SURVEY FOR INTESTINAL PARASITES IN BELIZE, CENTRAL AMERICA

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Abstract. A stool survey was carried out in 5 villages in the Toledo district of the Central American country of Belize. Eighty-two percent of a total population of 672 participated. The stools were examined by the formalin-ethyl-acetate concentration technique. Sixty-six percent of the population was found to have one or more intestinal parasites. The most common infection was hookworm (55%) followed by *Ascaris lumbricoides* (30%), *Entamoeba coli* (21%), *Trichuris trichiura* (19%), *Giardia lamblia* (12%), *Iodamoeba beutschlii* (9%), and *Entamoeba histolytica/dispar* (6%). Other parasites found were *Entamoeba hartmani, Strongyloides stercoralis, Endolimax nana, Isospora belli,* and *Chilomastix mesnili.* Children were more often infected than adults and more females had hookworm infections. Sixty percent of 111 households surveyed had dirt floors, 43% were without toilets, 35% of the houses were overcrowded, and 10% obtained drinking water from streams. Cross-tabulation and logistic regression analyses were used to identify risk and protective factors associated with parasitoses. The risk factors were: being in the Mayan Ketchi population group, and abtaining housework and drinking water from streams. Protective factors were: drinking treated water and the wearing of shoes.

INTRODUCTION

Intestinal parasitoses are a public health problem throughout most areas of Central and South America. The prevalences of these diseases are well documented in most Central American countries, especially Guatemala, Honduras, and Mexico with prevalence rates ranging from 11-90% (Anderson *et al,* 1993; Watkins *et al,* 1996; Sanchez *et al,* 1997). However, very little is known about the prevalence of intestinal parasites in Belize, except for a survey conducted in 1968 (Petana, 1968). Since there was a paucity of data from Belize, a cursory survey for intestinal parasites was carried out to obtain information that would be helpful for future planning of prevention and control programs.

MATERIALS AND METHODS

Belize is a small country nestled between Mexico to the north, Guatemala to the south and west and the Caribbean Sea to the east (Fig 1). The population of the country is only 250,000, divided into 4 ethnic groups: Mestizo, Creole, Mayan and Garifuna. The population density is low. The literacy rate is high in the cities, but low in the rural areas. Belize is the only country in Central America where the majority of the people speak English.

The Belizean Ministry of Health selected 5 villages: Golden Stream, Medina Bank, San Marcos, Tambran, and Bladden, all in the Toledo district of southern Belize (Fig 1). At the time of the survey, 553 (82% of 672) villagers from 111 households participated. The age of the populations surveyed ranged from 1 month to 98 years. The two major ethnic groups were Mayan Ketchi (66.2%) and Mayan Mopan (33.8%), and the majority worked on maize or orange farms. Sanitary conditions in the villages were poor; 42 of the households lacked toilet facilities and most homes had dirt floors. There was no electricity in any of the villages. Water pumps were available in most villages, while the rest used water from local streams. Only 33% of the people were considered literate.

A standard questionnaire was used to interview each participant for demographic information (age, sex, ethnicity, occupation, education

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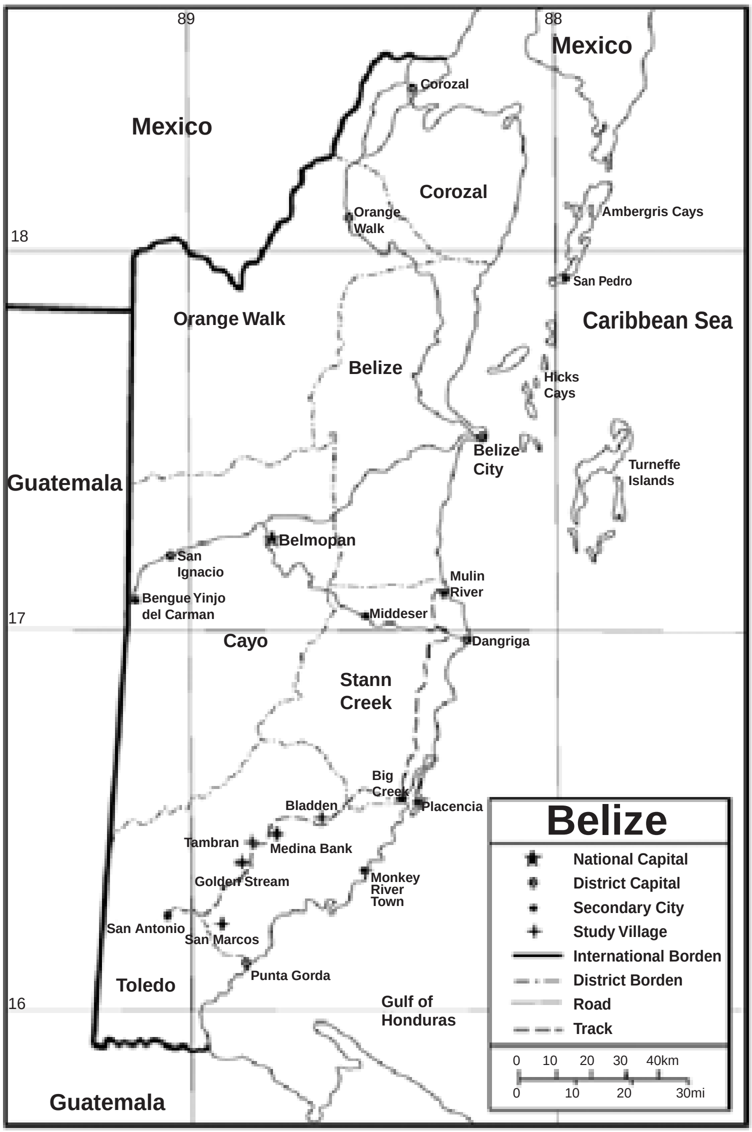

Fig 1– Map of Belize, Central America with location of study villages indicated as plus signs.

level) and risk factors for intestinal parasitic infection; house construction (floor type, number of rooms and occupants), sanitation practices (toilet facilities, trash, source of water, drinking water treatment, hand washing and wearing shoes), socio-economic status (ownership of house, electric appliances, and livestock). Geographical coordinates of each house were recorded using a hand-held Magellan Global Position System (GPS). The information was recorded and analyzed in the SPSS program (Chicago, IL). Descriptive statistics were used to summarize the data. Categorical 2 x 2 table data analysis was used to calculate odds ratio, and its associated 95% confidence interval. Chi-square association test for odds ratio (H_o: odds ratio = 0) and its p-value was also computed and displayed. Logistic regression was used to identify significant risk factors for parasitic infection.

Stool specimens were collected in paper or plastic cups, which were distributed with instructions. Stool cups were labeled with a name, ID number, and house number, and given to a responsible member of each household. The stool samples were transported to the laboratory where they were examined using the formalin-ethyl-acetate concentration technique (Anonymous, 1978).

RESULTS

The difference in parasite prevalence between villages was minimal; therefore, the data is presented collectively. The overall prevalence of intestinal parasitic infections was 75.6% (418). Sixty-seven percent (371) were positive for helminthes and 34% (188) were positive for protozoan parasites. Multiple infections were common: 27% (150) were infected with 2 parasites, either protozoa or helminths or both, 19% (104) had 3-4 parasites and 2.7% (16) had 5-7 parasites.

The most common parasites found were: hookworm (55%), *Ascaris lumbricoides* (30%), *Entamoeba coli* (21%), *Trichuris trichiura* (19%), *Giardia lamblia* (12%0, *Iodamoeba butschlii* (9%), *Entamoeba histolytica/dispar* (6%), *E. hartmanni* (3%). *Strongyloides stercoralis* (1%),

Table 1
Number of intestinal parasites (by single stool examination) in 5 villages in Toledo district, southern Belize by age groups and gender.

Age	Number of parasite positive															
	0-9		10-19		20-29		30-39		40-49		>50		Total			
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	(M)	(F)
Protozoa	92	(40)	40	(30)	22	(34)	15	(28)	9	(26)	10	(27)	188	(34)	91	97
Giardia lamblia	46	(20)	11	(8)	4	(6)	2	(4)	2	(6)	2	(5)	67	(12)	37	30
Entamoeba histolytica/dispar	13	(6)	8	(6)	4	(6)	2	(4)	2	(6)	2	(5)	33	(6)	14	19
Entamoeba coli	48	(21)	28	(21)	16	(25)	10	(19)	7	(21)	5	(14)	114	(21)	50	64
Entamoeba hartmanni	7	(3)	5	(4)	2	(3)	1	(2)	1	(3)	0		16	(3)	8	8
Iodamoeba beutschlii	22	(10)	16	(12)	6	(9)	2	(4)	4	(12)	0		50	(9)	20	30
Endolimax nana	2	(1)	0		0		0		0		0		2		1	1
Isospora belli	1		0		1	(2)	0		0		0		2		1	1
Chilomastix mesnili	1		1	(1)	0		0		0		0		2		1	1
Helminth	126	(55)	103	(77)	55	(85)	40	(75)	20	(59)	27	(73)	371	(67)	165	206
Ascaris lumbricoides	71	(31)	50	(38)	19	(29)	14	(26)	6	(18)	7	(19)	167	(30)	75	92
Hookworm	89	(39)	86	(65)	49	(75)	37	(70)	19	(56)	23	(62)	303	(55)	126	177
Trichuris trichiura	45	(19)	30	(23)	13	(20)	7	(13)	3	(9)	5	(14)	103	(19)	50	53
Strongyloides stercoralis	2	(1)	1	(1)	2	(3)	0		0		2	(5)	7	(1)	6	1
Total	231	(100)	133	(100)	65	(100)	53	(100)	34	(100)	37	(100)	553	(100)	275	296
Number parasites found	160	(69)	108	(81)	57	(88)	41	(77)	23	(68)	29	(78)	418	(76)	187	231
Number no parasites found	71	(31)	25	(19)	8	(12)	12	(23)	11	(32)	8	(22)	135	(24)	70	65

Endolimax nana, *Isospora belli*, and *Chilomastix mesnili* were found in less than 1% of those examined. Table 1 presents the overall results of single stool examinations, and prevalence by age and by sex. More females (296) than males (275) were found infected with one or more parasites; and more females (177) than males (126) had hookworm. The difference between males and females was small, but significant for hookworm infections ($p<0.025$). Children below 9 years of age were more commonly infected; 40% had protozoa and 55% had helminths.

Analysis of the demographic data and risk factors for parasitic infections indicated an association between parasitosis and risk factors. The total population participating in this study was 533: 296 (54%) females and 257 (46%) males. There were four occupational categories: 126 (23%) preschool children, 203 (37%) students, 120 (22%) housewives, and 104 (18%) laborers or farmers. The overall literacy rate was 33%, and only 35% wore shoes all the time. Socioeconomic status was indicated by ownership of electrical appliances (40%) (which were supplied by electrical generators or batteries) and livestock: pigs (26%) and horses (22%). Of the 111 participating households, none had electricity, 76 (60%) of the houses had dirt floors, and 48 (43%) had no toilet facilities. Thirty-five percent of houses had more than four people per room. Most residents used water from pumps. Only 10% admitted using water from streams. Sixteen percent of the households drank

Table 2
Results of chi-square analyses between each factor and helminthic and protozoa infection in Toledo district, southern Belize.

Factors		Odds ratio	95% C.I.	Pearson chi-square (p)
Positive for helminth				
Ethnicity	Ketchi: Mopan	1.56	(1.09,2.27)	0.017
Age	<15:>15	0.52	(0.36,0.75)	0.001
Education level	0-3:>4	0.56	(0.37,0.82)	0.003
Population density	High:Low	1.59	(1.11,2.28)	0.011
Drinking water	No treat:Treat	2.08	(1.16,3.72)	0.012
Wearing shoes	Yes:No	0.64	(0.45,0.93)	0.018
Positive for protozoan				
Garbage disposal	Yes:No	3.33	(1.54,7.19)	0.001
Type of water	Stream:Pump	1.89	(1.14,3.13)	0.013
Poultry	Yes:No	3.39	(0.99,11.59)	0.040

untreated water.

Two by two tables stratified the factors that influenced helminthic and protozoan infections. Odds ratio and its 95% confidence interval were calculated. The factors that were significantly associated with the infections are shown in Table 2.

Risk factors for helminthic infections were Mayan Ketchi ethnicity, older age group, crowded houses, drinking untreated water, and not wearing shoes. For protozoa infections, the risk factors were having a garbage pit near their houses and consuming stream water. The odds ratios in the Categorical 2 x 2 table data analysis are crude odds ratios (Table 2) without controlling other factors. To identify the risk factors that are significantly associated with the infection, a backward stepwise logistic regression method was performed by using helminthic and protozoa infection as dependent variables, and risk factors as independent variables. The results of adjusted odds ratios and their associated 95% confidence interval are presented in Tables 3 and 4, which were the only significant factors in the models.

Mayan Ketchi had more helminthic infections than Maya Mopan. The Mayan Ketchi live in the same area with Mayan Mopan but they seclude themselves and do not use toilets. Housewives had a higher risk of helminthic infections and people living in crowded houses also had a greater chance to become infected with helminths; similar findings were found in the people who drank stream water. People, who drank treated water, owned electric appliances (radio, television, etc) either had a lower risk for helminthic infection or these factors were protective.

DISCUSSION

This study provides additional data on the prevalence and distribution of intestinal parasitoses in Belize. The only previous study (Petana, 1968) was conducted in West-Central Belize, while the present study was conducted in Southern Belize.

The overall prevalence of intestinal parasites found in the present study was 76%, similar to the overall infection rate (74%) determined 30 years previously in West-Central Belize by Petana in 1968. Petana's findings were different from those reported here. His prevalence rates were *A. lumbricoides* (43%), *T. trichiura* (40%), *E. histolytica* (9%), hookworms (7%), *Hymenolepsis nana* (6%), *G. lamblia* (6%), *S. stercoralis* (2%), and *Enterobius vermicularis* (>1%). The major differences between these two studies were a higher rate for hookworm in the present study and a higher rate of *Ascaris lumbricoides* in the 1968 study.

Living conditions did not differ between the two populations with the exception of weather and elevation. Southern Belize is more tropical than western Belize, and the latter is also at a

Table 3
Results of logistic regression analyses of helminth prevalence in 5 villages of Toledo district, southern Belize with odds ratios for variables associated with the infection.

Independent variable	Odds ratio	95% CI	
		Upper	Lower
Constant			
Race (1=Ketchi, 0=Mopan)	1.41	0.94	2.12
Occupation (0=labour)			
Pre-school	0.46	0.25	0.84
Student	0.93	0.55	1.56
Housewife	2.20	1.16	4.16
Years of education	1.07	0.99	1.15
Density group (1=high, 0=low)	1.90	1.27	2.84
Trash (1=yes, 0=no)	1.72	0.91	3.25
Water (1=stream, 0=pump)	1.67	0.91	3.06
Water treatment (1=yes, 0=no)	0.46	0.25	0.86
Electrical appliance (1=yes, 0=no)	0.68	0.46	1.01

Table 4
Results of logistic regression analyses of protozoa prevalence in 5 villages of Toledo district, southern Belize with odds ratios for variables associated with the infection.

Independent variable	Odds ratio	95% CI	
		Upper	Lower
Constant			
Age	0.984	0.972	0.995
Years of education	0.931	0.875	0.991
Density group (1=high, 0=low)	0.689	0.473	1.004
Trash (1=yes, 0=no)	2.464	1.100	5.518
Water (1=stream, 0=pump)	1.819	1.077	3.072
Poultry (1=yes, 0=no)	3.462	0.944	12.698
Wearing shoes (1=yes, 0=no)	0.545	0.357	0.832

higher elevation. The ethnic groups were both Mayan; however in western Belize most of the participants were children, while in the present study over one half were above 10 years of age with infections highest in the 20-29 year age group. Distribution of infections by sex was not presented in the earlier study; however, in this study, females were more often infected than males. The presence of hookworm was higher in females (60%) than in males (40%). In studies reported in other parts of the world, males were reported infected more often than females (Bundy, 1988). Occupation of people in this study was probably a factor in hookworm infection, as over 38% of the males were laborers who usually wore shoes or boots, but did not work in the villages. In contrast, 94% of the women worked at home and 72% of them did not wear shoes. Females, therefore, had more exposure to hookworm infection than males. Similar findings were reported by Elkin *et al* (1986) in southern India, where there was a higher prevalence of intestinal parasites in women and children attributed to sociocultural factors. Women and children were confined to more contaminated domestic and peridomestic areas. The domestic lifestyle seemed to provide more opportunity for exposure to parasitic infections. The potential for multiple infections was also evident. A person with any helminthic infection had a propensity to have other parasitic infections.

To determine risk and protective factors associated with intestinal parasitoses, logistic regression was used (Hosmer and Lemeshow, 1989). This method helps to select the factors that are significantly associated with the infections and assists in the planning of prevention and control programs according to a basic knowledge of the biology and life cycle of the parasites.

Risk factors for infections were a Mayan Ketchi life style, older age group, crowded houses, drinking untreated water, and not wearing shoes. For protozoan infections, the risk factors were having a garbage pit near their houses, and consuming stream water. Because the contingency 2 x 2 tables do not control for other factors, a logistic regression method was performed to adjust for other factors by using helminthic and protozoan infection as dependent variables, and other factors as independent variables, to identify the factors that are significantly associated with infection. The results were calculated by comparing the contingency table with the results from the logistic regression method in Tables 3 and 4.

Prevention and control programs for intestinal parasitic disease should be focused on significant risk factors associated with distribution of intestinal parasites. This focus will help health care workers identify target populations for implementing appropriate prevention and control efforts. Targeting populations at risk will not only reduce the number of people who need to be educated and/or treated, but will also reduce the time and resources needed for prevention and control programs. From this study, the target population should be illiterate Mayan Ketchi housewives, from low-income overcrowded houses who need sanitary health education. The prevention and control program emphasis should be on clean drinking water, wearing shoes, and building a garbage pit.

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