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Epidemiology of HIV and *Schistosoma mansoni* infections among sugar-estate residents in Ethiopia

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Few studies have examined the interaction between schistosomiasis and infection with human immunodeficiency virus (HIV). The overlap between the two infections, and the effect of HIV infection on the egg output and worm load of individuals co-infected with *Schistosoma mansoni*, were therefore investigated in a sugar estate in central Ethiopia. The 1239 subjects were selected by stratified sampling of residents aged 15–54 years. The intensities of infection with *S. mansoni* were measured as egg output in stools (all subjects) and as the concentration of circulating cathodic antigen (CCA) in urine (a proxy for worm load, measured in 287 subjects).

Schistosome infection was detected in 358 subjects [adjusted prevalence (AP) = 31.4%] and HIV infection in 52 (AP = 3.1%). The two infections clustered into different populations of the estate: the schistosome infections were predominantly found in the camps, and primarily affected young people (aged < 20 years) and those working in the field, whereas the HIV epidemic was found in the main village, primarily affecting those aged > 20 years and those who had recently arrived on the estate. Schistosome infection was detected in 348 of the 1187 HIV-negatives (AP = 31.6%) and 10 of the 52 HIV-positives (AP = 25.1%; $P > 0.05$). *Schistosoma mansoni* egg output was significantly lower in the HIV-positives than in the HIV-negatives (Mann–Whitney test; $P = 0.03$; ratio of geometric means = 0.74), and remained so after controlling for potential confounders (gender, age, and residence). However, CCA concentrations (i.e. worm loads) were found to be similar for these two groups, after controlling for potential confounders (age, gender, residence, and duration of residence).

There have only been a few studies on the interaction between schistosomiasis and HIV infections (N'Zoukoudi-N'Doundou *et al.*, 1995; Karanja *et al.*, 1997). Schistosomiasis is endemic in approximately 75 countries in the tropics (Iarotski and Davies, 1981). Its distribution is focal, requiring the presence of water bodies containing the snails that act as intermediate hosts, poor hygiene, and particular human water-contact behaviours. Schistosomiasis is consequently more common in rural areas, and new outbreaks are often associated with agricultural development and irrigation

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projects. In contrast, the HIV epidemic was, until recently, predominantly a problem in urban areas (Anderson *et al.*, 1991; Mertens *et al.*, 1994). Its spread involves a combination of social and demographic factors, such as multiple sexual partnership and population mobility, more commonly found in large cities (Larson, 1989; Amat-Roze, 1993). However, with the extension of the HIV epidemic to rural areas of some tropical countries (especially Africa) during the last decade (Kengeya-Kayondo *et al.*, 1996), it is expected that some regions where schistosomiasis is endemic will soon also become endemic for HIV infection. The overlap between the two infections in a sugar estate of central Ethiopia, and the effect of HIV infection on the *Schistosoma mansoni* egg output and worm load in co-infected individuals, are the subjects of the present study.

SUBJECTS AND METHODS

Study Population

The Wonji–Shoa sugar estate, which lies 107 km south–east of Addis Ababa, in Ethiopia, was established in 1953 by a Dutch company. According to a census in June 1995, the total population of residents (i.e. those who had lived on the estate for >6 months) was then 24 262. Of these, 12 620 were adults aged 15–54 years. Those who live on the estate fall into two main groups: the residents of the villages of Wonji and Shoa (who work mainly in the sugar factories) and the residents of the camps, some of whom are seasonal workers from southern Ethiopia who return to the estate each year to cut the sugar cane. Wonji village, in the north of the estate, has several daily connections by bus to the nearby city of Nazareth, on the main trading road between Addis Ababa and the commercial ports on the Red Sea. For many years, infection with *S. mansoni* has been one of the main causes of morbidity seen in the local health facilities. In contrast, the first cases of HIV infection to be seen at Wonji hospital were recorded in 1992, although the annual numbers of such cases have since gradually increased (W. Masho, unpubl. obs.).

In preparation for a cohort study on the natural history of HIV infection, two surveys have been conducted on the estate, to assess the prevalence of HIV infection, the stability of the population, and the acceptability of a long-term research project on HIV/AIDS (Sahlu *et al.*, 1998). During the first survey, between November 1995 and April 1996, 8% of all the non-migrant workers aged 15–54 years were randomly selected from the census list, so that the precision around the estimated HIV prevalence would lie within 2%. Also, to get a precise estimate of HIV prevalence among the migrant workers, the sampling fraction was increased to 25% in their two camps. The second survey, carried out between June and September 1996, included all the factory workers aged 18–45 years who lived in Wonji village.

Following pre-test counselling and informed consent, each study participant provided a blood sample for serological analysis of HIV-1, a stool sample for diagnosing intestinal parasitic infections, and a urine specimen so that urine concentrations of schistosome circulating cathodic antigen (CCA) could be determined. Serum samples were tested for HIV-1 antibodies by Vironistika ELISA (Organon, Boxtel, The Netherlands). Sera found positive by this ELISA were checked using a commercial test based on western blotting (HIV Blot 2.2; Genelabs, Redwood City, CA). Eggs of *S. mansoni* in 41-mg stool samples were counted using one Kato smear/subject, counts being converted to eggs/g faeces. Individuals with positive egg counts were considered infected with *S. mansoni.* All those found to be infected with intestinal parasites or *S. mansoni* were treated free of charge. Post-test counselling was left optional to study participants who wanted to learn their HIV status.

Circulating Antigen

Concentrations of the CCA, associated with adult schistosomes (Deelder *et al.*, 1994), were determined in a subset of all urine specimens, using a sandwich ELISA based on a mono-

clonal antibody (De Jonge *et al.*, 1990). All urine samples available from HIV-positive individuals were tested, as well as a selection from HIV-negative individuals. Before testing, urine samples were pre-treated with alkaline buffer and heated to 70°C (Krijger *et al.*, 1994). The samples were tested in duplicate at a 1:8 dilution. For reference, serial dilutions of the trichloroacetic-acid-soluble fraction of the adult worm antigen (AWA-TCA), which contains approximately 3% (w/w) CCA, were assayed simultaneously on each plate. Antigen levels were calculated with a four-parametric, curve-fitting method and expressed as ng AWA-TCA/ml. Based on the previous testing of hundreds of negative controls, individuals with >30 ng AWA-TCA/ml urine were considered to have an active *Schistosoma* infection.

Statistical Analysis

Proportions and means for the total study population were adjusted for the stratified sampling design and study compliance, giving, for example, 'adjusted prevalences' (AP) for *S. mansoni* and HIV infection. Comparisons between groups were made using the χ^2, non-parametric test for trend for ordered groups (Cuzick), and *t*-tests (or Mann–Whitney tests for variables with non-normal distribution), as appropriate. A *P*-value of <0.05 was considered statistically significant. Covariate-adjusted, multivariate analysis of risk factors for HIV and schistosome infections was performed using a logistic regression model, again adjusted for the stratified sampling design and study compliance. Egg counts and CCA concentrations were characterized by ranges and geometric means of the positive values, following $\log_{10}$ transformation. The association between egg outputs and CCA concentrations was analysed using the Spearman's rank-correlation test. Independent predictors of faecal egg counts were identified in a linear regression model, using log-transformed egg output as the dependent variable, and socio–demographic characteristics plus HIV status as independent variables. The ratio of the geometric mean egg output for exposed and non-exposed subjects was obtained for each predictor (e.g. age-group, gender, HIV status) by taking the antilogarithm of the regression coefficient. The predictors of the log-transformed CCA concentrations, in those with active *Schistosoma* infection, were identified in a similar manner.

RESULTS

During the two surveys (November 1995–September 1996), 1750 individuals were randomly selected using the census list. Of these, five had died since the completion of the census, 20 were sick and thus not able to attend the study clinic, 60 had changed address (including those who left the sugar estate), and 97 were non-eligible because of their age (i.e. <15 or >54 years). Of the other 1568, 329 (21.0% overall; 35.8% of the factory workers and 15.3% of the non-factory workers) refused to participate in the study, and 1239 subjects (890 males and 349 females) were therefore finally enrolled. The mean age of the subjects was 30 years, with a range of 15–60 years (two individuals aged >54 years were inadvertently enrolled).

Schistosome infection was detected in 358 subjects and HIV infection in 52, giving adjusted prevalences of 31.4% and 3.1%, respectively. The two infections tended to cluster in different population subgroups of the estate. The factors associated with schistosome infection were male gender, young age (<20 years), residence in Shoa village or the camps, migrant-worker status, and field work (Table 1). In contrast, the factors associated with HIV infection were higher age (>20 years), residence in Wonji village, factory work, lack of education, and recent (<5 years) arrival on the estate (Table 2).

All factors associated with *S. mansoni* infection in the univariate analysis remained so in the multivariate (indicating their independent effect on the prediction of *S. mansoni* infection status), except for migrant status, which was strongly correlated with male gender, camp residence and field work.

Higher age (>20 years), residence in Wonji village, lack of education, and recent arrival in the estate remained independently

TABLE 1

Relationship between socio–demographic variables and Schistosoma mansoni *infection in 1239 residents of the Wonji–Shoa sugar estate, Ethiopia*

Variable	*No. of subjects*	*Prevalence of infection* (%)*	*Odds ratio and (95% confidence interval)*		P
			Crude	*Multivariate†*	
GENDER					
Female	349	21.4	1	1	
Male	890	37.7	2.23 (1.62–3.07)	1.72 (1.01–3.04)	0.03
AGE (years)					
15–19	199	39.2	1	1	
20–29	324	31.4	0.71 (0.47–1.06)	0.44 (0.26–0.74)	<0.001‡
30–39	384	26.3	0.55 (0.37–0.83)	0.35 (0.20–0.63)	
>39	322	28.3	0.61 (0.41–0.92)	0.28 (0.14–0.53)	
RESIDENCE					
Wonji village	390	2.1	1	1	
Shoa village	116	16.9	9.40 (3.34–26.5)	8.02 (2.86–22.5)	<0.001
Camp	733	43.7	35.8 (14.3–89.5)	27.8 (10.6–73.0)	<0.001
MIGRATION STATUS					
Migrant	298	50.0	2.49 (1.88–3.31)	1.02 (0.69–1.52)	>0.05
Non-migrant	941	28.6	1	1	
OCCUPATION					
Field worker	425	51.3	3.52 (2.60–4.78)	2.13 (1.29–3.51)	0.003
Factory worker	174	8.0	0.29 (0.12–0.72)	0.67 (0.25–1.80)	>0.05
Other	640	23.0	1	1	
EDUCATIONAL GRADE§					
<1	295	28.8	1	1	
1–6	389	35.5	1.76 (1.20–2.57)	1.47 (0.95–2.27)	>0.05‡
7–11	391	28.9	1.56 (1.06–2.28)	1.33 (0.76–2.33)	
>11	164	13.4	0.78 (0.44–1.38)	0.84 (0.39–1.79)	
DURATION OF RESIDENCE (years)					
0–4	37	32.6	1	1	
5–9	105	32.2	0.98 (0.37–2.58)	0.90 (0.31–2.60)	>0.05‡
10–14	112	28.6	0.83 (0.31–2.18)	0.57 (0.20–1.63)	
>14	981	31.4	0.95 (0.41–2.17)	0.95 (0.38–2.37)	
Unrecorded	4				

* Adjusted for the stratified sampling design and study compliance.

† From a multivariate logistic-regression model including all variables, adjusted for the stratified sampling design and study compliance.

‡ *P*-value for the odds of being infected with *S. mansoni* after an increase of one category in the multivariate analysis.

§ Grades 1–6, 6–12 and >12 correspond to primary, secondary and tertiary education, respectively.

associated with an increased risk of HIV infection in the multivariate analysis.

Schistosome infection was equally prevalent among the HIV-negatives (348/1187; AP = 31.6%) and HIV-positives (10/52; AP = 25.1%; $P > 0.05$). After controlling for socio–demographic characteristics (age, gender, residence, and work site), the odds of having schistosome infection did not differ between the HIV-positives and HIV-negatives

TABLE 2

Relationship between socio–demographic variables and HIV infection in 1239 residents of the Wonji–Shoa sugar estate, Ethiopia

Variable	*No. of subjects*	*Prevalence of infection* (%)*	*Odds ratio and (95% confidence interval)*		P
			Crude	*Multivariate†*	
GENDER					
Female	349	2.5	1	1	
Male	890	3.4	1.42 (0.62–3.24)	1.65 (0.65–4.17)	> 0.05
AGE (years)					
15–19	199	0.6	1	1	
20–29	324	2.9	5.44 (0.66–44.7)	4.47 (0.55–36.4)	0.04‡
30–39	384	2.9	5.37 (0.68–42.6)	4.60 (0.50–41.2)	
> 39	322	5.8	11.1 (1.44–86.1)	8.02 (0.91–70.8)	
RESIDENCE					
Wonji village	390	5.8	2.55 (1.20–5.40)	3.18 (1.24–8.18)	0.02
Shoa village	116	1.0	1	1	
Camp	733	2.6	1	1	
MIGRATION STATUS					
Migrant	298	3.0	0.98 (0.45–2.15)	0.89 (0.29–2.76)	> 0.05
Non-migrant	941	3.1	1	1	
OCCUPATION					
Field worker	425	3.0	1.10 (0.48–2.53)	1.00 (0.30–3.34)	> 0.05
Factory worker	174	7.2	2.82 (0.99–8.05)	1.29 (0.41–4.08)	> 0.05
Other	640	2.7	1	1	
EDUCATIONAL GRADE					
< 1	295	5.5	2.54 (1.20–5.36)	2.43 (1.02–5.79)	0.04
1–6	389	2.2	1	1	
7–11	391	2.3	1	1	
> 11	164	2.1	1	1	
DURATION OF RESIDENCE (years)					
0–4	37	9.9	3.74 (0.96–14.6)	7.93 (1.80–34.9)	0.006
5–9	105	3.9	1	1	
10–14	112	1.3	1	1	
> 14	981	2.9	1	1	

* Adjusted for the stratified sampling design and study compliance.

† From a multivariate logistic-regression model including all variables, adjusted for the stratified sampling design and study compliance.

‡ *P*-value for the odds of being infected with HIV after an increase of one category in the multivariate analysis.

[odds ratio (OR) from multivariate model = 1.01; $P = 0.98$]. There was also no difference in the proportions of HIV-positives (12/52; AP = 25.7%) and of HIV-negatives (439/1187; AP = 37.0%) who had been treated for schistosomiasis in the past ($P > 0.05$).

Among the 358 subjects who provided stool samples in which *S. mansoni* eggs were detected, the intensity of *S. mansoni* infection was low to moderate (24–960 eggs/g, with a geometric mean of 158 eggs/g). Independent predictors of egg count were male gender, young age (< 20 years), and residence in the

TABLE 3

Socio–demographic variables acting as independent predictors of the log-transformed counts of Schistosoma mansoni *eggs among 358 egg-positive residents of the Wonji–Shoa sugar estate, and the effect of HIV infection*

	*Egg-output ratio**	
Characteristic	*Univariate analysis*	*Multivariate analysis†*
Male gender	1.08 (0.96–1.23)	1.15 (1.02–1.31)
Age < 20 years	1.07 (0.94–1.20)	1.12 (0.99–1.28)
Residence in a camp	1.16 (1.03–1.39)	1.20 (1.00–1.44)
HIV infection	0.74 (0.55–1.01)	0.74 (0.55–1.00)

* The ratio between the geometric mean egg output of those with the characteristic and that for those without, obtained by taking the antilogarithm of the regression coefficients associated with the predictor.

† Including all variables of the table in the model.

camps (Table 3). HIV infection also predicted egg count, the geometric mean egg count been significantly lower in the 10 HIV-positives who were also egg-positive (118.2 eggs/g) than in the 348 HIV-negatives who were egg-positive (159.4 eggs/g; $P = 0.03$; see Fig.). The ratio between these two means, 0.74, had a 95% confidence interval (CI) of 0.55–1.01 ($P = 0.05$; Table 3). The egg outputs of the egg-positives remained significantly lower for the HIV-negatives than the HIV-positives after controlling for the three other predictors of log-transformed egg output in a multivariate analysis (ratio = 0.74; 95% CI = 0.55–1.00). Finally, HIV infection remained a predictor of decreased egg output when the analysis was restricted to the 215 subjects who were field workers ($P = 0.05$) or to the 328 who were camp residents ($P = 0.03$).

Of the 297 urine samples selected for the

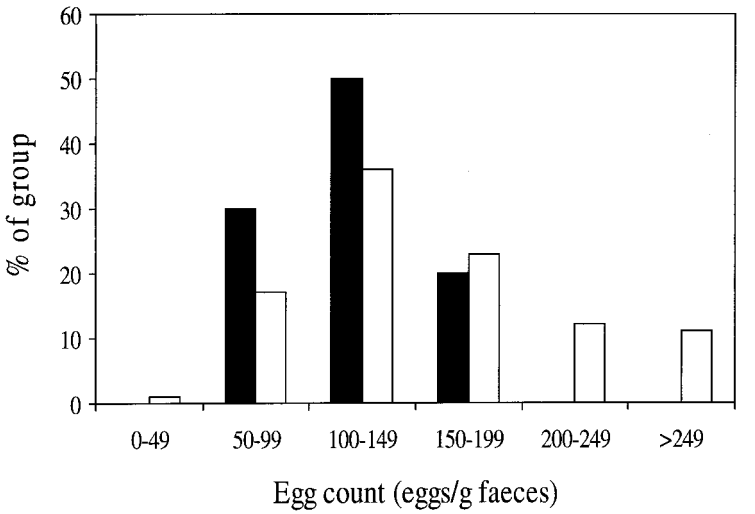

Fig. The distribution of the counts of *Schistosoma mansoni* eggs (eggs/g) among 348 HIV-negative (□) and 10 HIV-positive (■) individuals with *S. mansoni* infection.

determination of CCA concentration, 10 could not be analysed for various technical reasons. Results were therefore only available for the other 287 (48 from HIV-positives and 239 from HIV-negatives). Of these, 143 showed CCA levels indicative of active *Schistosoma* infection, with AWA-TCA concentrations ranging from 31.8–28 951 ng/ml and a geometric mean of 258.5 ng/ml.

Considering just the 143 subjects with >30 ng AWA-TCA/ml urine: (1) there was a good correlation between egg count and AWA-TCA concentration ($r = 0.48$; $P < 0.0001$); (2) the independent predictors of AWA-TCA concentration were those of egg count (i.e. male gender, age <20 years, and residence in the camps), plus duration of residence in the camps (Table 4); and (3) mean AWA-TCA concentrations were lower in the 14 HIV-positives (132.7 ng/ml) than in the 129 HIV-negatives (277.9 ng/ml; $P = 0.04$). The ratio between the latter means, 0.48, had a 95% CI of 0.23–1.01 ($P = 0.05$; Table 4). However, HIV infection was no longer a significant predictor of log-transformed AWA-TCA concentration after control for other predictors (corresponding ratio of means = 0.67; $P = 0.26$).

Among the 94 egg-positives who had their CCA concentrations measured, the decrease in egg output associated with HIV infection in the univariate analysis (ratio = 0.78) was little modified by the addition of CCA concentrations in the regression model (ratio = 0.83). This indicates that the reduction of egg output in HIV-infected subjects was independent of CCA concentration (and therefore of worm load).

DISCUSSION

Schistosome and HIV infections were both present on the estate. The prevalence of schistosome infection reported (31%) is likely to be an underestimate of the true prevalence, since it is based on a single Kato thick smear for each subject; the chart developed by De Vlas (1996) indicates that the true prevalence may be around 53%. Schistosomiasis has been present in Wonji for the past 40 years, following the building of the irrigation canals for the sugar plantation. Surveys carried out on the

TABLE 4

Socio–demographic variables acting as independent predictors of the log-transformed, urine concentrations of circulating cathodic antigen (CCA) among 143 residents of the Wonji–Shoa sugar estate with CCA levels indicative of active infection with Schistosoma mansoni, *and the effect of HIV infection*

	*Ratio of CCA concentrations**	
Characteristic	*Univariate analysis*	*Multivariate analysis†*
Male gender	1.76 (0.98–3.11)	2.18 (1.27–3.76)
Age <20 years	2.69 (1.49–4.96)	3.71 (2.07–6.69)
Residence in a camp	1.96 (1.08–3.54)	2.27 (1.30–3.94)
DURATION OF RESIDENCE (years)		
<5	1	1
5–9	2.21 (0.46–10.54)	3.57 (0.84–15.1)
10–14	2.32 (0.52–10.3)	3.87 (0.95–15.7)
>14	3.93 (1.02–15.1)‡	5.63 (1.61–19.6)‡
HIV infection	0.48 (0.23–1.01)	0.67 (0.33–1.35)

* The ratio between the geometric mean concentration of those with the characteristic and that for those without, obtained by taking the antilogarithm of the regression coefficients associated with the predictor.

† Including all variables of the table in the model.

‡ The regression coefficient associated with an increase of one category of duration of residence was significant ($P = 0.01$).

estate in the 1960s (Bruijning, 1969) documented prevalences of schistosome infection in adults similar to that observed in the present study. The emergence of the HIV epidemic is a more recent phenomenon, following the introduction of the virus in Ethiopia in the mid-1980s (Tsega *et al.*, 1988).

Interestingly, the schistosome and HIV infections on the estate clustered in two different populations: the schistosome infections in the camps (primarily in field workers) and the HIV in Wonji village. The association between schistosome infection and camp residence and field work is understandable, since contact with water infested with *S. mansoni* cercariae is likely to be most frequent under these two circumstances. That HIV infection was primarily restricted to Wonji village was more of a surprise. There are, living in the camps outside of this village, large populations of male migrant workers, who live on the estate for 8 months each year, harvesting the sugar cane. Although studies in other areas where HIV infection is endemic have revealed relatively high prevalences of infection among migrant populations (Kane *et al.*, 1993; Nunn *et al.*, 1995), this was not the case in the present setting. This unusual observation might be explained by the lower incidence of risky sexual behaviour among the migrant workers than among the factory workers of the estate, as described by Sahlu *et al.* (1998). In addition, the nearby city of Nazareth, where many commercial sex workers were found to be HIV-positive in 1988 (Mehret *et al.*, 1990), is more easily accessible from Wonji than from elsewhere on the estate. The HIV epidemic is expected to spread rapidly to the rest of the estate, now that it is established in the main village.

Egg output and CCA concentration in urine were used in the present study to estimate the intensities of *S. mansoni* infection. Concentrations of CCA correlate well with worm loads in laboratory animals, and with repeated egg counts in humans (Agnew *et al.*, 1995; Polman *et al.*, 1995; Van Lieshout *et al.*, 1995). The correlation between CCA (AWA-TCA) concentration and egg output in the present study was also highly significant, and the predictors of high CCA concentration turned out to be the predictors of high egg output. Both egg output and CCA concentration were much lower in adults aged >20 years than in younger subjects. This finding, which has been reported elsewhere (Polman *et al.*, 1995; Van Lieshout *et al.*, 1995; Agnew *et al.*, 1996), indicates that the falls often seen in egg counts with increasing host age may be related to genuine reductions in worm loads. The lower CCA concentrations observed in adult newcomers to the estate (i.e. those who have been residents for <5 years, with presumably no immunity against schistosomiasis) indicates that it takes at least 5 years of cumulative exposure to attain a stable worm load.

In the present study, those who were co-infected with *S. mansoni* and HIV excreted significantly fewer eggs of the schistosome than those who were infected with the schistosome and HIV-negative. This observation should be interpreted with caution, since only 10 co-infected subjects were available for comparison with 348 HIV-negative egg excreters. However, small sample size is a limitation in the absence of association (lack of statistical power), rather than in the presence of a positive finding. A more serious concern is that the observed relationship may be the result of a confounding effect. Confounding would occur if some external factors associated with HIV infection were also associated with decreased egg output. Indeed, some factors positively associated with HIV infection, such as older age and residence in Wonji village, were associated with decreased egg output. However, the relationship between HIV infection and lower egg output remained unaltered in a multivariate analysis controlling for these variables and other predictors of egg excretion, or after restricting the analysis to apparently 'homogeneous' populations such as field workers or camp residents. Finally, the present results are in accordance with the findings of the only other study published to date comparing the egg excretion of HIV-positive and HIV-negative individuals infected with *S. mansoni* (Karanja *et al.*, 1997). A biological explanation for this association therefore seems more likely than an epidemiological bias. One possibility

would be that the decrease in egg output is mediated by a decrease in worm load in HIV-infected individuals. Indeed, the results of a univariate analysis indicated that the mean CCA concentration, a proxy for worm load, was significantly lower in the subjects co-infected with *S. mansoni* and HIV than in the HIV-negatives who were infected with *S. mansoni*. However, after controlling for the other predictors of log-transformed CCA concentration, the reduction in CCA concentrations associated with HIV infection was no longer significant. Also, the magnitude of the decrease in egg output associated with HIV infection remained unchanged after the addition of CCA concentrations to the same regression model, indicating a mechanism independent of CCA concentration (or worm load). An alternative explanation for the decreased egg output with HIV infection is that egg transportation across the intestinal wall, which is dependent on $CD4^+$ T-cells (Lammie *et al.*, 1985; Doenhoff, 1997), is reduced in HIV-positives who have relatively low counts of these cells (Karanja *et al.*, 1997). Unfortunately, since no data on $CD4^+$ T-cells were collected during the present surveys, it was not possible to explore this hypothesis.

The present study appears to be the first community-based investigation of co-infection with *S. mansoni* and HIV. It has been useful in documenting the distinct socio–demographic characteristics of residents of one geographical area who were infected with *S. mansoni*, HIV or both pathogens. Attention should be paid to the differences in these characteristics when comparing the prevalence (or intensity) of *S. mansoni* infection in HIV-positive and HIV-negative individuals, since such differences may translate into varying concentrations of exposure to *S. mansoni* cercariae. The present results provide additional evidence to show that egg output is decreased by HIV infection, possibly through a deficit in egg excretion. One should therefore be aware of the increased risk of false-negative results in the diagnosis of schistosomiasis, by stool examination, in HIV-positive individuals. Whether the apparent egg retention in HIV-positives results in increased parenchymal damage of the liver remains to be studied. It is planned that, in the on-going exploration of the HIV infections in the residents of the Wonji–Shoa sugar estate, the effect of schistosomiasis on the progression of these infections (Actor *et al.*, 1993) will be investigated.

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