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# A STUDY OF RISK FACTORS FOR INTESTINAL HELMINTH INFECTIONS USING EPIDEMIOLOGICAL AND ANTHROPOLOGICAL APPROACHES

A. OLSEN*, H. SAMUELSEN† AND W. ONYANGO-OUMA‡

**Danish Bilharziasis Laboratory, Jaegersborg Allé 1 D, DK-2920, Charlottenlund, Denmark, †Department of International Health, Institute of Public Health, University of Copenhagen, Denmark and ‡Institute of African Studies, University of Nairobi, PO Box 30197, Nairobi, Kenya*

**Summary.** This study, conducted in Kisumu District, Kenya, identified important risk factors for infection with intestinal helminths using traditional epidemiological methods. This was combined with a rapid assessment study using qualitative methods, which focused on sanitation practices and local illness perceptions. The multiple logistic regression analysis revealed that the absence of latrines was a significant predictor for hookworm infection with an odds ratio (OR) of 1·9. The analysis also revealed that households without soap had a 2·6 times higher risk of being infected with *Ascaris lumbricoides* compared with households where soap was available, and that the number of inhabitants living in a household was a significant predictor for infections with hookworms (OR = 3.2). Furthermore, the presence of children of 5 years and under in the household was a predictor for infection with *A. lumbricoides* (OR = 2.7), while the absence of this age group was a predictor for hookworm infection (OR = 3.8). The qualitative part of the study revealed that people did not consider worms as a serious health threat, but as a nuisance. Among the population, latrines were seen as beneficial because they were believed to prevent disease, to provide privacy and to keep the environment free of faeces. Handwashing was done many times a day but usually not with soap, which was mainly used when bathing or washing the whole body. Many inhabitants in a household or the presence of children of 5 years and under were never mentioned as being a disadvantage, and these elements would therefore be difficult to include in a control strategy. Since the lack of latrines and of soap were identified as risk factors for infection, while latrines, soap and medicine were seen as assets by the population, it is suggested that helminth control interventions should be concentrated within these areas in this particular society.



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## Introduction

The World Health Organization estimates that more than one billion people are chronically infected with intestinal helminths (WHO, 1998). These helminths, especially hookworms, are abundant in the part of Kisumu District bordering Lake Victoria. Recent investigations in the area revealed that even low intensities of hookworm infections have an impact on the iron status of the infected population (Olsen *et al.*, 1998). Other researchers have also underlined the importance of hookworm, *A. lumbricoides* and *T. trichiura* infections on physical fitness, growth, appetite and cognitive performance in schoolchildren (Stephenson *et al.*, 1993a, b; Adams *et al.*, 1994; Nokes & Bundy, 1994). However, affected populations do not always consider these infections as health problems (Kamunvi & Ferguson, 1993), and thus the incentive to change behaviour or to invest in control interventions could be minimal.

Although there is not necessarily a direct link between increased knowledge and change of behaviour, the possibility of any disease control programme succeeding is highest in cases where the target population recognizes the disease as a health problem and is aware of the risk factors influencing the disease. Control interventions in relation to a specific disease are more difficult when the disease is not perceived as a major health problem and, therefore, risk factors are not considered important. In such cases, disease control is likely to be more efficient if these risk factors are targeted through interventions, which are perceived as assets by the population for other reasons. Furthermore, it is crucial that chosen strategies build on local understandings and do not transgress the social and moral norms and values of the society. Earlier studies have shown that the local population conceive *chira* to be a serious hazard (Ocholla-Ayayo, 1976; Parkin, 1978; Whyte, 1990; Kryger, 1992). *Chira* does not correspond to a biomedical disease, but is an affliction that can be fatal. *Chira* is a symbolic power, which might be released when important social and cultural values, often related to sexuality or seniority, have been violated. A person with *chira* will lose appetite, become weak and eventually die. Thus, the chosen control strategy must not include any elements that would violate the norms believed to cause *chira*.

The aim of the present cross-sectional study was to determine the incidence of intestinal helminths in the population, and to identify significant risk factors for the infections using multiple logistic regression analyses. In addition, the participants' perceptions of risk factors, sanitation practices, worms and illness in general were investigated in order to understand helminth infections in a local perspective. The combination of these two approaches allows risk factors to be determined, and concurrent interventions to be designed that could be promising elements of a control strategy.

## Methods of the epidemiological study

### *Study area and population*

The study population consisted of 752 individuals living in 233 households within 121 compounds in the villages of Asino, Ohala and Pith-Kodhiambo in south-west

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Seme Location, Kisumu District, Nyanza Province, Kenya. Asino and Pith-Kodhiambo villages are situated on the shore of Lake Victoria, while Ohala is on the slopes immediately north of Asino. The study was conducted from November 1994 to April 1995.

The population is predominantly Luo, who are mainly subsistence farmers. The principal crops in the area are finger millet, maize, groundnuts and cassava, and to a minor extent, beans, peas, potatoes and tomatoes. Zebu cattle, chickens and goats are abundant, as well as dogs and cats. Inhabitants living by the lake shore are full-time fishermen, while many others catch fish to supplement their income.

The study included all inhabitants over the age of 4 years present in the three villages at the time of the survey. The area was visited several times in order to include as many inhabitants as possible, and apart from children less than 4 years of age only adults not living permanently in the villages were excluded. More than 90% of the eligible individuals were included.

### *Intestinal helminths*

Stool samples were collected from all participants on two consecutive days and duplicate 50 mg Kato-Katz cellophane thick smears were made (WHO, 1991). The slides were examined within one hour for hookworm eggs, and on the following day for other intestinal helminth eggs. Intensity of infection was expressed as the mean eggs per gram faeces (epg) of the slides examined. Intensities for groups were expressed as the arithmetic mean of all investigated individuals. Individuals infected with any intestinal helminth were treated with albendazole (400 mg daily for 3 days).

### *Environmental conditions and socioeconomic status*

During the parasitological house-to-house survey the team recorded the presence or absence of latrines for each household. For practical reasons, 157 households were selected randomly (67% of the total number of households), and a short questionnaire was given by the team leader to the household head containing questions related to the presence or absence of latrines, cattle and soap. In addition, the socioeconomic status of the household head was determined by responses to questions on the level of his/her education, occupation, income and area of land owned.

### *Data analysis*

Statistical analysis was carried out using SPSS software. Chi-square tests were used to test for differences in proportions, while the Mann-Whitney *U* test was used to assess differences in intensities of infection. A significance level of 0·05 was used for all tests.

Multiple logistic regression analysis was done to identify predictors of the presence of infection. The analysis can be performed only on independent individuals and it was therefore important to determine whether the different helminth infections were clustered in households or compounds. It was found that *A. lumbricoides* was clustered in households, *T. trichiura* was clustered in compounds while hookworms

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seemed to have a scattered distribution (Olsen, unpublished results). Thus, analyses could be performed among individuals only for hookworm infections, but had to be performed among households and compounds for *A. lumbricoides* and *T. trichiura* infections, respectively. The highest power is retained in the analyses on individuals and therefore this has been preferred when possible. Variables assessed in the analysis on individuals were: sex, income and educational level of household head; area of land owned; number of household inhabitants; presence of children $\leq 5$ years of age, cattle, soap and latrines in the household; distance to lake shore and age and sex. For analysis on households, age and sex were excluded and for analysis on compounds household-dependent variables were excluded leaving only number of compound inhabitants, presence of children $\leq 5$ years of age, cattle and latrines in the compound and distance to lake shore. Validation of models was performed using the Hosmer-Lemeshow goodness-of-fit test (Hosmer & Lemeshow, 1989).

## Methods of the qualitative study

*Interviews and observations*

The qualitative part of the study was carried out as a rapid assessment where semi-structured interviews were conducted in 51 randomly selected households in the three study villages. These interviews were supplemented with observations in the households focusing on the living standards of the families visited, sanitary facilities and the general level of hygiene. The field study was divided into two phases: the first phase took place in November 1994 and the second phase in April 1995. About half of the interviews ($n=26$) were carried out in the first phase. These focused on the social composition of the households, the most common illnesses identified by the informants and sanitation practices in order to better understand local perception and practices related to health and illness. The second phase ($n=25$) focused on risk factors identified by the epidemiological study. Specific questions on recent illness episodes, sanitation practices (handwashing, disposal of excreta) and perceptions of worms, as well as practices in relation to worm infections, were included.

In both phases standard questions from question guides were asked in relation to each theme followed by in-depth questions related to the answers given. The majority of the interviews were recorded on tapes while observations were taken down as field-notes. The main group of informants consisted of female household members, both elderly women (grandmothers/mothers-in-law/female heads of households) and younger women with small children.

## Ethical considerations

This study obtained clearance as part of the Kenyan–Danish Health Research Project (KEDAHR) from the Kenya Medical Research Institute (KEMRI)/National Ethical Review Committee. The Central Medical Ethics Committee in Denmark also reviewed the protocol. Oral consent was obtained by village authorities through community meetings. Written consent in the local language, Dholuo, was obtained from

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participants and from parents or guardians on behalf of their children. Participants with parasitic infections were treated with standard drugs. Pregnant women were not treated, but offered treatment after delivery.

## Results of the epidemiological study

### *Occurrence of intestinal helminths*

The prevalence of hookworm, *A. lumbricoides* and *T. trichiura* infections was 62·9%, 16·1% and 23·9%, respectively. Arithmetic mean intensities of all investigated individuals were low for all three infections (127 epg, 651 epg and 30 epg, respectively).

### *Identification of potential risk factors*

Bivariate analyses of potential risk factors and indicators performed at the individual level revealed that significant risk factors for hookworm infection were: age above 15 years, household location more than 1000 m from the lake shore, low educational level of the household head, the absence of children of 5 years of age and under in the household and the absence of a latrine (Table 1). Likewise, analyses at the household level revealed that significant predictors of *A. lumbricoides* infection were: five or more inhabitants in the household, the presence of children of 5 years and under and the absence of soap (Table 1). Analyses performed at the compound level showed no significant risk factors for *T. trichiura* infections.

Potential risk factors are interrelated and, therefore, multiple logistic regression analyses were performed to assess the importance of one risk factor influenced by all other risk factors. The dependent variables were the presence/absence of hookworm and *A. lumbricoides* infections, respectively (Table 2). No risk factors were determined for *T. trichiura* infections.

### *Disposal of excreta and hygiene practices*

In the multiple logistic regression analysis, the absence of a latrine in the household was identified as a significant predictor of hookworm infection with an odds ratio of 1·9 (Table 2). The odds ratios indicate the increased/decreased risk of being infected in the presence of the specific variable. An odds ratio of 1·9 means that individuals living in households without latrines were 1·9 times more likely to have hookworm infection than individuals living in households with latrines.

The absence of soap in the household was associated with the presence of *A. lumbricoides*, as households without soap had a 2·6 times higher risk of being infected with this parasite compared with households where soap was present (Table 2).

### *Crowding and children $\leq 5$ years of age in households*

Although there was no crude association between number of inhabitants in households and hookworm infection, the multiple logistic regression analysis revealed

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**Table 1.** Potential individual, household and compound risk factors for hookworm infection and potential household and compound risk factors for *A. lumbricoides* infection. There were no significant compound risk factors for *T. trichiura* infection

| | | Infected with hookworms | | | Infected with *A. lumbricoides* | | |
|---|---|---|---|---|---|---|---|
| | Group | Investigated persons* | No. (%) | *p* value | Investigated households[a] | No. (%) | *p* value |
| Potential individual risk factor | | | | | | | |
| Age group | 3–15 years | 326 | 188 (57·7) | 0·009 | | | |
| | >15 years | 426 | 285 (66·9) | | | | |
| Sex | Female | 399 | 257 (64·4) | 0·36 | | | |
| | Male | 353 | 216 (61·2) | | | | |
| Potential household risk factor | | | | | | | |
| Distance from lake | 0–1000 m | 506 | 300 (59·3) | 0·003 | 150 | 47 (31·1) | 0·46 |
| | >1000 m | 246 | 173 (70·3) | | 83 | 30 (36·1) | |
| Household head | Female | 240 | 146 (60·8) | 0·42 | 87 | 29 (33·3) | 0·94 |
| | Male | 512 | 327 (63·9) | | 146 | 48 (32·9) | |
| Educational level of head | ≤standard 4 | 337 | 227 (67·4) | 0·002 | 98 | 33 (33·7) | 0·20 |
| | ≥standard 5 | 280 | 155 (55·4) | | 74 | 32 (43·2) | |
| Area of land owned | <3 acres | 271 | 168 (62·0) | 1·0 | 85 | 36 (42·4) | 0·17 |
| | ≥3 acres | 321 | 199 (62·0) | | 81 | 26 (32·1) | |
| Monthly household income | <1200 Kshs | 341 | 205 (60·1) | 0·31 | 98 | 43 (43·9) | 0·058 |
| | ≥1200 Kshs | 276 | 177 (64·1) | | 74 | 22 (29·7) | |
| Household size | 1–4 inhab. | 355 | 224 (63·1) | 0·92 | 150 | 37 (24·7) | <0·0005 |
| | ≥5 inhab. | 397 | 249 (62·7) | | 83 | 40 (48·2) | |
| Children ≤5 years in households | Present | 457 | 274 (60·0) | 0·038 | 125 | 54 (43·2) | <0·0005 |
| | Absent | 295 | 199 (67·5) | | 108 | 23 (21·3) | |
| Hygiene level of household | Soap present | 263 | 166 (63·1) | 0·27 | 114 | 38 (33·3) | 0·043 |
| | Soap absent | 101 | 70 (69·3) | | 41 | 21 (51·2) | |
| Potential compound risk factor | | | | | | | |
| Livestock in compound | Cattle present | 241 | 159 (66·0) | 0·64 | 100 | 36 (36·0) | 0·29 |
| | Cattle absent | 126 | 80 (63·5) | | 56 | 25 (44·6) | |
| Sanitation | Latrine present | 322 | 183 (56·8) | 0·003 | 90 | 27 (30·0) | 0·43 |
| | Latrine absent | 430 | 290 (67·4) | | 143 | 50 (35·0) | |

*Differences in investigated persons and households are due to missing values.

**Table 2.** Odds ratio (OR), 95% confidence intervals (95% CI) and corresponding *p* values of variables found to be predictors[a] of parasite infection (presence/absence) in multiple logistic regression analysis

| Risk factors[b] | Infection | Study population[c] | OR | 95% CI | *p* value |
|---|---|---|---|---|---|
| Disposal of excreta | | | | | |
| Latrine present | Hookworm | 333 ind | 1·00 | | |
| Latrine absent | | | 1·93 | (1·19–3·18) | 0·008 |
| Hygiene practice | | | | | |
| Soap present | *A. lumbricoides* | 140 hh | 1.00 | | |
| Soap absent | | | 2·56 | (1·14–5·75) | 0·022 |
| Crowding in households | | | | | |
| 1–4 inhabitants | Hookworm | 333 ind | 1·00 | | |
| ≥5 inhabitants | | | 3·17 | (1·71–5·86) | 0·0002 |
| Children ≤5 years of age | | | | | |
| Children ≤5 years absent | Hookworm | 333 ind | 3·77 | (2·00–7·09) | <0·00005 |
| Children ≤5 years present | | | 1·00 | | |
| Children ≤5 years absent | *A. lumbricoides* | 140 hh | 1·00 | | |
| Children ≤5 years present | | | 2·68 | (1·27–5·67) | 0·010 |

[a]Variables assessed in the analysis on individuals were: sex, income and educational level of household head; area of land owned; number of household inhabitants; presence of children ≤5 years of age, cattle, soap and latrines in the household; distance to lake shore and age and sex. For analysis on households, age and sex were excluded.
[b]The effect of different risk factors has been adjusted for all other risk factors.
[c]Analyses are performed on individuals (ind) or at household level (hh).

that the presence of five or more inhabitants in a household increased the risk of having hookworm infection by 3·2 times (Table 2).

The multiple logistic regression analysis showed that the presence of children of 5 years and under in the household was a significant predictor for having *A. lumbricoides* infection, with an odds ratio of 2·7 (Table 2). The situation was the reverse for hookworm infections, as households without children of 5 years and under had a higher risk of having hookworm infection (odds ratio of 3·8).

The risk of infection related to the presence of children of 5 years and under was investigated further using bivariate analysis. *A. lumbricoides* infection was present in 43·2% of households with children ≤5 years compared with 21·3% of households without this age group (Table 3). Likewise, 18·7% of inhabitants in households with small children were infected with *A. lumbricoides,* compared with 9·6% of inhabitants in households without small children. The mean intensity of *A. lumbricoides* was 740 epg in households with small children compared with 356 epg in households without small children. The crude relationship was still significant if all individuals of 5 years and under were excluded from the analysis (Table 3).

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**Table 3.** The proportion of *A. lumbricoides*-infected households, the prevalence of infected individuals and the mean intensity of infection in households with children ≤5 years of age absent or present in the household (95% confidence intervals in parentheses) for the total population and for the population above 5 years of age exclusively

| | Households with no children ≤5 years of age ($n$=108) | Households with children ≤5 years of age ($n$=125) | $p$ values |
|---|---|---|---|
| Total population | | | |
| *A. lumbricoides*-infected households (%) | 21·3 (13·6–29·0) | 43·2 (34·4–52·0) | <0·0005 |
| Prevalence of *A. lumbricoides*-infected individuals (%) | 9·6 (5·5–13·7) | 18·7 (14·0–23·4) | 0·001 |
| Mean intensity of *A. lumbricoides* infection (epg) | 356 (148–564) | 740 (475–1005) | 0·001 |
| Population ≥5 years of age | | | |
| *A. lumbricoides*-infected households (%) | 21·3 (13·6–29·0) | 34·4 (26·0–42·8) | 0·027 |
| Prevalence of *A. lumbricoides*-infected individuals (%) | 9·6 (5·5–13·7) | 16·9 (11·9–21·9) | 0·023 |
| Mean intensity of *A. lumbricoides* infection (epg) | 356 (148–564) | 635 (379–891) | 0·019 |

## Results of the qualitative study

### *Common diseases*

Data from the rapid assessment showed that worms were not mentioned explicitly by informants as one of the most frequent health problems in the villages. The most commonly mentioned symptoms were *melaria* (malaria), *wichbar* (headache), backache, stomach pain and diarrhoea. When asked about illness episodes within the previous week, only two out of the 25 households had not experienced any illness episodes; in eight households, more than one person had been ill during the preceding week. The most frequently mentioned symptoms were stomach problems including diarrhoea, headache and backpain (complaints of backpain were only among adults).

Only one woman mentioned worms as a recent illness. She explained that she had suffered from diarrhoea intermittently for a couple of months and that there was noise from her stomach. Her condition improved as long as she took medicine from the health clinic.

### *Disposal of excreta*

Latrines were found to be functioning in fifteen out of the 51 households where the qualitative interviews were conducted. However, informants from 20 households

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said that they formerly had latrines, but that the structures had fallen down and they had not yet built new ones. The presence of a latrine in a compound did not guarantee that all people living there always used it. Some latrines were locked and children very often did not use them when adults were working in the field or away for other reasons. Sharing latrines among certain relatives is taboo and is guarded by sanctions, especially in those compounds where local traditions are strongly upheld. Strict avoidance rules exist for in-laws, for instance, and between parents and their married children with regard to latrine sharing. In these compounds, parents use the one available latrine, and those who cannot share frequently defaecate in the bush or bury faeces in the farmland. However, customs are changing and in some households it was not considered wrong for family members to share a latrine.

Informants from 25 households were asked what they thought was good and what was bad about having a latrine. No one gave any particular reasons why latrines should be bad. The reasons why latrines were considered good can be grouped into three different kinds of responses. One group of answers dealt with the prevention of disease, emphasizing that disease is not spread as easily, and especially diarrhoea was mentioned as somehow being prevented. A few answers included worms. Another group of answers focused on privacy as a good thing about having latrines, and that it is considered embarrassing to ask visitors to go to the field. A third group of responses emphasized that it is not nice to have faeces lying around when there is no latrine. Those who do not have a latrine in their compound use the field, the bush or areas near the lake where they can get a bit of privacy. A few people mentioned that they sometimes find a place within the *dala* (compound) where they use the *jembe* (hoe) to dig a small hole, which is covered afterwards. Small children up to 3 or 4 years of age defaecate anywhere within the *dala*. A few women said they remove the children's faeces afterwards. The older children are taught to take the *jembe* and go to the farmland or bush.

### *Hygiene practices*

From the interviews it appears that handwashing is part of daily hygiene practice. All 25 informants questioned about this said that they washed their hands many times a day. As examples they mentioned that they washed their hands when they have been to the field, when they wanted to eat, when they had touched something dirty, etc. Some also mentioned that they washed their hands after defaecation. It is rare that hands are washed after handling children's faeces. Handwashing is done regularly and many times a day, but usually not with soap. It seems that handwashing means basically rinsing the hands in water. Many households have a small water basin available where the same water is used many times. Water is a scarce resource and therefore re-used. Soap is used mostly when bathing and washing the entire body, which 22 of the 25 women said they did every day.

### *Perception of worms*

In the semi-structured interviews in the second phase, questions were asked specifically about local perceptions of worms. According to the informants, there are

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different kinds of worms: red/white, good/bad and visible/invisible, depending on the terms that are used for worms.

The main symptoms described by the informants in relation to worm infections in children were that the hair or the body turns yellowish, the stomach might swell, the child might be hungry but is not satisfied after eating, or the child eats a lot but loses weight. In about half of the 25 households, where they were specifically asked about worms, the respondents said that they thought that at least one of their children suffered from worms on the day of interview, or had recently suffered from worms. However, except for one case, worms were not mentioned when they were asked about recent illness episodes. Bad worms in the stomach make a noise and give pain, while some informants explained that good worms help the blood circulate food. Worms are thought to be expelled when medicine is taken, whether it is medicine from the health clinic or herbal medicine. *Njokla* was described as a long red worm, which can be seen in the faeces after medical worm treatment. One woman explained that she believed that her young son had worms because he was shaking his head. Some worms are believed to affect the brain and cause epilepsy. She had already treated the boy with traditional medicine and hoped for his recovery.

When asked about causes of illness related to worms, many women said that they did not know what caused worms. However, some mentioned that children get worms from eating soil, which is a common practice in this area; others mentioned that raw or cold food such as cold *ugali* might cause worms.

### *Perception of risk factors*

From the interviews about perception of health and illness in general, it became clear that having a latrine was to some informants perceived as preventing disease, and in that sense not having a latrine was perceived as a risk factor for disease in general. However, *chira* was perceived as one of the real dangers in society. *Chira* will fall upon individuals who do not follow certain norms. Examples of this are if a second wife does something that the first wife should do, e.g. if she starts planting before the first wife has started, or if a husband or wife sleeps with another relative, or if a mother enters a married son's bedroom. Thus transgression of social or cultural norms is seen as an important behavioural risk factor from a local point of view. *Chira* was mentioned in one interview as a recent illness episode. The sister-in-law to the interviewee was becoming skinny. She was a divorced woman without children but it was said that she had been together with a man whose wife had died. This is also considered to be a transgression of a social norm, at least if the rituals in relation to the late wife had not yet been completed.

## Discussion

### *Identified risk factors for infection*

The epidemiological part of this study identified a lack of latrines, lack of soap, number of inhabitants and the presence/absence of children of 5 years and under in a household as risk factors for intestinal helminth infection.

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Using data analysis where a number of possible confounding factors were controlled for, the presence of a latrine in a household was shown to protect the inhabitants against hookworm infection. In contrast, latrines had no effect on the presence of other intestinal helminth infections. Several recent studies determined the risk factors for helminth infection (Tshikuka, Scott & Gray-Donald, 1995; Chongsuvivatwong *et al.*, 1996; Kightlinger, Seed & Kightlinger, 1998; Geissler *et al.*, 1998). Recently, Cairncross and colleagues (1996) distinguished between infections transmitted in the public domain, such as streets, schools, markets and public places of work, and those transmitted in the private domain, which is the area under the control of the household. They considered that *A. lumbricoides* and *T. trichiura* were transmitted mainly in the private domain, while several infections, including hookworms, were believed to be transmitted in both the private and public domains. One would expect that the relative importance of the two domains in the transmission of especially the latter type of infection would be related to the socioeconomic and behavioural factors of the households and community as a whole. Thus, as contamination of the public domain decreases, risk factors in the domestic domain will play a more important role (Cairncross *et al.*, 1996). The recognition of the existence of these two domains and how they interact makes it easier to understand why conflicting results are obtained in studies dealing with the effect of improved water supplies and sanitation on parasite infections (Esrey *et al.*, 1990; Walker *et al.*, 1992; Schulz & Kroeger, 1992; Sorensen *et al.*, 1994; Tshikuka *et al.*, 1995; Chongsuvivatwong *et al.*, 1994, 1996).

The low degree of aggregation of hookworm, and the combination of high prevalence and low intensities found in the study area, indicate that the public domain was most significant in the transmission of hookworm infection in this area. In other words, as Feachem and co-workers also concluded in 1983, even if families have latrines, they will not be protected from infection because the surrounding public area is highly contaminated. In the current study area, however, the private domain did play a role as latrines were found to have a protective effect. One explanation could be that even if only some individuals in a household used the latrine some of the time, contamination of the immediate environment and farmland in those households was less intense than the contamination of the environment of households that do not have any latrines at all.

The absence of soap in a household was a predictor of infection with *A. lumbricoides*. Some household heads mentioned that they washed their hands after defaecation, but it appeared that they usually did not use soap for handwashing. One explanation of the results is that the way the inhabitants used the available soap is sufficient to protect them against *A. lumbricoides* infection. Another, more likely, explanation is that household heads who have soap are generally more aware of hygiene practices than household heads not having soap, and consequently act in a number of other ways that protect the inhabitants against *A. lumbricoides* infection.

The number of inhabitants in a household was clearly a risk factor for contracting hookworm infection, which relates to a higher contamination level of the household and its environment resulting in higher transmission. The presence of children of 5 years and under in a household increased the risk of the inhabitants having *A. lumbricoides* infection. The private domain of households with children of

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5 years and under is likely to be more contaminated with *A. lumbricoides* eggs than households with no small children, because the majority of *A. lumbricoides* infections are found in small children and because small children are allowed to defaecate indiscriminately. When children $\leq 5$ years were excluded from the analysis, these particular households still had a higher *A. lumbricoides* prevalence and intensity than the households that did not originally include this age group. This means that older children and adults living together with small children had a higher risk of being infected with *A. lumbricoides* compared with those living without small children. It is difficult to explain why individuals in households without children of 5 years and under were more at risk of having hookworm infection than individuals in households that included such small children. At this stage no specific data exist to explain this. However, an explanation could be that adults sharing a household with small children may be more careful about how they dispose of their own faeces, or that adults without children spend more time in the public domain where hookworm larvae are believed to be abundant.

*Local perception of worms*

Intestinal helminth infections were abundant in the area, as approximately three-quarters of villagers had one or more of the three helminths. Worm infection was mentioned among other ailments of the stomach, but having worms was seen as the norm by informants, or as part of everyday life. This corresponds with earlier findings from the same province (Kamunvi & Ferguson, 1993), and can partly be explained by the very low intensities of infection that were present in the area. However, the local population was aware of worms and categorized the different kinds. Good worms help the blood circulate food (Nichter, 1988), while bad worms cause stomach pain. In his study in a neighbouring area Geissler (1998) found that children perceived worms as being necessary for life. The good worms 'eat' food and the bad worms 'neglect' it. From his anthropological study of perceptions of Guinea worms, a much more visible infection than hookworm and other intestinal worms, Bierlich (1995) reported that 'Guinea worm was considered a natural and inescapable feature of living, and people used few words to describe a case of Guinea worm'. Likewise, Green (1997) described the widespread belief in eastern and southern Africa of the existence of an invisible, internal 'snake', a kind of force inside the stomach, which moves around. This snake is called *nyoka* in the Shona and Tsonga languages. The term seems to correspond very well with the Luo term *njokla*, which was found in the current research area. Thus, it seems to be a widespread belief in many societies that having worms may not necessarily mean having an illness. Worms might be a nuisance, but they are not seen as particularly dangerous. It is the authors' impression that it was only if disturbing symptoms occurred, e.g. an enlarged stomach, that treatment was sought. Therefore, identifying causes of worm infections does not seem to be of great importance for the local population. Only a few informants expressed ideas about causal factors. Eating soil or cold food was mentioned as a possible cause, which is in accordance with studies from Bangladesh and Nepal (Rousham, 1994; Williams-Blangero *et al.*, 1998).

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*The notion and perception of risk factors*

For the epidemiologist, the concept of risk expresses a statistical measure of the degree of association between a characteristic and a disease within a defined population (Gifford, 1986). In other words, the study of risk and risk assessment concerns finding causes of dangers, which could be diseases, environmental pollution or other problems. Finding causes means going back in time and using experience systematically, but risk is also about the future, about probabilities. If a risk factor is present, what is the probability that individuals, groups or whole communities will get the disease, become polluted or be affected by whatever aspect of danger is investigated? Within cultural theory, the notion of risk and risk assessment is more about values, morality and politics. Risk is defined as a joint product of knowledge about the future and consent about the most desired prospects (Douglas & Wildavsky, 1982; Douglas, 1986, 1994). This means that there are always moral, social and political choices involved in discussing risks to the individual, whether they are seen from a social, medical or epidemiological perspective (Frankenberg, 1993). Turning the question around, if crowding, sanitation practices and hygiene are not seen as risk factors by the local population in relation to illness, what then is perceived to be risky behaviour? This study indicates that *chira* is a hazard that is considered to be one of the most important and serious afflictions (see also Ocholla-Ayayo, 1976; Parkin, 1978; Whyte, 1990; Kryger, 1992). In other words, transgression of social or cultural norms is seen as risky behaviour from a local perspective.

Although the local population knows that using a latrine might prevent certain diseases, it cannot be concluded that going to the field or bush is seen as risky behaviour. The different social principles that guide behaviour affect the judgement of which dangers should be feared most, which risks are worth taking and who should be allowed to take them. In this area it is considered important to follow the social and moral norms in order to avoid *chira*. Going to the field instead of using a latrine might not be seen as risky, or the risk might be worth taking because the moral and social norms related to sanitation practices can be followed. Thus, where the belief in *chira* is strong it affects the use of latrines in compounds with only one latrine. In such cases one may have to plan for more than one latrine per compound to cater for those parties that observe avoidance relations with regard to sanitary practices (e.g. fathers and daughters-in-law).

Another important aspect revealed by conversations with the local population is that when dealing with 'ordinary illnesses', i.e. illnesses that are part of everyday life, symptoms are interpreted and dealt with not by going back in time to identify the specific causes, but rather by going forward in time in an effort to get rid of the afflictions. Only when the usual treatment fails and the illness persists, as in the case of *chira*, does the specific illness narrative become important.

*Future risk studies*

It is concluded that the combination of epidemiological studies with rapid assessment techniques focusing on local understandings and practices enriches the understanding of behavioural risk factors and leads to more pragmatic recommendations

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for intervention. This means concentrating on interventions where an impact can be expected from a biomedical perspective, but at the same time where the people themselves feel that the intervention could be beneficial. This is especially important where resources are limited and helminth control may have a low priority. Although advantageous, there is no guarantee that these interventions will be successful, as many factors are important in changing local practices. Crowding and the presence of children of 5 years and under were never mentioned by respondents in conversations about illness, either when discussing illness in general or worm infections in particular. These elements were never mentioned as a disadvantage and will therefore be difficult to include in a control strategy. In contrast, since worms are seen as a nuisance and latrines, soap and medicine as assets, it would be appropriate to concentrate future interventions within these areas in this particular society. Despite the fact that this anthropological study was small (but rapid), it complemented the epidemiological study with important findings in order to identify measures for control of helminth infections that may be acceptable to the local population.

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