Assessment of Parasitic Disease in Children in Five Communities in the Border Region of Far West Texas

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This study, funded by the Office of Border Health of the Texas Department of Health (TDH), was commissioned to the University of Texas Health Science Center at Houston, School of Public Health, El Paso Regional Campus (UT-HSC) in June 2001.

The idea for the study was originally conceived by Miguel Escobedo and Katherine von Alt in January 2001. The original concept was to study the association between hygiene practices and intestinal parasite infestation in a sample of students attending first, second, and third grade at the following school districts: Canutillo, San Elizario, Presidio, and Terlingua. Participants in the study were to respond to a questionnaire on hygiene habits and to submit one stool sample.

Subsequent discussions led the research team to limit the scope of the study to an assessment of the prevalence of parasites in first-grade students in the above-mentioned school districts. The reasons leading to that decision included the facts that (1) the lack of baseline data hampered the possibilities of determining an appropriate sample size for the study, and (2) the link between poor hygienic practices and transmission of intestinal parasites is already well established.

A positive finding is likely to lead to a recommendation to invest in water and sewage systems, and in educating and facilitating the adoption of appropriate hygiene habits.

During the latter part of the planning phase, Terlingua was dropped from the study due its small number of students and the technical difficulties of conducting the study in such a remote area. In its place, the communities of Sierra Blanca and Fort Hancock were added.

The team of researchers involved in the execution of the study includes the following:

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Other TDH and UT-HSC staff assisted in several aspects of project management at different times during project execution.

Study Objective

To determine the prevalence of intestinal parasites in schoolchildren attending first-grade classes in the following Texas school districts: Canutillo, San Elizario, Presidio, Sierra Blanca, and Fort Hancock.

Parasites

Parasites can be classified into single-celled protozoa and multi-cellular metazoa. Although not all parasites may be pathogenic, the presence of parasites of unknown pathogenicity or which are non-pathogenic is still relevant because these organisms have similar life cycles and transmission routes *(Levinson and Jawetz, 1998)*.

Protozoa. Within the intestinal tract, three organisms are the most important pathogenic protozoans: *Giardia lamblia*, *Entamoeba histolytica*, and *Cryptosporidium parvum (Levinson and Jawetz, 1998)*. *Blastocystis hominis* may be pathogenic; *Chilomastix mesnili*, *Endolimax nana*, *Entamoeba coli*, *Entamoeba dispar*, *Entamoeba hartmanni*, *Entamoeba polecki*, and *Iodamoeba butschlii* are considered non-pathogenic. Detection of these non-pathogenic organisms in humans would suggest ingestion of contaminated water or food. Although these organisms by themselves may not cause illness, the presence of any of them may indicate possible exposure to pathogenic organisms *(CDC, 2001)*.

Metazoa. Included in this group are the medically important platyhelminthes (flatworms), which include the cestodes (tapeworms) and trematodes (flukes). Other metazoans include the nemathelminthes (nematodes/roundworms).

Tapeworms attach to the intestinal wall of humans and produce eggs that are excreted in the feces. The eggs may be directly transmitted to other humans (by unhygienic practices) or to intermediate hosts (cattle, pigs, and fish). Other humans are subsequently infected by ingestion of contaminated water or raw or undercooked infected meats, especially pork. The four medically significant tapeworms are *Taenia solium*, *Taenia saginata*, *Diphyllobothrium latum*, and *Echinococcus granulous (Levinson and Jawetz, 1998)*.

The medically important trematodes include several *Schistosom*a species (blood flukes), *Clonorchis sinesis* (liver fluke), and *Paragonimus westermani* (lung fluke). The medically important trematodes have a life cycle consisting of both a sexual cycle in humans and an asexual cycle in freshwater snails (intermediate hosts). Transmission to humans occurs either by direct penetration of the skin by free-swimming trematodes or by ingestion of cysts in undercooked fish or crabs *(Levinson and Jawetz, 1998)*. Two of the blood flukes, *Schistosoma mansoni* and *Schistosoma japonicum*, affect the gastrointestinal tract and can be diagnosed by identifying eggs in the stool.

Medically significant nematodes are divided into two classes: (1) intestinal nematodes and (2) tissue nematodes. The intestinal nematodes include *Enterobius* (pinworms), *Trichuris* (whipworms), *Ascaris* (giant roundworms), *Strongyloides* and *Trichinella* (small roundworms), and *Necator* and *Ancylostoma* (hookworms). *Enterobius* is found worldwide and is the most common helminth in the United States. Children younger than age 12 are the most commonly affected group. Diagnosis, however, cannot be achieved by examining a stool sample as the eggs can only be picked up from the peri-anal skin. The eggs of *Trichuris*, *Ascaris*, *Necator*, and *Ancylostoma* are shed in the stool. The larvae of *Strongyloides* can also be found in feces. The diagnosis of infection with *Trichinella* is made through muscle biopsy or serologic testing.

Living Conditions Along the U.S.-Mexico Border

It is estimated that 11.5 million people reside along the U.S.-Mexico border and that this population will double by the year 2020. Poverty characterizes much of the border area. In the United States, five of the seven poorest Metropolitan Statistical Areas (MSAs) are located along the border. Furthermore, more than 35% of Texas' border population lives in poverty *(USMBHC, 1998).* The U.S. General Accounting Office has found that the U.S.-Mexico border region includes hundreds of colonias, which are substandard developments lacking running water, sewage systems, and, often, electricity. There are an estimated 340,000 Texans (about 20% of the border population) and 15,000 New Mexicans living in colonias *(Dutton, Weldon, Shannon, & Bowcock, 2000).*

According to the Health Resources and Services Administration (HRSA), if it were the fifty-first state, the U.S.-Mexico border would rank last in per capita income, first in the number of schoolchildren living in poverty, last in access to health care (and first in the number of children who are uninsured), second in death rates from hepatitis, and third in death rates from diabetes *(HRSA, 1998).*

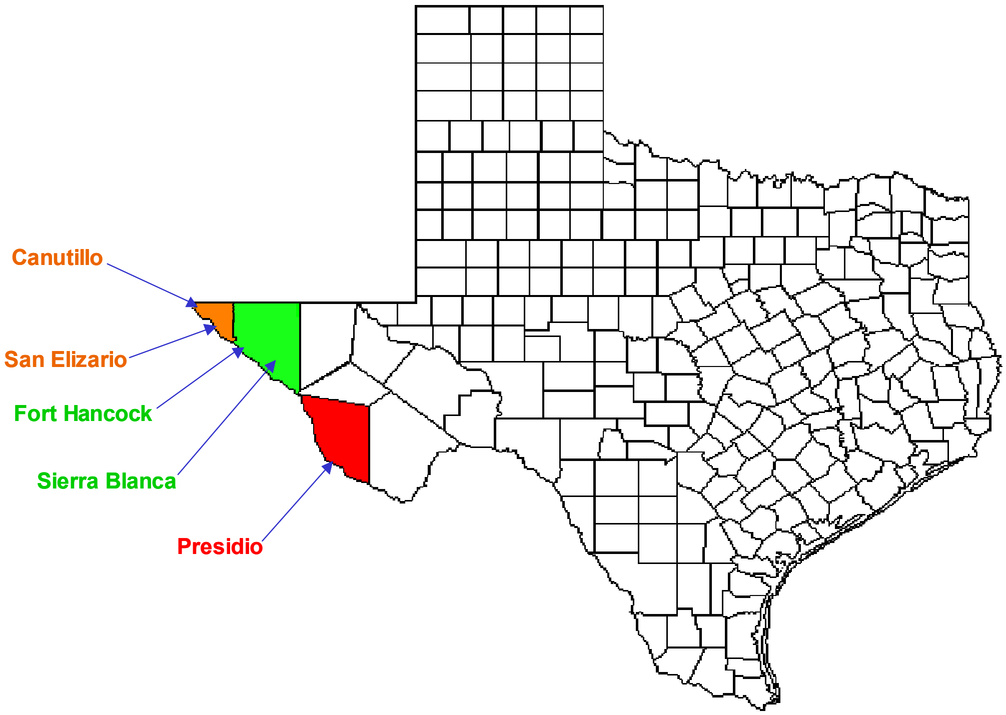
The Rio Grande supplies water for drinking and irrigation for more than 6 million people. However, some parts of the river exhibit fecal bacteria counts as high as 22,000 bacteria per milliliter *(USMBHC, 1998).* In addition, colonias without proper sewage systems often use open cesspools or other inadequate disposal methods that then pose a health threat to the community *(HRSA, 1998)*.

Frequent trade across the border includes food bought in Mexico and later consumed by U.S. residents. According to the Pan American Health Organization (PAHO), many waterborne and foodborne infections are endemic in northern Mexico and can be carried across the border *(PAHO, 2000)*. A study by Flores et al. (1983) showed that parasitic infections correlate positively with recent travel to Mexico, and a study of 90 Mexican immigrants resettled in California showed a parasite infection rate of 39% *(Arfaa, 1981)*.

Study Sites

The selection of communities to be included in the study was based on a variety of factors including poverty level, status as colonias or proximity to colonias, and history and relationship with the Texas Department of Health. For example, in 1997, the town of San Elizario, Texas, participated in a study on hepatitis A that was successful in bringing about an improvement in the community after a high prevalence rate was found *(Leach, Koo, Hilsenbeck & Jenson, 1999)*. Canutillo, Presidio, and Terlingua are school districts with which TDH has had a long history of collaboration. However, during the late planning stages of the study, it was decided to exclude the community of Terlingua from the study due to the small number of eligible students and the technical difficulties of conducting the study in this highly remote area. In its place, Sierra Blanca and Fort Hancock were added to the study.

Figure 1. Parasites Study Communities



Data is currently not available on water and sewage conditions specific to the communities under study, but TDH recently conducted a household survey of 2,194 homes along the border that compared environmental health and conditions in colonias to non-colonia communities *(Dutton, Weldon, Shannon, & Bowcock, 2000)*. The primary goal of that study was to acquire data regarding variables that are reflective of the environment and health status of Texas border residents living in both colonias and non-colonias. Variables studied included access to health care, child health, living conditions, blood-lead levels in children, and links to Mexico. Findings of the study include the following:

- Public sewer service was available to only 54% of the colonia residents.
- Colonia children 1 year to 5 years of age were much more likely than non-colonia children to have had diarrhea in the past two weeks.
- 11% of both colonia and non-colonia children younger than 1 year of age were reported to have had diarrhea in the past two weeks. In a preliminary survey of five El Paso colonias without drinking water or wastewater services (i.e., worst-case scenario) a two-week diarrhea prevalence of 20% was observed in children younger than 1 year of age.

Significance

Disease surveillance is generally weak in the U.S.-Mexico border region *(USMBHC, 1998)*. No data is available to describe the prevalence of intestinal parasite infections, but there is some evidence suggesting that intestinal parasite infections may exist at a higher prevalence in communities along the U.S.-Mexico border.

Community-based studies of parasitic diseases often focus on pediatric populations. A recent review of the literature on the relationship between the prevalence of parasites in children and the overall burden to the community found a consistent correlation between rates of infection in children and rates in adult populations. It is therefore appropriate to interpret such community-based studies on pediatric populations as somewhat reflective of the burden such infections have on the community *(Guyatt, Brooker & Donnelly, 1999)*.

Children are more susceptible to waterborne and foodborne infections because their immune systems are not fully developed and their playing and hygiene practices put them at greater risk of infection than older age groups. The consequences of infection may interfere with their growth and development and may limit their school achievement. The health effects of infection include anemia, growth reduction, protein-loosing enteropathy, malabsorption, rectal prolapse, chronic and recurrent abdominal pain, and intestinal obstruction. Several parasites may cause secondary complications such as wheezing, abscesses, and cysts.

In a study conducted in South Texas, researchers from the University of Texas Health Science Center at San Antonio found a high prevalence of hepatitis A in communities on the U.S. side of the Texas-Mexico border. In that study, children in border communities and colonias had an elevated risk for hepatitis A. More specifically, the prevalence of hepatitis A in children in San Antonio was 6% compared to 17% in urban communities along the border and 37% in colonia communities. Risk factors which were associated with hepatitis A included residence in a colonia, lack of consumption of bottled water, having resided in a developing country, and fewer years of maternal secondary education *(Leach, Koo, Hilsenbeck & Jenson, 1999)*.

In an article from the University of California at Los Angeles School of Medicine, the authors reported that infection with *Taenia solium*, and its more dangerous counterpart, cysticercosis, are frequently encountered in the southwestern United States. This is also true of regions of the United States that have large numbers of immigrants from nearby Mexico and parts of Central and South America *(Brown & Voge, 1985)*. The authors suggest that while contaminated meat may be one method of spreading infection, raw vegetables, unsanitary restaurants, hospital laboratories, and transient workers may be the more common pathways for spreading the infection. Children in homes employing transient workers are an especially vulnerable population *(Brown & Voge, 1985)*.

A study done between September 1981 and February 1982 in a pediatric clinic in Houston found that among 321 children 6 months to 16 years of age seen at the clinic for health maintenance or for acute illness, 158 (49.5%) tested positive for parasites. The pathogenic parasites found were, in order of prevalence, *Giardia lamblia*, *Ascaris lumbricoides*, *Trichuris trichiura*, *Hymenolepis nana*, and *Entamoeba histolytica*. "Two-thirds of patients with positive stool specimens had a personal or family history of recent travel, while only a third of patients with negative stool specimens had a similar history" *(Flores, Plumb, & McNeese, 1983)*. The authors concluded that Mexican-American children with frequent travel to Mexico have a high risk of infection and should be screened periodically regardless of symptoms.

The presence of parasites in children is quite common in developing countries. For this reason, most countries in Latin America conduct yearly de-parasitation campaigns. A study conducted in Bogota, Colombia, in 1997 among 237 children between 24 and 76 months of age documented that the prevalence of *Ascaris* and pinworms was 0.5%. *Entamoeba histolytica* affected 3.5% of the children, and *Giardia lamblia* affected 14.5%. Forty-five and a half percent of the children had chronic malnutrition, and 38.8% exhibited global malnutrition. The results of blood tests and other social and environmental variables of the infected children did not differ significantly from those not infected *(Cortés et al., 1999)*. Another study conducted among 198 rural schoolchildren ages 5 to 15 years demonstrated that the prevalence of *Ascaris lumbricoides* was 36.4%, *Trichuris trichiura* 34.8%, hookworms 18.2%, and *Strongyloides stercolaris* 4.5%. Fifty-one percent of the children were at risk of malnutrition, 83% had low hematocrit levels, and 55% had low hemoglobin levels. Most of these children had a deficit in learning capacity *(Reyes et al, 1999)*.

There is little epidemiologic data available regarding parasite prevalence rates in border communities in Mexico. However, a study in Tabasco, Mexico (central Mexico), looked at parasite prevalence rates in preschool children. The researchers found gastrointestinal parasites in 75% of the stool samples. Furthermore, 68% of the children were below the third percentile of height-for-age. Although the authors suggested no link, these statistics suggest a population at high risk for parasites and possible poor health and nutrition status *(Dewey, 1983)*.

It is believed that health professionals on the U.S. side of the border may not be aware of the prevalence of parasitic diseases in the region and may thus possibly under-diagnose both symptomatic and asymptomatic patients.

The results of this study yielded information that can lead to:

(1) Increased community and political awareness of the health problems that result from inappropriate access to clean water and sewerage services. The data may be used to request funds and programs to expand access of water and sewage services to underserved communities on the U.S. side of the border.

(2) Better knowledge of health conditions affecting schoolchildren and the subsequent adoption of educational programs for parents and children on hygiene habits, detection of parasitic problems, and sources of treatment.

(3) Increased awareness among the medical community about the prevalence of parasitic diseases in the U.S.-Mexico border region that may lead to timely detection and treatment.

Methodology

In the spring and summer of 2001, all school districts within the communities were approached and invited to participate, and all districts agreed to participate. Letters of support were then provided by each school district. In addition, each school designated a staff person to act as a contact for the project and provided information on the sizes of their first-, second-, and third-grade classes. As mentioned above, during the later stages of the design phase, it was decided to limit the study to first-graders.

Before starting the fieldwork, the study methods and consent forms were submitted to and subsequently approved by the Internal Review Boards of the Texas Department of Health and of the University of Texas-Houston Health Science Center. Also, the Department of Health Sciences and the Institutional Review Board at New Mexico State University approved the study and allowed graduate student Chris Adams to use the study for his capstone experience.

Data Collection in San Elizario

In early September 2002, Dr. Miguel Escobedo, Regional Director of TDH Public Health Region 9/10, contacted the superintendent of the San Elizario Independent School District to schedule a meeting among the research team, the superintendent, and the nurses of the three schools in the district. The purpose of this meeting was to discuss the methods for data collection and handling. During the meeting, the following strategy was agreed on:

- The school would provide the names of all the children enrolled in first grade and the research team would use the list to pre-assign a non-identifying code to each child.
- At least two meetings with the parents of the children were to be held at each school: one during regular school hours (at either 8 a.m. or 2 p.m.) and another one in the evening. The school nurses and the research team would then jointly schedule the meetings between the parents and the research team.
- The school would send letters inviting the parents to attend the meeting.
- At the meeting with the parents, the research team would present the study, distribute sample collection kits, and get consent forms signed.
- The teachers would collect assent forms signed by the children participating in the study.
- The parents would return the sample collection kits to the school nurse.
- A member of the research team would periodically go to the schools to collect the returned sample kits.
- TDH would mail the kits to the TDH laboratory in Austin on a weekly basis.
- The research team would send letters to the parents informing them of the results of the sample analysis and would follow up on all of the families whose children tested positive to ensure that they received adequate treatment.
- The school would receive five dollars for each sample returned, and gift certificates would be given to nurses and teachers participating in the program.

The only difference between the above-mentioned plan and the strategy outlined by the research team was that the research team had anticipated working through the teachers instead of the nurses. However, the nurses felt that some of the teachers would not feel comfortable discussing the project with the children. The nurses felt that they were in a better position to interact with children and their parents and also better equipped to collect and store the specimen sample kits. The school staff felt very strongly that the kits should only be handled by adults and never be left in the hands of children. They suggested that the kits be mailed directly by the parents to the laboratory, but the research team disagreed for fear of losing control of the study.

The fact that the involvement of the teachers was going to be limited also meant that some of the in-class activities that the research team had anticipated would not be conducted. Also, it became clear that the schools had a tight teaching schedule, and it would be difficult to add additional activities.

The research team decided that, for the study to be valid, there was a need to ensure the participation of at least 60% of the first-grade children. The school staff, however, mentioned that participation of parents in school activities tends to be very low.

The meetings with the parents were scheduled for Nov. 27 (Alarcon Elementary), Nov. 28 (Zambrano Elementary) and Nov. 29 (Borrego Elementary). The meeting on Nov. 28 was cancelled due to snow. Attendance at the other meetings was low, in part due to the bad weather and in part due to other community activities that were occurring on the same days.

The agenda for the meetings with parents was as follows:

- Explanation of the initiative: Dr. Luis Escobedo of the New Mexico Department of Health explained the importance of knowing the status of the community with respect to parasitic disease in children. He stressed the importance of knowing whether children were infected, so that they could be treated.
- Demonstration on how to collect the stool sample (using mashed potatoes and dyed water).
- Explanation of the incentive program, through which the school would receive five dollars for each sample returned.
- Questions and answers.
- Signing of consent forms (and assent forms if the child was present). If the child was not present, the school nurse and/or the teacher were to get the assent form signed by the child before the specimen collection.

- Distribution of sample collection kits to the parents who had signed the consent form. To maintain confidentiality, the two tubes inside the sample collection kit were labeled with a coded sticker. Another sticker with the coded number was placed on a log sheet that tracked all specimen samples and all necessary consent and assent forms of participating children. A fourth copy of the sticker was placed on the laboratory sample collection form that had already been filled out with the required information.
- The collection kits included laboratory collection tubes with instructions in English, Spanish, and pictorial form, as well as latex gloves and specimen hats.
- The dates when consents and assents are received were recorded on a log sheet along with the date when the collection kit was distributed.

At the end of the last meeting with the parents, each school nurse received a notebook with the names and codes of all the first-grade children in the school. Parents who wanted to participate in the study but had not attended the meeting were encouraged to contact the school nurse to receive a sample kit already appropriately labeled.

Only 17 samples (representing about 6 percent of the first-grade student body) were returned to the school nurses and subsequently shipped to Austin.

Data Collection in Canutillo

The experience in San Elizario suggested that, to reach the desired sample size, there had to be a change in the strategy for approaching the parents. The research team felt that the school district needed to take more ownership and present the project as a school activity, not as a research study. It was also felt that the study needed to rely more heavily on a school's ability to get parents to attend the meetings and participate in the project.

The first contact with the superintendent in Canutillo was on Oct. 31, 2002. The response from the superintendent and the special-education director was enthusiastic. They immediately organized a meeting of the research team with all of the teachers and nurses. In that meeting, the research team presented the methodology proposed in San Elizario and requested feedback. The staff in Canutillo said that the strategy presented was ideal and suggested enlisting the collaboration of the parent liaisons. It was also suggested that phone calls be made to all the parents the night before the meeting.

Canutillo Elementary School sent the first letter asking the parents to participate in the project on Jan. 11, 2003. On Jan. 14, a second letter was sent and a phone call was made to all of the parents of first-grade children attending Canutillo Elementary School, and the first parent meetings took place on Jan. 15 at 3 p.m. and at 6 p.m. The same procedure was followed for Damian Elementary, where the parent meetings were held on Jan. 31 (2 p.m. and 6 p.m.), at Davenport Elementary on Feb. 6 (2 p.m. and 6 p.m.), and at Bill Childress Elementary on Feb. 21 (2 p.m. and 6 p.m.).

In addition, the research team set up information tables in each school on the days of the parent-teacher conferences, distributed pamphlets in major public places, and assisted parent-teacher liaisons in making phone calls and reminding parents to return the kits. Additional reminder letters were mailed to the parents. On a few occasions there was a need to make home visits (to those parents who had signed consent forms but had not returned the kits and those parents who had not enrolled their children but had contacted the research team expressing willingness to participate). During the final two months of sample collection, the project coordinator and/or fieldworkers visited with parent liaisons, nurses, and teachers almost daily. All teachers and nurses were kept informed of the study's progress.

All of these efforts resulted in the collection of 208 sample kits, representing 57% of the children enrolled in first grade in the Canutillo Independent School District.

Data Collection in Presidio

During the early months of 2002, Dr. Miguel Escobedo of TDH introduced the study to the school superintendent and the TDH nurses while Dr. Nuria Homedes of UT-HSC, on a separate visit to Presidio, discussed the study with interested parties. A meeting between the parents and the research team was held on Sept. 11, 2002, at 3 p.m. This meeting was well attended, and most of the specimen collection kits were distributed during this session. The specimen collection methods followed the same procedures developed for Canutillo.

A total of 67 kits were returned, representing 62% of all the eligible children.

Data Collection in Sierra Blanca

TDH Office of Border Health staff met with the interim principal of Sierra Blanca Elementary School (SBES) on Oct. 17, 2002. The scope of the parasites study was explained to her, after which she expressed willingness to participate. She then wrote a letter of interest to TDH. A total of 12 children were eligible to participate in the study, and SBES provided TDH with a list of their names. Letters were mailed to the parents inviting them to participate in the study and also inviting them to an informational meeting. Before the meeting, TDH staff called those parents with available phone numbers to remind them about the meeting.

On Nov. 13, the informational meeting with SBES parents was held. Five of the parents signed up to participate in the study, and specimen collection kits were given to them. On Dec. 10, reminder letters were sent to these five potential participants reminding and persuading them to return the specimen kits. The procedures for the collection and delivery of specimens were the same as those followed in San Elizario, Canutillo, and Presidio. By the end of December 2002, only two of the five willing participants had provided samples. TDH did not pursue the remaining parents, assuming that they had changed their minds about participating. In addition, after Dec. 20, the school was closed for the holidays, making it difficult to continue with collection of specimens.

Data collection in Fort Hancock

On Oct. 21, 2002, TDH Office of Border Health staff met with the nurse of Fort Hancock Elementary School (FHES) and explained to her the scope of the parasites study and the procedures to be used. She affirmed that the school was interested in participating and suggested enrolling the assistance of the parent liaison. She provided TDH with a list of eligible children and an official letter accepting participation. Letters were mailed to the parents inviting them to participate in the study and to attend an informational meeting. Again, before the meeting, TDH staff called those parents with available telephones to remind them about the study.

On Nov. 14, the informational meeting was held with FHES parents, 30 of whom signed up to participate in the study. Specimen collection kits were distributed at the meeting. On Dec. 9, TDH staff sent letters to the parents who had signed up to participate to remind them about returning the samples.

The procedures used for the collection and delivery of specimens was the same as those followed with the other participating schools.

By the third week of December, a total of 29 samples had been collected. No additional telephone calls or reminders were mailed out due to school closure for the holidays.

Laboratory Methods

The Texas Department of Health central laboratory performed all of the testing for parasites. Although, for diagnostic purposes, it is recommended that three independently collected samples be used, a recent study concluded that examination of three samples was not always warranted *(Cartwright, 1999)*. In that study, the authors found that, in a population with a high prevalence (36.8% overall), the sensitivity of analyzing only one sample was 75.9%. They cited three previous studies in populations with lower prevalence rates that reported a sensitivity of more than 90% with one ova-and-parasite analysis. Furthermore, using only one ova-and-parasite analysis is common practice in epidemiologic studies of parasitic infection rates *(Flores, Plumb, & McNeese, 1983; Dewey, 1983; Nimri & Batchoun, 1994)*. Therefore, only one sample was used for this study.

The ova-and-parasite analysis used in this study is the standard protocol followed by the TDH central state reference laboratory in Austin. The techniques used in this protocol include a formalin-ethyl acetate concentration procedure, an acid-fast staining procedure, and a staining procedure with a poly-vinyl-alcohol fixative.

Data Analysis

A database containing entries for all variables used in the study was created using Microsoft Access. Microsoft Excel was the application used to determine prevalence and participation rates.

Results

San Elizario Independent School District

Nine of the 17 samples had at least one parasite, representing a prevalence of 52.9% (see Table 1). All nine showed the presence of *Blastocystis hominis* in amounts ranging from rare to moderate. In addition to *Blastocystis hominis*, one sample contained both *Entamoeba coli* and *Entamoeba hartmanni*, and another contained both *Entamoeba hartmanni* and *Endolimax nana*.

Table 1. Parasitic disease test positives in first-grade children, San Elizario Independent School District, 2001-2002 school year cycle

Parasite	Number *(%)* (N=17)	Many	Moderate	Few	Rare
Blastocystis hominis	9 *(52.9)*		3	5	1
Giardia lamblia					
Endolimax nana trophs	1 *(5.8)*			1	
Entamoeba hartmanni trophs	1 *(5.8)*				1
Entamoeba hartmanni cysts	1 *(5.8)*			1	
Entamoeba coli trophs	1 *(5.8)*			1	
Hymenolepis nana eggs					
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	9 *(52.9)*				

Canutillo Independent School District

A total of 208 stool samples were collected, with 45 (21.6%) of the children presenting at least one parasite. The results can be seen in Table 2. Tables 2a through 2d represent the prevalence of parasites in each school in the district.

Table 2. Parasitic disease test positives in first-grade children, Canutillo Independent School District, 2001-2002 school-year cycle

Parasite	**Number *(%)* (N=208)**	**Many**	**Moderate**	**Few**	**Rare**
Blastocystis hominis	29 *(13.9)*	4	1	18	6
Giardia lamblia	10 *(4.8)*	3	2	5	
Endolimax nana trophs	4 *(1.9)*	1	1	2	
Entamoeba hartmanni trophs	3 *(1.4)*			2	1
Entamoeba hartmanni cysts	1 *(0.5)*				1
Entamoeba coli trophs	10 *(4.8)*		1	5	4
Hymenolepis nana eggs	2 *(1.0)*		1	1	
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	45 *(21.6)*				

Table 2a. Parasitic disease test positives in first-grade children, Canutillo Elementary School, Canutillo Independent School District, 2002-2003 school-year cycle

Parasite	**Number *(%)* (n=44)**	**Many**	**Moderate**	**Few**	**Rare**
Blastocystis hominis	7 *(15.9%)*		2	3	2
Giardia lamblia	4 *(9.1%)*	1		3	
Endolimax nana trophs	2 *(4.5%)*	1		1	
Entamoeba hartmanni trophs	2 *(4.5%)*			1	1
Entamoeba hartmanni cysts					
Entamoeba coli trophs	2 *(4.5%)*			2	
Hymenolepis nana eggs					
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	11 *(25.0%)*				

Table 2b. Parasitic disease test positives in first-grade children, Jose Damian Elementary School, Canutillo Independent School District, 2002-2003 school-year cycle

Parasite	**Number *(%)* (n=54)**	**Many**	**Moderate**	**Few**	**Rare**
Blastocystis hominis	8 *(14.8%)*		1	6	1
Giardia lamblia	1 *(1.8%)*			1	
Endolimax nana trophs	2 *(3.7%)*		1	1	
Entamoeba hartmanni trophs					
Entamoeba hartmanni cysts	1 *(1.8%)*				1
Entamoeba coli trophs	4 *(7.4%)*		1	1	2
Hymenolepis nana eggs	1 *(1.8%)*			1	
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	11 *(20.3%)*				

Table 2c. Parasitic disease test positives in first-grade children, Deanna Davenport Elementary School, Canutillo Independent School District, 2002-2003 school-year cycle

Parasite	**Number *(%)* (n=56)**	**Many**	**Moderate**	**Few**	**Rare**
Blastocystis hominis	7 *(12.5%)*	1		4	2
Giardia lamblia	3 *(5.3%)*	1	1	1	
Endolimax nana trophs					
Entamoeba hartmanni trophs	1 *(1.7%)*			1	
Entamoeba hartmanni cysts					
Entamoeba coli trophs	3 *(5.3%)*			2	1
Hymenolepis nana eggs	1 *(1.7%)*		1		
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	13 *(23.2%)*				

Table 2d. Parasitic disease test positive in first-grade children, Bill Childress Elementary School, Canutillo Independent School District, 2002-2003 school-year cycle

Parasite	**Number *(%)* (n=54)**	**Many**	**Moderate**	**Few**	**Rare**
Blastocystis hominis	7 *(12.9%)*		1	5	1
Giardia lamblia	2 *(3.7%)*		2		
Endolimax nana trophs					
Entamoeba hartmanni trophs					
Entamoeba hartmanni cysts					
Entamoeba coli trophs	1 *(1.8%)*				1
Hymenolepis nana eggs					
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	10 *(18.5%)*				

Presidio

The results of the study in the Presidio Independent School District are displayed in Table 3. Seventeen (25.4%) of the participating children tested positive for parasites.

Table 3. Parasitic disease test positives in first-grade children, Presidio Independent School District, 2002-2003 school-year cycle

Parasite	Number *(%)* (N=67)	Many	Moderate	Few	Rare
Blastocystis hominis	9 *(13.4)*	1	4	1	3
Giardia lamblia	5 *(7.5)*	3	1		1
Endolimax nana trophs	6 *(9.0)*	1		4	1
Entamoeba hartmanni trophs					
Entamoeba hartmanni cysts					
Entamoeba coli trophs	3 *(4.5)*		2	1	
Hymenolepis nana eggs					
Iodamoeba butschilii cysts	1 *(1.5)*				
Chilomastix mesnili trophs	1 *(1.5)*		1		
Any parasite	17 *(25.4)*				

Fort Hancock

Only 29 children, representing 50.9% of those in first grade, participated in the study. Three (10.3%) of the participating children tested positive for parasites. The results of the study for Fort Hancock are displayed in Table 4.

Table 4. Parasitic disease test positives in first-grade children, Fort Hancock Independent School District, 2002-2003 school-year cycle

Parasite	Number *(%)* (N=29)	Many	Moderate	Few	Rare
Blastocystis hominis	2 *(6.9)*			1	1
Giardia lamblia	1 *(3.4)*			1	
Endolimax nana trophs	1 *(3.4)*				1
Entamoeba hartmanni trophs					
Entamoeba hartmanni cysts					
Entamoeba coli trophs					
Hymenolepis nana eggs					
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	3 *(10.3)*				

Sierra Blanca

Of the twelve eligible first-grade children, only two (16.7%) participated in the study. Of these two, only one (50%) tested positive for parasites. The results of the study for Fort Hancock are displayed in Table 5.

Table 5. Parasitic disease test positives in first-grade children, Sierra Blanca Independent School District, 2002-2003 school-year cycle

Parasite	Number (%) (N=2)	Many	Moderate	Few	Rare
Blastocystis hominis					
Giardia lamblia					
Endolimax nana trophs					
Entamoeba hartmanni trophs					
Entamoeba hartmanni cysts					
Entamoeba coli trophs	1 *(50.0)*			1	
Hymenolepis nana eggs	1 *(50.0)*			1	
Iodamoeba butschilii cysts					
Chilomastix mesnili trophs					
Any parasite	1 *(50.0)*				

Follow-Up of Children Testing Positive

The results of the tests were mailed to the parents of all participants. Every child with a positive test was referred for medical attention, and follow-up was assured. In addition, in the case of children who tested positive for *Hymenolepis nana* and *Giardia lamblia*, a home visit was made to conduct a visual survey of environmental conditions in and around the home. Dr. Miguel Escobedo evaluated and treated three children lacking access to medical follow-up. These children were eventually enrolled in the Texas Children’s Health Insurance Program.

Parents were provided information on healthy habits and avoidance of contamination of food and drink, and on ensuring the child’s access to treatment. In addition, the Texas Department of Health sent letters to pediatricians in the study areas to inform them of the study in case families called them to ask questions about the results of their children’s tests.

Discussion and Recommendations

The number of samples collected from San Elizario and Sierra Blanca are too small and thus cannot be used to generalize prevalence to the community level.

In Canutillo and Presidio, however, samples were obtained from almost 60% of the first-graders. Both communities exhibit a high prevalence of parasites (21.6% and 25.4%, respectively) and although not all of them are considered pathogenic, their presence suggests deficient hygiene habits and/or deleterious water and sewage conditions.

In an attempt to ascertain if the high prevalence of parasites was related to inadequacy of water and sewage systems, the public water-system providers in the study areas were contacted to determine if the families with children who tested positive were connected to municipal public water lines. It was discovered that most of the homes in each of the study areas were connected to the community public water system and also were connected to the community public sewage system.

It is believed that personal hygiene habits, as well as the consumption of foods bought in Mexico, may be responsible for the high number of children infected with intestinal parasites.

It is important to note that, for a country such as the United States, the prevalences reported in this study are very high. Parasites are common in developing countries (where de-parasitation campaigns are regularly conducted) but have never been perceived as a problem in the United States. This study raises concerns about the health conditions of border population groups which need to be addressed by the appropriate authorities.

Strategies to correct the situation include the following:

1. Ensure appropriate water and sewage systems for the entire border community. Even though most of the homes in Canutillo are connected to city water and sewage systems, not all of the households in that area are. The children could be playing in contaminated soil on either side of the border. Restricting families from crossing the border and eating in Mexico is unrealistic, so binational collaboration should be done to assess and improve any needed sanitary conditions on both sides of the border.
2. Improve hygiene habits. This is a feasible strategy that the health sector should engage in with a sustained effort to ensure that children and families develop better hygiene habits. To that aim, TDH could:

a. Officially inform all of the school districts of the results of the study and be prepared to provide technical assistance and educational materials that they may wish to incorporate into their school activities.
b. Officially inform the officials of the Texas Department of Health and El Paso City-County Health District of the results of the study and discuss a plan of action for El Paso County and the rest of the U.S.-Mexico border. The strategies for the communities in the study areas may include the dissemination of information to Federally Qualified Health Centers, public clinics, and health promoters. These entities may be able to educate communities in developing good hygiene habits.
c. Inform the city and county governments and binational institutions (e.g., the U.S.-Mexico Border Health Commission, the U.S.-Mexico Border Health Association, and the Pan American Health Organization). These groups may be in a position to increase funding for water and sewage systems, for further research, and for educational activities, both community-based and school-based.

In addition, the Texas Department of Health should consider the following activities:

3. Monitor the prevalence of parasites in other U.S.-Mexico border communities under the hypothesis that other border communities may be facing similar problems to those identified in Canutillo, Presidio, and Fort Hancock. Every effort needs to be made to eradicate the presence of parasites in schoolchildren, which, as mentioned above, can cause malnourishment and may even jeopardize the children's ability to learn.
4. Every three to five years, document the evolution of the prevalence of parasites in schoolchildren.
5. Conduct further research which may include studies to document the age at which children become infected with parasites, as well as the association between prevalence of parasites and hygiene habits, frequency of border crossing, frequency of eating in Mexico, and the presence of water and sewage systems in communities. The association between the presence of parasites, ability to learn, and presence of malnutrition in border communities deserves further exploration.
6. Disseminate the results of this study in health conferences and journals.

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