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Association between socio economic status and schistosomiasis infection in Jinja District, Uganda

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Summary

OBJECTIVE To examine the role of socioeconomic situation in influencing the risk and intensity of infection with *Schistosomiasis mansoni*.

METHODS Cross-sectional study in Walukuba Division bordering Lake Victoria, Jinja District. We assessed a random sample of 463 individuals aged 10–20 years for *Schistosoma mansoni* infection, water contact behaviour and treatment status with praziquantel as of the last mass treatment. Socio-economic conditions of the participants' households were assessed by calculating a wealth index (based on type of housing and ownership of assets). Households were classified in four classes; multivariate logistic regression analysis was used to identify independent predictors of being infected with schistosomiasis. Intensities of infection with *S. mansoni* were compared across the classes of wealth index.

RESULTS Wealth index emerged a risk factor for infection with *S. mansoni* after controlling for water contact and treatment with praziquantel. The adjusted odds ratio of being infected for the lowest level of wealth index compared to the highest was 10.42 (95% CI 3.38–32.36 $P < 0.001$). The intensity of infection decreased with wealth index Linearity F-ratio 13.91, 1 df, $P < 0.001$). The geometric egg count for those in the lowest wealth index was 230 (95% CI 199–279) compared to 114 (95% CI 80–162) for the highest wealth index.

CONCLUSIONS In addition to mass treatment with praziquantel, improving the socio-economic conditions of the population should be given priority.

keywords schistosomiasis, water contact, mass treatment, social economic situation, Uganda

Introduction

Schistosomiasis is both a disease of poverty and one of the neglected tropical diseases (Molyneux 2004; Hotez *et al.* 2007). Almost all of the 600 million people at risk of infection and about 200 infected with schistosomiasis reside in low-income countries of the globe (WHO 2007) with about 80% of the morbidity attributable to schistosomiasis occurring in impoverished communities and households of sub-Saharan Africa (WHO 2002). Although the relationship between schistosomiasis infections and level of well-being is clearly demonstrated both within and between countries, causality cannot be inferred from this established relationship (Weed 1986). Poverty promotes higher worm burdens, yet poor health induced by schistosomiasis can lead to lower incomes. The poverty attributable to schistosomiasis results from disfigurement or other sequels of long-term illness, impaired childhood growth and development, and reduced productive capacity (Ross *et al.* 2002; King *et al.* 2005; Hotez & Ferris 2006; Hotez *et al.* 2006). The Millennium Declaration, adopted by world leaders at the United Nations in September 2000, establishes an ambitious set of 8 Millennium Development Goals to eliminate extreme poverty, hunger, and disease by 2015. The achievement of these goals necessitates the control of the so called 'neglected tropical diseases' including schistosomiasis (Fenwick *et al.* 2005; Sachs & Hotez 2006).

The evidence linking social resources, economic status, and schistosomiasis infection at community and household levels, particularly in low income countries of sub-Saharan Africa, needs to be better defined (Lee 2005; Watts 2006). This understanding makes the targeting of interventions more equitable and provides tools for measuring impact of interventions. However, most previous studies on the socioeconomic determinants of schistosomiasis (Farooq *et al.* 1966; Jordan 1977; Costa *et al.* 1985; Barreto 1991; Firmo *et al.* 1996; Ximenes *et al.* 2001) have either analysed the univariate association between each social economic variable and schistosomiasis or explored the socioeconomic risk factors without controlling for other measures of exposure to schistosomiasis, such as water contact or access to treatment (Southgate *et al.* 2003). The current study analyses the relation between social economic status and risk of infection with schistosomiasis controlling for measures of exposure to schistosomiasis such as water contact and access to treatment.

Materials and methods

Study setting

The study was conducted in Walukuba division, located in Jinja Municipality and composed of both rural and urban populations. The division is bordered by Lake Victoria and *Schistosomiasis mansoni* is highly endemic in the area with 60% of the children in primary schools children infected in 2003 (Jinja district health reports, unpublished data). The division is made of three parishes and 21 villages and has a population of 40 882 people with an average household size of 4.5. The main socio-economic activities in the area are fishing, subsistence farming and petty trade. Since 2003, schistosomiasis in the area has been controlled by annual mass treatment with praziquantel, mainly of schoolchildren.

Study population

The study population included heads of households who are the major determinants of socio-economic status of the household and individuals aged 10–20 years residing in the same household who are more likely to be infected with schistosomiasis (Kabatereine *et al.* 2004). A random sample of about 20 homes was selected from each village from a list of all households using a table of random numbers. In each selected household, information was collected from the head of household regarding socio-demographic characteristics and ownership of assets. One individual in the same household selected randomly from those in the age group 10–20 years underwent a stool examination for *Schistosoma mansoni* infection and also answered questions regarding water contact in the previous one week and having taken praziquantel during the most recent mass treatment about 6 months before the date of interview. If there was no one in the 10- to 20-year age group or if such a person failed to provide a stool sample, the next household was included. The fieldwork was done in August 2007 during the school holidays.

Study variables

The dependent variables were status of schistosomiasis infection (positive/negative) and its intensity according to the number of eggs per gram of faeces (epgs). The independent variables were wealth index, water contact, having taken praziquantel as of last mass treatment and demographic variables.

Laboratory analysis

For the diagnosis of schistosomiasis the Kato method (Kato & Miura 1954) as modified by Katz *et al.* (1972) was used. Two slides were prepared from each faeces specimen, and the number of eggs counted on the slide was multiplied by 24 to obtain the number of eggs per gram. Two laboratory technicians independently performed the microscopic examination for each slide, and a third technician was responsible for preparing and allocating the slides to the technicians.

Water contact

In this study water contact was assessed using four variables: estimated distance from the house to lake Victoria, whether individual has been in contact with water of lake Victoria in the previous one week, number of times the individual had been in contact with water of the lake, and the estimated total duration of contact with the water of the lake.

Wealth index

We collected information on type of housing, water supply, faecal disposal facilities and on household assets, scored them and used the scores to create an index representing the wealth of the households interviewed according to the method described in the Uganda and Health Survey of 2006 [Uganda Bureau of Statistics (UBOS) and Macro International Inc. (2007)]. The household assets used to calculate the wealth index and their scores were: materials used for walls of main house (no bricks = 1, unburnt bricks = 2, burnt bricks with mud = 3, burnt bricks/stones with cement = 4); material used for the floor of main house (not cemented = 1, cemented = 2, tiled = 3); materials used for roofing of main house (thatch = 1, iron sheets = 2, tiles = 3); source of water (no tap water = 1, tap water outside house = 2, tap water inside house = 3); sanitation facility (none = 1, pit latrine = 2, ventilated improved pit latrine = 3, flush toilet = 4); household goods (radio, cupboard, bicycle or canoe each scored 1, telephone, television or motorcycle each scored 2, car or motorboat each scored 3). A wealth index scale ranging from 4 to 24 was created by summing the scores for each of the housing characteristics and household possessions. Four wealth classes were then constructed from the wealth index depending on the total scores: lowest (4–9), second

(10–14), third (15–19), and highest (20–24). Such an assets index has proved reliable in Uganda (Cortinovis *et al.* 1993; UBOS & Macro International Inc. 2007) and highly comparable to both poverty rates and gross domestic product per capita in other low income countries (Filmer & Pritchett 1998; Ruststein 1999).

Statistical analysis

Data were analysed at two levels, the household level and the individual level. At the household we investigated the association between schistosomiasis and demographic variables as well as the wealth index. At the individual level, the association between schistosomiasis and water contact and compliance with praziquantel was analysed. Bivariate analysis of various variables was done to identify risk factors for schistosomiasis infection using crude odds ratios (COR) and their 95% confidence intervals (CI). All variables that were significant on bivariate analysis ($P < 0.05$) were further analysed using logistic regression to identify independent predictors of infection with *S. mansoni*. Adjusted odds ratios (AOR) and their 95% CI were calculated after the logistic regression. The geometric means of *Schistosoma mansoni* eggs (eggs per gram of faeces) of the variables that remained significant after the logistic regression were then compared (using *F* ratios) to assess the association of the independent predictors with intensity of infection. For all the statistical analyses, STATA version 9.2 (Intercooled Stata 9.2 for windows StataCorp LP, TX, USA) and version 10.0 of SPSS (SPSS Inc., Chicago, IL, USA) were used. Standard *Stata* commands were used for adjusting the data for clustering at the village level. Cases with missing data were excluded from analysis.

Ethical considerations

The study was cleared by the intuitional review board of Makerere University school of Public Health and the Uganda National Council for Science and Technology. All schoolchildren in the selected households who had not received praziquantel during the most recent mass treatment were treated with praziquantel and albendazole.

Results

Of the 463 individuals aged 10–20 years who were parasitologically examined for schistosomiasis 65% tested positive (301/463). Of these 30% had a light infection (1–99 epgs), 35% had a medium infection (100–399 epgs) and 34 had a heavy infection (>399 epgs). The distribution of wealth index of the 463 individuals revealed 24% in the lowest category, 24% in the second, 23% in the third and 29% in the highest. Only 42% of the individuals aged 10–20 years reported having taken praziquantel at the last mass distribution. 67% reported having water contact in Lake Victoria within the previous week.

Determinants of infection with schistosomiasis

Demographic variables

The risk of schistosomiasis infection among individuals aged 10–20 within the family was significantly higher if the head of the household was a farmer or involved with fishing and living in a rural area. Religion and sex of the individual were not associated with risk of schistosomiasis infection (Table 1). The mean age of the 301 infected people was 13.3 years (SD = 3.2 years); the mean age of uninfected people was 13.0 years (SD = 2.9 years; $n = 162$). The difference in the mean ages of infected an uninfected individuals was not statistically significant: *F*-ratio ($F = 2.0$, 1 df, $P = 0.16$).

Socio economic variables and level of education

A statistically significant association was found between schistosomiasis infection of individuals aged 10–20 within the family and the level of education of the head of the

Table 1 Crude odds ratio (COR) and 95% confidence interval (CI) for schistosomiasis infection of individuals aged 10–20 years according occupation, place of residence, religion, of head of household, and sex of individual

Variable	Infected	Not infected	COR	95% CI	*P*-level
Place of residence					
Rural	205	45	5.56	3.65–8.47	<0.001
Semi urban	96	117	1		
Occupation of head of household					
Fishing	64	8	26.91	9.03–84.06	<0.001
Farmer	102	19	18.06	7.32–45.63	<0.001
Non employed	61	37	5.55	2.37–13.21	<0.001
Student	11	9	4.11	1.19–14.56	0.021
Business	52	52	3.36	1.46–7.88	0.003
Civil servant	11	37	1		
Religion of head of household					
Catholic	141	82	0.69	0.23–1.99	0.61
Protestant	91	55	0.66	0.21–1.96	0.57
Muslim	59	19	1.24	0.37–4.08	0.91
Other†	15	6	1		
Sex of individual aged 10–20 years					
Male	175	84	1.29	0.88–1.89	0.23
Female	126	78	1		

†Includes seventh day Adventists, and born again.

Table 2 Crude odds ratio (COR) and 95% confidence interval (CI) for schistosomiasis infection of individuals aged 10–20 years according education level and wealth class of head of household, and status of treatment of individual with praziquantel as of last distribution

Variable	Infected	Not infected	COR	95% CI	*P*-level
Level of education of head of household					
None	96	12	33.00	11.33–100.55	<0.001
Lower Primary	77	15	21.17	7.51–62.05	<0.001
Upper Primary	70	26	11.11	4.22–30.19	<0.001
Secondary	50	76	2.71	1.09–6.97	0.03
Tertiary	8	33	1		
Wealth Class of head of household					
Lowest	105	5	54.49	19.38–165.38	<0.001
Second	98	16	15.89	7.93–32.24	<0.001
Third	61	45	3.52	1.98–6.27	<0.001
Highest	37	96	1		
Individual aged 10–20 years treated with praziquantel at last distribution					
No	206	64	3.32	2.19–5.04	< 0.001
Yes	95	98	1		

Table 3 Crude odds ratio (COR) and 95% confidence interval (CI) for schistosomiasis infection of individuals aged 10–20 years according to water contact

Variable	Infected	Not infected	COR	95% CI	*P*-level
Reported contact with water of lake Victoria in previous week					
Yes	279	36	44.39	25.09–78.53	<0.001
No	22	126	1		
Frequency of contact with lake Victoria water in previous week					
More than once	260	22	67.69	34.63–134.07	<0.001
Once	19	14	7.77	3.16–19.34	<0.001
No contact	22	126	1		
Total duration of contact with water of lake Victoria in previous week					
>15 min	211	18	28.13	15.31–52.27	<0.001
5–15 min	35	12	7.00	3.21–15.50	<0.001
<5 min	55	132	1		
Distance from individual home to lake Victoria					
<5 km	220	39	29.15	10.68–83.37	<0.001
5–9 km	53	21	13.04	4.35–41.05	<0.001
10–14 km	22	71	1.60	0.54–4.92	0.49
>15 km	6	31	1		

household (Table 2). The groups without formal education and those whose head of household had only completed lower primary (up to primary four), had an extremely high risk of being infected (Table 2). Generally the risk of infection decreased with rising levels of education [Chi-square for linear trend (χ^2 for trend) = 105.41, 1 degree of freedom (df), $P < 0.001$]. As shown in Table 2, the risk of infection with schistosomiasis greatly drops with increasing levels of wealth. The fitted model using a linear trend for the wealth class (χ^2 for trend = 144.04, 1 df, $P < 0.001$) of the head of the household was highly significant. Not having received treatment with praziquantel at the last distribution increased the risk of infection with schistosomiasis (COR 3.32, $P < 0.001$).

Contact with water of Lake Victoria

Out of the 463 individuals aged 10–20 years, 311 (67.2%) reported that they have been in contact with water of lake Victoria (which is the only source of schistosomiasis infection in the area) within the week preceding the survey. Of the 311, 180 (57.8%) had gone to the lake to fetch water, 165 (53.1%) had gone to the lake to bathe, 139 (44.7%) had gone to the lake to wash, 50 (16.1%) had gone to the lake to fish, 37 (12%) had gone to the lake to play/swim, and 14 (4.5%) had been in contact with the lake Victoria for use as a means of transport. Table 3 demonstrates that all indicators related to contact with water of Lake Victoria increases the risk of individual infection. Increasing contact frequency (χ^2 for trend 249.92, 1 df, $P < 0.001$) and duration (χ^2 for trend 176.27, 1 df, $P < 0.001$) with the water of lake Victoria increases the risk of infection with schistosomiasis, whereas increasing distance from the lake reduces the risk of infection with schistosomiasis (χ^2 for trend 145.01, 1 df, $P < 0.001$).

Table 4 Adjusted Odds ratio (AOR) and 95% confidence interval (95% CI) for independent predictors of schistosomiasis infection among individuals aged 10–20 years (adjusted for each other)

Variable	AOR (95% CI)	*P*-level
Reported contact with water of lake Victoria in the past one week		
Yes	25.69 (8.15–81.00)	<0.001
No	1	
Total duration of contact with water of lake Victoria water in previous week		
>15 min	6.80 (1.87–24.77)	0.004
5–15 min	7.22 (1.50–34.78)	0.014
<5 min	1	
Taken praziquantel during last distribution		
No	4.90 (2.43–9.90)	<0.001
Yes	1	
Wealth class		
Lowest	10.42 (3.38–32.26)	<0.001
Second	5.35 (2.15–13.33)	<0.001
Third	2.77 (1.27–6.06)	0.011
Highest	1	

Table 5 A comparison of geometric means of schistosomiasis egg counts with their 95% CI within the independent predictors of schistosomiasis infection among individual aged 10–20 years

Variable	Number in category	Geometric mean	95% CI
Reported contact with water of lake Victoria within the past one week			
Yes	279	211.59	187.97–238.12
No	22	82.70	50.87–134.40
Total duration of contact with water of lake Victoria within the previous week			
<15 min	37	263.88	219.94–316.59
5–15 min	147	183.65	156.46–221.00
>5 min	55	137.82	103.28–187.95
Wealth Class			
Lowest	105	230.04	189.71–278.93
Second	98	228.86	187.71–279.13
Third	61	167.38	127.50–219.74
Highest	37	114.26	80.33–162.11
Taken praziquantel during last distribution			
No	206	225.79	197.06–258.76
Yes	95	147.81	118.55–184.29

Independent predictors of infection with schistosomiasis

A multivariate analysis was conducted using the variables that showed a statistically significant association with schistosomiasis in the univariate analysis. Using a backward step-down procedure, the variables shown in Table 4 (reported water contact with water of the lake, taking of praziquantel, wealth index, and duration of contact) were the ones that were retained in the final model. The model with four variables (seven attributes) could explain the 71.3% of the variance of being infected with schistosomiasis. The data fitted the model very well (–2 log likelihood 261.99, 7 df, $P < 0.001$). Of the 463 individuals aged 10–20 years, 86.8% were correctly classified; 88.7% of the infected and 83.3% of the uninfected (model $\chi^2 = 337.48$, 7 df, $P < 0.001$).

Intensity of infection with schistosomiasis

For the 301 individuals aged 10–20 years who were infected we compared the geometric mean of *S. mansoni* epgs in the different levels of the independent predictors of infection. We present in this paper the results obtained for those variables retained in the final model of the multivariate analysis. The intensity of infection decreased with wealth index (*F*-ratio 5.63, 3 df, $P < 0.001$; deviation from linearity *F*-ratio 1.08, 1 df, $P = 0.36$; Linearity *F*-ratio 13.91, 1 df, $P < 0.001$), but increased with increasing duration of contact with water of lake Victoria (*F*-ratio 7.74, 2 df, $P < 0.001$; deviation from linearity *F*-ratio 0.045, 1 df, $P = 0.83$; Linearity *F*-ratio 15.45, 1 df, $P < 0.001$). Table 5 also shows that the intensity of infection was lower among individuals who reported having taken praziquantel at the last distribution (*F*-ratio 11.20, 1 df, $P = 0.001$) and among those who reported no contact with the water of lake Victoria within the preceding week of the survey (*F*-ratio 17.62, 1 df, $P < 0.001$).

Discussion

Our results showing an association between schistosomiasis, water contact, exposure to treatment with praziquantel and wealth index are consistent with the results obtained in other studies (Farooq *et al.* 1966; WHO 1979; Costa *et al.* 1987; Barreto 1991; Sama & Ratard 1994; Ofoezie *et al.* 1998). Whereas previous studies have mainly suggested that the influence of social economic conditions on the prevalence and intensity of schistosomiasis infection is mainly mediated through low social economic class being more likely to result in contact with infectious water at an increasing intensity (Useh & Ejezie 1999; van der Werf *et al.* 2003; King *et al.* 2005), and due to limited access to mass treatment (Sturrock 1989; Savioli *et al.* 2004; Kabatereine *et al.* 2007), this study suggests that when access to treatment and water contact is controlled for wealth index does remain an independent predictor of schistosomiasis infection and intensity. A possible explanation for this is that infection of schistosomiasis within a home is a cause as well as a consequence of poverty (Hotez *et al.* 2007; WHO 2007).

Our findings that wealth index is an independent predictor of *S. mansoni* infection and intensity if replicated in further research could have implications for control strategies. The wealth index allows the identification of subgroups with greater risk of infection and once infected with higher intensity. Therefore, the wealth index may be used as a complementary or alternative way to identify those individuals who should be scheduled for re-treatment and re-examination. For instance praziquantel could be given to all the individuals whose households belong to the bottom three levels of wealth index (lowest second and third) and administered just to the infected persons among the households that are better off (the highest). Furthermore, re-treatment intervals could be 2 years or more among the wealthiest (e.g. 2 years or more) but less than a year among the poor (lowest second and third). More intense treatment with two doses could also be given to the poorer sections of the community (Richards *et al.* 2006). This targeting may help reduce treatment costs as well as improve availability of praziquantel in communities where the drug supply is limited (Anguzu *et al.* 2007).

The main strategy for the control of *S. mansoni* in Uganda and most low income countries of sub-Saharan Africa is mass treatment with praziquantel (Kabatereine *et al.* 2007; WHO 2007). Whereas it may reduce morbidity and risk of transmission, it rarely if ever eliminates infection, and prevalence usually returns rapidly to pre-control levels (Sturrock 1989; Savioli *et al.* 2004; Utzinger *et al.* 2005). Thus long term control of schistosomiasis will have to include other measures, such as improvement in social economic status of the population. Most countries that achieved long-term control of schistosomiasis experienced important socioeconomic changes resulting in improved living conditions. Important long term and sustainable achievements in schistosomiasis control occurred in Japan, Egypt, Brazil and China, all of which have a relatively a relatively high gross national product per capita compared to other countries where schistosomiasis is still endemic (Yokogawa 1976; Jordan & Rosenfield 1983; Leonardo *et al.* 2002; Utzinger *et al.* 2005; Brooker *et al.* 2008).

Long-term improvement in social economic status, however, may be a long term strategy for schistosomiasis control, a strategy that has been suggested to improve control in the short term and medium term is community empowerment, with greater equality in who has resources, authority, legitimacy, and influence (Laverack & Labonte 2000). This strategy is enhanced by, among other things, the development of local leadership, the development and strengthening of community organizations, and the development and strengthening of inter-organizational networks and political action. In addition, since community organization may remain local in character, with little if any influence on public policies, the formation of coalitions for political action may make it possible to overcome the limitations of community organizations and to exert pressure for social reform and political change (Labonte 1989; Laverack & Labonte 2000). Indeed, the international partnerships that have been created at global level regarding the so called neglected tropical diseases should be able to leverage resources that at national level should be used to enable economic empowerment of communities afflicted by schistosomiasis (Hotez *et al.* 2007). Schistosomiasis control in China was achieved in parallel with a much wider transformation of the society and intensive mobilization of the population on health issues (Utzinger *et al.* 2005).

One limitation of this study that is worth noting in interpreting this data is the multi-co linearity that may have occurred in our multivariate analysis. That happens when two or more regressors are highly correlated. In these cases it is difficult to disentangle the effects of the two (or more) regressors, and the standard errors may be large when both regressors are in the model. However, the effect of multi-co linearity is not considered a special problem in predicting the dependent variable (Wonacott & Wonacott 1985). Another limitation is that measures of water contact (based on self report) used in this study are relatively crude. Indeed the measurement of water contact is 'fraught with difficulties of precision and accuracy with the accuracy of exposure nearly impossible to assess (Bundy 1988; Bundy & Blumenthal 1990; Fulford *et al.* 1996). Although some epidemiologists have sought to increase the validity of assessing exposure by looking for more accurate ways of measuring water contact (Bundy 1988; Bundy & Blumenthal 1990) others have argued that improved measurement may be neither necessary nor sufficient; preferring instead a broader understanding of the processes underlying water-contact behaviour (Bethony *et al.* 2004). We believe that the variables to measure water contact in this study are fairly accurate, as recall time was limited to one week. Moreover, Lake Victoria is the only source of infection in this study, and having only one source of infection improves the reliability of self reported water contact (Gazzinelli *et al.* 2001).

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