ORIGINAL ARTICLE

A cross-sectional study of intestinal parasitic infections in a rural district of west China

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BACKGROUND: Parasitic infections are widespread in rural areas of West China. The remote and humid environment, traditional ways of life, contaminated potable water and limited health services all contribute to the transmission and persistence of fecal parasites.
OBJECTIVE: To describe the prevalence of intestinal parasitic infections in an area of West China, including its associations with demographic variables.
METHODS: Single fecal specimens were collected using a previously validated kit. Parasites were detected microscopically by iodine-stained smear, modified Kato-Katz thick smear, simple saline smear, test tube filter paper culture and adhesive cellophane tape anal swab.
RESULTS: The prevalence of enteric parasites in the population was 51.7%. The proportion of individuals infected with one parasite was 36.5%, two parasites 12.7%, three parasites 3.0% and four parasites 0.08%. Parasites identified included *Ascaris lumbricoides* in 41.4% of all individuals tested, *Ancylostoma duodenale* in 17.7%, *Trichurias trichuria* in 8.25%, *Enterobius vermicularis* in 0.43%, *Blastocystis hominis* in 1.37%, *Entamoeba coli* in 0.47%, *Entamoeba histolytica* in 0.16%, *Giardia lamblia* in 0.04%, *Strongyloides stercoralis* in 0.04% and *Clonorchis sinensis* in 0.04%. The prevalence was significantly increased in women, people aged 15 to 19 years and over 80 years, the rural farm population, farmers, preschool and primary school groups, residents of a hilly rather than mountainous or plains terrain, and in intermediate income groups. The prevalence was significantly negatively associated with educational level, but not with age or income.
CONCLUSIONS: This study supports the use of simple fecal examinations to monitor the parasite burden in rural areas of developing countries. Enteric parasites remain common in this population in rural China.

Key Words: *Amoebiasis;* Ancylostoma duodenale; Ascaris lumbriocoides; *Clonorchiasis, Fecal parasites; Giardiasis; Rural China*

Étude transversale des infections parasitiques intestinales dans un district rural de l'ouest de la Chine

HISTORIQUE: Les infections parasitiques sont généralisées dans les régions rurales de l'ouest de la Chine. Le milieu éloigné et humide, les modes de vie traditionnels, l'eau potable contaminée et les services de santé limités contribuent tous à la transmission et à la persistance des parasites fécaux.
OBJECTIF: Décrire la prévalence des infections parasitiques intestinales dans une région de l'ouest de la Chine, y compris ses associations avec leurs variables démographiques.
MÉTHODOLOGIE: Un seul prélèvement fécal a été colligé au moyen d'une trousse déjà validée. Les parasites ont été décelés au microscope par frottis à l'iode, méthode de Kato, simple frottis de sérum physiologique, culture de papier filtre en éprouvette et écouvillonnage anal par ruban adhésif de cellophane.
RÉSULTATS: La prévalence de parasites entériques dans la population s'élevait à 51,7%. La proportion de personnes infectées par un parasite était de 36,5%, par deux parasites, de 12,7%, par trois parasites, de 3,0%, et par quatre parasites, de 0,08%. Les parasites décelés étaient l'*Ascaris lumbricoides* chez 45,4% de tous les individus examinés, l'*Ancylostoma duodenale* chez 17,7% d'entre eux, le *Trichurias trichuria* chez 8,25%, l'*Enterobius vernicularis* chez 0,43%, le *Blastocystic hominis* chez 1,37%, l'*Entamoeba coli* chez 0,47%, l'*Entamoeba histolytica* chez 0,16%, le *Giardia lamblia* chez 0,04%, le *Strongyloides stercoralis* chez 0,04 % et le *Clonorchis sinensis* chez 0,04%. La prévalence étaient beaucoup plus élevée chez les femmes, les adolescents de 15 à 19 ans et les personnes de plus de 80 ans, dans la population agricole rurale, chez les fermiers, les groupes d'âge préscolaire et primaire, les habitants de régions vallonnées plutôt que montagneuses ou des plaines et les groupes à revenu moyen. De façon appréciable, la prévalence était associée négativement au niveau d'instruction, mais non à l'âge ou au revenu.
CONCLUSIONS: La présente étude appuie le recours à des examens fécaux simples pour évaluer le fardeau des parasites dans les régions rurales des pays en voie de développement. Les parasites entériques demeurent courants au sein de cette population de la Chine rurale.

The mortality and health problems parasitic diseases cause retard social and economic development in low-income countries (1). Parasitic diseases are also of concern in developed countries because of travel, immigration and an increasing population of immunocompromised people (2,3). Previous studies have reported a high prevalence of intestinal parasites in rural China (4,5), reaching 62.6% (95% CI 17.5% to 94.7%) in some areas (4). Trends observed have included a

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TABLE 1A
Infectious rates of different parasitic species in Beibei, China

		Number positive (%)				
Sampled areas (towns or communities)	**Tested population (participants)**	**Roundworm (Ascarid: *Ascaris lumbricoides*)**	**Hookworm (*Ancylostoma duodenale* and *Necator americanus*)**	**Whipworm (*Trichuris trichuria*)**	**Pinworm (*Enterobius vermicularis*)**	***Blastocystis hominis***
Xiema (rural)	506	319 (63.04)	281 (55.53)	130 (25.69)	8 (1.58)	15 (2.96)
Daijia (rural)	510	236 (46.28)	79 (15.49)	21 (4.12)	0 (0)	8 (1.57)
Caijia (rural)	515	150 (29.13)	40 (7.77)	31 (6.02)	1 (0.19)	0 (0)
Chengjiang (rural)	514	254 (49.42)	50 (9.73)	16 (3.11)	1 (0.19)	19 (3.70)
Urban	513	10 (119.69)	3 (0.59)	13 (2.53)	1 (0.20)	3 (0.59)
Total	2558	1060 (41.44)	453 (17.71)	211 (8.252)	11 (0.43)	35 (1.37)

Data continued in Table 1B (below)

TABLE 1B
Infectious rates of different parasitic species in Beibei, China

		Number positive (%)				
Sampled areas (towns or communities)	**Tested population (participants)**	***Entamoeba coli***	***Entamoeba histolytica***	***Giardia lamblia***	***Strongyloides stercoroliis***	***Clonorchis sinensisas***
Xiema (rural)	506	10 (1.98)	2 (0.40)	1 (0.20)	1 (0.20)	1 (0.20)
Daija (rural)	510	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Caijia (rural)	515	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chengjiang (rural)	514	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Urban	513	2 (0.39)	2 (0.39)	0 (9)	0 (0)	0 (0)
Total	2558	12 (0.47)	4 (0.16)	1 (0.04)	1 (0.04)	1 (0.04)

Data continued from Table 1A (above)

decrease in *Entamoeba histolytica*, *Fasciolopsis buski* and soil-transmitted helminths, and an increase in food-transmitted parasitic diseases including trichinosis, Clonorchiasis, oriental lung fluke, cysticercosis, and hydatidosis (4). The present study describes the prevalence and characteristics of parasitic infestation in a rural district of western China, including our experience with a simple stool collection tool.

METHODS

Study population

Beibei district has a population of 400,000 people, with one large urban area. For the present study, four rural quadrants were designated by East, West, South, and North coordinates, each including residents of different economic levels (high, intermediate and low). In each of the five areas (four rural and one urban), 500 to 550 people were randomly sampled. The total population that was approached to participate included 2644 people.

Ethics approval was obtained from town governments and the Beibei health bureau before the survey. All participants in the sample were assured of confidentiality, and advised that their participation was voluntary and that specimens would not be linked to individual identifiers. Each participant completed a short questionnaire that collected information including their residential area, sex, age, occupation and educational level. This information was linked by study number to the stool specimen and used only for analysis in the present study.

Laboratory methods

Each participant was provided with a standard fecal collection bag labelled with the participant's code and containing a dry plastic bag and a bamboo spike. Approximately 10 g of each participant's stool were collected and delivered to the laboratory within one day of collection. About 100 mg were filtered for the parasitological evaluation and 5 to 10 mg were smeared for direct microscopic detection. All samples were processed using five standard stool examination methods: iodine-stained smear for protozoal intestinal cysts, modified Kato-Katz thick smear (a semi-quantitative stool examination technique for detection of helminthic ova) (6,7), simple saline smear for intestinal protozoa trophozoites, a test tube filter paper culture method for detection of hookworm larvae (*Ancylostoma duodenale* and *Necator americanus*), and adhesive cellophane tape anal swab method for *Enterobius vermicularis* in children aged less than 12 years old. Stool specimens were initially read by two separate examiners, and reviewed by a third examiner if there was disagreement.

Statistical analysis

Standard statistical methods for categorical data were used. The significance level was $P<0.05$, and the calculation of 95% CIs followed standard methods.

RESULTS

Fecal specimens were provided by 2558 of the 2648 participants (96.6%). Parasites were identified in 1323 of these 2558 samples (51.7%, 95% CI 35.02% to 68.42%). There were 934 subjects with only one parasite (36.5%), 311 with two (12.2%), 76 with three (3.0%) and two with four (0.08%) (Table 1). The most common parasites were *Ascaris lumbricoides*, followed by hookworm (*A duodenale* or *N Americanus*) and *Trichurias trichuria* (Table 1).

The prevalence of parasites was higher in residents of the four rural communities (421 of 506 subjects [83.2%], 280 of 510

subjects [54.9%], 194 of 515 subjects [37.7%] and 288 of 514 subjects [56%]) than in the urban residents (140 of 513 subjects [27.3%]) (P<0.01). Parasites were also significantly more frequent in women (976 of 1349 [72.4%]) than in men (813 of 1209 [67.3%]) (P<0.05). When stratified by type of parasite, this sex variation was consistent only for *Ascaris* species. The highest rates were observed in persons aged 15 to 19 years, and more than 80 years (P<0.01). Prevalence rates in preschool and primary school groups were higher than in other educational groups, although *T trichuria* was less common in preschool children than in primary school students (4.41% versus 8.9%) (P<0.01). There were also significant differences in the prevalence rates among geographic and income groups (P<0.01). *Ancylostoma* species and whipworm were identified significantly less often in labourers, officers, students and children than in farmers (P<0.01) (Table 2). *Ancylostoma* species and *T trichuria* were more common in people, usually farmers who lived in hilly terrains (371 of 1535 [24.2%] and 177 of 1535 [11.5%] respectively) than in people from mountainous areas (79 of 510 subjects [15.5%] and 21 of 510 subjects [4.1%] respectively) or urban plains (three of 513 [0.6%] and 13 of 513 [2.5%], respectively) (P<0.01).

TABLE 2
Parasitic infections and occupation in Beibei, China

		Infectious rates (positive population / tested population)		
Occupation	**Tested population**	***Ascarid***	***Ancylostoma***	***Trichuris trichiura***
Farmer	1588	707/1588	382/1588	141/1588
		44.51%	24.1%	8.9%
Worker	306	71/306	1/306	10/306
		23.2%	0.33%	3.3%
Student	329	137/329	45/329	38/329
		41.6%	13.7%	11.6%
Child	272	126/272	24/272	18/272
		46.31%	8.8%	6.6%
Officer	63	19/63	1/63	4/63
		30.2%	1.6%	6.4%
Total	2558	1060/2558	453/2558	211/2558
		41.4%	17.7%	8.3%

DISCUSSION

Enteric parasites are common in this rural district of China. About one-half of the population had positive stool specimens, although the majority had only a single parasite identified. *Ascaris* species, *Ancylostoma* species and whipworm were the most common organisms. This is consistent with previous reports from rural China (4,5) and other developing countries (8-10). Most infections are asymptomatic, but roundworm infection may cause intestinal and respiratory symptoms, and is a cause of protein-energy malnutrition in undernourished children. Hookworm infection can cause anemia and hypoproteinemia (8). Multiple parasite infestations may not be independent because physiological, immunological or ecological factors that favour parasite infection may be specific to an individual (11).

The prevalence rate in females was significantly higher than in males. Sex-specific differences have been suggested to be due to differences in parasite susceptibility between the sexes (12), perhaps due to the influence of sex hormones (13). Some parasitologists suggest that susceptibility to parasitic infections is greater in males and may contribute to male-biased mortality (14). The present study, however, found a higher prevalence of parasitic infestation in women. The infection rate of female foreign workers in northern Taiwan was also reported to be 3-fold higher than that of males (15). A major contributor to parasitic diseases in the developing world is inadequate water and sanitation. Obtaining water for household use in most rural areas is done by women, and women spend more time actually working in the water, washing clothes and cooking. This increases exposure to waterborne diseases and may explain the increased prevalence observed in women (16).

Two species, roundworm and hookworm, were detected in all age groups. However, the infection rates did not correlate with increased age – rates were highest in the groups aged 15 to 19 years and over 80 years, and lowest in the groups aged 30 to 39 years and 70 to 79 years. Children may have higher rates of infection because of greater exposure, while the elderly may have greater rates of infection because of an age-associated decline in their immune systems (17). The prevalence of infection is higher and occurs at a younger age when the transmission rate is high. When the transmission rate is low, the peak prevalence is lower and occurs at an older age – a `peak shift' (18). Our observations would be consistent with a lower rate of transmission.

The prevalence of infestations in farmers was 8.3-fold higher than in all other occupational groups. Traditional life and farm labour practices, including irrigation and inappropriate fecal disposal, increase parasitic infectious risk in rural areas (19). The infection rate for farmers living in hilly terrains was higher than in mountainous areas. Disposal of human excreta is inadequate in some rural areas. In hilly land, sewage flows or leaks more easily to wells. Water drains more rapidly in mountainous areas, perhaps reducing infection rates. A recent World Health Organization report estimates that over 700 million Chinese people drink water contaminated with levels of animal and human waste exceeding government standards for safe water (28). The rates we observed were lower with increased education levels, similar to observations from Shanghai, China (21), although not all reports have confirmed this (10). The infectious rates were not, however, significantly associated with income.

Direct microscopy is widely used for the diagnosis of parasitic infections. Serial simple stool examinations may be a suitable method to detect pathogenic intestinal parasites. Only single samples were obtained for the present study, which may have underestimated the infection rates. Other, more sensitive and rapid techniques, such as polymerase chain reation (22), latex agglutination tests (23), serologic and intradermal tests (24), antigen detection tests and parasitic test kits (25,26) were not used. Though the direct microscopy approach needs experienced microscopists and is labour intensive and time consuming for accurate diagnosis, the procedure is relatively cheap and applicable for the diagnosis of parasitic infections in developing countries.

In 1990, major parasitic diseases were estimated to account for 11.7% of the disease burden from communicable diseases. In many nations, parasitic infections are the most frequent causes of disease attributed to contaminated drinking water. Parasitic cysts are resistant to chlorination and require water

filtration for removal, and the number of cysts required for infection may be very small (27). Thus, preventing drinking water contamination at the source is important in limiting transmission of these parasites (28). Improving private wells, based on national or provincial drinking water standards, and establishing safe public drinking water systems in rural areas may decrease parasitic density. Appropriate health education and management, and the improvement of toilets and stool disposal or personal hygiene, are also important to control parasitic infestations.

CONCLUSIONS

The present study reports a high prevalence of enteric parasites in one area of West China. The study demonstrates the usefulness of fecal examinations in developing countries, particularly in rural areas, because these examinations are easily performed at a low cost. Monitoring the prevalence of enteric parasites may be useful in assessing the effectiveness of public health interventions, particularly improvement in drinking water quality.

Mr Nian Ji Luo was responsible for the detection of parasites and for administration of the study.

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