Strongyloides stercoralis in an urban slum community in Bangladesh: factors independently associated with infection

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Abstract

Stool samples from 880 residents in an urban slum in Dhaka, Bangladesh, were collected on 3 occasions over one year, and examined for intestinal parasites. Information on many potential risk factors for infection was obtained by questionnaire from a respondent in each household studied. In a crude univariate analysis of the data, several of the factors were found to be significantly associated with *Strongyloides stercoralis* infection. Most of these factors were co-variate with one another, and with poverty generally. Using Mantel-Haenszel χ^2 tests to control for confounding effects of each variable individually, the following 4 factors remained independently associated with *S.stercoralis* infection: respondent's use of a community latrine rather than a private latrine, living in a house with an earth floor rather than a cement floor, being of Bihari ethnicity, and being 7–10 years of age. Implications of these results for the epidemiology and control of strongyloidiasis are briefly discussed.

Introduction

The intestinal nematode *Strongyloides stercoralis* is endemic in many communities throughout tropical and temperate regions, and is responsible for a wide range of symptoms (GROVE, 1989a). The transmission of *S.stercoralis* involves contamination of the environment by first-stage rhabditiform larvae from the faeces of infected people. Third-stage infective filariform larvae may mature within 24–48 h by direct development from rhabditiform larvae, or in 2–6 d by indirect development involving a single free-living generation. Infection occurs by skin penetration.

It is expected that risk factors for *S.stercoralis* infection may include poor personal hygiene and household sanitation, although the importance of specific factors has not been formally investigated. Some studies have suggested that earth floors offer a potentially suitable environment for transmission of infection within households (FAUST & GIRALDO, 1960), and that infection may be aggregated in certain households (SOROCZAN, 1976; LINDO, 1992). The most compelling evidence for the importance of hygenic and sanitary factors is that high prevalences of infection (>20%) are frequently recorded in institutions in which the personal hygiene of residents is severely impaired (BANKI *et al.*, 1963; YOELI *et al.*, 1963; PROKHOROV *et al.*, 1978; CORNEJO *et al.*, 1985).

As part of a study of reinfection with *Ascaris lumbricoides* among people living in an urban slum in Bangladesh (HALL *et al.*, 1992), information was collected on other intestinal infections, and on factors which could influence individuals' exposure to these infections. The data were analysed to determine the distribution of *S.stercoralis* infection, and to examine potential risk factors for infection.

Subjects and Methods

Parasitological survey

The study was undertaken among residents of a slum community in Mirpur, a suburb of Dhaka, Bangladesh. The study was primarily designed to examine reinfection with *A.lumbricoides*, and had been approved by the Ethical Review Committee of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The majority of subjects were Bihari refugees who had settled in camps after the war of independence from Pakistan in 1971 (WHITAKER *et al.*, 1982).

Three faecal samples were collected over one year from each of 880 individuals living in 280 households, at intervals of 6 months. The samples were fixed in 10% v/v formalin in saline (0·9% w/v NaCl), and processed by a quantitative ether sedimentation technique (HALL, 1981) before being examined microscopically for the eggs of *A.lumbricoides* and other intestinal parasites. The presence of larvae of *S.stercoralis* was also recorded. Each subject was subsequently treated with a single dose of 11 mg/kg body weight of pyrantel pamoate (Combantrin®; Pfizer, Bangladesh) in order to expel *A.lumbricoides* (see HALL *et al.*, 1992). Pyrantel is considered to be ineffective against *S.stercoralis* (see GROVE, 1989b). Specific treatment for *Strongyloides* was not given since the data were analysed retrospectively, after the *Ascaris* study had been completed.

Identification of factors associated with S.stercoralis *infection*

A questionnaire administered to the wife of the principal male member of each household, termed the respondent, was used to collect the following information: age, sex, and ethnic origin (Bangladeshi or Bihari) of all people living in the household; the number of years of residence in the area; the type of floor (earth or cement); the type of roof (bamboo, metal, or cement); the main source of water for drinking or washing (an owned or shared well, tube well or tap); the usual site of defaecation of the respondent and her children (indiscrimately, or in a community latrine, a latrine shared between neighbours, or a privately owned latrine); the respondent's reported ability to read (yes or no); and the estimated total monthly income of the household in Bangladesh taka (BDT). The proportion of subjects infected with *S.stercoralis*, defined as those in whose faeces larvae were seen at any of the 3 microscopical examinations, was tested for associations with each of these variables, and also with the *A.lumbricoides* worm burden, and the presense or absence of hookworm infection at the first examination, by calculating odds ratios with 95% confidence intervals, and by χ^2 tests. Variables which were recorded as continuous values were converted to categorical formats for analysis. Each of the variables which was significantly associated with *S.stercoralis* infection in the crude analysis was then re-tested for association with infection, using Mantel-Haenszel χ^2 tests to control for the effects of the other variables individually (KIRKWOOD, 1988).

Results

Detection of S. stercoralis *infection*

One hundred and two of 880 subjects (11·6%) had a detectable infection with *S.stercoralis* at at least one of the 3 six-monthly examinations; 34 (3·9%) at the first examination, 43 (4·9%) at the second, and 44 (5·0%) at the third. The Figure shows the proportion of individuals in whose faeces *S.stercoralis* larvae were detected at each or any of the examinations, according to mean age at first

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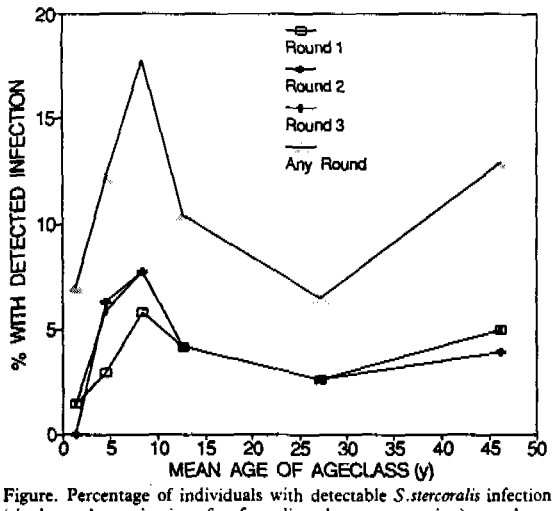

Figure. Percentage of individuals with detectable *S.stercoralis* infection (single stool examination after formalin–ether concentration) at each, or any, of the six-monthly examinations, according to age class (i.e., <2, 3–6, 7–10, 11–16, 17–36, or >37 years old).

examination. The peak proportion at any examination occurred in the 7–10 years age class, and was significantly greater than that in all combined younger and older age classes ($P<0.05$ for each comparison). The lowest proportions infected were in the <2 and 17–36 years age classes, and they were significantly lower than in the 7–10 years age class ($P<0.005$ for each comparison).

Factors associated with S.stercoralis *infection*

Several factors were associated with a greater risk of being infected at any of the 3 examinations (Table). Those with the most highly significant associations ($P<0.005$) were the use of a community latrine rather than a private latrine by respondents or children, and living in a house with an earth floor rather than a cement floor. Other factors associated with infection were Bihari ethnicity ($P<0.01$), a household size of 5 or more persons ($P<0.05$), inability of the respondent to read ($P<0.05$), living in a house with a metal roof rather than a cement roof ($P<0.05$), defaecating indiscriminately rather than in a private latrine by children ($P<0.05$), presence of hookworm infection ($P<0.05$), having not more than the median household monthly income ($P<0.05$) and, as mentioned above, being 7–10 years of age ($P<0.05$).

Many of these factors co-varied with one another, strongly suggesting that confounding was responsible for some of the observed associations. Therefore each of the variables associated with *S.stercoralis* infection in the crude analysis was further tested for association with infection after controlling for the effects of each of the other variables individually, using Mantel-Haenszel χ^2 tests. The variables which remained significantly associated with infection ($P<0.05$) after controlling for each of the others individually were respondent's use of a community latrine rather than a private latrine, living in a house with an earth floor rather than a cement floor, being of Bihari ethnicity, and being 7–10 years of age.

Table. Proportion of individuals infected with *S. stercoralis* (at any of three six-monthly examinations) according to potential risk factors

	No. infected	Odds ratio[a]
Age		
1–6 years	27/273 (9·9%)	–
7–10 years	37/208 (17·8%)	1·97 (1·16–3·33)*
>10 years	38/399 (9·5%)	0·96 (0·54–1·70)
Sex		
Female	53/498 (10·6%)	–
Male	49/382 (12·8%)	1·24 (0·81–1·89)
Ethnic identity of household		
Bangladeshi	10/196 (5·1%)	
Bihari	89/656 (13·6%)	2·91 (1·53–5·52)**
Mixed	3/28 (10·7%)	2·23 (0·61–8·11)
Household respondent's ability to read		
Able	22/269 (8·2%)	–
Unable	80/611 (13·1%)	1·69 (1·04–2·76)*
Income of household per month[b]		
>1040 BDT	42/451 (9·3%)	–
<1040 BDT	60/429 (14·0%)	1·58 (1·05–2·39)*
Site of respondent's defaecation		
Own latrine	17/234 (7·3%)	–
Shared latrine	18/233 (7·7%)	1·07 (0·55–2·08)
Community latrine	59/336 (17·6%)	2·72 (1·57–4·72)***
Indiscriminate	8/71 (11·3%)	1·62 (0·68–3·88)
Site of children's defaecation		
Own latrine	18/217 (8·3%)	–
Shared latrine	7/157 (4·5%)	0·52 (0·22–1·24)
Community latrine	35/194 (18·0%)	2·43 (1·35–4·38)**
Indiscriminate	41/294 (14·7%)	1·79 (1·01–3·17)*
Source of drinking water		
Own well or tap	15/122 (12·3%)	–
Common well or tap	87/758 (11·5%)	0·92 (0·49–1·73)
Source of washing water		
Own well or tap	15/137 (10·9%)	–
Common well or tap	87/743 (11·7%)	1·08 (0·60–1·93)
Number living in household		
<4	6/109 (5·5%)	–
5–8	77/636 (12·1%)	2·20 (1·02–4·73)*
>9	19/135 (14·1%)	2·56 (1·11–5·92)*
Time household has been in the community		
<10 years	33/332 (9·9%)	–
>10 years	69/548 (12·6%)	1·31 (0·89–1·92)
Type of floor		
Cement	12/214 (5·6%)	–
Earth	90/666 (13·5%)	2·63 (1·44–4·81)**
Type of roof		
Cement	2/54 (3·7%)	–
Bamboo	21/211 (10·0%)	2·87 (0·70–11·79)
Metal	79/165 (12·8%)	3·83 (1·00–14·90)*
Ascaris lumbricoides worm burden		
<13 worms	47/469 (10·0%)	–
>13 worms	55/411 (13·3%)	1·39 (0·90–2·39)
Hookworm infection		
Absent	87/800 (10·9%)	–
Present	15/80 (18·8%)	1·89 (1·04–3·43)*

[a]95% confidence interval in parentheses. Significantly different results are indicated thus: *$P<0.05$, **$P<0.01$, ***$P<0.001$.
[b]BDT=Bangladesh taka.

Discussion

Infections with *S.stercoralis* were found to be associated with certain factors related to domestic hygiene. The 2 factors which were most significantly, and independently, associated with infection were the use of a community latrine, rather than a privately owned latrine, and having an earth floor rather than a cement floor in the house. The high risk of infection associated with use of a community latrine may be due to the likelihood that more people use these latrines, so contamination of the ground by faeces from infected persons is expected to be greater. The risk of infection associated with having an earth floor suggests that some transmission of infection occurs within houses. Infective *S.stercoralis* larvae and other parasites have been detected on earth floors of houses in a slum community in Colombia, where the possibility of infection within households was also suggested (FAUST & GIRALDO, 1960). Studies in Poland (SOROCZAN, 1976) and Jamaica (LINDO, 1992) have suggested that *S.stercoralis* infections are aggregated in particular households.

The prevalence of *S.stercoralis* infection is age-dependent. In this study, the highest proportion infected was in the 7–10 years age class. Available data from other studies in Bangladesh show a similar pattern. In child-

ren, MUTTALIB *et al.* (1976) showed an increase in detected prevalence of *S.stercoralis* with age up to 8 years, and no further increase up to age 15. Surveillance of patients presenting to the diarrhoea hospital of ICDDR,B in 1989–1991 showed that the highest proportion with detectable infection was in the 5–9 years age class (Dr Salam, personal communication). A similar pattern of peak prevalence in older children has been observed in some studies in other countries (SORNMANI *et al.*, 1973; CABRERA, 1981; MARNELL *et al.*, 1992), although other studies have shown peak prevalence in adults (LAMY & LAMY, 1954; FAUST & GIRALDO, 1960; FOULON *et al.*, 1979; PROKHOROV *et al.*, 1983; WHITWORTH *et al.*, 1991; ARAKAKI *et al.*, 1992; ASHFORD *et al.*, 1992). The underlying cause of these apparent differences in the relationship between age and infection in different communities is presently unclear. The possibility of age-dependent differences in risks of exposure to infection, which may differ between communities, has not been investigated.

The higher prevalence of infection among persons of Bihari ethnicity, which was independent of confounding factors of household hygiene, is probably due to other risk factors associated with poverty or social history which were not investigated in the present study (WHITAKER *et al.*, 1982). This study did not detect a significant difference in prevalence between males and females, although some studies in other countries have shown significantly higher prevalences in males than in females (FAUST & GIRALDO, 1960; CABRERA, 1981; ARAKAKI *et al.*, 1992).

An accurate estimate of point prevalence of *S.stercoralis* in the study community cannot be derived from the present study, as the ether sedimentation technique employed is not very sensitive at detecting low intensity infections. The total proportion with detected infection at any of the 3 examinations is almost certainly closer to the real prevalence than the proportion at only one examination, as repeated examination increases sensitivity, and most *S.stercoralis* infections persist for considerably longer than one year, the period of the present study (JEFFERY, 1960). A more accurate estimation of prevalence could probably be obtained using either an agar plate method for faecal culture (KOGA *et al.*, 1991), or a sensitive and specific immunodiagnostic test based on serum immunoglobulin G recognition of specific *S.stercoralis* larval proteins (CONWAY *et al.*, 1993).

In conclusion, the results of the present study suggest that, in this urban slum community, transmission of *S.stercoralis* occurs mainly in the vicinity of community latrines, and also within households, where an earth floor is associated with an increased risk of infection. Changes in the household environment, particularly installation of sanitary facilities, and construction of a cement floor, would probably reduce the transmission of *S.stercoralis* infection. Even with the interruption of transmission, in the absence of chemotherapy, prevalence would be expected to decline only slowly, due to the longevity of individual infections (SATO, 1986). Oral administration of 400 mg albendazole daily for 3 d is safe and 60–80% effective at curing *S.stercoralis* infections, and is currently recommended by World Health Organization guidelines (WHO, 1990). Mass chemotherapy can reduce community prevalence effectively (ARGUEDAS *et al.*, 1975; GOULART *et al.*, 1977), although chemotherapy targeted to risk groups, or given selectively to those with detected infections, might provide more economical alternatives. The significance of *S.stercoralis* infection as a public health problem needs to be assessed more accurately before these options for community control can be properly evaluated.

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Announcement

PRIZES

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3. The closing date for receipt of project reports is 31 December. The project should have been done or completed in the previous twelve months.
4. A Committee of three shall choose the prize winners.
5. The announcement of the prize winners will be made at the March meeting of the Society.
6. The prizes will be presented by the President of the Society at the Annual General Meeting in June or July.

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