *Secretaría de Salud. Enfermeras* assigned to *colonias* in the town provide instructional sessions and demonstrations to residents on various health and hygiene related issues. Each nurse may have responsibility for four to five *colonias* and is required to provide 15 to 20 demonstrations per month (I.W., *Enfermera*, VHCS, personal communication). They are also required to make periodic visits to households in their assigned colonias to keep abreast of family health status, and promote programs such as the national childhood vaccination initiative. No effort was made to determine which households regularly attended the demonstrations by the VHCS, or benefited from frequent visitation by a VHCS *enfermera.*

VHCS e*nfermeras* also staff local *consultarios* or *casas pequenas de salud* (little houses of health) in colonias where they exist. These facilities provide residents with convenient access to health care for diagnosis and treatment of non-life threatening conditions like colds, sore throat, blood pressure checks, and so forth. The *enfermeras* are assisted by local committees of *promotoras* who reside in the *colonias.* The *promotoras* serve as liaisons to the VHCS in the *colonia* and provide reports on household health conditions to the *enfermeras.* The women who volunteer for service as *promotoras* are generally persons interested in improving the quality of life in the *colonia.* Some *promotoras* have political ambitions, but most volunteers are interested in securing additional services for the *colonia* such as paved roads, an outpost of the DIF (*Sistema Nacional Desarrollo Integral de la Familia)*, or a *casa pequena de salud.* These persons often see *promotora* service as a foot in the door to gain additional governmental assistance (I.W., *Enfermera*, VHCS, personal communication).

The VHCS is also the primary agency responsible for administration of the national targeted chemotherapy program to reduce helminthiasis in school-age children. This program is an extension of the UNESCO Basic Education initiative (Halloran et al 1989). The objective of the UNESCO program is to provide primary school education to all children in developing countries. Anthelminthic intervention

against *A. lumbricoides* and *T. trichiura* was identified by UNESCO officials over other infectious disease priorities because infection with these parasites attain their peak prevalence and intensity in school age children > 5 years of age (Bundy et al 1992). These parasites are ubiquitous in warmer climates and contribute directly to malnutrition and anemia which profoundly affect human growth as well as influence school absenteeism, mental alertness, and overall academic performance (Halloran et al 1989). In Valle Hermoso, children attending school receive treatment with Albendazole (400 mg, SID) three times each year. Anthelminthic treatments were administered during the study period between mid-September and the first week of October, around the first week of February, to coincide with the *Semana Nacional de Salud* (National Health Week), and at the end of May to coincide with summer dismissal for vacation. Fieldwork to collect fecal samples and interview cooperating household PCs was scheduled to allow children ample time to develop patent infections with, *Ascaris lumbricoides* and *Trichuris trichiura.* The pre-patent period for these parasites is approximately 56 and 90 days following reinfection (Beaver et al. 1984).

Economy and Employment

The economy of Valle Hermoso is based primarily on agriculture and secondarily on industrial manufacturing. Corn and sorghum are the principal agricultural commodities produced in the Rural Control Development district which includes Valle Hermoso. The value of these commodities in 1994-95 was approximately 48 and 36 million US$ (INEGI 1996[c]:280). Other agricultural commodities produced in the district include cotton, soybeans, beans, and vegetables. Livestock production is relatively unimportant and Valle Hermoso ranks 28[th] in beef production among 43 *municipios* in Tamaulipas (INEGI 1996[c]:299). *Maquiladora* manufacturing is a fairly recent development in Valle Hermoso which dates to the late 1980's and early 1990's. To date there are 11 *foreign-export only* manufacturing plants in the city limits of Valle Hermoso, and two plants in the nearby *poblano* of Anahuac. The plants produce automotive components, welding machinery, paper and allied products, and clothing. Municipio specific data on the economic contribution of these industries and the percent of the population employed by them is not available. However, in the nearby municipio of Rio Bravo which is comparable in size to Valle

Hermoso only 1.9% of the workforce is associated with *maquilladora* manufacturing (INEGI 1996[c]:336). In contrast, approximately 33% of the workforce in the urban area of Matamoros is associated with *maquilladora* manufacturing (INEGI 1996[c]:123). Only 1.4% of Valle Hermoso households surveyed during this study reported employment in a *maquilladora.* Weekly wages for *maquilla* workers average Mex$ 254, or approximately US$ 35 (Dwyer 1994). Of the 136 households for which the occupation of the head of household was reported, 35% were employed as day laborers in agricultural or construction work, 19% were employed in the commercial sector as butchers, shop keepers, bartenders, and taxi drivers, 13% as skilled tradesman, 13% were employed as unskilled laborers with steady employment in the formal job sector, and 9% were employed independently, or as personal helper/assistants (Table 6). The average weekly wages for these households was Mex$ 219 (US$ 30). This corresponds to approximately twice the minimum daily wage described for the *municipio* (INEGI 1998[b]). The minimum daily wage for Valle Hermoso is approximately 9.5% greater than that for all of Mexico and indicates a comparatively higher standard of living for the residents of the community (INEGI 1998[b]).

Household Expenditures

Estimated expenditures for households with two minimum incomes are presented in Table 7. These data are based on the 1994 national survey of household income and expenditures (INEGI 1995). Household income for 1994 was estimated from a summary of national economic activity (INEGI 1998[b]). These data indicated that approximately 50% of all household income is used for purchasing food and beverages. This figure includes dietary staples like beans, other vegetables, tortillas, meat, milk , bottled water, and alcoholic beverages like beer. Household services, including rent or house payment, and water and electrical utilities, account for 14% of total expenditures. Approximately 14% of all household expenditures are dedicated to purchase and maintenance of an automobile or other transportation related services. Home maintenance supplies for cleaning and repairing the house, furniture, and other household utensils account for approximately 9% of all expenditures. Clothing and health related expenditures account for 7 and 6% of all household purchases. The total expenditures listed in Table 7 closely parallel

Table 6. Occupations and estimated weekly salary listed for the head of Valle Hermoso households participating in the study.

Occupation	Estimated weekly salary (Mexican pesos)	Estimated weekly salary (U.S. Dollars)	Total households represented
Albanil (mason)	300	41.09	12
Al Dia (unskilled day worker)	120	16.43	1
Cantina (bartender/canteen worker)	150	20.54	1
Carnicero/comerciante (employed in butcher shop or grocery store)	200	27.39	3
Carpintero (carpenter)	300	41.09	2
Chofer (taxi cab driver)	300	41.09	5
Despachador (dispatcher)	180	24.65	3
Electromechanico (electrical mechanic)	400	54.79	1
Grangero (laborer at granary)	200	27.39	2
Guardia/Velador (bank guard or night watchman)	300	41.09	2
Hoja la tero (tinsmith)	400	41.09	1
Independiente/ Ayudante/ Empleado (employed independently or as a personal helper/assistant)	150	20.54	21
Jornalero (agricultural or construction laborer paid a daily wage)	180	24.65	47
Maquillador (factory worker)	200	27.39	2
Mechanico (mechanic)	400	54.79	7
Militar (military service)	200	27.39	1
Obreo (laborer with steady employment in a formally defined job setting)	180	24.65	17
Pintor (painter)	300	41.09	3
Solador (welder)	400	54.79	5
Total Households Represented			**136**

All salary estimates use the currency exchange rate of Mex$ 7.3 to US$ 1.

the estimated 1994 income for households with a two minimum income standard of living (INEGI 1998[b]). These figures indicate that the residents of Valle Hermoso have precious little income left over for unexpected health-related expenditures, such as treating the entire family for endoparasitic infection, in spite of their higher standard of living compared to other Mexicans.

Table 7. Quarterly household expenditures estimated for Mexican households with 2 minimum incomes. Data is based on a national survey of household income and expenditures for localities with 2500 inhabitants and greater. Source: *Encuesta Nacional de Ingresos y Gastos de los Hogares* 94 (INEGI 1995).

Object of Expenditure	**Estimated quarterly household expediture (Mexican pesos)**	**Percent of total household expenditures**
Health related expenses	134.16	6.19
Household services (rent, energy, utilities)	305.35	14.10
Home maintenance supplies	185.33	8.55
Clothing	152.32	7.03
Food and beverages consumed in the home	1092.75	50.40
Transportation (automobile, taxi, etc)	295.29	13.63
Total Household Expenditures	**2165.20**	**99.9**
Estimated Household Income (1994)[1]	2183.60	
Surplus Income	18.40	0.84

[1] Estimated salary for 1994 is based on x2 minimum daily salary for 5.5 days x 13 weeks (INEGI 1998)

CHAPTER 5

PARASITOLOGICAL ANALYSIS

Introduction

This portion of the research was undertaken to identify and describe the endoparasitic infections of the Valle Hermoso children. The primary objective of this analysis was to establish household infection status as a dependent variable for use in the analysis of the interview data collected with the HHHQ and MHPQ. Additional objectives were to examine and describe the distribution of parasitic infections in the study population using attributes like the age and sex of the host (child), and the presence/absence of infected siblings in the household as independent variables. The relative percentage of children infected with multiple parasites was also calculated and examined for statistical associations between parasitic species. The association of parasitic infections with households based on the number of resident children, and the occurrence of particular parasites in households and *colonias* were also examined as potential risk factors.

Results of the Analysis

Fecal samples from 438 children were collected from cooperating households and analyzed for endoparasitic helminth eggs or larvae, protozoan cysts, and coccidian oocysts by the methods described in chapter 2. Two hundred-twenty three samples were obtained from males, and 215 samples were from females. The mean age of the population was approximately 6 years, and there was no significant difference in age between males and females (Table B1). A total of 217 families from the eight *colonias* defined in chapter 2 were represented (Table B1). Detailed household interview data described in chapter 6 was available for 188 of these families.

Fecal samples from 30% of the children were positive for one or more endoparasitic species (Table B2). *Giardia lamblia* accounted for 12.5% of the infections. Other nonpathogenic protozoan

parasites represented in the samples were: *Entamoeba. coli*, *Ent. hartmanni*, *Endolimax nana*, and *Iodamoeba büetschlii.* Cysts of *Ent. histolytica* were found in a single sample. Helminth parasites found in the children include: *Hyemolepis nana*, *Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis*, *Ancylostoma/Necator* (hookworm), and *Strongyloides stercoralis.*

Infection status was significantly associated with age of the child. School age children six years and older were more likely to be infected with any parasite when compared with children five years and less (Table B3). Statistical differences in the mean age of children infected with particular parasitic species were determined by Student's T test for unpaired samples. Infections with *H. nana* and *Ent. hartmanni* were significantly associated with older children (Table B4). Other parasites that exhibited a tendency to occur in older children, but were not statistically significant, were *T. trichiura*, *Ent. coli*, *E. nana*, and *I. büetschlii* (Table B4). Infections with *A. lumbricoides* and *G. lamblia* were more common in younger children, but this association also was not significant (Table B4). Infection status was also significantly associated with the presence of an infected sibling in the household. Infected children were nearly three times more likely to have an infected sibling than their uninfected cohorts (Table B5). Infection status was not associated with the sex of the child. Although slightly more female children were infected with any parasite, male children were equally likely to be infected (Table B6).

Infections with two or more parasites occurred in 33% of all children tested. Among the children with multiple infections, 44% were infected with three or more parasites. There was no association between the sex of the child and the likelihood of being infected with two or more parasites. Spearman Rank Order correlation coefficients were calculated to describe the distribution of parasitic species among the infected children. The occurrence of *A. lumbricoides*, *H. nana*, *G. lamblia*, and *Ent. coli* was significantly correlated with the presence of a sibling infected with any endoparasite in the household (Table B7). *Ent. hartmanni* was positively correlated with *E. nana*, *Ent.coli*, *I. büetschlii*, and *H. nana. T. trichiura* and *A. lumbricoides* were correlated with each other and *I. büetschlii. G. lamblia* was only correlated with *H. nana* (Table B7).

Approximately 36% of households had one or more children infected with any parasite. Household infection status was significantly associated with the number of resident children. Households

with three or more children were nearly five times more likely to have an infected child when compared to households with two and fewer children (Table B8). *G. lamblia* was the most ubiquitous parasite with its occurrence in 21% of Valle Hermoso households (Table B9). Other parasites found in approximately 10% of households were *Ent. coli, Ent. hartmanni, E. nana*, and *H. nana* (Table B9). The distribution of *A. lumbricoides, I. büetschlii* and *T. trichiura* was comparatively more limited and found in approximately 5, 4, and 3% of households, respectively (Table B9). *Ent. histolytica, S. stercoralis*, and the human hookworm, *Ancylostoma/Necator*, were distributed as single cases in less than 1% of Valle Hermoso households (Table B9). Infections with *A. lumbricoides*, *H. nana*, and *G. lamblia* exhibited a tendency to cluster in households. Approximately 40% of all household infections with *A. lumbricoides* involved more than a single child. Infections with *H. nana* and *G. lamblia* were distributed similarly in 23 and 22% of households, respectively (Table B9).

In 1996, household informants were asked to comment on use of antiparasitic medications and remedies within their families. Informants were asked to answer *yes* or *no* if their children had been recently treated with any pharmaceutical compound or herbal remedy with antiparasitic activity. No effort was made to determine if parents were acknowledging use of medications in the household, or receipt of anthelmintic treatment at school. Households answering affirmatively were then asked to estimate the number of weeks since the last treatment. Household use of an antiparasitic drug or herbal remedy was acknowledged by 69% of the households from whom fecal samples were obtained. Household infection status was not significantly associated with acknowledged use of an antiparasitic drug or remedy (Table B10). Additionally, there was no difference in mean length of time since the last application of antiparasitic drugs or remedies between uninfected and infected households (Table B10).

Households with endoparasitic infections were found in all *colonias* (Table B11). The prevalence of infection in households in each of the *colonias* ranged between 28 and 60% (Table B11). Infections with *G. lamblia, Ent. hartmanni*, and *E. nana* were the most ubiquitous and occurred in all *colonias*. *H. nana* and *Ent. coli* were found in 88% of *colonias*, and *A. lumbricoides* was found in 75%. *I. büetschlii* was present in five of eight *colonias*. *T. trichiura*, and *E. vermicularis* occurred in four of eight *colonias*. *Ent. histolytica*, and *Ancylostoma/Necator* occurred as single cases in one *colonia* each.

Identification of statistically meaningful relationships in the distribution of parasitic infections between the *colonias* is problematical given their sporadic occurrence and low relative frequencies. Nevertheless, examination of the frequency data for *G. lamblia* suggested that the 30% occurrence in *Los Vecinos* was higher than reasonably expected by random chance. The statistical association of *G. lamblia* with households in *Los Vecinos* was confirmed by Chi Square ($p < .05$, 1 *df*). The odds ratio calculated for the distribution of *G. lamblia* indicated that children of *Los Vecinos* were approximately two times more likely to be infected with the parasite compared to children of all other *colonias* (Table B12). The Kruskal-Wallis nonparametric analysis of variance by ranks procedure was used as an additional effort to characterize the distribution of parasitic infections between *colonias*. Infections with *A. lumbricoides*, *H. nana*, *G. lamblia*, *E. coli*, *E. hartmanni*, and *E. nana* were assigned scores based on their rank ordered abundance in each of the eight *colonias*. The mean rank for all parasitic infections in each *colonia* was calculated, and evaluated against the null hypothesis of no significant difference in ranked means with the Chi Square statistic ($p < .05$, 7 *df*), which is equivalent to the Kruskal-Wallis H when more than five groups are involved (Zar 1974:178). This test indicated that the ranked abundance of parasitic infections between the eight *colonias* was indeed significantly different. However, further testing for statistical differences between the mean ranks with Dunn's multiple comparison procedure for nonparametric analysis of variance by ranks indicated that only two *colonias* (*Campo de Sueños* and *Fuente de Suerte*) could be considered significantly different with respect to their rank ordered parasite abundance. The mean abundance of parasitic infections was highest in *Campo de Sueños* and lowest in *Fuente de Suerte*. The mean abundance scores for all other *colonias* fell within the range of these two extremes. These *colonias* can be considered as a single homogenous group with no statistically significant difference in the abundance of parasitic infections between them.

Predictive Value of a Single Negative Fecal Examination

A primary methodologic concern of this research was assessing the accuracy of a single negative test result. The question of interest was *what is the likelihood that an individual with a single negative test result is actually uninfected rather than being judged falsely negative for a given parasite?* The predictive

value of a single negative fecal examination was calculated using procedures outlined by Fletcher et al. (1988). The predictive value of a diagnostic test is a function of the sensitivity, or ability, of the test to correctly identify an infected individual, and the prevalence of the parasite of interest. Sensitivity values for detecting endoparasitic species with a single fecal examination were compiled from research by Nazer et al. (1993), and Marti and Koella (1993). Prevalence values for endoparasitic species identified in the Valle Hermoso fecal samples are presented in Table B13. Negative predictive values calculated for the Valle Hermoso endoparasite data range from 92.70% for *T. trichiura* to nearly 100% for hookworms (Table B13). These results demonstrate that a single fecal examination is sufficient to conclude, with a high degree of certainty, that the individual from whom the stool was submitted is uninfected.

CHAPTER 6

HOUSEHOLD INTERVIEW ANALYSIS

Introduction

Interviews were conducted with informants in Valle Hermoso households to obtain information about the recognition, treatment, and prevention of parasitic infections in children. The data were analyzed for consensus between the household comparison groups defined in chapter 2 by comparing relative percentages of affirmative responses for each item of the HHHQ. Whenever sufficient directionality in the pattern of responses between household groups was detected, these data were used as independent variables and tested for statistical association against the dependent variable household infection status defined in chapter 4. The underlying expectation of this analysis was that household infection status could be understood as a result of differing degrees of household knowledge about the recognition, treatment, and prevention of parasitic infections. The data presented in this chapter are summarized from the HHHQ and the MHPQ described in chapter 2. The quantitative aspects of household parasite knowledge presented in this chapter are largely derived from the *yes, no, don't know* format of the HHHQ. However, the open-ended format of the MHPQ allowed for collection of highly detailed parasite-related information that could not be economically obtained with the HHHQ. The goal of this chapter is to seamlessly integrate the data from both sources so that parasite knowledge can be quantitatively compared between these analytically defined household groups while preserving the qualitative distinctions that underlie the community's conceptual understanding of how parasitic infections are acquired, diagnosed, treated, and prevented. The characteristics of the interviewed households and their informants are presented in the first section. In the subsequent sections, the results of the analyses of the household interview data are organized under separate subheadings for discussion of beliefs about the acquisition of parasites, symptoms of infection, and the treatment and prevention of parasitic infections.

Demographic and Household Characteristics

Interviews were conducted with 244 households in eight *colonias* (Table C1). For analytical purposes the households were differentiated into comparison groups as *outside comparison households*, *infected households*, and *uninfected households* according to the criteria presented in chapter 2. The number of interviewed households in each analytical comparison group is presented in Table C2. The demographic characteristics for the informants in all three analytical groups were similar. Approximately 90% of the persons interviewed were female and married (Table C3). The average age was 31 years, and there was no significant difference in age between informants in any of the household groups (Table C3). The mean period of residence for informants in each of their respective *colonias* was between seven and five years, and was not significantly different between household comparison groups (Table C3).

The household characteristics for all comparison groups were similar. Weekly household income was greater for outside comparison households when compared to infected and uninfected households (Table C4). However, this difference was not significant. Differences in home ownership between groups was also not significant (Table C4). Infected households had significantly more resident children than uninfected and outside comparison households. The mean number of resident children for infected households was 3.06 compared to the outside comparison and uninfected households with 2.6 and 2 children, respectively (Table C4). Household infection status was significantly associated with the type of facilities available for disposal of fecal waste. Flush toilets were comparatively more common in uninfected households than in comparison and infected households (Table C5). However, the absence of a flush toilet was not a significant risk factor for household infection status when infected and uninfected households were compared separately (Table C5). Infection status was also significantly associated with source of drinking water used in the household (Table C5). Infected households were nearly five times more likely to take their drinking water directly from the faucet without treatment compared to uninfected households (Table C5).

Knowledge and Use of Cholera Preventive Measures

Knowledge of the recommendations promulgated by government public health agencies for cholera prevention was present for all household comparison groups. Approximately 64 to 81% of informants in each group were able to recall at least one preventive measure from memory (Table C6). Household infection status was not associated with the ability to recall cholera preventive measures (Table C6). Infected households were just as likely to recall at least one preventive measure as the outside comparison and uninfected households. However, uninfected households were significantly associated with the ability to list three or more preventive measures (Table C6). Informants that were unable to list three or more cholera preventive measures were approximately two times more likely to have an infected child in the household (Table C6).

Recognition and recall of the major classes of cholera preventive measures were similar between household comparison groups. These can be classified with respect to treatment of drinking water, personal hygiene, and food hygiene (Table C7). Specific measures recognized for treating drinking water included boiling, filtering, and adding a small amount of chlorine bleach. One household provided a very specific recommendation that two drops of *cloro* per liter were necessary to adequately disinfect drinking water. Five households specifically mentioned that people should not drink water directly from the faucet, or from the faucet without treatment. Personal hygiene measures primarily concerned hand washing practices either before meals and, or after using the bathroom (*lava los manos antes de comer y después ir al bano*). Only nine households (2% of all responses) specifically mentioned the importance of using designated latrines for defecation or offered the admonishment that persons *no defecar al aire libre* (literally, don't defecate freely in the open). One household also noted that regular application of lime to the latrine was an important measure for cholera prevention. Food hygiene measures included washing fruits and vegetables to remove contaminates (*lava fruitas y verduras muy bien*), and cooking all food well (*cosinado todo comidas muy bien*). Infrequently, (2.6% of all responses) household informants stated that it was important to cook fish well, and that seafood should not be eaten raw (*no come mariscos cruda*). Few households (2.8% of all responses) also mentioned that people should avoid eating the foods available from street vendors (*no come comida en la calle*), or that one should only eat clean, well prepared food

from one's own house. There were no statistically significant associations between the frequency with which the different classes of preventative measures were recalled and household infection status (Table C7).

Reported usage of anti-cholera measures was consistent between households irrespective of their infection status (Table C8). Although a greater proportion of the outside comparison households reported inconsistent usage of preventive measures when compared to infected and uninfected households, this association was not significant (Table C8). Inconsistent use of cholera prevention measures was also not a significant risk factor for household infection status when infected and uninfected households were compared separately (Table C8).

Acquisition of Parasitic Infections

The acquisition of endoparasitic infections was examined with respect to hygiene, dietary, and folk related beliefs. The susceptibility of children as the primary population at risk for parasitic infection, and the role of children as a reservoir for infecting adults in the household, was addressed in two additional questions. Household informants were also asked if infections with *lombrices* (worms, or parasitic helminths) were acquired in the same way as parasitic protozoan species. For this aspect of the research the term *amebas* (amoebae infection) was recognized as a generalized term or linguistic gloss applicable to all of the various waterborne protozoan species responsible for intestinal diarrhea. Questions on the HHHQ that explored the occurrence of parasitic infection and its relationship with hygiene related exposures included living in a dirty house, having contact with animals, and children eating dirt or putting dirty things in their mouth. Infection with helminth species like *Hymenolepis nana* and *Enterobius vermicularis* is enhanced in households with poor hygiene. Soiled bed sheets, blankets, and clothing provide excellent mechanisms for transmission of the immediately infective eggs to all household members. Household pets can be mechanical vectors for transporting infective stage helminth eggs like those of *Trichuris trichiura* and *Ascaris lumbricoides* on their fur to susceptible human hosts. Dogs are especially important in this regard given their predilection for rolling in human excrement. The coprophagic behavior of young dogs also serve to disseminate infective helminth eggs by transporting them from human latrine areas into

socially acceptable locations like the play and work areas outside of houses and dwellings (Beaver et al. 1984). Children who eat dirt or frequently put dirty objects in their mouths are at increased risk for a variety of fecal-orally transmitted parasitic species, especially geohelminths like *T. trichiura* and *A. lumbricoides*.

Informants in all comparison groups acknowledged that living in a dirty house was an important way in which people become parasitized (Table C9). Approximately 88% of uninfected households agreed with this statement. The frequency of affirmative answers was similar for the outside comparison and infected households (Table C9). There was less agreement among households that having contact with animals played an important role in parasitic infection (Table C9). Fewer uninfected households answered affirmatively compared to infected and outside comparison households. All household groups exhibited similar patterns of agreement on the concept that children become infected from eating dirt (Table C9). The frequency of affirmative responses ranged from 90% among the outside comparison group to 80% among uninfected households.

Questions from the HHHQ that explored dietary related beliefs and their association with increased risk of parasitic infection included drinking unclean water, and consumption of poorly cooked or spoiled food. Infections with protozoan species such as *Giardia lamblia*, *Cryptosporidium parvum*, and *Entamobea histolytica* have been linked to fecal contamination of piped water sources used to supply households with water for drinking and food preparation (Beaver et al. 1984; Herwaldt et al. 1991, 1993; MacKenzie et al. 1994). People and households that routinely use drinking water that has not been adequately disinfected with iodine, chlorine bleach, or microfiltration are at increased risk for parasitic infection. Parasitic protozoa may also be transmitted in infant formula and ice cubes prepared from contaminated water.

Parasitic infections can also be acquired from consumption of inadequately cooked food. Human cestode infections with *Taenia saginatta* (beef tapeworm) and *T. solium* (pork tapeworm) are acquired by ingestion of the metacestode stage (cysticerci) encysted in the meat cuts from cows and pigs who serve as intermediate hosts for the parasites. Protozoan species like *Sarcocystis hominis* and *S. suihominis* are also transmitted to humans by the infective stages found in poorly cooked beef and pork. *Toxoplasma gondii* is

another protozoan species whose infective stages are often transmitted to humans in inadequately cooked meat products from a large number of warm-blooded vertebrate hosts (Dubey and Beatie 1988). The infective eggs of *A. lumbricoides* and *T. trichiura* can also be transmitted to the human population via poorly cooked and inadequately washed fruits and vegetables. The eggs of these geohelminths often become associated with produce when field crops are fertilized with night soil (human excreta) or irrigated with raw sewage (Beaver et al. 1984). Spoiled foods are generally synonymous with bacterial contamination resulting from inadequate refrigeration, or fecal contamination during butchering and processing prior to human consumption. Although recognition of illness produced by bacterial etiologic agents was not a primary interest of this research, consumption of spoiled food often results in nausea, abdominal cramping, and diarrhea. These symptoms could be seen as the product of parasitic infection, and labeled as such by Valle Hermoso households.

There was universal agreement among households that drinking unclean water was an important way in which people become infected with worms and amoebas. The frequency of affirmative responses ranged from 84% in infected households to 74% in the outside comparison households (Table C9). Dietary indiscretions, such as consumption of poorly cooked and spoiled food, were also acknowledged as ways in which people become infected with parasites. All household comparison groups exhibited similar patterns of agreement on the question that worms were obtained from eating spoiled food. The frequency of affirmative responses ranged from 73% in the outside comparison group to 65% in uninfected households (Table C9). There was less agreement among households that worms were obtained from consumption of poorly cooked food. Infected and outside comparison households had similar patterns of agreement with 66 and 61% of informants responding affirmatively (Table C9). In contrast, only 48% of uninfected households agreed with this question, 29% disagreed, and 23% did not know whether the question was true or not.

Folk related beliefs for the acquisition of parasitic infection included such ideas as children being born with worms, that worms are obtained from eating too much candy, eating from the same plate, and other transmission mechanisms that are at variance with a biomedical understanding of parasite epidemiology. The belief that children are born with worms is a persistent, although infrequently reported,

folk explanation for the origin of intestinal helminth infections (Hoeppli 1959; Vecchiato 1997; Williams-Blangero et al. 1998). Such beliefs may have originated from observations of prenatally transmitted roundworms (*Toxacara canis*) in stillborn puppies, or as explanations for the rapid onset of clinical disease produced by helminths like *Strongyloides stercoralis*, or *S. fulleborni* in neonatal children (Ashford et al. 1992). Beliefs that intestinal worms are acquired from eating too much candy, sweet milk, or other sugary substances are well documented cross-culturally (Ngokwey 1988; Rousham 1994; Williams Blangero 1998). The basis of this belief may stem from the association that diets composed of excess sugary foods are often diarrheic and result in the spontaneous passage of large roundworms (*A. lumbricoides*). Other explanations for the origin of intestinal helminth or amoebae infections, such as eating from the same plate, and eating the same foods all the time, were identified as locally relevant folk etiologies during open-ended interview sessions with Valle Hermoso residents prior to the development of the HHHQ. The etiologic explanation that worms were acquired from eating *masa cruda* (raw tortilla dough) was adapted from my childhood experience and the assurance of my grandmother that eating raw biscuit dough and pie crust would inevitably result in a massive worm infection.

There was little consensus with respect to folk beliefs, such as children being born with worms, becoming infected from eating the same food all of the time, or eating from the same plate (Table C10). The pattern of responses for all household groups was one of ambiguous agreement. Most households were not sure if children were born with worms (Table C10). Fewer households answered affirmatively to this question than any other parasite acquisition question on the HHHQ. The idea that worms can be acquired from eating the same foods all of the time appears to be a more salient concept for explaining why some people are infected and not others. Over half of the infected and uninfected households answered this question affirmatively (Table C10). Infected and outside comparison households also believed that *ameba* infections can be acquired from sharing the same plate. However, the responses for uninfected household were ambiguous and informants responded with *yes, no, or don't know* in approximately equal numbers (Table C10). Infected and outside comparison households agreed that children are at increased risk of obtaining worms when they eat *masa cruda* (Table C10). In contrast, only 48% of uninfected households answered affirmatively, and 38% did not know if children could get worms that way. Households from all

comparison groups agreed that children who eat too much candy will get worms (Table C10). The pattern of responses was similar for the question that worms could be acquired from drinking *leche dulce* (sweetened or condensed milk) (Table C10). Agreement with this belief was stronger among members of the outside comparison group where 72% of informants responded affirmatively. The responses from uninfected households were more evenly divided. Only 53% of informants from these households responded affirmatively, and 28% were not sure if worms were obtained from drinking sweet milk (Table C10).

Households in all comparison groups acknowledged that infections with parasitic helminths were not restricted to children (Table C11). Consensus among informants was high, and only a small percentage of the informants in each household group agreed with the statement that *only children get worms* or did not know. However, there was less consensus among informants on the belief that adults often get worms from their children. The pattern of responses was similar for each household comparison group (Table C11). Although a higher percentage of informants from infected households agreed with this statement, the difference between comparison groups was not significant ($p = .98$, 2 *df*) (Table C11). Infected households and outside comparison households agreed that parasitic infections with worms and amoebas were obtained in the same way. Although, a higher proportion of uninfected households disagreed with this belief, the difference between comparison groups was not statistically significant ($p = .07$, 2 *df*).

Three open-ended questions from the MHPQ were relevant to the issue of how parasitic infections are acquired. Informants were asked to describe the ways in which people become infected with *lombrices* and *amebas* in separate questions. Informants were also asked to elaborate on why they believed or did not believe that children acquired worms from eating too much candy.

Responses on the two questions about how people became infected with *lombrices* and *amebas* fell into the basic categories of things people do and things people eat or drink. These responses agreed generally with the previously described results from the HHHQ which examined parasite acquisition as a product of hygiene and dietary related behaviors. Informant responses were almost equally divided on the idea that worms were obtained from things people do and things people eat (Table C12). More infected households expressed the belief that worm infections resulted from the things people ate. The qualitative

nature of the data did not permit statistical analysis, but this difference does not appear to be intuitively significant. *Ameba* infections were also largely believed to be acquired from things people ate (Table C13). Infected households and outside comparison households shared this belief, although uninfected households were equally divided on the concept (Table C13). Again, the qualitative nature of the data was not amenable to statistical testing of this difference.

Informant responses of how parasitic infections are associated with eating too much candy indicated that many of the reasons for this belief are reasonable, and classification of this concept as a folk-related belief is perhaps unjustified. Informants in all household groups responded affirmatively that children become infected with worms from eating too much candy (Table C14). Acceptance of this belief was pronounced among the informants from infected households, and less so in the uninfected households. Many informants expressed the idea that candy suppressed the children's appetite and compromised their nutritional status, or that they were not interested in eating nutritious food (Table C14). These children are perceived to be not as healthy as other children, and therefore more susceptible to parasitic infection. Other informants recognized that children were more likely to consume their candy treats without proper hand-washing, or that the candy was contaminated when obtained unwrapped from street vendors.

Symptoms of Parasitic Infections

Household recognition of the symptoms associated with parasitic infection was tested with 12 questions on the HHHQ. Informants from additional households were asked to describe the symptoms associated with helminth and protozoan infections in two separate questions on the MHPQ. The symptoms listed on the HHHQ were derived from several sources. Limited interviews with Tamaulipas residents who submitted fecal samples for endoparasite diagnostic evaluation at a free public health clinic sponsored by Remote Area Medical was one source of parasite symptom information. Open-ended interview sessions conducted during a pilot study of the association of the Hispanic folk-illness *empacho* with endoparasitic infection also resulted in a list of symptoms parents use to identify parasitic infections in children (Faulkner et al. 1994). Previously published KAP research on parasitic infections, and diarrheal disease, and clinical

parasitology textbooks, were also consulted (Beaver et al. 1984; Escobar et al. 1983; Kamunvi and Ferguson 1993; Rousham 1994; Scrimshaw and Hurtado 1988; Stapleton 1989).

The 12 symptom-related questions from the HHHQ were classified according to two analytical categories: pathognomonic symptoms that are obviously related to a disease state, and symptoms that are connected with a disease state based on the intuition of a parent or caregiver. Pathognomonic symptoms included vomiting, diarrhea, poor weight gain, abdominal distention (operationally defined as hard/swollen stomach), abdominal cramping (operationally defined as stomach ache), and scratching the buttocks and perianal area. Many of these symptoms have been physically linked to parasitic infection through experimental research which provides an understanding of their physiologic and metabolic basis. Infections with roundworms, *A. lumbricoides*, may produce cramping, vomiting, and a distended abdomen if the worm burden is high and the child is nutritionally impaired (Beaver et al. 1984). The relationship between intestinal ascariasis and impaired growth is well established (Beaver et al. 1984). Infections with the intestinal flagellate protozoan *G. lamblia* are often associated with diarrhea and abdominal cramping (Beaver et al. 1984). Individuals may also loose weight from dehydration and malabsorption of nutrients associated with the diarrhea (Beaver et al. 1984). Intense anal itching and scratching the perianal tissues is associated with human pinworm infections with *E. vermicularis*. The adult female pinworm crawls from the anus of the infected host to deposit her eggs on the perianal surface. Antigenic stimulation of the host tissues by uterine secretions from the adult worm provokes the scratch response and characteristic symptoms of infection. Symptoms that are linked to parasitic infection based on the experience and intuition of the parent or caregiver included restless sleep, grinding teeth, poor appetite, excessive hunger, excessive salivation, and crying often. These symptoms are generally associated with a perceived deviation from a normative health state based on the mother or caregiver's prior experience. From this perspective, definitions of normative and diseased health states are based on qualitative characteristics shared by a reference group of the parent or caregiver's peers rather than measurable physical characteristics like elevated body temperature and increased frequency and volume of watery stools (Fabrega 1981). Some behavioral characteristics like grinding teeth, fretful sleep, and poor appetite have been linked to human

pinworm infection. However, these symptoms could also result from psychosocial anxiety. In this case, they would be indicators of an emotional rather than physical departure from a normative health state.

Vomiting was recognized as a symptom of parasitic infection by informants from infected households. Uninfected households were less inclined to view this as a characteristic symptom (Table C15). Uninfected households exhibited a comparatively more ambiguous pattern of agreement and many informants did not know if vomiting was a symptom of parasitic infection (Table C15). Households in all comparison groups agreed that diarrhea is a symptom associated with parasitic infection. Infected households and outside comparison households exhibited similar patterns of agreement (Table C15). This was less pronounced in uninfected households who accounted for a higher percentage of individuals who did not know about diarrhea and the association with parasitic infection than any other group. All households believed that a child that does not gain weight may be infected with parasites. Adherence to this belief was more pronounced among infected households (Table C15). A hard or swollen stomach was not universally recognized as symptomatic of parasitic infection. Infected and uninfected households shared similar opinions of this characteristic as a symptom (Table C15). Stomach ache was widely acknowledged as a symptom of parasitic infection. Approximately 80% of households in each comparison group answered affirmatively (Table C15). Infected and uninfected households strongly agreed that children who scratch their buttocks are infected with worms (Table C15). Fewer households in the outside comparison group answered affirmatively, but the percentage of households who agreed that this behavior was symptomatic was greater than 70% (Table C15).

Restless sleep was recognized as symptomatic of parasitic infection by infected households (Table C16). Uninfected households exhibited an ambiguous pattern of agreement with almost equal numbers of affirmative and don't know responses. All households agreed that when children grind their teeth at night (in their sleep) they are probably infected with worms. Approximately 80% of informants in each comparison group responded affirmatively on this symptom (Table C16). There was general agreement among households that a poor appetite may indicate parasitic infection in children. This pattern of agreement was more pronounced among infected households, and less so in uninfected households (Table C16). Infected households were also more inclined to believe that parasitic infections are associated with

children who are hungry all the time and *eat much food* (Table C16). This belief was less pronounced in uninfected households (Table C16). Responses among the uninfected households were divided between individuals who thought this behavior was symptomatic and those who did not know. Infected households agreed with the statement that parasitic infections may be associated with children who salivate (or drool) often (Table C16). Uninfected households were split on this symptom with approximately equal numbers of informants responding affirmatively or did not know (Table C16). Frequent crying as a symptom of parasitic infection also yielded a pattern of ambiguous agreement among uninfected and infected households. Responses of informants were divided between those who agreed, disagreed, and did not know (Table C16). Infected households were less inclined to reject frequent crying as a symptom (Table C16). Households in the outside comparison group, however, were more inclined to accept this as a symptom with approximately 53% of informants responding affirmatively (Table C16). This tendency was not statistically significant ($p = .24$, 2 *df*).

Symptoms for infection with parasitic helminths and amoebae compiled from the open-ended interview format of the MHPQ are listed in Table C17 and Table C18. Both lists are strikingly similar. Approximately 60% of the symptoms are classified as general gastrointestinal complaints. Stomach ache, diarrhea, and vomiting are the chief symptoms for helminth infection (Table C17). Infection with amebas is similarly diagnosed with the exception that stools with blood or mucous take precedence over vomiting (Table C18). Helminth infections are also differentiated by their association with causing children's noses to itch, excess salivation, and high blood pressure (Table C17). Amoebae infections also cause their victims to be without strength, easily startled, and are often fatal (Table C18). Infected children also have restless sleep, and grind their teeth. In general these results corroborate the previously described symptom profiles obtained with the HHHQ. Symptoms like diarrhea, vomiting, and stomach ache are conspicuous in their association with parasitic infection. Fever, head ache, seizures, and death are manifestations of advanced visceral amebiasis (Beaver et al. 1984). It is likely that the serious nature of this clinical syndrome underlies its recognition among household informants. Other symptoms like grinding teeth, restless sleep, and excessive salivation are associated with parasitic infection based on experience and intuition of a parent or caregiver. The inclusion of these items in the responses to the open-ended questions

is further indication of their saliency as symptoms of parasitic infection among Valle Hermoso households, despite their ambiguous relation with a clinically defined disease state.

Treatment of Parasitic Infections

Household treatment of parasitic infection was examined with six questions on the HHHQ. Informants from additional households were interviewed with the MHPQ to compare and contrast their preference and use of pharmaceutical antiparasitic compounds and herbal based preparations for treating parasitic infections with respect to perceived efficacy and economic affordability. Informants were also asked to provide the primary source consulted in their household for information about curing parasitic infections, and recommendations they would offer a relative or neighbor if their advice were sought.

Informants in all household comparison groups agreed that there were many effective medicines for treating parasitic infection (Table C19). This belief was most pronounced in uninfected households with over 90% of informants responding affirmatively. Opinion among households was divided on the efficacy of pharmaceutical antiparasitic compounds compared to herbal preparations with antiparasitic activity (Table C19). Although many households believed that the herbal preparations obtained from the *mercado* (a traditional market where vendors sell from small stalls) were as effective as pharmaceutical compounds, an almost equal number of households disagreed, and others simply did not know. Most households agreed that pharmaceutical antiparasitic compounds were expensive for most families to purchase. This belief was most pronounced in uninfected households (Table C19). Although most informants from infected households believed that pharmaceutical compounds were expensive, an almost equal number disagreed (Table C19). Informants in all comparison groups acknowledged that there was a difference in the price of herbal based remedies and pharmaceutical compounds (Table C19). Household informants also recognized that helminths and *amebas* were treated with different drugs (Table C19). There was a high degree of consensus among informants that it was necessary to treat all persons in the household in the event that one person was diagnosed with parasitic infection (Table C19).

Household informants interviewed with the MHPQ demonstrated a clear preference for pharmaceutical antiparasitic compounds over herbal based alternative preparations (Table C20).

Informants in each comparison group were able to provide the names of specific antiparasitic medications for treatment of infections with helminth and protozoan species (Table C20). Herbal remedies with antiparasitic activity were also named by informants from infected and uninfected households (Table C20). The reasons for the preference of pharmaceutical compounds were similar for all household groups. Confidence in the ability of doctors to prescribe safe and effective medicines accounted for approximately 35% of all responses (Table C21). Additional reasons included the superior efficacy of pharmaceuticals to remove all of the parasites, and the safety of the compounds (Table C21). Other household informants stated a preference for herbal alternatives based on personal experience (Table C22). The belief that pharmaceutical compounds were expensive for most families to purchase was also affirmed by informants in each household comparison group (Table C23). Most informants in the outside comparison group believed that pharmaceutical antiparasite medications were affordable. However, this pattern was reversed for infected households. Many informants recognized that the increased efficacy of the compounds made them a cost effective purchase despite their expense (Table C23). Household informants in all comparison groups utilized the services of a doctor or health professional at the *Centro de Salud* or IMSS for obtaining information about curing parasitic infections (Table C24). Knowledgeable family members and neighbors were also consulted for advice. Most households acquired antiparasitic medications from government operated health facilities at the *Centro de Salud* or the IMSS clinic (Table C25). Medications obtained from these facilities are often available *gratis* or for a nominal fee. Some households elected to purchase their antiparasitic medications from local *pharmacias* or *boticas*. All of the antiparasitic compounds listed in Table C20 are available *over-the-counter* in Mexico; however, these households would be required to pay the full purchase price for their medications. This pattern of health care utilization was also apparent in the recommendations informants reported they would offer a neighbor or relative if their advice were sought for curing parasitic infections (Table C26). Although most informants would advise their relative or neighbor to seek assistance from a doctor or medical professional at the *Centro de Salud*, approximately 20% of the recommendations were based on prior personal experience and involve diagnosis and treatment outside of formally defined medical channels.

Prevention of Parasitic Infections

Eight questions on the HHHQ were used for examining knowledge and beliefs on household prevention of parasitic infections. Informants from additional households were interviewed with the MHPQ to collect detailed knowledge on the widespread belief that prevention of parasitic infections in children is impossible. Informants were also asked to provide recommendations they would offer a relative or neighbor for prevention of parasitic infection if their advice were sought.

Prevention of parasitic infections is possible with a rudimentary understanding of the mechanisms by which the infective stage parasites are transmitted to susceptible individuals in the host population. Questions contained in this section of the HHHQ tested household awareness of basic personal and food hygiene measures such as hand washing, and treatment of drinking water, and consumption of clean, well prepared foods as methods for preventing parasitic infections. These questions were rephrased from preventive measures outlined in pamphlets and posters distributed in connection with government anti - cholera campaign. The statement *es impossible a impedir infecciones parasitos en niños* (it is impossible to prevent parasitic infections in children) was intended to probe household informants to find out if they believed that they were powerless or in control of their health status, at least with regard to endoparasitic infection. Elsewhere, investigators of human health behavior have hypothesized that persons living in the midst of endemic infectious diseases exhibit a tendency to believe that they are powerless to prevent infection with parasitic, bacterial, and viral agents (Coreil and Marshall 1982; Logan 1991; Patrick 1993). Understanding the basis of this belief and its intra-cultural distribution would be helpful to increasing household compliance with public health interventions intended to reduce infectious diseases.

Households in all comparison groups believed that parasitic infections in children were preventable. This belief was most pronounced in uninfected households where 60% of informants disagreed with the statement *it is impossible to prevent parasitic infections in children* (Table C27). The disparity between informants who agreed and disagreed with this statement was much narrower among infected households (Table C27). However, patterning in the distribution of this belief was not statistically significant among household comparison groups ($p = .56$, 2 *df*). Households in all comparison groups recognized that children are at increased risk for parasitic infection when they play outside in the dirt

(Table C27). Hand washing with soap was widely recognized as an effective intervention to prevent parasitic infections (Table C27). Reducing contact with animals was also accepted as a effective method for preventing infections (Table C27). All household comparison groups recognized that drinking water can be made safe for consumption by boiling or the addition of a small amount of chlorine bleach (Table C27). Households in all groups disagreed with the statement that consumption of clean, well prepared food was linked to parasitic infection (Table C27). There was universal agreement among households that good hygiene will prevent parasitic infections and other illnesses (Table C27).

Household informants interviewed using the MHPQ were also asked if they agreed or disagreed with the statement that *it is impossible to prevent parasitic infections in children.* Disagreement was pronounced among uninfected households who believed that parasitic infections in children were preventable. However, opinion was divided among infected households where 43% of informants agreed that prevention of parasitic infection in children is impossible. This pattern of agreement was similar to that obtained with the HHHQ (Table C27). As a follow-up to their response, informants in all household comparison groups were asked why they agreed or disagreed that it is impossible to prevent parasitic infections in children. Households answering affirmatively, that prevention is impossible, recognized that the infective stages of parasitic species are everywhere and one has little control over contact with them (Table C28). Secondly, informants recognized that they have little control over the behavior of children once they are outside of supervision (Table C28). Thus, parasitic infection is an inevitable consequence of life.

Household informants that disagreed with the belief that prevention of parasitic infection in children is impossible provided a variety of reasons why this statement was not true in their opinion (Table C29). Two lines of reasoning were evident in the informant's approaches to preventing parasitic infections. One approach advocated drug intervention for preventing clinical disease. Accordingly, these informants maintain that *parasites can be prevented only through medication*, or that they are controlled by *attending to it in time and treating every six months* (Table C29). From the other perspective, prevention of parasitic infection is largely a matter of hygiene (Table C29). These informants recognize that *a clean house*, *hand washing before meals*, and *teaching the children to be careful* will enable one to prevent infections (Table

C29). Although the qualitative nature of these data preclude statistical testing, superficially it appears that these contrasting approaches are associated with household infection status. Approximately 65% of all responses were hygiene oriented among uninfected households. In contrast, therapy oriented measures dominated the responses of infected households (Table C29).

Informants in all household comparison groups recommended that relatives and neighbors consult the doctor or other members of the medical community for advice on the prevention of parasitic infection (Table C30). Hygiene related preventive measures accounted for 65 and 63% of recommendations given by infected and uninfected households, respectively. Informants also recommended using the same medicines as prescribed on the previous visit, or medicines that they had personal experience with. Although these recommendations only accounted for 11% of all responses, it is further indication of an alternative pattern of health seeking behavior among Valle Hermoso residents. These individuals, it is presumed, would be inclined to diagnose and treat parasitic infections within their households and not resort to services provided through formal medical channels.

CHAPTER 7

LOCUS OF ILLNESS CONTROL

Introduction

Household informants in 1994 and 1995 were interviewed with a Spanish translation of Coreil and Marshall's (1982) *Locus of Illness Control* (LIC) instrument. The purpose of this analysis was to obtain information from Valle Hermoso informants about their beliefs on illness prevention and cure. The general nature of the questions contained in the LIC instrument were expected to provide quantitative data on the health-related perceptions of Valle Hermoso households that would be free of bias stemming from inquiry into household hygienic behaviors and their association with cholera prevention and parasitic infection. This phenomenon has been described as *courtesy bias* (Bhattacharyya 1997). Interview data collected in the context of public health intervention programs that include health education components are recognized as being especially susceptible to this form of bias because informants are often afraid of being scolded for not providing correct answers (Bhattacharyya 1997).

To briefly review, the LIC attempts to discriminate two basic personality types and their associated health related behaviors. The personality types designated as *internal* and *external* refer to the way(s) in which individuals intuitively predict and perceive the outcomes of health-related events resulting from particular decisions, actions, and behaviors. Internally oriented individuals see their health as the product of their own decisions, actions, and behaviors. They are presumed to actively engage in behaviors that prevent illness. In contrast, externally oriented individuals percieve their health as something that is largely beyond their control. The health-related consequences of their decisions, actions, and behaviors are the result of fate, chance, luck, and the interventions of powerful others. In some culture settings these may be conceptualized as deities, saints, malevolent spirits, and sorcerers.

Analysis of Variance

Mean LIC scores for the *illness cure* and *illness prevention* subscales and the total LIC scale were similar for control, infected and uninfected households (Table D1). All LIC mean scores (*illness cure*, *illness prevention*, and combined total) were slightly below the approximate mid-point of the range of possible scores (Table D1). These scores indicate a general tendency toward the internal dimension, or beliefs that illness prevention and cure are largely a matter of personal decisions, behaviors, and activities. Control and infected households had slightly higher mean scores for *illness prevention* and the combined total. Infected and uninfected households were approximately equal on the *illness cure* subscale. However, none of the variation in the mean scores for the *illness prevention* subscale, and the total LIC or median scores for the *illness cure* subscale, was statistically significant (Table D1).

Variation in the mean and median LIC scores was also minimal across the different age classes of household informants. Once again mean scores on the prevention, and cure subscales, and the combined total were just below the approximate mid-point of the range of possible scores, and indicate an internal orientation for the informants (Table D2). Scores on the prevention subscale were slightly higher for older informants in the 44 to 70 year age class, and lowest for informants in the 18 to 25 year age class. This pattern was reversed on the cure subscale where younger informants had the highest score. These slight variations in mean and median score, however, were not statistically significant (Table D2).

Mean and median LIC scores also showed no appreciable variation relative to the informants ability to recall cholera preventive measures from memory (Table D3). The mean and median score for the *illness prevention*, and *illness cure* subscale, and the total LIC was below the middle of the range of possible scores. Variation in the LIC scores was not statistically significant (Table D3). As noted above, these scores fall within the limits of the internal dimension of the LIC scale and indicate that illness prevention and cure are largely a matter of personal responsibility for this population.

The mean and median LIC scores of the informants were also similar irrespective of their *colonia* of residence (Table D4). All LIC scores were below the middle of the range of possible scores, and associated with the internal dimension. Slight variations in the mean and median scores between the different *colonias* were not statistically significant (Table D4).

The internal orientation of the population on the illness cure and prevention subscales is clearly evident in the item by item comparison of the LIC scale. Informant scores fall within the range of the internal dimension (≥ 1 and < 2) for five of the six items on the illness cure subscale. An external orientation is indicated only for item 12 where the majority of informants (78%) share the belief that the ultimate outcome of an illness event is, at least sometimes, largely a matter of God's will. Informant scores on the prevention subscale similarly fall in the internal range of the scale for six of nine of the items. The external dimension is indicated only for statements 5, 8, and 13. Overall, this pattern of variation is consistent throughout the population, irrespective of the various household comparison group affiliations imposed by this analysis (Tables D5 through D9).

When household infection status was examined as the independent variable in the item by item analysis of the LIC, the Kruskal-Wallis single factor nonparametric ANOVA failed to detect any difference in the median score of the informants (Table D5). All p-values are greater than .05 (Table D5).

In the analysis of the LIC scale by age class only items 4 and 6 had statistically significant differences in median score (Table D6). Although the mean score for all age classes fell within the possible range of internal dimension scores, older informants (between 44 and 70 years) scored higher, and closer to the external dimension than the other age groups. Dunn's multiple comparison procedure indicated that the only the median scores for the 18 to 25 and the 44 to 70 year age classes were significantly different ($p < .05$, 3 *df*). All other comparisons between age classes were essentially equal. For item 6 the reverse situation applies and younger informants in the 18 to 25 year age class scored at the external end of the continuum. When the differences in median score for item 6 were examined with Dunn's test, only the scores for the 18 to 25 and 33 to 43 year age classes were significantly different ($p < .01$,1 *df*) (Table D6).

Analysis of the LIC scores according to number of the cholera prevention measures informants were able to recall yielded statistically significant results only for items 5, 11, and 15 (Table D7). The mean score for item 5 was within the range of the external dimension for all classes of informants irrespective of their ability to recall any cholera preventive measures. However, informants who were unable to list any cholera prevention measures had a higher score on the external continuum. Dunn's multiple comparison test indicated that the only statistically significant difference in median score was

between informants who were unable to list any preventive measures and informants who were able to list two measures for cholera prevention (p =.02, 3 *df*). All other comparisons in the median score for item 5 were essentially equal. The median score for item 11 was statistically significant. All scores were within the range of the internal dimension. Informants who were unable to list any cholera prevention measures scored lower on the internal continuum (p < .05, 3 *df*). Variation in the median scores for item 15 was also significant. All scores for item 15 were within the range of the internal dimension. Informants who were unable to list any preventive measures scored lower on the internal continuum than any other household comparison group (p = .04, 3 *df*).

Informant variation in the median LIC score was significant for items 4, 5, 6, and 14 when the *colonia* of residence was used as the independent variable in the Kruskal-Wallis ANOVA model (Table D8). Overall, the scores for each of the LIC items follow the same pattern of internal and external orientations as for the other analyses. Six of eight *colonias* share an internal orientation on item 4. However, *Los Vecinos* and *La Liberdad* stand out as the only two *colonias* with scores on the external dimension. *Los Vecinos* has the higher score on the external continuum (Table D8). The score for *La Liberdad* actually represents an even split between the internal and external dimensions. Dunn's multiple comparison test indicated that the score for *Los Vecinos* was significantly higher than scores for *Los Indios* (p < .05, 7 *df*), and *Fuente de Suerte* (p < .01, 7 *df*) (Table D8). All other comparisons between *colonias* for item 4 were essentially equal.

All *colonias* were externally oriented for item 5. *La Corona* had the highest score on the continuum (Table D8). However, the median score for this *colonia* was not significantly different from the other *colonias* when compared with Dunn's test (p > .05, 7 *df*). Item 6 scores were on the internal dimension of the LIC for all *colonias* (Table D8). *Los Vecinos* had the lowest score, and *Sal Si Puedes* had the highest. Scores for these colonias were not significantly different when compared with Dunn's test (p > .05, 7 *df*). Scores for item 14 were similarly oriented on the internal dimension (Table 7.8). *Los Indios* had the highest score. *Sal Si Puedes* and *La Liberdad* had scores at the extreme end of the internal continuum. Differences in the median score between the *colonias* for item 14 were not statistically significant (p > .05, 7 *df*).

Factor Analysis

The LIC data were partitioned into three data matrices; outside comparison households who did not provide fecal samples for parasitologic analysis, infected households, and uninfected households. Each matrix was analyzed separately using the factor analysis multivariate procedure with the SAS (Carey, NC) software package for the personal computer.

The outside comparison households were analyzed with a six factor model that accounts for 73.53% of the cumulative variation expressed in the informant's responses on the 15 item LIC instrument. Eigenvalues and the percent of variation in LIC scores accounted for by each of the 6 factors prior to rotation are presented in Table D9. Six distinct clusters of relationships between items on the LIC instrument are apparent in the varimax rotated factor matrix (Table D10). In contrast to the unrotated factor matrix, each factor in the rotated matrix is independent of the other factors, and no significance is attached to the ordering of the factors (Rummel 1967:466-467). Thus, from a theoretical perspective, each factor is equally influential in defining the constellation of illness control concepts shared by the households. The resulting picture is akin to a six dimensional projection of the important underlying concepts used by Valle Hermoso households to explain the presence and absence of illness, and the options available for treatment of sick individuals.

Factor 1 is dominated by high positive loading on items 12 and 5 (Table D10). Both items have external directionality. Item 12, a cure subscale item, expresses the belief that illness cure is largely a matter of divine intervention, or God's will (or purpose) (Table D10). Item 5, a prevention subscale item, expresses the belief that there are persons who are sick all of the time, while others are never sick (Table D10). Factor 2 is loaded primarily on item 3, a cure subscale item with internal directionality, and secondarily on item 13 a prevention subscale item with external directionality (Table D10). Essentially this factor affirms that although almost all diseases have a cure, there is no use in worrying about illness, if you are going to have one it will occur. Factor 3 is loaded, almost equally, on items 7 and 14. Both are prevention subscale items with external directionality. These items express the belief that illness prevention and susceptibility are primarily a matter of luck and outside of one's personal control. Factor 4 is characterized by positive loading on items 2, 8, and 15. Items 2 and 8 are prevention subscale items with

internal and external directionality, respectively. Item 2 is the dominant variable and affirms that illness avoidance can be achieved by following a lifestyle according to God's commandments. According to item 8, illness susceptibility is the result of living under a lot of pressure, interpreted literally as working too much. Item 15 is a cure subscale item, with internal directionality. This item recognizes that most illnesses are curable by skilled doctors with the proper medicines. Factor 5 is defined by the positive loading on item 9, a cure subscale item with internal directionality. This item also affirms the curative role of modern medical science. Factor 6 is also defined by a positive loading on a single item. Item 6 is a cure subscale item with external directionality. Item 6 expresses the belief that the majority of illnesses will be cured even without treatment.

Taken as a whole, the dominant theme expressed by these results is that illness susceptibility and avoidance are largely under the control of external forces outside of one's personal decisions, actions, and behaviors. Externality is emphasized in five of the six factor weights associated with the prevention subscale. The importance of luck as an influential force in illness susceptibility is especially apparent in the high positive loading on Factor 2. Illness cure, in contrast, is viewed as a domain in which one has considerable control. Internality is expressed in three of the five factor weights associated with cure subscale items. Faith in the ability of science and medicine to cure disease is evident in the high loading on Factor 5. However, externality in illness cure is also strongly expressed in Factor 1. The belief that God has the final word in the resolution of illnesses is not a surprise, given the prominent spiritual roles God and the Roman Catholic Church share in the daily lives of many Mexican households.

The illness cure and prevention concepts of infected households are characterized by a six factor model that accounts for 72% of the cumulative variation expressed in LIC responses on the 15 item instrument. Eigenvalues and the percent of variation in LIC scores accounted for by each of the six factors prior to rotation are presented in Table D11. Six distinct clusters of relationships between items on the LIC instrument are apparent in the varimax rotated factor matrix (Table D12).

Factor 1 is dominated by high positive loading on items 7, 14, and 12 (Table D12). All items have external directionality. Items 7 and 14 are prevention subscale items which express the belief that illness avoidance and susceptibility is primarily a matter of luck (Table D12). Item 12 is a cure subscale item

presenting the concept that illness cure is largely a matter of divine intervention, or God's will (or purpose). Factor 2 is loaded primarily on item 4, 5, and 13 (Table D12). All are prevention subscale items with external directionality (Table D12). Essentially this factor affirms the belief that if God wants to send an illness, people are powerless to avoid it. It also maintains that worrying about illness is a fruitless enterprise because it is a natural state which affects all people irrespective of their best prevention efforts. This latter point is evident in the loading of item 5 where "some people are sick all of the time, and others are never sick". Factor 3 is loaded on item 9, a cure subscale item with internal directionality (Table D12). This item expresses the optimism that modern medicine, or science, will find cures for all health problems. Factor 4 is loaded on item 8, a prevention subscale item with external directionality (Table D12). Accordingly, people are at increased risk for illness when they live under much pressure or work too hard (Table D12). Factor 5 is defined by loading on items 3, and 15 (Table D12). Both items are part of the cure subscale, and exhibit internal directionality (Table D12). Both items are mirror images and express the belief that most diseases can be cured. Factor 6 is loaded on items 6 and 2 (Table D12). Item 6 is a cure subscale item with external directionality, and item 2 is a prevention subscale item with internal directionality. Item 6 is the dominant variable and expresses the belief that the majority of illnesses will be cured even without treatment. Item 2 affirms that illness avoidance can be achieved by following a lifestyle according to God's commandments.

The primary concept shared by infected households is that illness susceptibility and avoidance are largely controlled by external forces outside of one's personal decisions, actions, and behaviors. Six of the seven factor weights associated with the prevention subscale exhibit externality. Luck is viewed as an influential force that underlies wellness and increases illness susceptibility. However, these households acknowledge that individuals have considerable control over illness cure. Three of five factor weights associated with cure subscale items exhibit internality. As noted for the outside comparison households, externality in illness cure is expressed in the belief that God has the final word in the resolution of illnesses.

The illness prevention and cure beliefs of uninfected households were also characterized by a six factor model that accounted for 73% of the cumulative variation expressed in the informant's responses on the 15 item LIC instrument (Table D13). Six distinct clusters of relationships in the LIC responses of these

households are apparent in the varimax rotated factor matrix (Table D14). Each of the six factors is assumed to be equally influential in the illness control concepts shared by uninfected households.

Factor 1 is dominated by high positive loading on items 7, 14, and 12 (Table D14). All items have external directionality. Items 7 and 14 are prevention subscale items which express the belief that illness avoidance and susceptibility is primarily a matter of luck. Item 12 is a cure subscale item presenting the concept that illness cure is largely a matter of divine intervention, or God's will (or purpose) (Table D14). Factor 2 is characterized by loading on items 9 and 3 (Table D14). Both are cure subscale items with internal directionality. Item 9 expresses the optimism that all diseases will eventually be cured by modern medical science. Item 3 affirms that almost all disease can be cured. Factor 3 is loaded on items 11 and 3 (Table D14). Both items are associated with the prevention subscale and have internal directionality. This factor reflects the belief that illness prevention is under one's personal control. Factor 4 is loaded on cure subscale items 1 and 15 (Table D14). Both items have internal directionality. Item 1 affirms that individuals have many treatment options for curing illness. Item 15 recognizes that most diseases can be cured by good doctors with appropriate medicines. Factor 5 is dominated by loading on items 8 and 5 (Table D14). Both items are from the prevention subscale and have external directionality. Item 8 attributes illness to living under too much pressure, or working too hard. Item 5 acknowledges that some people are sick all of the time, while other are never sick. Factor 6 is defined by a single item on the cure subscale with external directionality (Table D14). Item 6 expresses the belief that most illnesses will be cured on their own even when no treatments are used.

In general, the illness control concepts shared by uninfected households are similar to those of the outside comparison and infected households. Illness susceptibility and avoidance are perceived as the being under control of external forces outside of one's personal decisions, actions, and behaviors. Four of the six factor weights associated with the prevention subscale exhibit externality. Luck is viewed as an influential force that underlies wellness and increases illness susceptibility. Uninfected households, however, stand in contrast with the outside comparison and infected households on Factor 3 which acknowledges that individuals do indeed have control over illness prevention (Table D14). The dominance of this factor by the loading on item 11 is not found in the six factor models for other households.

Uninfected households are also similar to other households with respect illness cure concepts. Four of six factor weights associated with cure subscale items exhibit internality. As noted for the outside comparison and infected households, externality in illness cure is expressed in the belief that God has the final word in the resolution of illnesses. To reiterate from the previous discussion, this belief is not surprising given the prominent spiritual roles God and the Roman Catholic Church share in the daily lives of many Mexican households.

CHAPTER 8

DISCUSSION

Introduction

This research was undertaken to investigate the relationship between endoparasitic infection and acknowledged knowledge and use of cholera prevention measures in Valle Hermoso households. Endoparasitic infection was assumed to be an appropriate indicator of household compliance with the Mexican government's cholera prevention initiative because infection with many endoparasite species results from improper hygienic behavior, such as inadequate hand-washing before meals and after defecation, eating improperly washed fruits and vegetables, and promiscuous defecation habits. Uninfected households were hypothesized to be comparatively more attuned to illness prevention, and health management would be based on increased familiarity and faithful compliance with anti-cholera measures promulgated by the government. Infected households, in contrast, were expected to be less attuned to illness prevention and household health would be managed therapeutically on a case by case basis.

Data to evaluate these hypotheses were obtained through microscopic analysis of fecal samples from children in cooperating households for diagnostic stages of intestinal parasites. The results of this analysis were collated with the results of structured interviews conducted with the primary caregiver of each household to obtain information on household knowledge and use of cholera prevention measures, and information on the recognition, treatment, and prevention of parasitic infections in children. Additional information on the beliefs of household informants about illness prevention and cure was obtained with a Spanish translation of the *Locus of Illness Control* survey instrument developed by Coreil and Marshall (1982). Taken as a whole, these analyses permit one to subdivide the population of cooperating Valle Hermoso households and compare the prevalence of endoparasite infection with respect to:

1. the personal habits of the informants,
2. the age/gender compositions of their children,
3. variation in the immediate recall and acknowledged use of cholera preventive measures,

4. differing degrees of knowledge regarding the acquisition, diagnosis, treatment and prevention of parasitic infections, and
5. variation in beliefs about illness prevention and cure.

The salient points resulting from these analyses are briefly discussed below under their respective headings.

Parasitological Analysis

Fecal samples from 30% the children were positive for one or more endoparasitic species. Parasites capable of producing clinical disease accounted for approximately 20% of the infections. *Giardia lamblia*, the flagellate protozoan associated with diarrheal disease, was the most ubiquitous of the pathogenic species, with an occurrence of 12.5% in the children's fecal samples. The comparatively lower prevalence of infections with *Ascaris lumbricoides*, and *Trichuris trichiura* probably reflects the effect of suppressive targeted chemotherapy for school age children 5 years and greater. Although fieldwork to collect the fecal samples was scheduled to allow children sufficient time to develop patent infections with *A. lumbricoides* and *T. trichiura,* the long-term effect of suppressive drug therapy would be a net reduction in the number of infective eggs available in the environment for reinfecting new hosts. The prevalence of infection with the nonpathogenic protozoan species such as *Entamoeba coli*, *Ent. hartmanni*, *Endolimax nana*, and *Iodamoeba büetschlii*, and the nonpathogenic tapeworm *Hymenolepis nana* indicate the persistence of inadequate hygienic behavior. The prevalence of these species was not impacted by the three annual treatments of albendazole used in the school chemotherapy program because the drug is not effective against the parasites, and they are typically not targeted for treatment in the medical sector because they are not associated with clinical disease. Infected children were significantly older (Table B3) and almost 3 times more likely to have an infected sibling (Table B5) than children from uninfected households. *H. nana* and *Ent. hartmanni* were significantly associated with older children (Table B4). *A. lumbricoides*, *H.. nana*, *G. lamblia*, and *Ent. coli* were significantly correlated with the presence of an infected sibling in the household (Table B7).

Approximately 36% of households had one or more infected children (Table B11). Households with three or more children were nearly five times more likely to have an infected child compared to households with two and fewer children (Table B8). Infected households were found in all *colonias* (Table

B11). With the exception of *G. lamblia*, there were no significant associations in the distribution of particular parasites species with particular *colonias*. However, children from *Los Vecinos* were approximately two times more likely to be infected with *G. lamblia* than children of other *colonias* (Table B12).

The endoparasitic species identified in this study are broadly considered hygiene related parasites because of their ubiquitous association with poor sanitation and crowded living conditions. The lifecycle biology, epidemiology, and public health significance of these species are briefly discussed below as a contextual reference point for orienting the results of this investigation with other studies of human parasitism in Latin America.

All of the endoparasitic protozoan species identified in the Valle Hermoso fecal samples are commonly acquired by consumption of fecally contaminated food and water. Their occurrence in an infected host is an important biological indicator of household hygienic behavior. *E. nana*, *I. büetschlii*, *Ent. coli*, *Ent. hartmanii,* and *Ent. histolytica* belong to family Endamoebidae which, with few exceptions, is exclusively composed of organisms parasitizing the alimentary tract of a variety of invertebrate and vertebrate hosts (Beaver et al. 1984). A distinctive feature of these organisms is the so called *amoeboid movement* of their trophozoite stages. All of these species multiply by binary fission, and their lifecycles include a trophozoite, precyst, cyst, and metacystic stage. All species have direct lifecycles and do not require an intermediate host prior to infecting the definitive or final host. The lifecycle biology for the nonpathogenic amoebae is similar to their pathogenic relative, *Ent. histolytica,* with the important exception that they do not digest away host tissue and invade the viscera. Additional comments on the pathogenic potential of *Ent. histolytica*, and its association with clinical disease, are addressed in a separate paragraph following the general discussion of the amoebae lifecycle biology.

The trophozoite is the actively feeding and replicating stage for all intestinal amoebae. Trophozoites live and multiply in the lumen of the large intestine, and apparently feed on mucosal secretions, yeast, starches, and other components of the intestinal flora (Schmidt and Roberts 1989). Encystment occurs when the trophozoites become incorporated in the feces of the host and are carried to the rectum. During encystment the organism passes through the precyst, cyst, and metacystic stages, and is finally passed in the feces of the infected host. The mature cyst is protected by a thin, tough hyaline cyst

wall secreted during the encystment process. Mature cysts are protected by the cyst wall and remain viable and infective in cool moist environments. The cysts are normally resistant to levels of chlorine used for water purification, and are said to retain their infectivity after passage through the intestine of flies and cockroaches (Schmidt and Roberts 1989). Recognition of this latter point has implications for transmission in human populations because these insects may be important transport hosts for moving infective cyst stages from fecally contaminated loci (latrines and bushes around the house) to food preparation and consumption areas in houses.

Ent. histolytica is the only intestinal amoebae associated with clinical disease. The disease, amebiasis, is characterized by an intestinal phase of mild to severe abdominal discomfort with periodic episodes of diarrhea and accompanying dehydration, and weight loss which can lead to serious incapacitation. The parasite is also unique among the other amoebae in its ability to perforate the intestinal wall and invade and colonize the viscera. Invasive amebiasis results from trophozoites entering the liver via the portal circulation. In the liver, the trophozoites feed on parenchymal tissue and multiply. Abscesses result from the extensive tissue destruction. Rupture of the abscess releases additional trophozoites into the peritoneal cavity where they attack other organs. Untreated amebiasis may be fatal. Extensive destruction of host liver tissue impairs bile synthesis and blood detoxification and often results in cardiac failure. Death may also occur from diarrhea and dehydration in children. Peritonitis produced by gut perforation, and secondary bacterial infections in other abscessed organs may also contribute to mortality caused by this parasite.

G. lamblia is a flagellate protozoan parasite that resides in the intestinal tract of humans and other mammalian hosts (Beaver et al. 1984). The parasite has a two stage life cycle that includes both a trophozoite and cyst stage. The life cycle is direct and does not require an intermediate host prior to infecting the definitive or final host. The trophozoite is the motile, feeding stage of the organism and attaches to the villi of the small intestine in the infected host by means of an adhesive sucking disk (Schmidt and Roberts 1989). The cyst is the dormant stage of the life cycle and is passed in the feces of the infected host. *Giardia* cysts are resistant to deterioration and may remain viable for several weeks in cold (but not frozen) wet environmental conditions (Beaver et al. 1984). Many cases of infection with *Giardia* are asymptomatic and often go undiagnosed, and untreated. These individuals continue shedding cysts in

their stools and serve as reservoirs for infecting other household members. Available evidence suggests that some individuals residing in hyper-endemic localities are capable of acquiring protective immunity to infection with the parasite (Istre et al. 1984). Other individuals, however, are more sensitive to infection and experience increased mucous production, severe and transitory diarrhea, dehydration, intestinal pain, flatulence, and weight loss (Beaver et al. 1984). In heavy infections, the absorption of dietary fats and nutrients may be impaired because of the dense coating of trophozoites on the intestinal epithelium (Beaver et al. 1984). Children in developing countries are particularly vulnerable to the adverse effects of giardiasis. In rural Guatemala, for example, it was found that the death rate resulting from diarrhea was 519 times greater than that in the United States for preschool age children per 1,000 population (M. Logan 1978). This high mortality rate can be attributed, in part, to traditional medical practices such as withholding food and liquids which serves to exacerbate harmful dehydration resulting from the diarrhea (M. Logan 1978). Thus, while giardiasis is generally not fatal in immunocompetent individuals, the presence of infection in traditional non-westernized settings may be an important cause of excess morbidity and mortality.

Prevalence rates for nonpathogenic intestinal protozoa are often published as an incidental finding in studies of childhood diarrhea and infection with other enteric pathogens. Chacin-Bonilla et al. (1993) reported the following rates in a random sample of families from a community in Venezuela: *E. nana* 17.4%, *I. büetschlii* 2.8%, *Ent. coli* 26.4%, and *Ent. hartmanni* 5.6%. Infection with *G. lamblia*, and *Ent. histolytica* was 15% and 18.9%, respectively (Chacin-Bonilla et al. 1993) . Sarti et al. (1992) reported similar rates in a community wide survey of families in Morelos, Mexico: *E. nana* 9.3%, *I. büetschlii* 17.2%, and *Ent. coli* 23.9%. Infection with *G. lamblia*, and *Ent. histolytica* was 5.4% and 4.2%, respectively (Sarti et al. 1992). Diaz-Camacho et al. (1991) reported prevalence rates of 26% for *G. lamblia*, and 8% for *Ent. histolytica* in a community in Sinaloa, Mexico. Vargas Mena et al. (1970[a], 1970[b]) reported prevalences of 14.8 and 20.6% for *E. nana*, 5.4 and 9.3% for *I. büetschlii*, 27.4 and 28.8% for *Ent. coli*, 14.0 and 17.6% for *G. lamblia*, and 15.6 and 14.8% for *Ent. histolytica,* in separate studies of parasitism in school children from *municipios* in the northern and eastern regions of Nuevo León. Flores-Castañeda et al. (1991) identified *Ent. histolytica* in 13.4% of examined fecal samples in a survey of older students (16 to 19 years) from the metropolitan area of Monterrey, Nuevo León. The prevalence of *Ent.*

coli was 13.2%, and *G. lamblia* was found in 4.3% of the students' fecal samples (Flores-Castañeda et al. 1991). Reports from state public health laboratories in the U.S. document the occurrence of these parasites in the U.S. (Kappus et al. 1994). Endoparasitic protozoa identified in the fecal samples analyzed in the U.S. are: *E. nana* 4.2%, *I. büetschlii* .6%, *Ent. coli* 4.2%, *Ent. hartmanii* 1.4%, *G. lamblia* 7.2%, and *Ent. histolytica* .9%.

The somewhat high prevalence figures documented for *Ent. histolytica* in the Mexican and other Latin American studies is controversial, and contrasts with the low prevalence observed in the Valle Hermoso samples. González Ruiz and Bendall (1995) noted that imprecise differentiation of *Ent. histolytica* from its nonpathogenic cousin *Ent. hartmanni* has resulted in overestimates of its prevalence in endemic countries such as Mexico and El Salvador. Further, they note that *E. hartmanni* was not reported in epidemiologic surveys until measurement of the cysts with an occular micrometer became a recognized diagnostic procedure (González Ruiz and Bendall 1995). Both species have cysts with 4 nuclei. The cysts of *Ent. hartmanni* are smaller and average 10μm in diameter (Garcia and Bruckner 1993). The nuclei also appear smaller in relation to the cyst and typically occupy less than ½ of the cytoplasmic interior of the cyst (Price 1994). In contrast, the cysts of *Ent. histolytica* average 12.5μm in diameter, and have larger nuclei which appear to occupy approximately ½ of the cytoplasmic interior (Garcia and Bruckner 1993; Price 1994). The WHO has recommended that calibrated occular micrometers be used for identification of the two species in routine diagnostic work (González Ruiz and Bendall 1995). In the Valle Hermoso survey *Ent. histolytica* and *Ent. hartmanni* were differentiated based on the size of the cyst measured with a calibrated occular micrometer, and secondarily with the morphologic characteristics of their nuclei.

The prevalence of *G. lamblia* in the Valle Hermoso samples is consistent with the results reported from the other Latin American surveys, and much lower than the prevalence noted for the study in Sinaloa. The prevalence of the other protozoan species in the Valle Hermoso samples is comparable to the figures reported from U.S. public health laboratories. The relatively low occurrence of infection with these hygiene-related parasites among Valle Hermoso households may be related to their increased access to piped water sources. Flores-Castañeda et al. (1991) suggested that the discrepancy between the lower prevalence of protozoan infections observed in their study and the higher figures noted by Vargas Mena et al. (1970[a], 1970[b]) can be partly explained by differential access to municipal water sources. The Vargas

Mena et al. (1970[a], 1970[b]) studies were conducted in rural communities of Nuevo León 20 years earlier when access to potable water and other sources of household water was much more limited.

Abundant and accessible water supplies are linked to health through consumption of potable water that is free of fecally transmitted microorganisms, and increased hand-washing before meal preparation, eating, and following defecation. Guerrant et al. (1996) commented on the complex relationship between water and health. He noted that improved water supplies and sanitation often resulted in 18 to 37% percent reductions in diarrheal disease morbidity (Guerrrant et al. 1996). Additionally, citing work by Hughes (1983), he noted that studies of diarrheal diseases and water use suggested that individuals and households using between 20 to 30 liters of water per capita per day have lower diarrhea associated morbidity.

Limited access to water for consumption and hand-washing is a continuing problem for the occupants of *colonias* at the edge of sprawling municipal centers like Ciudad Juarez, Matamoros, and Reynosa in the U. S.-Mexico border region (Hearn 1993; Warner 1991). Chech and Essman (1992) documented fecal contamination of the regional groundwater in Juarez, Mexico at the upper end of the Rio Grande. They suggested that sewage contaminated water is probably the major source of pathogenic bacteria, protozoa, gastrointestinal helminths, and enteric viruses for the human population on both sides of the U.S. Mexican border. The higher prevalence of Hepatitis Type A antibodies in the U.S. border population (18.3 per 100,000 population) which is nearly double the infection rate of the U.S. population at large was cited as indirect support for this assertion. Similarly, a country wide survey found 84% of Mexican school age children positive for Hepatitis A antibodies compared to 24% of U.S. school age children (Kumate et al. 1982). While it is not possible to comment on the quality of municipally piped water in Valle Hermoso in the present study, it has been noted that approximately 96% of households in the municipal limits of Valle Hermoso have access to piped water (INEGI 1996[a]). This statistic suggests that water quantity is not a problem for Valle Hermoso households, and that their standard of living is comparatively higher than that of many residents in the U.S.-Mexico Border region.

Hymenolepis nana was the only cestode (tapeworm) parasite found in the Valle Hermoso fecal samples. This parasite lives in the small intestine of humans and rodents worldwide. *H. nana* has a three stage lifecycle that includes the embryonic oncosphere, metacestode, and adult stages. Although the typical cestode lifecycle requires an intermediate host for development to the metacestode stage prior to infecting

the definitive or final host, *H. nana* is unique in its ability to directly infect its hosts. Most human infections are the result of accidental ingestion of eggs (shelled embryos) passed in the feces of the infected definitive host. The eggs are swallowed, and hatch in the small intestine where they develop into oncospheres. The oncosphere penetrates the villi and develop into cysticercoid type metacestodes. After a brief period of development, the cysticercoids migrate out into the lumen of the small intestine, attach to the mucosa, and develop into mature worms. The mature worm is composed of a scolex or holdfast organ and proglottids which contain both male and female reproductive structures. After fertilization, the gravid proglottids detach from the scolex, disintegrate, and release the eggs into the lumen where they are incorporated into the feces of the infected human or rodent host. Transmission of the infective eggs to the definitive host by fecally contaminated fingers, or in fecally contaminated food and water completes the life cycle. Indirect infections may also result from ingestion of the metacestode stage in an infected grain beetle or flea. This second mode of transmission is thought to be rare (Schmidt and Roberts 1989). Continued self-infection in children and immunocompromised persons may result in the accumulation of large worm burdens, and blockage of the small intestine. *H. nana* is well tolerated in humans and generally not associated with clinical illness. Allergic reaction to the worms is thought to be the primary mechanism responsible for illness. Headaches, dizziness, anorexia, periodic diarrhea, restlessness, and irritability have been reported from individuals with *H. nana* infections that are uncomplicated with other parasitoses (Beaver et al. 1984).

The reported prevalences of *H. nana* are: 9% in small children from Argentina, and 15% in Venezuela (Beaver et al. 1984; Chacin-Bonilla et al. 1993). In Mexico, the prevalence of *H. nana* was 21% in Sinaloa, 5% in Morelos, and 19.8 and 16.4 % in the northern and eastern regions of Nuevo León (Diaz-Camacho et al. 1991; Sarti et al. 1992; Vargas Mena et al. 1970[a], 1970[b]). This contrasts with 0.4% prevalence in the United States based on data collected from State Public Health laboratories (Kappus et al. 1994). Although differences in hygienic behavior and sanitation are widely recognized risk factors for infection with *H. nana*, Mason and Patterson (1994) suggested that the presence of infected siblings in the household may account for different prevalence rates in loci where sanitation and hygienic behavior is uniformly poor. The lower (6%) prevalence of *H. nana* in the Valle Hermoso samples is consistent with the observation that households in this investigation may represent a higher standard of community

sanitation and personal hygienic behavior that is intermediate between the previous surveys in Sinaloa and Nuevo León and the conditions represented by the U.S. samples.

Nematode parasites identified from the Valle Hermoso fecal samples are *Enterobius vermicularis*, *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm (probably *Necator americanus*), and *Strongyloides stercoralis* (Table B2). All of these parasites, with the exception of *E. vermicularis*, are broadly considered as soil-transmitted nematodes, or geo-helminths, because their lifecycle includes a period of development in fecally contaminated soil prior to infection of the definitive host. The lifecycles of these species are direct and do not require an intermediate host for transmission of the infective stage to the human definitive host. Infection with *E. vermicularis*, *A. lumbricoides*, and *T. trichiura* is by ingestion of embryonated eggs. Infection with *N. americanus* and *S. stercoralis* is by percutaneous penetration of the host by infective stage larvae which undergo a free-living stage in the soil.

Adult *E. vermicularis* worms live in the lower portion of the small intestine and feed on epithelial cells and bacteria (Beaver et al. 1984; Schmidt and Roberts 1989). Following copulation in the ileocecal region, the gravid females migrate in the lumen of the colon, emerge from the host and oviposit on the perianal folds surrounding the anus. The eggs are infective within a few hours following deposition, and may remain viable for up to 13 days under cool, moist conditions (Beaver et al. 1984). During oviposition the emergence of the gravid females produces a crawling sensation and puritis which elicits a scratching response and sometimes results in scarification and secondary bacterial infection of the perianal tissues (Beaver et al. 1984; Schmidt and Roberts 1989). Transmission of the infective eggs to the definitive host by anus-mouth contact via a contaminated finger completes the life cycle (Beaver et al. 1984). The eggs may also be dislodged from contaminated clothing, or bed linens; these are often aerosolized, and swallowed or inhaled by other persons sharing the sleeping quarters or residence of an infected individual (Beaver et al. 1984). This second mode of transmission accounts for the high prevalence of infection among members of the same household (Beaver et al. 1984; Schmidt and Roberts 1989). Clinical signs associated with pinworm infection in children include: nervousness, irritability, anorexia, insomnia, and nightmares (Beaver et al. 1984; Schmidt and Roberts 1989).

Infections with *A. lumbricoides* and *T. trichiura* result from ingestion of embryonated eggs which have undergone a 14 to 28 day period of development in fecally contaminated soil. Typically, the eggs are

swallowed during the consumption of unwashed fruits or vegetables (Beaver et al. 1984). The coprophagous behavior of domestic animals, particularly dogs, may also play an important role in transmission because the eggs are able to pass unaffected through the intestine of these animals (Beaver et al. 1984). This potential mode of transmission permits the transfer of infective stage organisms to socially acceptable locations for accidental ingestion via unwashed hands or suspended in aerosolized dust particles and inhaled (Beaver et al. 1984). The eggs of *A. lumbricoides* hatch in the stomach. The larvae penetrate the intestinal wall, migrate through the liver, and are carried in the portal circulation to the lungs (Beaver et al. 1984). After a brief period of growth and development, the larvae continue up the respiratory tree to the throat where they are swallowed and enter the alimentary tract (Beaver et al. 1984). In the small intestine, the larvae molt twice, become sexually mature male and female worms, and copulate (Beaver et al. 1984). Fertilized eggs are passed in the feces of the infected host, approximately eight to nine weeks post-infection (Beaver et al. 1984).

The lifecycle of *T. trichiura* does not include the pulmonary migration described for *A. lumbricoides*. The embryonated eggs hatch in the small intestine, and the larvae enter the crypts of the lower intestine and colon, and eventually become established in the epithelium of the cecum. The larvae become sexually mature worms, copulate, and pass fertilized eggs in the feces approximately three months post-infection.

Infections with *N. americanus* (human hookworm) and *S. stercoralis* (human threadworm) are the result of percutaneous penetration of the host by infective stage larvae which have undergone a free-living stage in the soil. In both cases, the larvae penetrate the host and are carried to the lungs in the pulmonary circulation. After a brief period of development in the lungs, the larvae migrate through the bronchi, and are carried up the trachea to the throat where they are swallowed, enter the alimentary tract and continue to the small intestine (Beaver et al. 1984). *S. stercoralis* larvae develop into parthenogenic females in the lungs. This transformation does not occur with hookworms. *N. americanus* molts and differentiates into sexually mature male and female worms in the small intestine, and fertilized eggs are passed in the feces of the host approximately five weeks post-infection. In the case of *S. stercoralis*, the parthenogenic females mature in the small intestine approximately two weeks post-infection. The mature females produce partially embryonated eggs which hatch in the mucosal epithelium, and the hatched larvae are discharged in

the feces of the infected host. The propensity for autoinfection is a distinguishing feature of the *S. stercoralis* lifecycle. This may occur when some of the hatched larvae molt and develop into infective stage larvae en transit, penetrate the bowel, and return to the small intestine via the previously described pulmonary migration route. Accumulation of substantial worm burdens by the autoinfection route of transmission may be fatal in neonatal children and immunocompromised persons (Ashford et al. 1992).

In human populations a large number of soil-transmitted nematode infections are asymptomatic and do not result in clinical disease. However, adverse effects of heminthiasis (that is infection with disease) may result from mechanical damage during larval penetration and migration, immune reactions in the tissues elicited by migrating larvae, blood loss from feeding hookworms, and nutritional impairment from anorexia, and diarrhea produced by the adult worms (Beaver et al. 1984; Stephenson 1987). Allergic reactions from migrating ascarid larvae may stimulate a pneumonia-like illness known as pulmonary ascarisis. Simultaneous migration of large numbers of larvae can be fatal. Secondary bacterial infections sometimes occur as complications from percutaneous penetration by hookworm and *S. stercoralis* larvae. *Hookworm disease* may result from chronic infection with *N. americanus* in individual cases. The severity of the disease is directly proportional to the worm burden and the overall nutritional health of the infected individual (Schmidt and Roberts 1989). The adverse effects of hookworm disease are exacerbated by poor nutrition and concurrent infections with other parasitic helminths such as *A. lumbricoides* and *T. trichiura* (Beaver et al. 1984; Schmidt and Roberts 1989). Children raised under these circumstances may exhibit retarded physical and mental development and impaired antibody production to various infectious diseases (Schmidt and Roberts 1989). In some Mexican families the annual economic losses from intestinal parasitism may be equivalent to seven weeks earnings because of absenteeism at work, reduced productivity, poor scholastic performance, and the cost of medical services and drugs (Botero 1981).

The maintenance of the soil-transmitted nematodes in a host population is dependent on the presence of:

1. infected individuals in the population,
2. continuous inoculation of the soil with viable eggs or larvae, and
3. suitable environmental conditions for the development of the eggs and larvae to infective stage (Beaver et al. 1984).

Promiscuous defecation habits and the use of human excreta to enhance soil fertility contribute to the endemicity of helminthosis (that is infections without disease) in human populations by providing exceptional opportunities for the continuous inoculation of the soil with viable parasite progeny (Beaver et al. 1984). Moist shady locations with temperatures between 22 and 30° C (71 and 86° F) facilitate the development of viable eggs and larvae to the infective stage (Beaver et al. 1984). The eggs of *A. lumbricoides* and *T. trichiura* are highly resistant to desiccation and frost and remain dormant under such conditions. These may undergo accelerated development to infective stage with the return of favorable conditions. In temperate regions, the seasonal distribution of rainfall and temperature are important environmental constraints which affect the development of eggs and larvae to infective stage (Beaver et al. 1984). Under favorable environmental conditions, *N. americanus* and *S. stercoralis* larvae may remain viable in the soil for several weeks (Beaver et al. 1984; Schmidt and Roberts 1989).

Prevalence rates for endoparasitic nematode infections in Latin America are available from several studies. Chacin-Bonilla et al. (1993) reported the following rates in a random sample of families from a community in Venezuela: *A. lumbricoides* 52.8%, *T. trichiura* 69.8%, and *S. stercoralis* 5.6 %. Sarti et al. (1992) reported lower rates in a community wide survey of families in Morelos, Mexico: *A. lumbricoides* 8.3%, and *T. trichiura* 2.5%. Diaz-Camacho et al. (1991) reported the following prevalence rates: *A. lumbricoides* 0.7%, *T. trichiura* 10%, and *S. stercoralis* 2.8 % in a community in Sinaloa, Mexico. Vargas Mena (1970[a], 1970[b]) reported prevalence figures of 3.0 and 2.2% for *A. lumbricoides*, 0.3 and 0.5% for *T. trichiura*, and 0.2% for *S. stercoralis* in separate surveys of school children from the northern and eastern regions of Nuevo León. The prevalence of these parasites contrast with figures available for U.S. reports from state public health laboratories (Kappus et al. 1994). Prevalence rates for the U.S. are: *A. lumbricoides* 0.8%, *T. trichiura* 1.2%, hookworm 1.5%, and *S. stercoralis* 0.4%. Differences in hygienic behavior and sanitation may account for variability in the prevalence rates. The lower prevalence figures in Morelos and Sinaloa may be the result of increased public health involvement in these regions of Mexico. The arid environmental conditions in Nuevo León have been cited as justification for the lower prevalence of soil-transmitted nematodes in the earlier studies conducted by Vargas Mena and colleagues (Flores Castañeda 1991). This is reasonable because those surveys were carried out nearly 20 years before targeted chemotherapy programs became a standard feature of community helminth control efforts. As previously

noted the low prevalence of *A. lumbricoides* and *T. trichiura* infections in the Valle Hermoso samples is probably a reflection of the targeted chemotherapy directed at school age children in the community. However, the hot-arid environmental conditions in Valle Hermoso are quite similar to those described for the northeastern portion Nuevo León. It is likely that a combination of harsh environmental conditions, suppressive chemotherapeutic control measures, and increased community hygiene is responsible for the low prevalence of endoparasitic nematode infections in Valle Hermoso.

Prevalence figures for *E. vermicularis* are probably underreported in the previously cited surveys because the eggs are rarely encountered in fecal examinations. Such examinations only reveal 5% of the known infections with the parasite identified by the superior scotch tape technique (Beaver et al. 1984). Sarti et al. (1992) noted that the eggs of *E. vermicularis* were encountered in 1.1% of stools examined from Morelos, Mexico. Vargas Mena et al. (1970[a], 1970[b]) reported that the prevalence of *E. vermicularis* was 8.5 and 12.3% in school children from northern and eastern Nuevo León. In contrast, only 0.4% of stools examined in the U.S. contained evidence of pinworm infection (Kappus et al. 1994).

Household Interview Analysis

Informants from 244 households provided information on their knowledge and accepted use of cholera prevention measures disseminated by government public health authorities. Detailed information on the identification, treatment, and prevention of parasitic infections in children was also obtained through structured interviews with the primary caregiver from these households. Two different survey instruments were used. The HHHQ (Table A2) recorded the responses of household informants on a series of questions about parasite-related knowledge in a *yes-no-don't know* format. These data were quantifiable and appropriate for statistically testing hypotheses based on variation in the responses of infected and uninfected households. In contrast the MHPQ (Tables A3 through A5) was used to record responses to a narrowly focused series of questions on parasite-related beliefs. The *open-ended* format of these questions encouraged informants to provide detailed responses of why people thought eating too much candy was associated with parasitic infections, or why people thought it was impossible to prevent infections in children. These data are an invaluable source for describing the qualitative distinctions that underlie the

community's conceptual understanding of how parasitic infections are acquired, diagnosed, treated, and prevented.

The ability of household informants to recall cholera preventive measures was high. Approximately 72% of infected households and 81% of uninfected households were able to recall at least one preventive measure (Table C6). Uninfected households were significantly associated with the ability to recall three or more preventive measures (Table C6). Recognition of the major classes of preventive measures was similar between infected and uninfected households. These included preventive measures directed at treatment of drinking water, personal hygiene, and food hygiene. Personal hygiene measures such as hand-washing before meals and after using the bathroom were listed with the highest frequency (Table C7). Food hygiene measures such as washing fruits and vegetables, and cooking foods completely were second in importance. Preventive measures related to seafood and consumption of food from street vendors were infrequently mentioned by households. This was interesting in light of their important roles in the epidemiology of cholera (Albert et al. 1997) and foodborne disease outbreaks (Moy 1997). Seafood is not a major household dietary item in Valle Hermoso, and similar communities in northeastern Tamaulipas. Residents of the community have a decided preference for *fajitas carne asda* (beef skirt, or flank steak, cooked over the fire), and many people have an acknowledged taste for *cabrito* (baby goat). The low frequency of seafood-related food hygiene responses may reflect this dietary preference. Secondly, the small size of the community enables Valle Hermoso residents to become familiar with particular street vendors. According to residents, particular foodstands that are known to have good hygiene are patronized preferentially, and those without good hygiene simply do not stay in business. The small size of the community may also facilitate closer supervision of local food vendors by government health authorities. This would also have the effect of insuring good hygiene and reducing the likelihood of foodborne disease outbreaks. The low frequency of preventive measures associated with street vended food suggests that the perceived risk of foodborne illness among Valle Hermoso residents is relatively low and many people have confidence in the quality of foods served at these sites.

There was a high degree of consensus among households that parasitic infections were acquired from poor hygiene. Living in a dirty house, eating dirt or placing dirty things in the mouth, and drinking unclean water were acknowledged by a clear majority of uninfected and infected households as behaviors

that place people at risk for parasitic infection (Table C9). Many of these same ideas were expressed by residents in the open-ended interview sessions. The responses of these residents underscored the importance of personal hygiene and food hygiene-related beliefs in the acquisition of parasitic infection (Tables C12 and C13). Two informants also recognized that parasitic infections can be acquired from inhaling contaminated air. The *povo* (dust) driven by the constantly blowing wind is popularly regarded as a mechanical vector for aerosolizing the *huevocitos* (little eggs of the worms) for their inhalation by susceptible hosts (M.L., *Hierbera*, personal communication). Folk-related beliefs such as people being born with worms, eating the same foods all of the time, and eating from the same plate where characterized by ambiguous patterns of agreement between uninfected and infected households (Table C10). Although many households were unsure about the validity of these beliefs, their persistence in the community was noted in the responses from the open-ended interview sessions (Tables C12 and C13). The belief that children acquire worms from eating too much candy was initially recognized as folk-related belief based on the idea that excessive behaviors are often associated with increased risk of illness in Hispanic folk etiologies (Foster 1976, 1984). Excessive consumption of candies, sweet foods, and sugary substances has also been associated with parasitic infection in other cross-cultural studies of human parasitism (Nogokwey 1988; Rousham 1994; Williams Blangero et al. 1998). The high degree of consensus on this belief among uninfected and infected households prompted further examination of its underlying rationale with the open-ended interview format. Household informants overwhelmingly associated excessive candy consumption with inadequate nutrition and poor dietary behaviors in children, and it was these factors that placed the children at increased risk for parasitic infection (Table C14). These results are provocative enough to suggest that future researchers would be well advised to examine the putative association between candy consumption and parasitic infection in greater detail rather than accepting it *prima facie* as an element in a folk-etiology model.

Valle Hermoso household informants recognized endoparasitic infections in their children with pathognomonic symptoms that are obviously related to a disease state, and symptoms that are connected with a disease state based on the intuition and experience of the parent or caregiver. Pathognomonic symptoms included vomiting, diarrhea, poor weight gain, abdominal distention, abdominal cramping, and scratching the buttocks or perianal area (Table C15). These symptoms have been linked to parasitic

infection through experimental research. Symptoms that are linked to parasitic infection based on the intuition and experience of the parent or caregiver included restless sleep, grinding teeth, poor appetite, insatiable hunger, excessive salivation, and crying often (Table C16). Household informants exhibited a higher degree of consensus for the pathognomonic symptoms than for symptoms linked to parasitic infection by experience and intuition. The primary symptoms of parasitic infection recognized by informants from uninfected and infected Valle Hermoso households were children scratching their buttocks, stomach ache, diarrhea, and poor weight gain. Informants also agreed that children were likely to be infected with endoparasites when they grind their teeth at night, and when they have a poor appetite. Symptoms for infection with *lombrices* and *amebas* elicited during the open-ended interview session were strikingly similar, and it should not be surprising that approximately 60% of all symptoms listed would be classified as general gastrointestinal complaints (Tables C17 and C18). Interestingly, no informant mentioned that observing worms in the child's stool was a symptom of parasitic infection. The tendency of *Ascaris* to advertise its presence by spontaneous passage in the stool of an infected host is well recognized cross-culturally as a characteristic symptom of endoparasitic infection (Booth et al. 1993; Berlin and Berlin 1996; Rousham 1994; Williams-Blangero et al. 1998). The high degree of saliency for this symptom may be proportional to the occurrence of *Ascaris* in the human population For example, Rousham (1994) noted that 70% of children in the communities he surveyed in Bangladesh were infected with *A. lumbricoides.* Williams-Blangero et al. (1998) similarly observed that the prevalence of *A. lumbricoides* ranged between 50 and 94% of children in the Jirel region of Nepal. Berlin and Berlin (1996) also noted the high prevalence and endemicity of ascariasis among the Mayan peoples of highland Chiapas, Mexico. Although mother's were not specifically asked if they ever saw worms in their children's stool samples, it is possible that the low prevalence of *Ascaris* infections in the community underlies the apparent absence of *worms in the stool* as a recognized symptom of parasitic infection among Valle Hermoso household informants.

Informants in uninfected and infected households agreed that there were many effective medicines for treating parasitic infections (Table C19). Opinion was divided among informants on the efficacy of pharmaceutical anthelminthic compounds compared to herbal preparations with antiparasitic activity. Household informants agreed that pharmaceutical compounds were expensive for most families to purchase (Table C19). Infected households noted that the superior efficacy of the compounds made them a cost

effective purchase (Table C23). Household informants demonstrated a clear preference for pharmaceutical compounds in the open-ended interview sessions (Table C20). Many informants were able to provide the names and the approximate cost of specific medications used in their households to treat parasitic infection. Reasons given for the preference of pharmaceutical compounds were confidence in the ability of the doctor to prescribe safe and efficacious drugs, the superior efficacy of the drug to remove all parasites, and the safety of the compounds (Table C21). Most informants in uninfected and infected households utilized government health care services at the *Centro de Salud* or the IMSS clinic to obtain information about and treatment for parasitic infections. However, many informants indicated a preference for obtaining the information and medications to manage parasitic infections in their households from the local *farmacia* or *botica* (Table C25). Although medications can be obtained at the *Centro de Salud* gratis or for a nominal cost from the IMSS, households electing to purchase anthelminthics from the *farmacia* must pay the full purchase price. The household cost of treating a family of five (two adults, three children) with an OTC anthelminthic like Vermox (mebendazole) would be Mex$ 30 (US$ 4.15), or approximately 14% of the family's average weekly income.

K. Logan (1983) noted that self-medication and use of OTC medications were commonly employed for diarrhea and stomach ache by families in Ciudad Juarez. Informants preferentially used the services of pharmacists to obtain information and medication for treating illness because as residents of the neighborhoods in which they operated their businesses, the pharmacists were perceived to be more knowledgeable about the health problems and living conditions of their clients (K. Logan 1983). As healthcare providers, the advice and medications that pharmacists dispense is under constant scrutiny (K. Logan 1983). Pharmacists who fail to provide sound advice and efficacious medications soon go out of business (K. Logan 1983). Another reason cited for the preferential use of pharmacists over physicians was the cost of health services (K. Logan 1983). Households were able to bypass expensive office visits and still obtain medication for treatment of their illnesses (K. Logan 1983). To many persons, the pharmacist was seen as an individual with specialized health care knowledge who was also a social equal. Accordingly these persons were perhaps more comfortable consulting the pharmacist because there was no lengthy wait, no examination, and no unfamiliar technical language about their health complaint (K. Logan 1983).

A detailed study of treatment seeking behavior similar to that previously described by K. Logan (1983) was beyond the scope of the present research. It is clear, however, that additional investigation is necessary to determine why some households prefer to purchase medications for treating parasites when they are available at nominal cost or free of charge from government health care sources. It would also be interesting to follow households prospectively to describe which gastrointestinal illness episodes were treated through formal medical channels, and which episodes were managed by self-diagnosis and use of OTC medications. It is important to acknowledge the prominent role local pharmacists play as health care providers for clients seeking information and medications for treating endoparasitic infections. Additional investigations should be conducted to ascertain the extent of their knowledge on how endoparasites are acquired, treated, and prevented. Perhaps these individuals can be utilized more fully in community-wide intervention programs designed to reduce parasite-related morbidity.

Household informants from uninfected and infected households acknowledged that parasitic infections in children were preventable (Table C27). This belief was most pronounced in uninfected households where 60% of informants disagreed with the statement *es impossible a impedir infecciones parasitos en niños* (it is impossible to prevent parasitic infections in children). The disparity between informants who agreed and disagreed with this statement was narrower among informants from infected households. However, the occurrence of this belief was not statistically associated with household infection status. Once again, informant responses from the open-ended interview sessions are useful for understanding the underlying rationale of this belief. Households that agreed with the statement that parasite prevention is impossible maintained that the infective stages of the parasites are everywhere and one has little control over contact with them (Table C28). Secondly, these informants recognized that they have little control over the behavior of their children once they are outside of supervision. This belief was expressed during an informal visit with residents of *Los Vecinos* when one mother commented that *con niños no hay nada que se puede hacer* (with boys there is nothing you are able to do). Unfortunately, small sample sizes prevented a statistical test of the hypothesis that agreement with the belief that *prevention of parasitic infections is impossible* should be associated with households with all male children or households with three or more children.

Household informants that disagreed with the belief that prevention of parasitic infections in children was impossible expressed two basic ideas on why this statement was not true (Table C29). One group of informants maintained that parasites can be prevented only through medication, or that they are controlled by attending to it in time and treating every six months (Table C29). From the other perspective, prevention of parasitic infection was largely regarded as a matter of hygiene. Accordingly, these informants recognized that a clean house, hand-washing before meals, and teaching children to be careful would enable one to prevent parasitic infections in children. Once again, small sample sizes precluded statistical testing, although it appears that the distribution of these beliefs was associated with household infection status. In uninfected households 65% of all responses were prevention oriented (Table C29). In contrast, therapy oriented prevention measures dominated the responses of infected households.

These results call attention to the importance of understanding peoples' contrasting concepts of parasite prevention, and the strategies used to achieve the goal. For many people preventing parasitic infection is synonymous with avoidance of clinical disease. The objective of suppressive anthelminthic therapy is to control the worm burden of infected individuals below the threshold necessary to produce clinical disease. This strategy may be the only recourse for families living in localities where the environment is saturated with parasite infective stages and avoidance is impossible despite the use of proper hygienic measures (Knightlinger et al. 1998). However, in localities where the infective potential of the environment is low, prevention of parasitic infections through good hygiene can be a more cost effective alternative for households with limited economic resources. This hygiene-oriented approach to health maintenance would have the additional benefit of reducing the frequency of enteric infections with bacterial and viral enteric agents associated with diarrheal disease and gastrointestinal illnesses. Household resources could then be allocated to providing better nutrition for children, which in turn would assist their physical development and immunologic ability to resist common childhood diseases.

Locus of Illness Control Analysis

Informants from Valle Hermoso households were interviewed with the *Locus of Illness Control* survey instrument to obtain information about beliefs on illness prevention and cure. The general questions contained in the LIC instrument were expected to provide quantitative data on health-related beliefs that

would be free of bias associated with inquiry into specific household hygienic behaviors, cholera prevention, and parasitic infection. A primary hypothesis underlying the application of the LIC was that informants from uninfected households were expected to conform to the model specified for internally oriented individuals. According to the LIC model, internally oriented persons perceive their health as the product of their own decisions, actions, and behaviors. They are presumed to actively engage in behaviors that prevent illness. Thus, it was predicted that LIC scores for prevention would be relatively lower (more internal) for uninfected households when compared to the scores for infected households. It was also hypothesized that the LIC scores for cure would be lower (more internal) for infected households when compared to uninfected households. The rationale for this expectation was based on M. Logan's (1991) observation that in situations where acute infectious diseases predominate, people will have more confidence in curative rather than preventive medicine because most causes of illness are effectively controlled therapeutically with antibiotic and antiparasitic medications and remedies. Thus, informants from infected households were hypothesized to conform to a model that recognized prevention of parasitic infections in children was nearly impossible, but control of the infections and avoidance of disease was possible through the many available therapeutic options.

Statistical variation in the LIC score of Valle Hermoso informants was analyzed with appropriate single factor ANOVA models for normally and non-normally distributed data, and by the multivariate factor analysis procedure. The mean of the summed LIC scores for all treatment groups and independent variable combinations fell within the middle of the possible range (15 to 45) of LIC total scores. LIC scores for the prevention and cure subscales also fell within the range of scores associated with the internal (prevention oriented) dimension of the LIC continuum. These data indicate that the overall orientation of the Valle Hermoso population is toward illness prevention. Moreover, the low (internal oriented) score on the cure scale indicates that community residents also believe that they have control over the outcome of illness events, either through chemotherapeutic means, or by access to skilled doctors and health specialists.

This general orientation toward illness prevention may be a product of the intensive community-wide public health effort aimed at prevention of cholera and other infectious diseases. As previously noted, this effort is vigorously promoted by public health officials through the network of volunteer *promotoras* who personally visit *colonia* residents to stay abreast of health issues and through strategically

communicated mass media programming. The message that *higéne es salud* (hygiene is health) is also prominently displayed in local restaurants and public access bathrooms throughout the city.

Analysis of the summed LIC scores with the parametric ANOVA and nonparametric Kruskal-Wallis ANOVA with did not reveal any significant differences in the mean and median scores for uninfected and infected households (Table D1). Mean and median LIC scores were also not significantly different with respect to the informant's *colonia* of residence, or the relative age of the informant (Tables D2 and D4). Despite the lack of significance, younger informants appeared to score more externally on the cure subscale than older informants (Table D2). This observation is interesting because it is tempting to predict that older informants should be markedly more external because of their increased susceptibility to chronic, degenerative disorders which are relatively difficult to manage therapeutically. Mean and median LIC scores for the prevention and cure subscales and the total LIC instrument were essentially equal for all informants irrespective of their ability to list 0, 1, 2, or ≥ 3 cholera preventive measures (Table D3). This observation may be an indication that the mean and median LIC scores are not predictive of actual preventive behavior. The ability of informants to list ≥ 3 cholera preventive measures has been previously shown to be statistically associated with household infection status (Table C6).

M. Logan (1991) observed that true variation in LIC scores would be masked by use of the mean of summed LIC scores. Following his approach, an analysis of the item specific scores for the LIC instrument was undertaken to see if any potentially interesting associations emerged with respect to the independent variables of household infection status, informant age class, recall of cholera prevention measures, and *colonia* of residence. Item specific LIC scores were not significantly different with respect to household infection status. LIC scores for each item were essentially equal for informants from uninfected and infected households.

When informant age class was considered as an independent variable the scores for LIC item 4 "if God wants to send you an illness" and LIC item 6 "most illnesses are cured on their own" were statistically significant (Table D6). LIC item 4 is a prevention subscale item with external wording. The score for older informants in the 44 to 70 year age groups was much more externally oriented than the score for younger informants in the 18 to 25 year age classes. This observation is consistent with Patrick's (1993) observation that health perceptions of older people are perhaps more influenced by fear of chronic degenerative

diseases associated with advancing age, and that religion has more importance in their daily lives than younger informants. Patrick (1993) expressed reservation that, in its original language, the LIC instrument did not adequately discriminate between living an upright-moral life according to God's commandments and a *good life* potentially defined as a personally satisfying lifestyle. The Spanish translation of the LIC administered in this investigation was quite clear in its emphasis on living an upright moral life according God's commandments (*si usted sigue una vida de lo que Dios dice, usted rarament se enfermará*). Interestingly, older informants did not believe that living an upright moral life is protective against disease. This appears to reinforce the point that, according to these informants, no one is immune to many chronic degenerative diseases like arthritis, diabetes, and coronary heart disease. LIC item 6 is a cure subscale item with external wording. The score for younger informants in the 18 to 25 year age class was much more externally oriented than the score for older informants in the 33 to 43 year age class. This score may reflect the perception related differences in illness susceptibility between older and younger informants. On average, younger informants are more likely to experience self-limiting infections like the common cold more often than serious diseases that require medical intervention. Secondary complications to these illnesses often require medical intervention as individuals increase in age and their natural immunity decreases. Alternatively, this score may reflect the uncertainty over illness cure which is perhaps associated with the inexperience of new mothers who are assuming the caregiver role in their households. For many new parents confronting childhood illnesses like colic, and various upper respiratory tract and enteric viral infections appears to reinforce the belief that many illnesses are self-limiting with or without therapeutic intervention.

LIC items 5, 11, and 15 exhibited statistically significant variation when examined by their relationship to informants ability to recall cholera prevention recommendations. LIC item 5, "some people are sick all the time," is a prevention subscale item with external wording (Table D7). Informants who were unable to list any cholera preventive measures exhibited greater externality than informants who were able to list 2 preventive measures. Subsequent testing of informant variation in the item specific scores for LIC items 11 and 15 indicated that all scores for these items were equal and not significantly different, irrespective of the informants abilities to list cholera preventive measures.

Analysis of the item specific LIC scores by the informants *colonia* of residence identified four items (LIC 4, 5, 6, 14,) that were statistically significant (Table D8). However, only one of the four items identified by the Kruskal-Wallis test was significantly different with Dunn's multiple comparison tests. LIC item 4, "If God wants to send you an illness" was associated with *Los Vecinos*. The higher and external oriented score for this *colonia* indicates that residents of the community share a perception that they have little control over illness prevention. Previously, it was noted that children from this *colonia* were approximately two times more likely to be infected with the protozoan parasite *Giardia lamblia* than children of other *colonias* (Table B12). Informants from *Los Vecinos* were also associated with a lower, and, comparatively more internal score on LIC item 6, "most illnesses are cured on their own". This item is a cure subscale item, with external wording. However, the lower score of the *Los Vecinos* informants was not significantly different than the scores of informants from other *colonias* using Dunn's multiple comparison test. Despite its lack of significance, the internal orientation on LIC item 6, taken in context with the external orientation of LIC item 4, seems to indicate support for M. Logan's (1991) observation that people confronting acute, infectious diseases will have more faith in curative medicine rather than preventive medicine. Interestingly, this *colonia* mounted a successful effort to establish a VHCS staffed *casa pequena de salud* in the community during the study period. It would appear from this evidence that although the residents of this community are inclined to the belief that there is little they can do to prevent illness, they have taken full advantage of all available options to curing illnesses when they occur.

The LIC data for Valle Hermoso were also analyzed with a multivariate factor analysis procedure to better characterize the variation subtly expressed in the item by item ANOVA of the informants' responses. The LIC data were partitioned into data matrices corresponding to the analytic groups defined in chapter 2. Each data matrix was analyzed separately with a six factor model that accounted for between 63 and 73% of the cumulative variation in LIC scores. The six factor model was chosen *a priori* to maintain consistency with previous research by M. Logan (1991). Each of the six factors resulting from the analysis were assumed to be equally influential in the constellation of illness control beliefs shared by Valle Hermoso households (Rummel 1967). The resulting picture was a six dimensional projection of the important concepts used to explain the presence and absence of illness, and the options available for treatment of sick individuals.

The illness control concepts shared by uninfected and infected households were similar (Tables D12 and D14). Illness susceptibility and avoidance were perceived to be outside of one's personal decisions, actions, and behaviors. For both uninfected and infected households the predominate pattern for the prevention subscale was associated with the external dimension. Luck was viewed as a primary force that underlies wellness and it may also increase illness susceptibility. However, uninfected households contrasted with infected households on a single factor which acknowledged individuals' control over illness prevention (Table D14). This factor was defined by a dominant score on item 11, "when people eat right and take care of their bodies they will seldom get sick." The occurrence of this prevention-oriented factor was not found in the models posited for the other households surveyed in this investigation.

Uninfected households were also similar to infected households with respect to illness cure concepts. The predominate pattern for both groups associated cure subscale items with an internal orientation. This was prominently expressed among uninfected households where an illness cure factor was defined by dominance on LIC items 3 and 9 which recognized that "almost all illnesses have a cure", and "in the future modern science will find a cure for all diseases." However, the belief that God has the last word in the resolution of illness is an important component in the model of illness cure beliefs elucidated by this analysis. The prominent spiritual role of God as well as the Roman Catholic Church in the daily lives of Mexican households underlies the importance of this concept.

These results are consistent with M. Logan's (1991) observation that people confronting acute infectious diseases will exhibit an external orientation with respect to illness prevention beliefs. However, the expression of an *illness-prevention* factor for uninfected households indicates that these households may indeed relate to the threat of parasitic infections differently than infected households. The results further demonstrate that additional investigation of illness-control beliefs need to be carried out in populations that can be subdivided according to defined health risks and other independent variables such as age, sex, and religious beliefs. These studies would contribute to a better understanding of the variation in peoples' orientation toward preventive and curative medicine.

CHAPTER 9

CONCLUSIONS

This investigation of human parasitism and its association with preventive health behavior in a Mexican community has been strengthened by the use of a multidisciplinary approach based on the methods and theoretical paradigms from the fields of anthropology, parasitology, and epidemiology. Previous studies of human parasitism in human populations have primarily focused on describing the epidemiologic attributes of infected and non infected individuals and households. Variables like the age/gender compositions of infected vs. uninfected persons and households, the presence/absence of infected siblings, the number of children per household, and household income and available resources have been standard features of these analyses (Dunn 1968, 1972; Knightlinger et al. 1996, 1998; Kloos et al. 1981; Mason and Patterson 1994). Other studies of the knowledge, attitudes, and perceptions of people toward parasitic infection have not examined variability in beliefs relative to differences in infection status (Booth et al. 1993; Rousham 1994; Williams-Blangero et al. 1998). This study has attempted to provide a context for understanding the occurrence of parasitic infection in households with regard to variation in beliefs about its recognition, treatment, and prevention.

The working hypothesis employed for this research assumed that uninfected households shared a model which regarded endoparasitic infection in children as a preventable health effect. These households were assumed to actively engage in preventive behaviors like hand-washing, cooking food well, and drinking treated or bottled water. These preventive measures are widely disseminated as part of the national cholera prevention program of the Mexican government. Faithful use of the prevention measures should reduce susceptibility to parasitic infections and other infectious diseases. Infected households, on the other hand, were assumed to accept parasitic infections in children as an inevitable consequence of life, and the natural inclinations that put children at risk for infection. While these households may indeed pursue illness prevention behaviors, therapeutic intervention would be a comparatively more important strategy for maintaining health and avoiding infection with parasitic agents capable of producing clinical

disease in children. The assumption that endoparasitic infection was an appropriate biological indicator of household compliance with the national cholera prevention initiative was justified on the recognition that all of the parasitic species identified in the Valle Hermoso samples are transmitted to susceptible hosts through faulty hygienic behaviors.

Evidence supporting the general tendencies of this hypothesis was found in the results of the separate analyses conducted for this investigation. Epidemiologic attributes associated with increased risk of parasitic infection were the child's age, and the presence of an infected sibling. Household infection status was also influenced by the number of resident children, use of untreated drinking water from the faucet, and the inability of the child's mother or caregiver to recall three or more prevention measures for minimizing the risk of cholera infection in the household. The associations of child age, the presence of an infected sibling, and the number of children in the household with increased risk of parasitic infection are interesting in light of informant perceptions on why prevention of parasitic infections in children was impossible. Parasitic infections in children were believed to be inevitable because of their proclivity to put things in their mouths, eat foods and drink beverages that were not hygienically prepared, and engage in other activities that put them at risk for parasitism when they played outside of their parent's supervision. It is likely that the supervisory abilities of mothers and caregivers are also strained in families with three and more children, thus providing plausible justification for increased family size as a risk factor for parasitic infection. Likewise, it is understandable that the risk of parasitic infections should increase with age as children become more ambulatory and their school and play activities take them farther from the watchful eye of their mothers. Infected siblings provide a reservoir and mechanism for introducing infective parasite stages to the household which can be shared among all family members. The linkage of household infection status with decreased familiarity, and perhaps use, of cholera prevention measures was the most obvious association in the entire study. Although these measures have been disseminated by government public health agencies to reduce morbidity and mortality from cholera, they are also basic household hygiene measures that are effective in preventing illness resulting from a variety of enteric infectious agents that depend on fecal-oral, and food and water-borne modes of transmission.

Evidence that uninfected households avoid illness and parasitic infection through attention to illness prevention and health maintaining behaviors was also indicated by results from the analysis of the

Locus of Illness Control data. Additional insight into the illness prevention beliefs of uninfected households was expressed in the reasons why parasitic infections are preventable (Table C29). Taken together, these data provide a compelling argument that uninfected households are comparatively more illness-prevention oriented than infected households. The factor analysis of the LIC data indicated that the definition of an illness-prevention factor for uninfected households discriminated their health-related beliefs from infected households. The dominant score on the factor affirmed the importance of the belief that "when people eat right and take care of their bodies they will seldom get sick" among uninfected households. This factor reflects the perception that illness-prevention is under one's personal control. The models of illness control beliefs posited for the other household groups in the study did not contain a similar factor. Household informants were also asked why they believed parasitic infections in children were preventable. Two patterns of responses emerged. One group recognized that parasites can only be prevented by medication, or by attending to it in time and treating every six months (Table C29). The other group expressed the belief that prevention of parasitic infections was a matter of hygiene. These informants maintained that a clean house, hand-washing before meals, and teaching the children to be careful enabled one to prevent parasitic infections. Small sample sizes and the qualitative nature of the data precluded statistical testing. However, approximately 65% of all responses associated with uninfected households were prevention oriented (Table C29). Therapy oriented prevention measures dominated the responses of infected households.

The complimentary use of quantitative and qualitative data collection methodologies resulted in a wealth of parasite-related information suitable for making comparisons between uninfected and infected households, and preserved the conceptual distinctions underlying households' understanding of parasite acquision, treatment, and prevention. This was poignantly expressed in an analysis of the reasons given by informants for why worm infections are associated with the consumption of too much candy. Previous studies associated eating sugar or sugary foods with worm infection based on interviews with informants (Rousham 1994; Williams-Blangero et al. 1998). It is unclear from these studies if the investigators followed these questions with other queries that asked for the reasoning behind informants' responses. In the present study, the results indicated that candy consumption was linked to worm infection through depressed appetites, poor nutrition, and concomitant increased susceptibility to illness. These results are

provocative enough that future researchers would be well advised to pay close attention to the reasoning underlying similar associations between candy (or sugar) consumption and helminth infections rather than accepting it as a folk etiology.

The results of this study indicate that additional research on household use of *over-the-counter* (OTC) pharmaceutical compounds for treatment of parasitic and other infectious diseases is needed. Unrestricted use of OTC antibiotics has been identified as an emerging health problem in Brazil and other developing countries (Schorling and Guerrant 1996). Mothers and caregivers who obtain OTC medications without first consulting a health care specialist often run the risk of using drugs that are not effective against particular parasites and disease producing agents (Schorling and Guerrant 1996). These persons are also more likely to use OTC medications inappropriately at less than effective doses. Children who are too young, or malnourished, are also at risk for toxic and other untoward side effects resulting from OTC drug use. OTC drug use is also expensive for families living in poverty. Moreover, household caregivers who self-diagnose and treat parasitic and other infectious diseases outside of established public health channels often fail to obtain information necessary to prevent disease by interrupting the deadly cycle of infection and re-infection (Rousham 1994).

Future investigators should examine why some households prefer to purchase medicines for treating parasitic infections when they are available at nominal cost or free from government health care agencies. Individual households should be followed prospectively to describe which gastrointestinal illnesses are diagnosed through formal medical channels and which episodes are managed by self-diagnosis and use of OTC medications. Additionally, the treatment preferences of household caregivers should be examined in greater detail to determine why some households exhibit a clear preference for herbal alternatives to pharmaceutical antiparasitic compounds. The prominent role of local pharmacists and *hierberas* as health care advisors for clients seeking information and medications for treating parasitic infections should be acknowledged. Investigations should be conducted to determine the extent of their knowledge on how endoparasitic infections are acquired, treated, and prevented. It may be feasible to incorporate these individuals more fully in community-wide parasite control programs.

The results of this research also indicate that additional investigation of *Locus of Illness Control* beliefs needs to be carried out in populations that can be subdivided according to defined health risks and

independent variables such as age, sex, family size, and religious orientation. Few such studies have been conducted to date. It would be interesting to compare the illness-control beliefs of similar Hispanic households in *colonias* on the Texas side of the U.S.-Mexico border. A working hypothesis for this study would be that the greater personal involvement of government public health agencies with households on the Mexican side of the border would be reflected by greater internality in LIC scores. Accordingly, Mexican households would be predicted to have a stronger association with illness-prevention beliefs than similar households located on the U.S. side of the border. Additional information on perceived health-related risks and issues as well as biographic and demographic data for household informants should be collected to compliment the LIC beliefs and assist in their interpretation.

In summary, this study provides a context for offering the following recommendations to health researchers and public health workers investigating cultural variability in the beliefs associated with the recognition, treatment, and prevention of endoparasitic infections in households and communities. Moreover, these recommendations should also be applicable to investigation and development of interventions for other infectious agents of public health interest.

1. Future researchers investigating the association between helminth infection and consumption of candy, sugary food, or sugar should follow *yes, no, don't know* type questions with other *open sentence frame* style queries to understand the reasoning behind informant's beliefs. This study demonstrated that the association between eating candy and parasitic infection is not simply an element in a folk etiology model, but the product of a coherent system of beliefs based on the perceived nutritional requirements of children, and their hygienic behavior.

2. Future research needs to be conducted on the role of OTC pharmaceutical compounds in household management of endoparasitic infection and other gastrointestinal diarrhea producing illnesses. These studies should collect quantitative data on the purchase and use of specific OTC medications and the frequency of their usage in households. Qualitative data regarding gastrointestinal illnesses that are self-diagnosed and treated with OTCs should also be compared with data on the severity and frequency of illnesses that are diagnosed and treated through formal medical channels. Educational materials should stress the dangers of unrestricted OTC use without proper diagnostic examinations for parasitic infection.

3. Local pharmacists and *hierberas* should be interviewed to determine the extent of their knowledge on how endoparasitic infections are acquired, treated, and prevented. The prominent role of these individuals as health care advisors for clients seeking information and medications for treatment of endoparasitic infection indicates that they should be more fully incorporated in community-wide parasite control programs.

4. Public health interventions that emphasize the economic benefits of preventing rather than curing parasitic infections and hygiene-related diseases should be implemented as an important adjunct to existing community health programs. Many of the community residents interviewed in this study were adamant that parasitic infections in children were preventable with attention to the children's hygiene and behavior and very little economic investment. This indicates a willingness on the part of community residents to participate in preventive health programs.

The results of this study support the conclusion that endoparastitic protozoa and helminths infections are related to the illness prevention beliefs and behaviors in the households in which they occur. Uninfected households were comparatively more attuned to illness prevention as indicated by their responses to questions about on cholera prevention, and how parasites are acquired, diagnosed, treated, and prevented. The *Locus of Illness Control* responses of uninfected households also indicated a general orientation toward health maintenance through illness prevention behavior. Infected households, in contrast, were more inclined to accept parasitic infections as a consequence of everyday life and recognize that the adverse effects of parasitism can be controlled with highly effective medicines. Public health interventions that emphasize the economic benefits of preventing rather than curing parasitic infections and other hygiene-related diseases can be an important adjunct to existing community health programs aimed at reducing childhood morbidity and mortality. In communities like Valle Hermoso, the relatively low frequency of endoparasitism should be advertised to residents by public health promoters as encouragement that *higiéne es salud* and that achievement of community-wide reductions in parasite-related morbidity is a public health problem for which there is a solution.

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APPENDICES

Appendix A

Household Interview Materials

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We are conducting an investigation of the occurrence of infection with parasites in the families of Valle Hermoso. We are also investigating peoples' beliefs about symptoms, control and prevention of infection with parasites. The purpose of this research is to determine how many families in Valle Hermoso are infected with parasites, and if their beliefs are effective in preventing infection with parasites. If you wish to participate in this investigation, you must:

1. inform the head of the family and your children of this discussion and obtain their permission,

2. collect fecal samples from all family members for analysis of parasitic infection,

3. allow us to ask some questions regarding your beliefs about how parasites are acquired, the symptoms of infection, and how parasites are treated and prevented in your family.

It is important for you to know that we will inform the health department if a family member is infected with parasites so appropriate medication can be provided to your family. This medication will be provided by the health department to your family without cost. We also want you to know that your participation in this investigation is voluntary, and you are able to refuse to answer any, or all of the questions if you wish, or leave the investigation at any time without consequence. All of your answers to the questions will be kept completely confidential, and the health department will only be notified if a member of your family is positive for infection with parasites.

Consent to participate will be granted by an affirmative answer to these questions:

4. "Do you wish to participate in this study?

5. "Will you collect fecal samples from family members for analysis of endoparasites?"

6. "Will you allow me to ask you some questions regarding beliefs about the management and prevention of endoparasites in your family?"

7. "Do you understand that participation in this investigation is voluntary, and you are able to refuse to answer any question you wish, or leave the investigation at any time without consequence."

Figure A1.1. English translation of the informed consent statement used for enlistment of household informants.

Conducimos una investigación de la ocurrencia de infección con parásitos en las familias de Valle Hermoso. También quiermos a apprender de las creencias de los gentes de síntomos, control y prevención de infección con parásitos. El propósito de esta investigación es determinar cuántos se infectan familias en Valle Hermoso con parásitos, y si sus creencias sean eficaces en infección del impedir con parásitos. Si desea a participe en esta investigación, tiene que:

1. informar la cabeza de la familia y sus niños de esta discusión y obtienen su permiso,

2. cobrar muestras de excrmento de todos socios de familia para análisis de infección con parásitos,

3. permitir nos preguntar algunas preguntas sobre su creencias de cómo parásitos adquirir, el síntomos de infección, y cómo se tratan parásitos e impidió en su familia.

Es importante para Usted saber que informaremos el departamento de salud si se infecta un socio de familia con parásitos tan apropiado medicinas puede ser proveer a su familia. Este medicinas será proveer por el departamento de salud a su familia sin coste. Nosotros también quierale saber esa su participación en este investigación es voluntaria, y puede negarse contestar alguno, o todo de las preguntas si desea, o licencia la investigación a algun tiempo sin consecuencia o multa. Todo de sus respuestas a las preguntas serán mantener completamente confidencial, y el departamento de salud solamente es notificado si un socio de su familia sea positivo para infección con parásitos.

Tu pudes a consentimiento participar ser otorgar por una respuesta afirmativo a estas preguntas:

4. "¿Participa usted deseo a en este investigación?"

5. "¿Le cobrar muestras de excrmento de socios de familia para análisis de parásitos?"

6. "¿Le me permitir preguntarle algunas preguntas sobre las creencias de la tratan y prevención de parásitos en su familia?"

7. "¿Le hacer entender esa participación en este investigación es voluntaria, y puede negarse contestar alguno pregunta le desear, o sale el investigación a algun tiempo sin consecuencia o multa?"

Figure A1.2. Spanish translation of the informed consent statement used for enlistment of household informants.

Biographical Information

Name:_____

Colonia:_____ **Age:**_____ **Sex:**_____

Marital Status:____ **Occupation of Spouse:**_____

Do you own your house: _____ **How many years have you lived here:**_____

Name and Age of Children: _____

_____

_____

Water for the household is obtained from:

faucets in the street faucets in the house

the river/canal a spring/well

other _____

Water for drinking is: boiled used directly from the faucet

bottled treated with Clorox filtered

Where does the family go to the bathroom: latrine bathroom in the house

outside in the open

Is the latrine used only by your family or shared with other families?

Do you know the government recommendations for prevention of cholera:

yes no

If you are able list them for me_____

_____

_____

Do you follow the recommendations: all of the time sometimes never

Figure A2.1. English translation of the Household Health and Hygiene Questionnaire (HHHQ) administered during the 1994 and 1995 field sessions.

Beliefs Regarding Illness Prevention

Please respond to the following questions with:

yes no sometimes

1. When people get sick, there is usually not much they can do about it:

   yes no sometimes

2. If you lead a God pleasing life, you will rarely get sick:

   yes no sometimes

3. Almost all diseases have a cure:

   yes no sometimes

4. If God wants to send you an illness, there is nothing you can do about it:

   yes no sometimes

5. Some people get sick often while others always seem to stay healthy:

   yes no sometimes

6. Most illness will be cured in a manner of time whether or not treatments are used:

   yes no sometimes

7. People who stay in good health are just lucky:

   yes no sometimes

8. If you become ill, it is because you live under a lot of pressure (or work too much):

   yes no sometimes

9. In the future modern science will find a cure for all diseases:

   yes no sometimes

10. Most people become sick because they worry too much:

    yes no sometimes

11. When people eat right and take care of their bodies, they seldom get sick:

    yes no sometimes

12. When people become sick it is up to God whether or not they get well:

    yes no sometimes

13. There is no reason to worry about illness. You will have what comes to pass:

    yes no sometimes

14. When people are sick, it is usually the result of bad luck:

    yes no sometimes

15. Most diseases can be cured by a good doctor or healer with the proper medicines:

    yes no sometimes

Figure A2.1. (continued).

Beliefs about Infection with Parasites

Please respond to the following questions with:

yes no don't know

16. Children are born with worms:

yes no don't know

17. People get worms from eating poorly cooked food:

yes no don't know

18. If people drink unclean water they get worms:

yes no don't know

19. Children that eat too much candy it will get worms:

yes no don't know

20. People who live in dirty houses often get worms:

yes no don't know

21. Only children get worms:

yes no don't know

22. Eating the same thing all the time will give you worms:

yes no don't know

23. Adults often get worms from their children:

yes no don't know

24. If you eat spoiled food you will get worms:

yes no don't know

25. People who have much contact with animals often get worms:

yes no don't know

26. Children become infected with worms from eating dirt:

yes no don't know

27. Children get worms from eating raw tortilla dough:

yes no don't know

28. People become infected with amebas in the same ways as they are infected with worms:

yes no don't know

29. Drinking unclean water will give you amebas:

yes no don't know

Figure A2.1. (continued).

30. If you drink sweet milk you will get worms:

yes no don't know

31. People become infected with amebas by eating from the same plate:

Beliefs about Symptoms of Parasitic Infection

32. Vomiting is a symptom of infection with worms or amebas:

yes no don't know

33. Children with worms often scratch their buttocks:

yes no don't know

34. Diarrhea is a symptom of infection with worms or amebas:

yes no don't know

35. When a child eats much food it is a symptom of infection with worms:

yes no don't know

36. A child with restless sleep is usually infected with worms:

yes no don't know

37. When a child salivates often it indicates infection with worms or amebas:

yes no don't know

38. A hard stomach is a symptom of infection with worms or amebas:

yes no don't know

39. A child that does not gain weight is usually infected with parasites:

yes no don't know

40. When a child does not eat it indicates infection with parasites:

yes no don't know

41. Stomach ache is a symptom of infection with parasites:

yes no don't know

42. Children who grind their teeth at night are usually infected with worms:

yes no don't know

43. When children cry often they usually have parasites:

yes no don't know

Figure A2.1. (continued).

Beliefs about Treating Parasites

44. There are many effective medicines for treating parasites:

yes no don't know

45. The herbal remedies from the market are as effective as the medicines from the doctor for curing parasites: yes no don't know

46. If one person in the house is infected with worms or amebas, it is necessary to treat all persons living in the house: yes no don't know

47. Medicines from the doctor are too expensive for most families to purchase:

yes no don't know

48. Herbal remedies sold in the market are almost the same price as the parasite medicines of the doctor:

yes no don't know

49. Worms and amebas can be treated with the same drug:

yes no don't know

Beliefs about Prevention of Parasites

50. It is impossible to prevent parasitic infections in children:

yes no don't know

51. If you wash your hands with soap you are able to prevent infection with parasites:

yes no don't know

52. Parasites are killed by boiling the water before it is used for drinking:

yes no don't know

53. If children play in the dirt in front of the house they have parasites:

yes no don't know

54. If you reduce contact with animals you are able to prevent infection with parasites:

yes no don't know

55. If you eat clean, well prepared food you will become infected with parasites:

yes no don't know

56. Parasites are killed by adding Chloro to the drinking water:

yes no don't know

57. Good hygiene will prevent parasitic infections and many other illnesses:

yes no don't know

Figure A2.1. (continued).

Información Biografía

Nombre:_____

Colonia:_____ **Edad:**_____ **Sexo:**_____

Estado civil:_____ **Occupacion del esposo:** _____

Es usted dueño de su casa:_____ **Cuantos años vive aqui:**_____

Nombre y edad de niños:_____

_____

_____

El agua para la familia se obtiene de:

llaves en la calle llaves en la casa

rio/canal un pozo

otro_____

El agua para bebida esta: hervida se toma directamente de la llave

embotellada le pone Cloro la filtra

A donde van al baño: letrina pieza de baño en la casa

al a aire libre

Es el baño usado solamente por toda la familia o por varias familias

Sabe usted las recomendaciones del gobierno para prevención de colera:

si no

Puede usted decirmelas: _____

_____

_____

Sigue las recomendaciónes: todo el tiempo a veces nunca

Figure A2.1. Spanish translation of the Household Health and Hygiene Questionnaire (HHHQ). administered during the 1994 and 1995 field sessions.

Creencias en Cuanto a Prevención de Enfermedad

Por favor me puede responder algunas preguntas:
me responda si no o a veces

1. Cuando las personas se enferman, usualmente es mucho lo que se puede hacer al respecto:
   si no a veces
2. Si usted sigue una vida de lo que Dios dice, usted rarament se enfermará
   si no a veces
3. Casi todas las enfermedades tienen remedio:
   si no a veces
4. Si Dios quiere mandarle una enfermedad, nadie lo puede impedir:
   si no a veces
5. Hay personas que se enferman todo el tiempo y otras nunca
   si no a veces
6. La mayoría de las enfermedades se curan solas aun cuando no se traten:
   si no a veces
7. La gente que tiene buena salud es por pura suerte:
   si no a veces
8. Si usted se enferma, es porque usted vive bajo mucho presión (trabaja mucho):
   si no a veces
9. En el futuro, los doctores van a encontrar remedio para todo enfermedades:
   si no a veces
10. La mayoría de los personas se enferman porque se preocupan mucho:
    si no a veces
11. Cuando las personas comen bien y mantienen un cuerpo sano, raras veces se enferman:
    si no a veces
12. Cuando las personas se enferman, todo depende de Dios si se mejoran:
    si no a veces
13. No hay para que preocuparse de las enfermedades, que lo tiene que pasar:
    si no a veces
14. Cuando las personas se enferman, usualmente es como resultado de mala suerte:
    si no a veces
15. La mayoría de las enfermedades pueden ser curada por un buen médico con las proprias medicinas (o por un curandero con las proprias remedios):
    si no a veces

Figure A2.2. (continued).

Creencias sobre Infección con Parásitos

Por favor me puede responder algunas preguntas:

me responda si no o no sé

16. Los niños nacen con lombrices: si no no sé

17. Las personas que tienen lombrices es porque no hierven la comida bien:
si no no sé

18. Si lo gente bebe agua sucia se enferma con lombrices:
si no no sé

19. Los niños que comer muchos dulces se enferman lombrices:
si no no sé

20. La gente que vive en casas sucias se enferman con lombrices menudo:
si no no sé

21. Solamente los niños tienen lombrices:
si no no sé

22. El comer las mismas cosas todo el tiempo le da lombrices:
si no no sé

23. Adultos a menudo obtiene lombrices de sus niños:
si no no sé

24. El que come comidas echodas a perder se enferma con lombrices:
si no no sé

25. Las personas que tenga mucho contacto con animales a menudo se enferman con lombrices:
si no no sé

26. Los niños que comen la tierra se enferman con lombrices:
si no no sé

27. Los niños se enferman con lombrices cuando comen masa cruda:
si no no sé

28. La gente se enferma con amebas en la misma froma que se enferma con lombrices:
si no no sé

29. Si usted toma agua sucia le den amebas:
si no no sé

Figure A2.2. (continued).

30. El que toma leche dulce le den lombrices:

si no no sé

31. Las personas que comen del mismo plato se enferman con amebas:

si no no sé

Creencias sobre Síntomos de Infección con Parásitos

32. Vomitar es un síntoma de infección con lombrices o amebas

si no no sé

33. Niños con lombrices a menudo se rascan su trasero

si no no sé

34. Diarrea es un síntoma de infección con lombrices o amebas

si no no sé

35. Cuando un niño come mucha comida es un síntoma de infección con lombrices:

si no no sé

36. Cuando los niños no duermen bien es porque tienen lombrices:

si no no sé

37. Cuando un niño saliva mucho es porque tiene lombrices o amebas:

si no no sé

38. Un estómago duro es un síntoma de infección con lombrices o amebas:

si no no sé

39. Un niño que no gane peso usualmente está infectado con parásitos:

si no no sé

40. Cuando un niño no come indica infección con parásitos:

si no no sé

41. Dolor de estómago es un síntoma de infección con parásitos:

si no no sé

42. Los niños que hacen rechinar los dientes al dormir usualmente es infectado con lombrices:

si no no sé

43. Cuando los niños lloran a menudo tienen parásitos:

si no no sé

Figure A2.2. (continued).

Creencias sobre Tratan Parásitos

44. Hay muchas medicinas buenas para curar parásitos:

si no no sé

45. Las hierbas del mercado son tan buenas como los medicinas del doctor para curar parásitos:

si no no sé

46. Si se infecta una persona en la casa con lombrices o amebas, es necesario tratar todas personas que vive la casa: si no no sé

47. Las medicinas del médico son muy caras para comprar:

si no no sé

48. Son las hierbas del mercado volen tanto como las medicinas del doctor:

si no no sé

49. Los lombrices y las amebas pueden ser tratar las misma medicinas:

si no no sé

Creencias sobre Prevención de Parásitos

50. Es imposible impedir infecciónes con parásitos en niños:

si no no sé

51. Si una persona se lava las manos con jabon se puede impedir infeccíon con parásitos:

si no no sé

52. Los lombrices se matan cuando se hierve el agua antes de tomarle:

si no no sé

53. Si los niños estan jugando en la tierra a fuera la casa, tienen parásitos:

si no no sé

54. Si reduce contacto con animales se puede impedir la infección con parásitos :

si no no sé

55. Si usted come alimentos limpios y bien preparados se infectará con parásitos:

si no no sé

56. Los parásitos mueren cuando se agrega Cloro al agua de bebida:

si no no sé

57. Buena limpieza impede infecciónes con parásitos y muchas otras enfermedades:

si no no sé

Figure A2.2. (continued).

Biographical Information

Name:_____

Colonia:_____ **Age:**_____ **Sex:**_____

Marital Status:____ **Occupation of Spouse:**_____

Do you own your house: _____ **How many years have you lived here:**_____

Name and Age of Children: _____

_____

_____

Water for the household is obtained from:

faucets in the street faucets in the house

the river/canal a spring/well

other _____

Water for drinking is: boiled used directly from the faucet

bottled treated with Clorox filtered

Where does the family go to the bathroom: latrine bathroom in the house

outside in the open

Is the latrine used only by your family or shared with other families?

Do you know the government recommendations for prevention of cholera:

yes no

If you are able list them for me_____

_____

_____

Do you follow the recommendations: all of the time sometimes never

Figure A3.1. English translation of the Modified Household Parasite Questionnaire (MHPQ), Version 1 administered during the July 1995 field session.

1. How do people become ill with worms: _____

_____

_____

2. How do people become ill with amebas: _____

_____

_____

3. Many persons say children become ill with worms when they eat too much candy.

What is your opinion: _____

Why is this true or false: _____

_____

4. Do you know some symptoms of infection with lombrices, yes no

Tell them to me_____

_____

_____

5. Do you know some symptoms of infection with amebas, yes no

Tell them to me_____

_____

_____

6. Where do you obtain medicines for curing worms and amebas:_____

_____

_____

Figure A3.1 (continued).

7. How much do the medicines cost: _____

_____

_____

8. In your opinion are they very expensive or a good buy: _____

_____

_____

9. If your son or daughter has worms or amebas who do you ask for advice about curing it: _____

_____

10. If your sister/brother or neighbor seeks advice for curing worms and amebas what do you recommend

_____

11. If your sister/brother or neighbor seeks advice for preventing woms and amebas what do you recommend

_____

Figure A3.1 (continued).

Información Biografía

Nombre:_____

Colonia:_____ **Edad:**_____ **Sexo:**_____

Estado civil:_____ **Occupacion del esposo:** _____

Es usted dueño de su casa:_____ **Cuantos años vive aqui:**_____

Nombre y edad de niños:_____

_____

_____

El agua para la familia se obtiene de:

llaves en la calle llaves en la casa

rio/canal un pozo

otro_____

El agua para bebida esta: hervida se toma directamente de la llave

embotellada le pone Cloro la filtra

A donde van al baño: letrina pieza de baño en la casa

al a aire libre

Es el baño usado solamente por toda la familia o por varias familias

Sabe usted las recomendaciones del gobierno para de colera:

si no

Puede usted decirmelas: _____

_____

_____

Sigue las recomendaciónes: todo el tiempo a veces nunca

Figure A3.2. Spanish Translation of the Modified Household Parasite Questionnaire (MHPQ), Version 1 administered during the July 1995field session.

1. Como se enferma la gente con lombrices: _____

_____

_____

2. Como se enferma la gente con amebas: _____

_____

_____

3. Muchas personas dicen los niños se enferman con lombrices cuando se comen muchos dulces.

   Que es su opinion: _____

   Por que es este cierto o falso: _____

   _____

4. Sabe alguns síntomas de infección con lombrices, si no decirmelas_____

_____

_____

5. Sabe alguns síntomas de infección con amebas, si no decirmelas_____

_____

_____

6. Donde obtienes las medicinas para curar infección con lombrices y amebas:_____

_____

_____

Figure A3.2. (continued).

7. Cuanto cuestan las medicinas: _____

_____

_____

8. En su opinion, estan muy caras o una buena comprar: _____

_____

_____

9. Si su niño o niña tiene lombrices o amebas, a quien le preguntas como curarlo:_____

_____

_____

10. Si su hermana (o) o vecina (o) le pide consejos para curar lombrices y amebas, que le recomiendas:

_____

_____

11. Si su hermana (o) o vecina (o) le pide consejos para la prevención de lombrices y amebas, que le recomiendas:

_____

_____

Figure A3.2. (continued).

Biographical Information

Name:_____

Colonia:_____ **Age:**_____ **Sex:**_____

Marital Status:____ **Occupation of Spouse:**_____

Do you own your house: _____ **How many years have you lived here:**_____

Name and Age of Children: _____

_____

_____

Water for the household is obtained from:

faucets in the street faucets in the house

the river/canal a spring/well

other _____

Water for drinking is: boiled used directly from the faucet

bottled treated with Clorox filtered

Where does the family go to the bathroom: latrine bathroom in the house

outside in the open

Is the latrine used only by your family or shared with other families?

Do you know the government recommendations for prevention of cholera:

yes no

If you are able list them for me_____

_____

_____

Do you follow the recommendations: all of the time sometimes never

Figure A4.1. English translation of the Modified Household Parasite Questionnaire (MHPQ), Version 2 administered during the December 1995 field session.

1. How do people become ill with worms: _____

_____

2. How do people become ill with amebas: _____

_____

_____

3. Many persons say children become ill with worms when they eat too much candy.

   What is your opinion: _____

   Why is this true or false: _____

   _____

4. Do you know some symptoms of infection with lombrices, yes no

   Tell them to me_____

   _____

5. Do you know some symptoms of infection with amebas, yes no

   Tell them to me_____

   _____

6. Many persons say "it is impossible to prevent parasitic infections in children".

   What is your opinion: _____

   Why is this true or false: _____

   _____

Figure A4.1 (continued).

7. Where do you obtain medicines for curing worms and amebas:_____

_____

_____

8. How much do the medicines cost: _____

_____

_____

9. In your opinion are they very expensive or a good buy: _____

_____

_____

10. If your son or daughter has worms or amebas who do you ask for advice about curing it: _____

_____

11. If your sister/brother or neighbor seeks advice for curing worms and amebas what do you recommend

_____

12. If your sister/brother or neighbor seeks advice for preventing woms and amebas what do you recommend

_____

Figure A4.1 (continued).

Información Biografía

Nombre:_____

Colonia:_____ **Edad:**____ **Sexo:**_____

Estado civil:____ **Occupacion del esposo:** _____

Es usted dueño de su casa:_____ **Cuantos años vive aqui:**_____

Nombre y edad de niños:_____

_____

_____

El agua para la familia se obtiene de:

llaves en la calle llaves en la casa

rio/canal un pozo

otro_____

El agua para bebida esta: hervida se toma directamente de la llave

embotellada le pone Cloro la filtra

A donde van al baño: letrina pieza de baño en la casa

al a aire libre

Es el baño usado solamente por toda la familia o por varias familias

Sabe usted las recomendaciones del gobierno para prevención de colera:

si no

Puede usted decirmelas: _____

_____

_____

Sigue las recomendaciónes: todo el tiempo a veces nunca

Figure A4.2. Spanish translation of the Modified Household Parasite Questionnaire (MHPQ), Version 2 administered during the December 1995 field session.

1. Como se enferma la gente con lombrices: _____

_____

_____

2. Como se enferma la gente con amebas: _____

_____

_____

3. Muchas personas dicen los niños se enferman con lombrices cuando se comen muchos dulces.

¿Que es su opinion: _____

¿Por que es este cierto o falso: _____

_____

4. Sabe alguns síntomas de infección con lombrices, si no decirmelas_____

_____

_____

5. Sabe alguns síntomas de infección con amebas, si no decirmelas_____

_____

_____

6. Muchas personas dicen "es impossible a impedir infecciónes parásitos en los niños".

¿Que es su opinion: _____

¿Por que es este cierto o falso: _____

_____

Figure A4.2. (continued).

7. Donde obtienes las medicinas para curar infección con lombrices y amebas:_____

_____

_____

8. Cuanto cuestan las medicinas: _____

_____

_____

9. En su opinion, estan muy caras o una buena comprar: _____

_____

_____

10. Si su niño o niña tiene lombrices o amebas, a quien le preguntas como curarlo:_____

_____

_____

11. Si su hermana (o) o vecina (o) le pide consejos para curar lombrices y amebas, que le recomiendas:

_____

_____

12. Si su hermana (o) o vecina (o) le pide consejos para la prevención de lombrices y amebas, que le recomiendas:

_____

_____

Figure A4.2 (continued).

Biographical Information

Name:_____

Colonia:_____ **Age:**_____ **Sex:**_____

Marital Status:____ **Occupation of Spouse:**_____

Do you own your house: _____ **How many years have you lived here:**_____

Name and Age of Children: _____

_____

_____

Water for the household is obtained from:

faucets in the street faucets in the house

the river/canal a spring/well

other _____

Water for drinking is: boiled used directly from the faucet

bottled treated with Clorox filtered

Where does the family go to the bathroom: latrine bathroom in the house

outside in the open

Is the latrine used only by your family or shared with other families?

Do you know the government recommendations for prevention of cholera:

yes no

If you are able list them for me_____

_____

_____

Do you follow the recommendations: all of the time sometimes never

Figure A5.1. English translation of the Modified Household Parasite Questionnaire (MHPQ), Version 3 administered during the April 1996 field session.

1. Many persons say children become ill with worms when they eat too much candy.

   What is your opinion: _____

   Why is this true or false: _____

   _____

2. Do you know some symptoms of infection with lombrices, yes no

   Tell them to me_____

   _____

3. Do you know some symptoms of infection with amebas, yes no

   Tell them to me_____

   _____

4. Many persons say "it is impossible to prevent parasitic infections in children".

   What is your opinion: _____

   Why is this true or false: _____

   _____

5. Many persons say the herbal remedies from the *mercado* are just as effective as the medicines from the doctor (pharmacy) for curing parasites.

   What is your opinion: _____

   What is the reason for your opinion: _____

   _____

Figure A5.1 (continued).

6. Where do you obtain medicines for curing parasites

Pharmacy Herbal Remedies Vendor Health Center

Other:_____

7. Which kind of medicines do you prefer:_____

Why:_____

If you are able, tell me some medicines used to cure parasites in your family:_____

_____

8. How much do the medicines cost: _____

In your opinion are they very expensive or a good buy: _____

9. If your son or daughter has worms or amebas who do you ask for advice about curing it: _____

_____

10. If your sister/brother or neighbor seeks advice for curing worms and amebas what do you recommend

_____

11. If your sister/brother or neighbor seeks advice for preventing worms and amebas what do you recommend:

_____

Figure A5.1 (continued).

Información Biografía

Nombre:_____

Colonia:_____ **Edad:**_____ **Sexo:**_____

Estado civil:_____ **Occupacion del esposo:** _____

Es usted dueño de su casa:_____ **Cuantos años vive aqui:**_____

Nombre y edad de niños:_____

_____

_____

El agua para la familia se obtiene de:

llaves en la calle llaves en la casa

rio/canal un pozo

otro_____

El agua para bebida esta: hervida se toma directamente de la llave

embotellada le pone Cloro la filtra

A donde van al baño: letrina pieza de baño en la casa

al a aire libre

Es el baño usado solamente por toda la familia o por varias familias

Sabe usted las recomendaciones del gobierno para prevención de colera:

si no

Puede usted decirmelas: _____

_____

_____

Sigue las recomendaciónes: todo el tiempo a veces nunca

Figure A5.2. Spanish translation of the Modified Household Parasite Questionnaire (MHPQ), Version 3 administered during the April 1996 field session.

1. Muchas personas dicen los niños se enferman con lombrices cuando se comen muchos dulces.

   ¿Que es su opinion: _____

   ¿Por que es este cierto o falso: _____

   _____

2. Sabe alguns síntomas de infección con lombrices, si no decirmelas_____

   _____

   _____

3. Sabe alguns síntomas de infección con amebas, si no decirmelas_____

   _____

   _____

4. Muchas personas dicen "es impossible a impedir infecciónes parásitos en los niños".

   ¿Que es su opinion: _____

   ¿Por que es este cierto o falso: _____

   _____

5. Muchas personas dicen las hierbas del mercado son tan effectiva como las medicinas del doctor (farmacia/botica) para curar parásitos.

   ¿Cual es su opinion: _____

   ¿Cual es la razon para su opinon: _____

   _____

Figure A5.2. (continued).

6. Donde obtienes las medicinas para curar infección con parásitos

Farmacia/Botica Hierbería Centro de Salud

Otro:_____

7. Cual son medicamentos prefieres tu:_____

Porque:_____

Puedes, decirme algunas medicamentos contra parásitos que usa por tu familia:_____

_____

8. Cuanto cuestan las medicinas: _____

En tu opinion, son muy caras o una buena comprar:_____

_____

9. Si su niño o niña tiene lombrices o amebas, a quien le preguntas como curarlo:_____

_____

_____

10. Si su hermana (o) o vecina (o) le pide consejos para curar lombrices y amebas, que le recomiendas:

_____

_____

11. Si su hermana (o) o vecina (o) le pide consejos para la prevención de lombrices y amebas, que le recomiendas:

_____

_____

Figure A5.2. (continued).

Appendix B

Parasitological Analysis: Summary Tables

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Table B1. Sample statistics of children, households, and *colonias* analyzed for endoparasitic infection. Statistically significant differences in age and sex for all children ≤16 years old was determined by Student's T test for unequal groups. Children for whom age was not recorded were excluded from the analysis.

	Males	Females
Samples	223	215
Mean Age [1]	5.68 (3.52)[a]	5.51 (3.93)
Total Children	438	
Total Households	217	
Total *Colonias*	8	

[a]standard deviation
[1]not significantly different (p=.28, 408 *df*)

Table B2. Endoparasitic species identified by microscopic examination of fecal samples from Valle Hermoso children. Prevalence was calculated from the number of samples positive for a given parasite divided by the total number of samples examined and the quotient multiplied by 100.

Parasite Species	Samples Positive/Examined	Percent Prevalence
Protozoa		
Giardia lamblia	55/438	12.55
Entamoeba coli	27/438	6.16
Entamoeba hartmanni	24/438	5.47
Entamoeba histolytica	1/438	0.22
Endolimax nana	23/438	5.25
Iodamoeba büetschlii	10/438	2.28
Helminths		
Hymenolepis nana	28/438	6.39
Ascaris lumbricoides	16/438	3.65
Trichuris trichiura	6/438	1.36
Enterobius vermicularis	6/438	1.36
Ancylostoma/Necator[1]	1/438	0.22
Strongyloides stercoralis	1/438	0.22

[1]The eggs of these human hookworm genera are morphologically indistinquishable.

Table B3. Endoparasitic infections in Valle Hermoso children according mean age and sex. Statistically significant differences in infection status by age for all children ≤16 years old was determined by Student's T test for unequal groups. Children for whom age was not recorded were excluded from the analysis.

	Males	Females
Infected children [1]	6.47 (3.08)[a]	6.18 (3.44)
Uninfected children[2]	5.75 (3.30)	5.39 (3.55)
All children[3]		
Infected	6.32 (3.26)	
Uninfected	5.62 (3.46)	

[a] standard deviation
[1] not significantly different (p=.62, 125 *df*)
[2] not significantly different (p=.30, 281 *df*)
[3] significantly different (p=.05, 408 *df*)

Table B4. Distribution of endoparasitic species identified in Valle Hermoso children. Parasitic species are listed according to mean age of infected and uninfected children ≤ 16 years. Statistically significant differences in mean age were determined by Student's T test for unequal groups. Children for whom age was not recorded were excluded from the analysis.

Parasite Species[1]	Mean age of infected children	Mean age of uninfected children	P value
Protozoa			
Giardia lamblia	5.70	5.85	0.764
Entamoeba coli	6.52	5.79	0.293
Entamoeba hartmanni	7.88	5.71	0.003*
Endolimax nana	6.57	5.79	0.286
Iodamoeba büetschlii	7.70	5.79	0.077
Helminths			
Hymenolepis nana	7.07	5.74	0.045*
Ascaris lumbricoides	4.50	5.89	0.107
Trichuris trichiura	6.83	5.82	0.519
Enterobius vermicularis	6.16	5.83	0.808

* Statistically significant difference ($p < .05$, 480 *df*)

[1] *Entamoeba histolytica*, *Ancylostoma/Necator*, and *Strongyloides stercoralis* were excluded because they were only present as single cases.

Table B5. Endoparasitic infection in Valle Hermoso children and their siblings. Odds ratio and 95% confidence limits test the association between infection status and the likelihood of a sibling infected with any endoparasite species. The exclusion of 1 from the 95% confidence interval indicates that infected children are 2.8 times more likely to a have an infected sibling than uninfected children.

	Sibling positive for any endoparasite	Sibling negative for any endoparasite
Infected children	75*	38
Uninfected children	100	146
Odds Ratio	2.88	
Upper 95% confidence limit	1.76	
Lower 95% confidence limit	4.72	

* Statistically significant by Chi Square ($p < .01$, 1 *df*)

Table B6. Endoparasitic infections in Valle Hermoso children according to sex of the host. Statistically significant association in infection status by sex for all children was determined by Chi Square.

	Positive for 1 or more parasite species[1]	Negative for any parasite species
Male children	63	160
Female children	68	147
All children	131	307

[1]not significantly different ($p=.44$, 1 *df*)

Table B7. Spearman rank order correlation coefficients for endoparasitic species identified from Valle Hermoso children. Independent variables of child age, and the occurrence of a sibling infected with any endoparasite are also included. Each cell in the matrix includes the correlation coefficient, the number of observations, and the probability (p-value) of obtaining similar results by random chance. Boldfaced p-values ($\leq .05$) indicate statistically significant correlation coefficients.

	Ascaris	*Trichuris*	*Enterobius*	*Hymenolepis*	*Giardia*	*E. coli*	*E. hartmanni*	*Endolimax*	*Iodamoeba*	Sib Positive	ChildAge
Ascaris	1.00										
	(438)										
	***										
Trichuris	0.1864	1.00									
	(438)	(438)									
	0.0001	***									
Enterobius	0.0818	-0.0139	1.00								
	(438)	(438)	(438)								
	0.0875	0.7716	***								
Hymenolepis	0.0486	-0.0308	0.0495	1.00							
	(438)	(438)	(438)	(438)							
	0.3095	0.5197	0.3008	***							
Giardia	0.0364	0.0146	-0.0447	0.0981	1.00						
	(438)	(438)	(438)	(438)	(438)						
	0.4468	0.76	0.3505	**0.0402**	***						
E. coli	0.0513	-0.0302	0.0515	0.2047	0.0461	1.00					
	(438)	(438)	(438)	(438)	(438)	(438)					
	0.2836	0.5277	0.282	**0.0000**	0.3351	***					
E. hartmanni	0.0601	-0.0284	-0.0284	0.1831	0.0299	0.272	1.00				
	(438)	(438)	(438)	(438)	(438)	(438)	(438)				
	0.2092	0.5531	0.5531	**0.0001**	0.5325	**0.0000**	***				
Endolimax	0.0633	0.0603	-0.0277	0.1058	0.0652	0.195	0.3481	1.00			
	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)			
	0.1859	0.2074	0.5619	**0.0269**	0.1727	**0.0000**	**0.0000**	***			
Iodamoeba	0.0517	0.1135	-0.018	0.1475	0.0805	0.0244	0.2319	0.1696	1.00		
	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)		
	0.2797	**0.0177**	0.7065	**0.002**	0.0926	0.6103	**0.0000**	**0.0004**	***		
Sib Positive	0.149	0.0515	0.0515	0.1554	0.1326	0.1187	0.0386	0.0907	0.0782	1.00	
	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(352)	
	0.0052	0.335	0.335	**0.0036**	**0.013**	**0.0262**	0.4701	0.0892	0.1427	***	
ChildAge	-0.048	0.0352	0.0318	0.1225	0.001	0.0932	0.1575	0.0756	0.0819	0.1556	1.00
	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(438)	(352)	(438)
	0.3161	0.4619	0.5055	**0.0105**	0.9831	**0.0513**	**0.001**	0.1142	0.0868	**0.0036**	***

Table B8. Endoparasitic infection in Valle Hermoso children and households with 3 or more resident children. Odds ratio and 95% confidence limits test the association between infection status and the likelihood of a household with 3 or more resident children having at least 1 child infected with any endoparasite species. The exclusion of 1 from the 95% confidence interval indicates that infected children are 4.76 times more likely to come from households with 3 or more children when compared to households with 2 and fewer children.

	Households with 3 or more children	Households with 1 or 2 children
Infected children	50*	29
Uninfected children	29	80
Odds Ratio	4.76	
Upper 95% confidence limit	9.35	
Lower 95% confidence limit	2.44	

*Statistically significant by Chi Square ($p < .01$, 1 *df*)

Table B9. Household distribution of endoparasitic species identified from fecal samples of Valle Hermoso children.

Parasite Species	Households Positive/Examined	Households with more than 1 infected child
Protozoa		
Giardia lamblia	45/217	10/45
Entamoeba coli	23/217	3/23
Entamoeba hartmanni	23/217	1/23
Entamoeba histolytica	1/217	--
Endolimax nana	21/217	2/21
Iodamoeba büetschlii	9/217	1/9
Helminths		
Hymenolepis nana	21/217	5/21
Ascaris lumbricoides	10/217	4/10
Trichuris trichiura	5/217	1/5
Enterobius vermicularis	5/217	1/5
Ancylostoma/Necator[1]	1/217	--
Strongyloides stercoralis	1/217	--

[1] The eggs of these human hookworm genera are morphologically indistinquishable.

Table B10. Acknowledged antiparasitic drug use in Valle Hermoso households sampled in 1996. Analysis of the data by Chi Square tested the hypothesis that there was no difference in distribution of infected vs. uninfected households with respect to drug treatment. Student's T.test was used to test the hypothesis of no difference in the mean number of weeks post drug treatment between uninfected and infected households.

	Infected Households	Uninfected Households
Drug Treatment	8	19
No Drug Treatment	2	10
Chi Square	0.73	p = .69[a]
Mean Number of Weeks Post-Treatment	32.57	24.18
Student's T Test	0.67	p = .50[b]

[a] Not significantly different by Fisher's Exact test
[b] Not significantly different by Student's T test.

Table B11. Household distribution of infections with any endoparasite species in Valle Hermoso *colonias* based on microscopic examination of fecal samples from children in 217 households.

Colonia[a]	**Children Positive/Examined**	**Households Positive/Examined**
Campo de Sueños	27/97	17/43
El Arbolado	14/57	11/30
Fuente de Suerte	12/55	9/32
La Corona	20/64	16/31
Los Indios	8/16	6/9
La Libertad	5/19	5/14
Los Vecinos	28/80	15/32
Sal Si Puedes	18/50	12/26

[a] All *colonia* names are pseudonyms to protect the privacy of their residents.

Table B12. Infection with *Giardia lamblia* in children from Los Vecinos. Odds ratio and 95% confidence limits test the association of *G. lamblia* infection in Los Vecinos compared to all other *colonias* in Valle Hermoso. The exclusion of 1 from the 95% confidence interval indicates that children infected with *G. lamblia* are 2.27 times more likely to come from Los Vecinos when compared to all other *colonias* participating in the study.

	Children with *Giardia lamblia* infection	**Children without *Giardia lamblia* infection**
Children from *Los Vecinos*	17*	63
Children from all other *colonias*	38	320
Odds Ratio	2.27	
Upper 95% confidence limit	4.46	
Lower 95% confidence limit	1.15	

*Statistically significant by Chi Square ($p < .01$, 1df)

Table B13. Predictive value of a single negative fecal examination for correctly identifying endoparasitic species in Valle Hermoso children. Percent sensitivity figures have been taken from published results of experimental studies by Nazer et al (1993), and Marti and Koella (1993)

Parasite Species	**Percent Prevalence**	**Percent Sensitivity**	**Negative Predictive Value**
Giardia lamblia	12.55	62.8[a]	94.93
		75.0[b]	96.53
Hymenolepis nana	6.39	47.0[a]	96.63
Ascaris lumbricoides	3.65	55.0[a]	98.32
		91.6[b]	99.68
Trichuris trichiura	1.36	50.0[a]	92.70
		88.8[b]	98.26
Ancylostoma/Necator[1]	0.22	77.4[a]	99.99
		80.0[b]	99.99

[1] The eggs of these human hookworm genera are morphologically indistinquishable.

[a] Sensitivity figures from Nazer et al (1993)

[b] Sensitivity figures from Marti and Koella (1993)

Appendix C

Household Interview Analysis: Summary Tables

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Table C1. Households in Valle Hermoso *colonias* interviewed about parasite and illness prevention beliefs.

Colonia[a]	Households with fecal samples	Households without fecal samples	Total households interviewed
Campo de Sueños	38	3	41
El Arbolado	17	9	26
Fuente de Suerte	31	4	35
La Corona	28	10	38
Los Indios	9	5	14
La Libertad	8	2	10
Los Vecinos	32	10	42
Sal Si Puedes	25	13	38
Total Households			**244**

All *colonia* names are pseudonyms to protect the privacy of their residents.

Table C2. Households in Valle Hermoso *colonias* interviewed about parasite and illness prevention beliefs according to comparison group assignment.

Household Comparison Group	
Outside comparison (no fecal samples)	56
Infected	79
Uninfected	109
Total Households	**244**

Table C3. Characteristics of household informants interviewed about parasitic infection and illness prevention beliefs. Statistically significant differences in mean age of informants, and years of residence in their *colonia* were determined by single factor ANOVA.

Outside Comparison Households	
Females	90%
Males	10%
Mean age[1]	31.83 (11.83)[a]
Mean years residing in *colonia*[2]	7.45 (4.87)
Infected Households	
Females	92%
Males	7.8%
Mean age	31.40 (8.16)
Mean years residing in *colonia*	5.41 (4.94)
Uninfected Households	
Females	90%
Males	9.5%
Mean age	31.37 (8.58)
Mean years residing in *colonia*	6.46 (3.83)

[a] standard deviation
[1] not significantly different ($p = .80$, 2, 230 *df*)
[2] not significantly different ($p = .22$, 2, 140 *df*)

Table C4. Characteristics of Valle Hermoso households interviewed about parasitic infections and illness prevention beliefs. Statistically significant differences in mean income and number of resident children were determined by single factor ANOVA.

Outside Comparison Households	
Mean Weekly Income (Mexican Pesos)[1]	235.75 (105.03)[a]
Own their house[2]	69%
Number of resident children*	2.62 (1.46)
Infected Households	
Mean Weekly Income (Mexican Pesos)	215.26 (79.56)
Own their house	74%
Number of resident children*	3.06 (1.34)
Uninfected Households	
Mean Weekly Income (Mexican Pesos)	216.93 (86.22)
Own their house	69%
Number of resident children*	2.01 (0.95)

[a] standard deviation
[1] not significantly different ($p = .69$, 2, 127 *df*)
[2] not significantly different ($p = .83$, 2 *df*)
* statistically significant difference ($p = .05$, 2, 236 *df*)

Table C5. Fecal waste disposal and source of drinking water for interviewed households. Statistical association between household infection status, type of facilities for fecal waste disposal, and source of drinking water was determined by chi square analysis.

Outside Comparison Households	
Facilities for fecal waste disposal	
Flush toilet in house	5 (9.80%)
Outside latrine	46 (90.19%)
Source of household drinking water	
Commercially bottled	39 (72.22%)
Faucet without treatment	14 (25.92%)
Faucet with treatment [1]	1 (1.85%)
Infected Households	
Facilities for fecal waste disposal	
Flush toilet in house[2]	11 (14.86%)
Outside latrine	63 (85.13%)
Source of household drinking water	
Commercially bottled	42 (56.00%)
Faucet without treatment[3*]	30 (40.00%)
Faucet with treatment	3 (4.00 %)
Uninfected Households	
Facilities for fecal waste disposal*[1]	
Flush toilet in house	25 (24.50%)
Outside latrine	77 (75.49%)
Source of household drinking water*[2]	
Commercially bottled	88 (83.01%)
Faucet without treatment	13 (12.26%)
Faucet with treatment	5 (4.71%)

*[1]statistically significant association ($p = .05$, 2 *df*)

*[2]statistically significant association ($p < .01$, 2 *df*)

[1]water is filtered, treated with chlorine bleach (*pone una gota de cloro*), or boiled.

[2]Odds ratio for household infection status and absence of flush toilet equal to 1.86 ($p = .11$, 1 *df*). Lack of statistical significance as a risk factor is indicated by inclusion of 1 in the 95% confidence interval (0.80 to 4.39).

[3*]Odds ratio for household infection status and use of untreated drinking water equal to 4.84 ($p < .01$, 1 *df*). Statistical significance as a risk factor is indicated by exclusion of 1 from the 95% confidence interval (2.16 to 10.96).

Table C6. Recall of cholera preventive measures by household informants. Statistically significant association between household infection status, and informant's ability to recall preventive measures was determined by chi square analysis.

Outside Comparison Households	
Able to recall at least 1 preventive measure[1]	36 (64%)[a]
Able to recall 3 or more preventive measures	13 (36%)[b]
Infected Households	
Able to recall at least 1 preventive measure	57 (72%)
Able to recall 3 or more preventive measures[2*]	27 (34%)
Uninfected Households	
Able to recall at least 1 preventive measure	88 (81%)
Able to recall 3 or more preventive measures*	58 (53%)

[a] calculated from total number of households interviewed within each comparison group

[b] calculated from number of households with ability to recall cholera preventive measures in each comparison group

[*] statistically significant association ($p < .01$, 2 *df*)

[1] not statistically different ($p = .06$, 2 *df*)

[2*] Odds ratio for household infection status and inability to list ≥ 3 cholera preventive measures equal to 2.19 ($p < .01$, 1 *df*). Statistical significance as a risk factor is indicated by exclusion of 1 from the 95% confidence interval (1.15 to 4.17).

Table C7. Recognition of cholera preventive measures by household informants. Statistically significant association between household infection status, and recognition of specific preventive measures was determined by chi square analysis.

Outside Comparison Households	**Number of responses**
Treatment of drinking water[1]	24 (29%)
Personal hygiene[2]	24 (29%)
Food hygiene[3]	27 (32%)
Other preventative measures	5 (7%)
Infected Households	
Treatment of drinking water	32 (24%)
Personal hygiene	51 (39%)
Food hygiene	41 (31%)
Other preventative measures	7 (5%)
Uninfected Households	
Treatment of drinking water	44 (18%)
Personal hygiene	100 (41%)
Food hygiene	85 (35%)
Other preventative measures	12 (5%)
Total Responses	**452**

[1] not statistically significant (p = .10, 2 *df*)
[2] not statistically significant (p = .10, 2 *df*)
[3] not statistically significant (p =.70, 2 *df*)

Table C8. Reported frequency of household use of cholera preventive measures. Statistically significant association between household infection status, and household use of cholera preventive measures was determined by chi square analysis.

Outside Comparison Households	
Consistent use of preventive measures	18 (51%)[a]
Inconsistent use of preventive measures[1]	17 (49%)
Infected Households	
Consistent use preventive measure	34 (59%)[a]
Inconsistent use of preventive measures[2]	24 (41%)
Uninfected Households	
Consistent use preventive measure	45 (57%)[a]
Inconsistent use of preventive measures	34 (43%)

[a] calculated from total number of households interviewed within each comparison group

[1] not statistically significant ($p = .78$, 2 *df*)

[2] Odds ratio for household infection status and inconsistent use of preventive measures equal to .099 ($p = .98$, 1 *df*). Lack of statistical significance as a risk factor is indicated by inclusion of 1 in the 95% confidence interval (0.47 to 2.10).

Table C9. Hygiene and dietary beliefs about the acquisition of endoparasitic infections. Frequency and relative percentage (in parenthesis) of household informants responding to questions about hygiene and dietary beliefs for the acquisition of parasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	**No**	**Don't Know**
Outside Comparison Households			
Living in a dirty house	31 (86%)	7 (11)	1 (3)
Contact with animals	23 (66)	6 (17)	6 (17)
Eating dirt	32 (88)	3 (8)	1 (3)
Drinking unclean water	29 (74)	5 (13)	5 (13)
Eating poorly cooked food	22 (61)	9 (25)	5 (14)
Eating spoiled food	25 (74)	5 (15)	4 (12)
Infected Households			
Living in a dirty house	44 (80)	5 (9)	6 (11)
Contact with animals	37 (69)	2 (4)	15 (27)
Eating dirt	50 (89)	3 (5)	3 (5)
Drinking unclean water	46 (84)	6 (11)	3 (5)
Eating poorly cooked food	37 (66)	10 (18)	9 (16)
Eating spoiled food	38 (68)	7 (12)	11 (20)
Uninfected Households			
Living in a dirty house	51 (78)	10 (15)	4 (6)
Contact with animals	36 (55)	8 (12)	22 (33)
Eating dirt	63 (95)	1 (2)	2 (3)
Drinking unclean water	56 (85)	4 (6)	6 (9)
Eating poorly cooked food	31 (48)	19 (29)	15 (23)
Eating spoiled food	42 (65)	7 (11)	16 (24)

Table C10. Folk related beliefs about the acquisition of endoparasitic infections. Frequency and relative percentage (in parenthesis) of household informants responding to questions on folk related beliefs for the acquisition of endoparasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	**No**	**Don't Know**
Outside Comparison Households			
Children are born with worms	9 (26%)	12 (34)	14 (40)
Eating the same food all of the time	14 (41)	13 (38)	7 (21)
Eating from the same plate	19 (54)	8 (23)	8 (23)
Eating raw tortilla dough (*masa cruda*)	23 (70)	7 (21)	3 (9)
Eating too much candy	28 (77)	7 (19)	1 (3)
Drinking sweet milk (*leche dulce*)	26 (72)	5 (14)	5 (14)
Infected Households			
Children are born with worms	17 (30)	20 (36)	19 (34)
Eating the same food all of the time	33 (60)	10 (18)	12 (22)
Eating from the same plate	29 (53)	12 (21)	14 (25)
Eating raw tortilla dough (*masa cruda*)	33 (59)	5 (9)	18 (32)
Eating too much candy	46 (82)	5 (9)	5 (9)
Drinking sweet milk (*leche dulce*)	38 (69)	3 (5)	14 (25)
Uninfected Households			
Children are born with worms	17 (27)	16 (25)	31 (48)
Eating the same food all of the time	34 (51)	19 (29)	13 (20)
Eating from the same plate	23 (35)	20 (31)	22 (34)
Eating raw tortilla dough (*masa cruda*)	31 (48)	9 (14)	25 (38)
Eating too much candy	58 (89)	1 (2)	6 (9)
Drinking sweet milk (*leche dulce*)	34 (53)	12 (19)	18 (28)

Table C11. Beliefs about acquisition of endoparasitic infections. Frequency and relative percentage (in parenthesis) of household informants responding to questions on beliefs about the acquisition of endoparasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	**No**	**Don't Know**
Outside Comparison Households			
Only children get worms	5 (14%)	28 (80)	2 (6)
Adults often get worms from their children	16 (46)	8 (23)	11 (31)
People get worms and *amebas* in the same ways	22 (61)	9 (25)	5 (14)
Infected Households			
Only children get worms	6 (11)	47 (85)	2 (4)
Adults often get worms from their children	29 (53)	14 (25)	12 (22)
People get worms and *amebas* in the same ways	36 (65)	8 (15)	11 (20)
Uninfected Households			
Only children get worms	3 (5)	61 (92)	2 (3)
Adults often get worms from their children	27 (42)	14 (22)	24 (37)
People get worms and *amebas* in the same ways	27 (42)	18 (28)	19 (30)

Table C12. Explanations for how people become infected with helminth parasites. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households
By means of the dirt
From the dirt
[When] *the children eat dirt*
[When people or children] *eat the dirt*
[When people] *eat contaminated food*
[When people] *don't have precaution with their food* [during preparation]
[When people] *don't cook food well*
[When people] *don't wash fruits* [before they are eaten]
[When people inhale] *contaminated air*
[When people] *have direct contact* [with contaminated sources]
[When people] *have poor hygiene*
[When people] *don't wash their hands before eating and after using the bathroom*
Infected Households
Grabbing contaminated things
Lifting foods to the mouth [with dirty hands]
From eating the same thing
When they eat one thing
Eating to much candy
Eating unwashed vegetables
[Eating] *unwrapped candy from street vendors*
[Eating] *food prepared outside of the house*
Lack of hygiene
Inhale contaminated air

Table C12. continued.

Uninfected Households
[When they] *eat candy and foods without nutritional value*
[From] *eating much candy*
[From] *eating* [foods available] *in the street*
[From] *eating foods*
[From] *eating much flour*
[When they] *drink unclean water*
From the dirt
Because they don't wash hands
Don't wash hands before meals
Don't wash hands before eating
When they eat with dirt on their hands

Table C13. Explanations for how people become infected with intestinal protozoan parasites. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households
[When] *they drink unclean water*
[When people eat] *contaminated vegetables*
[When people eat] *things that are not washed*
[When people eat] *lettuce that is not washed*
[When people] *eat food* [that is available] *in the street*
[When children] *eat contaminated candy from the street* [vendors]
[When people] *have no attention to quality* [well prepared] *food*
[When people] *don't wash their hands*
[People become infected] *in the same ways as for lombrices* [worms]
[The amoebas are] *acquired at birth*
Infected Households
[When people eat] *fruits that are not washed*
[When people eat] *lettuce that is not washed*
[When people] *eat food* [that is available] *in the street*
[When children] *eat ice treats* [raspas] *from street vendors*
[When people] *eat only 1 thing* *Because they* [children] *eat candy*
[When people] *eat food* [that is available] *in the street*
[When people] *eat in dirty places* *From lack of hygiene*

Table C13. continued

Uninfected Households
[When they] *eat unwashed vegetables*
[When they] *eat unwashed fruits and vegetables*
[From] *eating* [foods available] *in the street*
[From] *eating something dirty* [or placing dirty objects in mouth]
[When] *they prepare something* [food] *with dirty hands*
[When they] *do not cook vegetables well*
[When people] *don't clean their food well*
Lack of hygiene
When they eat with dirty hands

Table C14. Beliefs about the association between eating too much candy and parasitic infections in children. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households
Much candy is not good
Because the candy is not an ingredient for the health of the children
Because the candy takes away hunger [and the desire to eat food]
They [the children] *don't eat food from eating too much candy*
They [the candies] *are contaminated during preparation*
From the candy when it has been contaminated
If they [the children] *don't wash their hands first* [before eating the candy]
The candies are contaminated
The problems in the mouth [from tooth decay, oral hygiene, etc.] *cause sickness*
Infected Households
Candy contains no vitamins
Candy produces the parasites
It [the candy] *takes away the appetite*
When they [the children] *eat candy they don't eat food*
Because of the candy they [the children] *don't eat food*
Because it [the candy] *is all they* [the children] *ever eat*
They don't eat good [nutritious] *food*
They eat it [the candy] *with dirty hands*
When they are not wrapped [the candy is contaminated]
Uninfected Households
Because they [the children] *won't eat food*
They [the children] *begin to eat less food*
Because they [the children] *substitute the candy for food*
It [the candy] *causes lack of appetite*

Table C14. continued.

Uninfected Households
When they [the children] *eat candy, they don't want food*
They [the children] *only want to eat candy*
[The children] *eat only a little food from eating candy*
It [the candy] *suppresses the appetite*
The candy is dirty [contaminated]
They [the candies] *are prepared with dirty water*
Candy lacks important ingredients for health
They [the children] *don't have the motive for development* (with the candy)
Because her niece has many worms [and eats too much candy]

Table C15. Pathognomonic symptoms of endoparasitic infection. Frequency and relative percentage (in parenthesis) of Valle Hermoso households responding to questions on symptoms used to diagnose endoparasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	**No**	**Don't Know**
Outside Comparison Households			
Vomiting is a symptom of infection with worms or *amebas*	18 (55%)	10 (30)	5 (15)
Diarrhea is a symptom of infection with worms or *amebas*	27 (75)	7 (19)	2 (5)
A child that does not gain weight is usually infected with parasites	24 (66)	6 (17)	6 (17)
A hard stomach is a symptom of infection with worms or *amebas*	24 (66)	6 (17)	6 (17)
Stomach ache is a symptom of infection with parasites	31 (86)	2 (6)	3 (8)
Children with worms often scratch their buttocks	28 (78)	3 (8)	5 (14)
Infected Households			
Vomiting is a symptom of infection with worms or *amebas*	35 (65)	5 (9)	14 (26)
Diarrhea is a symptom of infection with worms or *amebas*	40 (74)	10 (19)	4 (7)
A child that does not gain weight is usually infected with parasites	40 (71)	6 (11)	10 (18)
A hard stomach is a symptom of infection with worms or *amebas*	31 (54)	3 (6)	20 (37)
Stomach ache is a symptom of infection with parasites	48 (87)	3 (5)	4 (7)
Children with worms often scratch their buttocks	52 (94)	1 (2)	2 (4)
Uninfected Households			
Vomiting is a symptom of infection with worms or *amebas*	31 (47)	11 (17)	24 (36)
Diarrhea is a symptom of infection with worms or *amebas*	45 (68)	8 (12)	13 (20)
A child that does not gain weight is usually infected with parasites	45 (68)	6 (9)	15 (23)
A hard stomach is a symptom of infection with worms or *amebas*	34 (51)	5 (7)	28 (42)
Stomach ache is a symptom of infection with parasites	54 (81)	3 (4)	10 (15)
Children with worms often scratch their buttocks	60 (91)	1 (2)	5 (7)

Table C16. Symptoms linked to parasitic infection by caregiver's intuition and experience. Frequency and relative percentage (in parenthesis) of Valle Hermoso households responding to questions on symptoms used to diagnose endoparasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	No	Don't Know
Outside Comparison Households			
A child with restless sleep is usually infected with worms	24 (67%)	7 (19)	5 (14)
Children who grind their teeth at night are usually infected with worms	30 (83)	3 (8)	3 (8)
When a child does not eat it is a symptom of infection with worms or *amebas*	26 (74)	5 (14)	4 (11)
When a child eats much food it is a symptom of infection with worms	21 (64)	10 (30)	2 (6)
When a child salivates often, it is a symptom of infection with worms or *amebas*	21 (62)	5 (15)	8 (23)
When a child cries often, it is a symptom of infection with parasites	19 (53)	11 (31)	6 (16)
Infected Households			
A child with restless sleep is usually infected with worms	37 (67)	2 (4)	16 (29)
Children who grind their teeth at night are usually infected with worms	48 (86)	4 (7)	4 (7)
When a child does not eat it is a symptom of infection with worms or *amebas*	45 (80)	4 (7)	7 (13)
When a child eats much food it is a symptom of infection with worms	40 (72)	2 (4)	13 (24)
When a child salivates often, it is a symptom of infection with worms or *amebas*	32 (58)	2 (4)	21 (38)
When a child cries often, it is a symptom of infection with parasites	26 (46)	5 (9)	25 (45)
Uninfected Households			
A child with restless sleep is usually infected with worms	28 (43)	12 (18)	25 (38)
Children who grind their teeth at night are usually infected with worms	56 (84)	6 (9)	5 (7)
When a child does not eat it is a symptom of infection with worms or *amebas*	45 (69)	13 (20)	7 (11)
When a child eats much food it is a symptom of infection with worms	37 (56)	8 (12)	21 (32)
When a child salivates often, it is a symptom of infection with worms or *amebas*	32 (48)	3 (4)	31 (47)
When a child cries often, it is a symptom of infection with parasites	24 (36)	17 (26)	25 (38)

Table C17. Symptoms of helminth infection compiled from open-ended interviews with household informants.

Symptom of infection with helminths (worms)	Household Comparison Group			Total Responses
	Outside Comparison	Infected	Uninfected	
Fever	1		3	4
Headache	1			1
Seizures	1			1
High blood pressure	1			1
Scratch nose/cause nose to itch		2		2
Salivate when they sleep	1			1
Grind their teeth	1		1	2
Don't know any symptoms		2		2
Gastrointestinal Complaints				
Stomach ache	2	2	6	10
Stomach inflammation	1			1
Diarrhea	2	2	3	7
Vomiting	2	1	2	5
Nausea (cause revulsion)		1		1
No appetite	1		2	3
Subtotal Gastrointestinal Complaints	8	6	13	27
Total Responses	14	10	17	**41**

Table C18. Symptoms of *ameba* infection compiled from open-ended interviews with household informants.

Symptom of infection with amoebas (protozoa)	Household Comparison Group			Total Responses
	Outside Comparison	Infected	Uninfected	
Fever	2		1	3
Headache	1		2	3
Seizures	1			1
Death	2			2
Without strength	1			1
Easily startled	1			1
Feel bad all over			1	1
Restless sleep	1			1
Grind their teeth	1			1
Don't know any symptoms		2	1	3
Gastrointestinal Complaints				
Stomach ache	5	2	1	8
Diarrhea	3	2	3	8
Stool with mucous and /or blood	1	2	1	4
Vomiting	2		1	3
Nausea (cause revulsion)		1		1
No appetite	1	1	1	3
Subtotal Gastrointestinal Complaints				
Total Responses	22	10	12	**44**

Table C19.Household beliefs about treatment of parasitic infection. Frequency and relative percentage (in parenthesis) of Valle Hermoso households responding to questions on treatment of endoparasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	No	Don't Know
Outside Comparison Households			
There are many effective medicines for treating parasitic infections	32 (91%)	1 (3)	2 (6)
The herbal remedies from the market are as good as the medicines from the doctor for curing parasites	18 (50)	12 (33)	6 (17)
Medicines from the doctor are very expensive to purchase	21 (58)	9 (25)	6 (17)
Herbal remedies from the market cost the same as medicines from the doctor	9 (25)	23 (64)	4 (11)
Worms and *amebas* are treated with the same medicines	8 (22)	22 (61)	6 (17)
If one person in the house is infected with worms or *amebas*, it is necessary to treat all persons living in the house	29 (81)	6 (17)	1 (2)
Infected Households			
There are many effective medicines for treating parasitic infections	45 (80)	5 (9)	6 (11)
The herbal remedies from the market are as good as the medicines from the doctor for curing parasites	22 (39)	20 (36)	14 (25)
Medicines from the doctor are very expensive to purchase	26 (47)	21 (38)	8 (15)
Herbal remedies from the market cost the same as medicines from the doctor	11 (20)	34 (60)	11 (20)
Worms and *amebas* are treated with the same medicines	11 (20)	34 (60)	11 (20)
If one person in the house is infected with worms or *amebas*, it is necessary to treat all persons living in the house	50 (89)	3 (5)	3 (5)
Uninfected Households			
There are many effective medicines for treating parasitic infections	62 (93)	1 (1)	4 (6)
The herbal remedies from the market are as good as the medicines from the doctor for curing parasites	33 (50)	19 (29)	14 (21)
Medicines from the doctor are very expensive to purchase	36 (54)	17 (26)	13 (20)
Herbal remedies from the market cost the same as medicines from the doctor	11 (17)	36 (55)	18 (28)
Worms and *amebas* are treated with the same medicines	8 (12)	35 (53)	22 (34)
If one person in the house is infected with worms or *amebas*, it is necessary to treat all persons living in the house	62 (93)	3 (4)	2 (3)

Table C20. Antiparasitic medications known by Valle Hermoso household informants. The English translated responses of the informants are indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households	**Frequency and percent of household responses**
Metronidazol or *Flagyl* [an antiprotozoal medication]	2 (40%)
Albendazole or *Zentel* [an anthelminthic medication]	1 (20)
Does not remember specific medications	2 (40)
Infected Households	
Metronidazol or *Flagyl* [an antiprotozoal medication]	
Albendazole or *Zentel* [an anthelminthic medication]	1 (25%)
Mebendazole or *Vermox* [an anthelminthic medication]	1 (25)
Avocado, Estfiate, Epazote [herbal antiparasitic remedies]	1 (25)
Does not remember specific medications	1 (25)
Uninfected Households	
Metronidazol or *Flagyl* [an antiprotozoal medication]	2 (9%)
Albendazole or *Zentel* [an anthelminthic medication]	6 (26)
Mebendazole or *Vermox* [an anthelminthic medication]	8(35)
Piprizine or *Pipiruit* [an anthelminthic medication]	1 (4)
Epazote, Hierba buena [herbal antiparasitic remedies]	1 (4)
Does not remember specific medications	5 (22)

Table C21. Reasons for preferential use of pharmaceutical compounds for treatment of parasitic infections. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households
The doctor is a professional and more knowledgeable about the selection of effective medicines
Because they [the medicines] *are prescribed by the doctor*
Some herbal remedies can be harmful
Infected Households
Because they [the medicines] *are prescribed by the doctor*
They [the medicines] *are effective and prescribed by the doctor*
They [the medicines] *are safer and more effective*
Uninfected Households
Persons in the botica know about parasites
Hierberos in the mercado don't perform an examination
Those [the vendors] *in the mercado don't have the preparation* [formal training] *or experience*
Doctors have the preparation and experience
Herbal remedies don't kill the parasites
The farmacia has the same medicines as the Centro de Salud
The ones [medicines] *from the doctor are better and more effective*
Only the doctors know how to cure [parasites]
Because they [the medicines] *remove all of the parasites*
Doctors recommend the perfect medicine
They [the medicines] *are effective*
Because there is more security with those medicines
It is the only one they give [at the *Centro de Salud* or IMSS]
Because they [the medicines] *are special for that purpose*

Table C22. Reasons for preferential use of herbal remedies for treatment of parasitic infections. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households
They [herbal remedies] *are natural*
Some occasions [times when the remedies cure better] *are not explainable by science*
Infected Households
Applied [herbal remedies] *in my family with optimal results*
Some herbs work, its been proven
Always had positive results from them (herbal remedies)
Milk-garlic and avacado shell is very effective (personal experience with effective remedies)
Uninfected Households
Has given them [herbal remedies] *in the past*
Sometimes natural medications are more effective
They [herbal remedies] *are better than medicines from the doctor* [pharmaceuticals]
Has used both herbal remedies and medicines
There are cases where good results were obtained with herbal remedies

Table C23. Opinions about the affordability of pharmaceutical based antiparasitic medications. The English translated responses of the informants are indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households	**Frequency and percent of household responses**
Pharmaceutical antiparasite drugs are expensive	5 (36%)
Some are free but others are very expensive	
Pharmaceutical antiparasite drugs are affordable	9 (64)
A good buy for health	
Some have the concept they [the drugs] *are expensive*	
A good buy because it protects the children	
Infected Households	
Pharmaceutical antiparasite drugs are expensive	9 (64%)
Although expensive they are a good buy because they prevent illness	
Expensive but effective	
Pharmaceutical antiparasite drugs are affordable	5 (36)
A good buy because it expels the parasites very well	
Uninfected Households	
Pharmaceutical antiparasite drugs are expensive	8 (50%)
Expensive but necessary	
Pharmaceutical antiparasite drugs are affordable	8 (50)
Its only a little [amount of money]	
Because you only have to give a small amount [of drug]	

Table C24. Action strategies used by household informants to obtain information about curing parasitic infections.

Outside Comparison Households	Frequency and percent of household responses
Doctor	12 (80%)
Doctor or nurse at Centro de Salud or IMSS	1 (7)
Knowledgeable family member or neighbor	2 (13)
Infected Households	
Doctor	17 (85%)
Knowledgeable family member or neighbor	1 (5)
Consult medical book and doctor	1 (5)
Nobody	1 (5)
Uninfected Households	
Doctor	26 (90%)
Doctor or nurse at Centro de Salud or IMSS	2 (7)
Knowledgeable family member or neighbor	1 (3)

Table C25. Action strategies used by household informants to obtain medications for curing parasitic infections.

Outside Comparison Households	Frequency and percent of household responses
Doctor	2 (11%)
Centro Salud or IMSS	12 (67)
Farmacia or *Botica*	4 (22)
Hierberia	
Infected Households	
Doctor	1 (5%)
Centro Salud or IMSS	10 (48)
Farmacia or *Botica*	8 (38)
Hierberia	2(10)
Uninfected Households	
Doctor	3 (8%)
Centro Salud or IMSS	15 (42)
Farmacia or *Botica*	15 (42)
Hierberia	3 (8)

Table C26. Recommended action strategies of household informants for curing parasitic infections. The English translated responses of the informants are indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households	**Number of times each action strategy was recommended**
Go to [or] *consult the doctor*	7 (41%)
Go to the hospital [or] *Centro de Salud*	2 (12)
Treat the symptoms	1 (6)
Use Epazote or Hierba buena	1 (6)
Give them [the infected child] *warm milk*	1 (6)
Buy [or] *use the same medicine* [used by my family or my friends]	5 (29)
Infected Households	
Go to [or] *consult the doctor*	15 (63%)
Go to the hospital [or] *Centro de Salud*	1 (4)
Consult medical book or doctor	1 (4)
Take the medicines they [doctors] prescribe	1 (4)
Have good hygiene	2 (8)
Buy [or] *use the same medicine* [used by my family or my friends]	3 (13)
Take candy from the children	1 (4)
Uninfected Households	
Go to [or] *consult the doctor*	23 (72%)
Go to the hospital [or] *Centro de Salud*	1 (3)
Go to the farmacia [ask pharmacist for advice]	1 (3)
Buy [or] *use the same medicine* [used by my family or my friends]	3 (9)
Use Vermox	1 (3)
Have good hygiene [or] *cleanliness*	2 (6)
No opinion about medicines	1 (3)

Table C27. Beliefs about prevention of endoparasitic infection. Frequency and relative percentage (in parenthesis) of household informants responding to questions about prevention of endoparasitic infections. All relative percentages have been rounded upward for descriptive purposes only.

	Households Responding		
	Yes	No	Don't Know
Outside Comparison Households			
It is impossible to prevent parasitic infections in children	15 (42%)	20 (56)	1 (2)
If a person washes their hands with soap they are able to prevent parasitic infections	28 (76)	8(22)	1 (2)
Worms are killed by boiling water before drinking it	28 (78)	7 (19)	1 (3)
If children play in the dirt outside of the house they will get parasites	27 (75)	7 (19)	2 (6)
Reducing contact with animals will prevent parasitic infections	19 (54)	12 (34)	4 (11)
If you eat clean, well prepared food you will become infected with parasites	4 (11)	30 (83)	2 (6)
Parasites are killed by adding *cloro* to drinking water	31 (86)	2 (6)	3 (8)
Good hygiene will prevent parasitic infections and many other diseases	34 (92)	2 (5)	1 (3)
Infected Households			
It is impossible to prevent parasitic infections in children	23 (41)	29 (52)	4 (7)
If a person washes their hands with soap they are able to prevent parasitic infections	43 (77)	10 (18)	3 (5)
Worms are killed by boiling water before drinking it	40 (73)	9 (16)	6 (11)
If children play in the dirt outside of the house they will get parasites	36 (68)	8 (15)	9 (17)
Reducing contact with animals will prevent parasitic infections	36 (64)	13 (23)	7 (12)
If you eat clean, well prepared food you will become infected with parasites	9 (16)	44 (79)	3 (5)
Parasites are killed by adding *cloro* to drinking water	37 (66)	9 (16)	10 (18)
Good hygiene will prevent parasitic infections and many other diseases	52 (93)	3 (5)	1 (2)
Uninfected Households			
It is impossible to prevent parasitic infections in children	21 (32)	39 (60)	5 (8)
If a person washes their hands with soap they are able to prevent parasitic infections	52 (80)	11 (17)	2 (3)
Worms are killed by boiling water before drinking it	41 (66)	12 (19)	9 (15)
If children play in the dirt outside of the house they will get parasites	45 (71)	3 (5)	15 (24)
Reducing contact with animals will prevent parasitic infections	41 (64)	12 (19)	11 (17)
If you eat clean, well prepared food you will become infected with parasites	9 (14)	49 (77)	6 (9)
Parasites are killed by adding *cloro* to drinking water	43 (68)	8 (13)	12 (19)
Good hygiene will prevent parasitic infections and many other diseases	60 (88)	4 (6)	4 (6)

Table C28. Reasons why prevention of parasitic infections in children is impossible. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households
Because they [the children] *don't have the ability to resist* [infection]
Children are always putting things in their mouth
Infected Households
Because they [the parasites] *attach everywhere and no one knows* [they are infected]
They [the parasites] *attach everywhere and you don't know* [if you are infected]
Because they [the children] *play and go to school* [outside of supervision]
Uninfected Households
Because they [the children] *are very dirty*
Once in awhile they [the parasites] *cannot be cured; I once had amebas and lived sick until they were cured*

Table C29. Reasons why prevention of parasitic infections in children is possible. The English translated response of the informant is indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households

If you avoid drinking water and eating from the same plates and glasses [as infected people] *it is possible to prevent infections*

If you have much care with the children [infections can be prevented]

There are many medicines for prevention of infection

There is penicillin and other antibiotics

Attend to it [the parasitic infection] *in time and treat every 6 months*

Give the medicines on time

Go to the Centro de Salud for treatment

If you have clean things [infections can be prevented]

Wash the hands [to prevent infections]

Infected Households

Attend to it in time [and you are able to prevent infection]

Because one is able to treat them [the children] *in time*

Prevention is possible with much care

There are medicines for prevention of infection

They [the parasites] *can be prevented only with medication*

You can give them fruits, cookies, and sweet bread [pan dulce] *in place of candy*

Uninfected Households

Because there are medicines

Because there are treatments

Because there is medicine

There are medicines

You are always able [to prevent infections] *with watchfullness and medicines*

[A] *clean house* [will] *prevent infections*

Table C29 continued.

Uninfected Households
[If you] *have good clean food* [they can be prevented]
Have good clean food [and] *wash hands before eating* [to prevent infections]
If we have careful attention and teach them [the children] *to be careful there will be no problems*
With interest [in hygiene] *you are able to prevent* [infections] *with little money*
Washing and cleanliness reduces infection
You can wash hands to prevent stomach infections
Avoid the reasons for obtaining them [parasitic infections]
If you have strict control of hygiene prevention is possible despite the beliefs of people in the colonia
If they follow the recommendations, they [the people] *are able to prevent them*
You are able to attend to them [the children] *in time*
Because if you take samples for analysis, you are able to get drugs for teatment
Because with care infections can be avoided

Table C30. Recommended action strategies for prevention of parasitic infection. The English translated responses of the informants are indicated by italics. Additional comments added for clarification of informant responses are unitalicized.

Outside Comparison Households	Number of times each action strategy was recommended
Go to [or] *consult the doctor*	5 (26%)
Go to the Centro de Salud	2 (11)
Have frequent analysis [preventive health exams]	1 (5)
Buy [or] *use the same medicine* [used by my family or my friends], [also] *treat with pills, go to the botica*	4 (21)
[Have] *proper hygiene* [or] *wash hands often*	4 (21)
Don't let the children eat dirt [or] *candy*	3 (16)
Infected Households	
Go to [or] *consult the doctor for advice* [or] *analysis*	4 (20%)
Go to the Centro de Salud	1 (5)
Ask doctor for the same medicines prescribed before	1 (5)
Avocado shell will prevent parasites cheaply without fuss	1 (5)
Have much hygiene [or] *cleanliness with food in household* [and] *boil water, wash fruits and vegetables*	8 (40)
Don't let children eat candy [or] *keep children clean,* [or] *don't let children play with animals*	5 (25)
Uninfected Households	
Go to [or] *consult the doctor* [or] *Centro de Salud for advice on prevention; understand how to cure them*	10 (31%)
Use [or] *get the same medicine as the previous visit*	2 (6)
Have cleanliness in foods [or] *wash fruits and vegetables, cook food well, boil the water*	5 (16)
Have absolute hygiene; wash hands before eating and after the bathroom; use the recommendations	8 (25)
Watch the children well; show them how to be clean; don't let them play in dirt; don't feed them much candy	7 (22)

Appendix D

Locus of Illness Control: Summary Tables

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Table D1. Mean of summed *Locus of Illness Control* scores for Valle Hermoso households according to infection status. Mean scores are listed for descriptive purposes only. Statistically significant variation in the mean score of household comparison groups on the prevention subscale and the total LIC instrument were determined by single factor ANOVA ($p \leq .05$, 2 and 116 *df*). Statistically significant variation in the median score of household comparison groups on the cure subscale was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 2 *df*)

Household Comparison Group	*Locus of Illness Control* Mean Score		
	Prevention[1]	Cure[2]	Total[3]
Outside Comparison	16.84 (2.27)[a]	9.50 (1.44)	26.34 (2.71)
Infected	16.87 (2.10)	9.00 (1.70)	25.87 (2.94)
Uninfected	16.27 (2.41)	9.06 (2.15)	25.34 (3.11)

[a] standard deviation
[1] not significantly different (p= .39, 2, 116 *df*)
[2] not significantly different (p= .32, 2 *df*)
[3] not significantly different (p= .29, 2, 116 *df*)

Table D2. Mean of summed *Locus of Illness Control* scores for households according to age class of informants. Mean scores are listed for descriptive purposes only. Statistically significant variation in the mean score of each informant age class on the prevention subscale and the total LIC instrument was determined by single factor ANOVA ($p \leq .05$, 2 and 111 *df*). Statistically significant variation in the median score of each informant age class on the cure subscale was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 3 *df*)

Informant Age Class	*Locus of Illness Control* Mean Score		
	Prevention[1]	Cure[2]	Total[3]
18 to 25 years	16.13 (2.23)[a]	10.00 (1.41)	26.13 (1.64)
26 to 32 years	16.47 (2.20)	9.09 (2.01)	25.57 (3.16)
33 to 43 years	16.46 (1.88)	8.84 (1.78)	25.30 (2.49)
44 to 70 years	17.00 (2.67)	8.96 (1.80)	25.96 (3.59)

[a] standard deviation
[1] not significantly different (p= .61, 2, 116 *df*)
[2] not significantly different (p= .19, 3 *df*)
[3] not significantly different (p= .78, 2, 116 *df*)

Table D3. Mean of summed *Locus of Illness Control* scores according to ability of household informants to recall cholera prevention measures. Mean scores are listed for descriptive purposes only. Statistically significant variation in the mean score of informants recall of Cholera prevention measures on the prevention subscale and the total LIC instrument was determined by single factor ANOVA ($p \leq .05$, 3 and 115 *df*). Statistically significant variation in the median score of informants recall of Cholera prevention measures on the cure subscale was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 3 *df*)

Cholera Prevention Measures	*Locus of Illness Control* Mean Score		
	Prevention[1]	Cure[2]	Total[3]
O	16.62 (1.86)[a]	9.05 (1.69)	25.67 (2.69)
1	17.85 (1.46)	9.71 (2.13)	27.57 (2.29)
2	16.40 (2.66)	9.00 (1.84)	25.40 (3.57)
≥ 3	16.57 (2.43)	9.20 (1.96)	25.77 (2.88)

[a] standard deviation
[1] not significantly different (p= .39, 3, 115 *df*)
[2] not significantly different (p= ..82, 3 *df*)
[3] not significantly different (p= .51 3, 115 *df*)

Table D4. Mean of summed *Locus of Illness Control* scores for household informants according to *colonia* of residence. Mean scores are listed for descriptive purposes only. Statistically significant variation in the mean score of each *colonia* on the prevention subscale and the total LIC instrument was determined by single factor ANOVA ($p \leq .05$, 7 and 111 *df*). Statistically significant variation in the median score of each *colonia* on the cure subscale was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 7 *df*)

***Colonia* of Residence**	***Locus of Illness Control* Mean Score**		
	Prevention[1]	**Cure[2]**	**Total[3]**
La Corona	16.80 (1.89)[a]	9.00 (1.82)	25.80 (2.36)
Los Vecinos	17.00 (2.44)	8.58 (1.93)	25.58 (3.72)
El Arbolado	16.46 (1.94)	8.69 (1.49)	25.15 (2.79)
Los Indios	17.00 (2.95)	8.91 (1.44)	25.91 (3.20)
Sal Si Puedes	15.57 (1.27)	9.42 (1.51)	25.00 (2.16)
Fuente de Suerte	16.52 (2.35)	8.81 (1.75)	25.33 (2.67)
Campo de Sueños	16.68 (2.77)	10.15 (2.14)	26.84 (3.68)
La Liberdad	15.80 (1.30)	10.40 (1.81)	26.20 (2.49)

[a] standard deviation
[1] not significantly different (p= .86, 7, 111 *df*)
[2] not significantly different (p= .23, 7 *df*)
[3] not significantly different (p= .77, 7, 111 *df*)

Table D5. Mean of item specific *Locus of Illness Control* scores from Valle Hermoso households according to infection status. Mean scores are listed for descriptive purposes only. Statistically significant variation in item score for control, infected, and uninfected households was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 2 *df*).

Locus of Illness Control Item	Mean Score			P-value[1]
	Outside Comparison	Infected	Uninfected	
1. When persons get sick, there is usually much they can do about it	1.30 (0.54)[a]	1.30 (0.59)	1.38 (0.61)	0.71
2. If you follow a life like God says you will rarely get sick	1.69 (0.88)	1.76 (0.87)	1.72 (0.82)	0.93
3. Almost all diseases have a cure	1.42 (0.70)	1.50 (0.72)	1.46 (0.71)	0.88
4. If God wishes to send you an illness there is nothing you can do about it	1.57 (0.90)	1.63 (0.85)	1.57 (0.77)	0.93
5. There are persons that are sick all of the time and others that are not	2.53 (0.70)	2.60 (0.57)	2.51 (0.71)	0.91
6. The majority of illnesses are cured alone even when they are not treated	1.50 (0.64)	1.26 (0.53)	1.40 (0.53)	0.14
7. The people that have good health is from pure luck	1.69 (0.92)	1.41 (0.74)	1.42 (0.80)	0.34
8. If you become ill, it is because you live under a lot of pressure (work too much)	2.19 (0.84)	2.39 (0.77)	2.17 (0.76)	0.30
9. In the future, the doctors will find a cure for all diseases	1.46 (0.76)	1.43 (0.75)	1.51 (0.80)	0.90
10. The majority of persons are sick because they worry too much	1.69 (0.73)	1.89 (0.87)	1.76 (0.78)	0.65
11. When persons eat well and maintain a healthy body, they are rarely sick	1.46 (0.70)	1.47 (0.75)	1.21 (0.46)	0.16
12. When persons are sick it all depends on God if they get better	2.46 (0.81)	2.30 (0.86)	2.08 (0.88)	0.16
13. There is no reason to worry about illness, you have what comes to pass	2.57 (0.75)	2.41 (0.80)	2.46 (0.77)	0.63
14. When people are sick, it is usually the result of bad luck	1.42 (0.75)	1.28 (0.62)	1.42 (0.77)	0.65
15. The majority of illnesses can be cured by a good doctor with the proper medicines	1.34 (0.62)	1.19 (0.50)	1.21 (0.50)	0.44

[a] standard deviation

[1] calculated from mean of ranked median scores

Table D6. Mean of item specific *Locus of Illness Control* scores according to age class of informants. Mean scores are listed for descriptive purposes only. Statistically significant variation in item score according to informant age class was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 3 *df*).

Locus of Illness Control Item	Informant Age Class				P-value[1]
	18 to 25	26 to 32	33 to 43	44 to 70	
1. When persons get sick, there is usually much they can do about it	1.46 (0.64)[a]	1.35 (0.61)	1.34 (0.56)	1.18 (0.53)	0.23
2. If you follow a life like God says you will rarely get sick	1.93 (0.79)	1.64 (0.82)	1.53 (0.81)	1.87 (0.94)	0.29
3. Almost all diseases have a cure	1.60 (0.50)	1.50 (0.77)	1.38 (0.63)	1.43 (0.75)	0.45
4. If God wishes to send you an illness there is nothing you can do about it	1.13 (0.51)[+]	1.64 (0.82)	1.53 (0.85)	1.84 (0.88)[+]	0.03*
5. There are persons that are sick all of the time and others that are not	2.40 (0.63)	2.54 (0.70)	2.69 (0.61)	2.50 (0.67)	0.35
6. The majority of illnesses are cured alone even when they are not treated	1.73 (0.59)[+]	1.38 (0.58)	1.15 (0.36)[+]	1.34 (0.54)	0.01*
7. The people that have good health is from pure luck	1.66 (0.90)	1.31 (0.68)	1.34 (0.74)	1.65 (0.90)	0.15
8. If you become ill, it is because you live under a lot of pressure (work too much)	2.20 (0.77)	2.14 (0.78)	2.42 (0.75)	2.31 (0.85)	0.45
9. In the future, the doctors will find a cure for all diseases	1.26 (0.59)	1.50 (0.77)	1.61 (0.85)	1.46 (0.80)	0.59
10. The majority of persons are sick because they worry too much	1.66 (0.72)	1.95 (0.82)	1.88 (0.86)	1.53 (0.71)	0.13
11. When persons eat well and maintain a healthy body, they are rarely sick	1.53 (0.74)	1.33 (0.61)	1.23 (0.58)	1.40 (0.71)	0.41
12. When persons are sick it all depends on God if they get better	2.66 (0.61)	2.14 (0.89)	2.15 (0.92)	2.28 (0.85)	0.23
13. There is no reason to worry about illness, you have what comes to pass	2.13 (0.83)	2.59 (0.70)	2.53 (0.70)	2.37 (0.90)	0.20
14. When people are sick, it is usually the result of bad luck	1.46 (0.74)	1.31 (0.64)	1.26 (0.60)	1.50 (0.88)	0.71
15. The majority of illnesses can be cured by a good doctor with the proper medicines	1.26 (0.45)	1.21 (0.52)	1.19 (0.49)	1.25 (0.56)	0.86

[a] standard deviation

[1] calculated from mean of ranked median scores

*statistically significant

+ statistically significant by Dunn's multiple comparison procedure

Table D7. Mean of item specific *Locus of Illness Control* scores according to ability of household informants to recall cholera prevention measures. Mean scores are listed for descriptive purposes only. Statistically significant variation in item score according to informant recall of Cholera prevention measures was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 3 *df*).

Locus of Illness Control Item	Cholera Prevention Measures				P-value[1]
	0	1	2	≥ 3	
1. When persons get sick, there is usually much they can do about it	1.25 (0.54)[a]	1.57 (0.78)	1.25 (0.52)	1.42 (0.62)	0.29
2. If you follow a life like God says you will rarely get sick	1.52 (0.81)	1.85 (0.90)	1.88 (0.84)	1.80 (0.75)	0.23
3. Almost all diseases have a cure	1.32 (0.61)	1.28 (0.48)	1.55 (0.80)	1.57 (0.75)	0.34
4. If God wishes to send you an illness there is nothing you can do about it	1.72 (0.87)	1.71 (0.95)	1.37 (0.62)	1.60 (0.86)	0.45
5. There are persons that are sick all of the time and others that are not	2.72 (0.50)+	2.71 (0.48)	2.25 (0.71)+	2.55 (0.72)	0.02*
6. The majority of illnesses are cured alone even when they are not treated	1.35 (0.66)	1.28 (0.48)	1.37 (0.56)	1.40 (0.49)	0.74
7. The people that have good health is from pure luck	1.37 (0.70)	1.71 (0.95)	1.59 (0.88)	1.46 (0.84)	0.65
8. If you become ill, it is because you live under a lot of pressure (work too much)	2.37 (0.77)	2.28 (0.75)	2.18 (0.78)	2.20 (0.81)	0.69
9. In the future, the doctors will find a cure for all diseases	1.52 (0.84)	1.85 (0.90)	1.22 (0.50)	1.51 (0.78)	0.19
10. The majority of persons are sick because they worry too much	1.70 (0.85)	2.00 (0.81)	1.92 (0.67)	1.77 (0.85)	0.48
11. When persons eat well and maintain a healthy body, they are rarely sick	1.20 (0.46)	1.71 (0.75)	1.55 (0.75)	1.35 (0.67)	0.05*
12. When persons are sick it all depends on God if they get better	2.52 (0.75)	2.28 (0.95)	2.18 (0.78)	2.04 (0.95)	0.09
13. There is no reason to worry about illness, you have what comes to pass	2.60 (0.77)	2.57 (0.78)	2.22 (0.80)	2.48 (0.75)	0.12
14. When people are sick, it is usually the result of bad luck	1.40 (0.74)	1.28 (0.75)	1.40 (0.74)	1.33 (0.67)	0.93
15. The majority of illnesses can be cured by a good doctor with the proper medicines	1.07 (0.26)	1.42 (0.53)	1.40 (0.69)	1.24 (0.57)	0.04*

[a] standard deviation

[1] calculated from mean of ranked median scores

* statistically significant

+ statistically significant by Dunn's multiple comparison procedure

Table D8. Mean of item specific *Locus of Illness Control* scores for informants according to *colonia* of residence. Mean scores are listed for descriptive purposes only. Statistically significant variation in item score according to *colonia* of residence was determined by Kruskal-Wallis single factor nonparametric ANOVA ($p \leq .05$, and 7 *df*).

Locus of Illness Control Item	*Colonia* of Residence				
	La Corona	*Los Vecinos*	*El Arbolado*	*Los Indios*	*Sal si Puedes*
1. When persons get sick, there is usually much they can do about it	1.32 (0.55)[a]	1.23 (0.66)	1.07 (0.27)	1.33 (0.65)	1.28 (0.48)
2. If you follow a life like God says you will rarely get sick	1.64 (0.81)	1.29 (0.58)	2.15 (0.98)	1.58 (0.79)	2.14 (1.06)
3. Almost all diseases have a cure	1.64 (0.90)	1.29 (0.68)	1.46 (0.66)	1.16 (0.38)	1.14 (0.37)
4. If God wishes to send you an illness there is nothing you can do about it	1.60 (0.81)	2.23 (0.90)[+]	1.53 (0.87)	1.25 (0.62)	1.71 (0.95)
5. There are persons that are sick all of the time and others that are not	2.76 (0.59)	2.70 (0.47)	2.53 (0.66)	2.66 (0.65)	2.00 (0.81)
6. The majority of illnesses are cured alone even when they are not treated	1.16 (0.37)	1.05 (0.24)	1.53 (0.77)	1.50 (0.67)	1.71 (0.95)
7. The people that have good health is from pure luck	1.32 (0.74)	1.58 (0.87)	1.38 (0.76)	1.91 (0.99)	1.28 (0.75)
8. If you become ill, it is because you live under a lot of pressure (work too much)	2.60 (0.64)	2.41 (0.71)	2.23 (0.92)	2.08 (0.79)	2.00 (0.81)
9. In the future, the doctors will find a cure for all diseases	1.64 (0.86)	1.29 (0.68)	1.53 (0.87)	1.25 (0.62)	1.42 (0.78)
10. The majority of persons are sick because they worry too much	1.84 (0.85)	1.58 (0.71)	1.76 (0.92)	2.00 (0.85)	1.57 (0.78)
11. When persons eat well and maintain a healthy body, they are rarely sick	1.40 (0.70)	1.17 (0.39)	1.38 (0.76)	1.50 (0.90)	1.71 (0.95)
12. When persons are sick it all depends on God if they get better	2.04 (0.93)	2.47 (0.80)	2.00 (0.91)	2.41 (0.90)	2.57 (0.78)
13. There is no reason to worry about illness, you have what comes to pass	2.44 (0.87)	2.52 (0.80)	2.30 (0.85)	2.08 (0.99)	2.14 (1.06)
14. When people are sick, it is usually the result of bad luck	1.20 (0.50)	1.47 (0.80)	1.15 (0.55)	1.91 (0.90)	1.00 (0.00)
15. The majority of illnesses can be cured by a good doctor with the proper medicines	1.20 (0.50)	1.23 (0.66)	1.07 (0.27)	1.25 (0.45)	1.28 (0.75)

[a] standard deviation

[1] calculated from mean of ranked median scores

*statistically significant

+ statistically signinficant by Dunn's multiple comparison procedure

Table D8. continued.

Locus of Illness Control Item	*Colonia* of Residence			P-value[1]
	Fuente de Suerte	*Campo de Sueños*	*La Liberdad*	
1. When persons get sick, there is usually much they can do about it	1.28 (0.46)[a]	1.57 (0.69)	1.80 (0.83)	0.15
2. If you follow a life like God says you will rarely get sick	1.81 (0.87)	1.89 (0.80)	1.40 (0.89)	0.13
3. Almost all diseases have a cure	1.47 (0.60)	1.78 (0.78)	1.20 (0.44)	0.15
4. If God wishes to send you an illness there is nothing you can do about it	1.19 (0.51)	1.57 (0.76)	2.00 (1.00)	0.01*
5. There are persons that are sick all of the time and others that are not	2.66 (0.57)	2.26 (0.73)	2.20 (0.83)	0.03*
6. The majority of illnesses are cured alone even when they are not treated	1.42 (0.50)	1.57 (0.50)	1.20 (0.44)	0.02*
7. The people that have good health is from pure luck	1.33 (0.73)	1.57 (0.83)	1.60 (0.89)	0.40
8. If you become ill, it is because you live under a lot of pressure (work too much)	2.09 (0.70)	2.00 (0.94)	2.60 (0.54)	0.16
9. In the future, the doctors will find a cure for all diseases	1.38 (0.66)	1.57 (0.83)	1.60 (0.89)	0.76
10. The majority of persons are sick because they worry too much	2.04 (0.80)	1.73 (0.80)	1.40 (0.54)	0.57
11. When persons eat well and maintain a healthy body, they are rarely sick	1.33 (0.48)	1.42 (0.60)	1.00 (0.00)	0.68
12. When persons are sick it all depends on God if they get better	2.04 (0.97)	2.36 (0.68)	2.80 (0.44)	0.32
13. There is no reason to worry about illness, you have what comes to pass	2.71 (0.46)	2.63 (0.59)	2.60 (0.54)	0.63
14. When people are sick, it is usually the result of bad luck	1.33 (0.73)	1.57 (0.83)	1.00 (0.00)	0.02*
15. The majority of illnesses can be cured by a good doctor with the proper medicines	1.19 (0.40)	1.26 (0.45)	1.80 (1.09)	0.71

[a] standard deviation
[1] calculated from mean of ranked median scores
*statistically significant

Table D9. Factor analysis results for *Locus of Illness Control* scores from households that did not provide fecal samples for parasitologic analysis. Eigenvalues were calculated from the sum of squared factor weights from the original 6 factor matrix prior to orthogonal rotation by the varimax method. The percent of variation accounted for by each factor is the quotient of the eigenvalue divided by the total number of variables (15) in the analysis multiplied by 100. The 6 factors account for 73.53% of the cumulative variation in LIC scores.

Factor	Eigenvalue	Percent Variation	Cumulative Percent
1	2.928742	19.52	19.52
2	2.291173	15.27	34.80
3	1.757009	11.71	46.51
4	1.536311	10.24	56.75
5	1.489388	9.93	66.68
6	1.026725	6.84	73.53

Table D10. Varimax rotated factor matrix for *Locus of Illness Control* scores from households that did not provide fecal samples for parasitologic analysis. Boldfaced numbers in the table indicate the factor weights which explain a significant amount of the variation in scores for the 15 item Locus of Control instrument for each of the six factors.

Locus of Control Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1	-0.20083	-0.06841	-0.17232	-0.29030	-0.58843	0.48707
2	-0.28402	0.09334	-0.14881	**0.69881**	0.20141	0.13039
3	-0.03995	**0.79605**	-0.09669	0.17975	0.04430	-0.27373
4	-0.74313	-0.03847	0.08524	-0.00346	-0.18387	0.21734
5	**0.75619**	-0.16923	0.02055	-0.25782	-0.00543	-0.01641
6	-0.03472	-0.01571	0.09528	0.13708	-0.05136	**0.87879**
7	0.02595	-0.02004	**0.85602**	-0.13724	0.12936	0.14790
8	0.27766	0.36186	0.01922	**0.59894**	0.29625	0.37518
9	0.03445	0.04796	-0.11275	-0.01268	**0.86479**	0.00095
10	0.09980	-0.75947	0.18503	0.06464	0.04959	-0.33991
11	-0.70813	-0.01536	-0.19257	0.39849	-0.23136	-0.26818
12	**0.83646**	0.05847	0.07220	0.17257	-0.10855	0.00985
13	0.09209	**0.55634**	0.41684	-0.24048	0.19019	-0.08505
14	0.03517	-0.12944	**0.85436**	0.06647	-0.30135	-0.07457
15	-0.06746	-0.38071	-0.00352	**0.65451**	-0.24141	-0.12856

Table D11. Factor analysis results for *Locus of Illness Control* scores from infected Valle Hermoso households. Eigenvalues were calculated from the sum of squared factor weights from the original 6 factor matrix prior to orthogonal rotation by the varimax method. The percent of variation accounted for by each factor is the quotient of the eigenvalue divided by the total number of variables (15) in the analysis multiplied by 100. The 6 factors account for 63.94% of the cumulative variation in LIC scores.

Factor	Eigenvalue	Percent Variation	Cumulative Percent
1	2.264828	15.10	15.10
2	1.760251	11.74	26.83
3	1.648618	10.99	37.82
4	1.513622	10.99	47.92
5	1.300412	8.67	56.58
6	1.102842	7.35	63.94

Table D12. Varimax rotated factor matrix for *Locus of Illness Control* scores from infected Valle Hermoso households. Boldfaced numbers in the table indicate the factor weights which account for a significant amount of the variation in scores for the 15 item Locus of Control instrument for each of the six factors.

Locus of Control Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1	0.04998	0.21511	-0.60158	0.17143	0.04795	-0.11470
2	-0.16343	-0.19532	0.07328	0.14626	-0.01234	**0.71390**
3	0.05262	-0.12038	-0.09774	0.00744	**0.80923**	0.04204
4	-0.28125	**0.68247**	-0.35895	-0.09414	0.13096	0.05490
5	-0.04146	**0.61928**	-0.05805	0.12721	-0.00093	-0.12535
6	0.37342	0.11183	-0.04142	-0.12596	0.04172	**0.75479**
7	**0.72654**	0.00302	0.04319	-0.07567	0.17342	0.08182
8	0.12349	-0.08676	0.10846	**0.89778**	-0.00968	-0.08989
9	0.09168	0.08732	**0.75086**	0.09800	-0.01314	-0.07228
10	-0.00891	-0.05398	0.29446	-0.70924	0.04238	-0.32110
11	-0.05551	-0.46164	-0.03518	0.24455	0.18096	0.41806
12	**0.62450**	0.01969	-0.43440	0.12413	-0.44176	0.13709
13	0.16464	**0.66873**	0.46016	-0.20928	-0.11876	0.09006
14	**0.70933**	-0.13172	0.14663	0.23094	0.16629	-0.09478
15	0.16535	0.08637	0.01225	-0.01967	**0.74780**	0.02705

Table D13. Factor analysis results for *Locus of Illness Control* scores from uninfected Valle Hermoso households. Eigenvalues were calculated from the sum of squared factor weights from the original 6 factor matrix prior to orthogonal rotation by the varimax method. The percent of variation accounted for by each factor is the quotient of the eigenvalue divided by the total number of variables (15) in the analysis multiplied by 100. The 6 factors account for 72.08% of the cumulative variation in LIC scores.

Factor	Eigenvalue	Percent Variation	Cumulative Percent
1	2.924188	19.49	19.49
2	2.225334	14.84	34.33
3	1.737069	11.58	45.91
4	1.544574	10.30	56.21
5	1.251578	8.34	64.55
6	1.129133	753	72.08

Table D14. Varimax rotated factor matrix for *Locus of Illness Control* scores from uninfected Valle Hermoso households. Boldfaced numbers in the table indicate the factor weights which explain a significant amount of the variation in scores for the 15 item Locus of Control instrument for each of the six factors.

Locus of Control Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1	-0.11028	-0.06305	0.26223	**0.76153**	-0.05183	0.05073
2	0.04964	0.05622	**0.68693**	0.22960	-0.37717	0.13526
3	0.17640	**0.76489**	0.23308	0.09192	-0.05584	0.02593
4	-0.02601	-0.09920	-0.16085	0.43700	0.52573	-0.38759
5	-0.15702	-0.08534	0.03383	-0.32320	**0.66284**	0.35552
6	0.04839	-0.07731	0.07407	-0.01057	-0.07233	**0.76557**
7	**0.83461**	0.17074	0.14885	-0.21132	0.13561	0.00091
8	0.40056	0.08578	-0.11095	-0.10262	**0.72523**	-0.05106
9	-0.10568	**0.89257**	-0.15788	0.06043	0.02385	0.10994
10	-0.77426	0.16400	0.20668	-0.19566	-0.09784	-0.19842
11	-0.03245	0.01077	**0.88107**	0.01935	0.06620	-0.05398
12	**0.79021**	0.14618	-0.19013	-0.00578	-0.28783	-0.04294
13	0.01651	-0.29469	0.09210	-0.08126	-0.14339	-0.71641
14	**0.77685**	-0.10241	0.29341	-0.16388	0.21791	-0.09853
15	-0.04044	0.32797	-0.04417	**0.74656**	-0.17098	0.02321

VITA

Charles Thomas Faulkner was born in Paris, France on August 10, 1954. He was raised as a United States Navy dependent and attended public and private schools in the United States and Japan. He enrolled at the University of Tennessee, Knoxville in 1976. He received a Bachelor of Arts degree in Anthropology in 1982. He continued his education at the University of Tennessee and conducted his Master's thesis research on prehistoric dietary behavior and parasitic infection in an analysis of 2000-year-old human fecal samples from Big Bone Cave in Van Buren County, Tennessee. He received a Master of Arts degree in Anthropology in 1989. Charles remained at the University of Tennessee, and began working toward the Doctor of Philosophy degree in 1990. His education during this period was focused on the cultural aspects of human parasitism and diagnostic veterinary parasitology. This changed emphasis required additional training in parasitology, epidemiology, and medical anthropology. The Doctor of Philosophy degree was awarded in December 1998.

Dr. Faulkner joined the staff of the Clinical Parasitology Service Laboratory at the University of Tennessee College of Veterinary Medicine as a Senior Laboratory Technician in 1988. He was promoted to Laboratory Technologist in 1990. He received his present appointment as a Research Associate in 1997. His duties at the College of Veterinary Medicine have included management of the Clinical Parasitology Service Laboratory and instruction of veterinary students in diagnostic parasitology.

Dr. Faulkner is a member of the American Society of Parasitologists, the Southeastern Society of Parasitologists, the American Anthropological Association, the Society for Medical Anthropology, the United States-Mexico Border Health Association, and *Sigma Xi*, the Scientific Research Society.