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Human excretion behaviour in a schistosomiasis endemic area of the Gezira, Sudan

(Allen)

Ann K. Cheesmond and Alan Fenwick

Department of Sociology and Social Anthropology, University of Hull, and the Gezira Schistosomiasis Project, P.O. Box 2371, Khartoum, Sudan

Introduction

Schistosomiasis is a human disease caused by blood flukes transmitted by snails. Because eggs from human faeces or urine have to enter the water to infect the intermediate hosts, and this only happens where inadequate water supplies combine with poor sanitation and waste disposal, the disease has been described as man-made.

Blanket control measures against the snails in Gezira, Sudan, were unsuccessful in eliminating transmission, and the objective of the study described here was to contribute information on human behaviour in the resident and migrant population to a new approach to control strategy. If localized control measures are to be applied, it is essential to know how and where transmission takes place. The excretory behaviour of individuals and associated ablutions form a key factor in such decision taking.

Remarkably little research has been done on the excretory behaviour of people whose living conditions contribute to the transmission of diseases via faeces or urine. The field studies of social anthropologists have sometimes offered glimpses of this most private of acts (Fortes 1945, Malinowski 1929, Wilson 1959), but do not go into the mundane details of who, when, where, and what is done afterwards, that might be relevant for the understanding of the epidemiology of diseases. Very few studies exist which were undertaken to consider human factors (including excretory behaviour) relevant for the transmission of specific parasitological diseases (Husting 1968, Kochar *et al.* 1976).

In the present study observations were made over a year, of the excretory and post-excretory behaviour of people living or working in the fields of the Gezira Irrigation Scheme in Sudan, where the prevalence of *Schistosoma mansoni* is over 50%, and in adult males and school age

children is about 80% (Omer *et al.* 1976, Anin & Fenwick 1977, Kardaman 1979).

Methods

The study area

The Gezira irrigated area including the 1963 Managil extension consists of 2 million feddans (1 feddan = 1.04 acre) which is divided for irrigation and cultivation purposes into fields each 1420 X 294 m (90 feddans). Each field is irrigated by its own small channel (*abueshreen*) which runs from a minor canal down the long side of the field. The minor canals total about 10 000 km and are of varying length from 2 to 20 km. One of these minor canals - Toba (Figure 1) - was selected as the focus for this study. It is 4.8 km in length and irrigates most of the 17 fields on either side. Observations covered the minor canal itself, the banks of the canal, the abueshreens, and fields on both sides up 450 m from the canal.

Population under study (Figure 1)

T16 villagers

People from the Fur and Tama tribes of Western Sudan live in this small village (population 121) situated 0.6 km from the tail of Toba minor canal and occupying the breadth of 1 field.

T17 villagers

In the next field to T16 and 0.8 km from Toba canal live 114 'Fellata' people of Nigerian origin.

Neither village has any latrine facilities, nor a clean water supply. The residents of both T16 and T17 form the nucleus of the farm labourers who work the fields in the study area.

Field Inspector's house

Three kilometres from the offtake of the Toba

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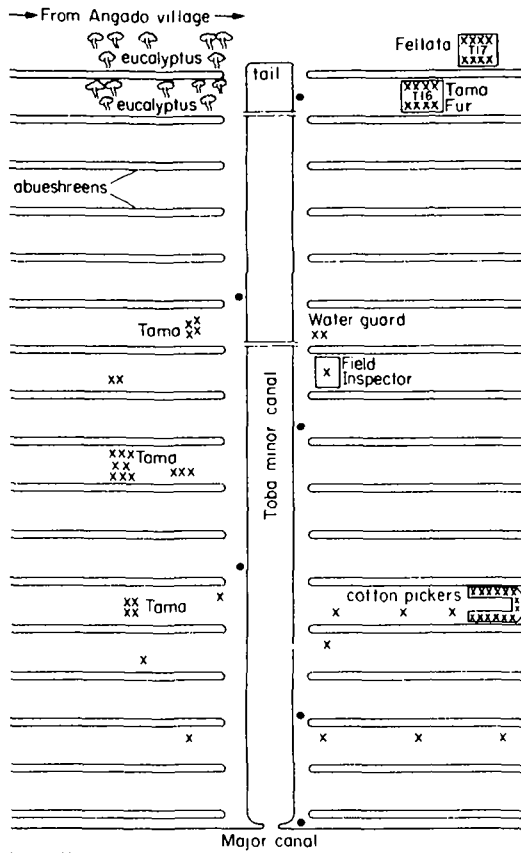


Figure 1. The experimental area - Toba Canal.
● observation points, X dwellings.

minor canal there is the residence of a Gezira Board Field Inspector and his servant. Adjacent to the bridge over the canal lives an Arab irrigation employee (Water Guard) with his wife and 10 children.

Tenant farmers

The tenants of the land irrigated by Toba minor canal are mostly Arab males from two permanent villages (population approx. 1000 each) respectively 2 km to the east and south-west of the canal. These tenants are frequent visitors to their holdings during daylight, and members of their families (male and female) join them in the busy harvesting period (November-March).

Migrant labourers

For the cotton picking and subsequent cotton stalk removal there is an influx of migrant labour in January each year and a gradual exodus which

is completed by May. One regular group of migrants come from a village to the east of the Blue Nile and they construct up to 30 temporary huts in one fallow field.

A second category of migrants are young adult Western Sudanese males who drift around Gezira taking piece-work for periods from only a few days up to 2-3 months.

Other field huts in the area were constructed as temporary second homes by labourers from T16 and T17 who move with their families to be near their work over the harvesting period.

Other visitors

Short term visits were made to the area in April by wheat harvesters, and in April/May by shepherds bringing stock to feed on the cotton leaves.

Thus the population within the observed area fluctuated greatly, both with season and time of day, though the total work force down the length of the canal never exceeded a few hundred. The peak season was the harvesting period November-March, and there was a daily peak from 7 a.m. to 1 p.m. The fields were often deserted during the hot afternoons from 1 p.m. to 4 p.m.

Observation techniques

Six separate observation points were selected along the canal. By parking a land rover on the raised canal banks, and by observing with binoculars from the vehicle roof, all activities in the minor canal, in the abueshreen offtakes and 450 m into the flat open fields, could be watched with *minimum observer interference*.

Each of these six observation points was visited for at least one 12-hour stretch (dawn-dusk) each month for a year. Observations were recorded into note books on the spot and were transcribed later. Individuals were not identified by name, but sex, ethnic group and estimated age were recorded.

Direct evidence of excretion often existed - when the act was clearly visible, when faeces or wet ground were seen afterwards - but usually only circumstantial evidence was available - posture of a person, duration of holding the posture, adjustment of clothing, subsequent actions (cleaning with grass, ablution, wiping or washing left hand) or behaviour of accompanying persons. Acts of excretion were only recorded if the observer was certain that excretion was happen-

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ing. Activities in the fields are likely to have been underestimated both because they were scanned less often and because vision was more likely to be obscured by standing crops and land irregularities. It was in the actions subsequent to excretion that the researcher was most interested. Failure to ablute meant possible contamination might happen elsewhere; the use of an ablutions vessel removed this doubt. The low density of population meant that the observer was able to follow a person's activities over several hours if he or she was working in a field, but only out of sight if he were en route to somewhere (which might be for only 5 min).

In addition to the observations made from the fixed points, excretions were also witnessed during 'canal runs'. This entailed driving slowly up and down the length of the canal noting details of who was doing what and where in order to give a 'snap shot' picture of the whole canal and to form a basis for estimating observer effect.

Snail sampling

Whenever the observations suggested that a particular water contact site had been or could have been contaminated with faeces, follow-up snail sampling was planned. The prepatent period for development of the miracidium in the snail through the sporocyst stages to the emergence of cercariae varies in Sudan with the season. During the summer months development may be completed in under 20 days but in the relatively cool winter the period may be 30-40 days.

Selected sites were therefore sampled from 2 weeks to 8 weeks after any suspected contamination. Snails were collected using a dipnet scoop, counted, examined for patent trematode infection in 75 x 25 mm glass tubes and then returned to site.

Results

A total of 398 acts of excretion by Arabs, Tama, Fur and Fellata were recorded, but as there was

no significant difference in excretory behaviour between the groups, ethnic origin has been ignored in the presentation of results (Table 1). There were relatively few excretions by children, which reflects both the lower numbers of children within observation range, and the practice of children of excreting close to their homes, either in the compound or just outside. Small children, who wear very little clothing, urinate freely both inside and outside the house. Faeces are covered with sand by an older child and disposed of on open ground.

Table 1. Observed excretions

| | Men | Women | Boys | Girls | Total |
|------------------|-----|-------|------|-------|-------|
| Defaecations | 109 | 61 | 12 | 11 | 193 |
| Urinations | 106 | 62 | 12 | 25 | 205 |
| Total excretions | 215 | 123 | 24 | 36 | 398 |

Of the six observation sites used, the one site at the tail end of Toba minor canal near T16 and T17, yielded more observed events than the remainder of the canal sites put together. As expected the early morning was the preferred time for excretion (Table 2), though there are no observations of excretion during the hours of darkness.

Urination

Table 3 indicates the sites selected for the 205 observed urinations. Both males and females seem to stop, squat and urinate wherever the need is felt. If they are not alone they will probably turn their back on their companion, but they will seek no greater privacy. Men may urinate within a few metres of women, but women do not do so in the sight of a man. Only on two occasions were people seen to urinate into water - once from the bank of an abueshreen, and once from the bank of the minor canal. All other urinations occurred on dry earth giving

Table 2. Excretion by time of day

| | Before 9 a.m. | 9-12 | 12-3 p.m. | After 3 p.m. | Total |
|---------------|------------------|----------|-----------|-----------------|-------|
| Canal tail | 103 | 52 | 43 | 50 | 248 |
| Rest of canal | 81 | 36 | 10 | 23 | 150 |
| Total | 184 (46%) | 88 (22%) | 53 (13%) | 73 (18%) | 398 |

12
6
72

Table 3. Urinations

| | Near minor canal | Near abueshreen | In field | Total |
|--|------------------|-----------------|----------|-------|
| Canal tail end (one observation point) | 13 | 15 | 75 | 103 |
| Canal length (five observation points) | 7 | 26 | 69 | 102 |
| Total | 20 | 41 | 144 | 205 |

Minor canal: on or inside the raised canal banks.

Near abueshreen: within 1 or 2 metres of a wet abueshreen.

Field: any location such as woods, fallow field, roadway or standing crop when water of any kind was not within 2 metres.

Table 4. Defaecations

| | | Near minor canal | Near abueshreen | In the fields | Total |
|-----------------|--------|------------------|-----------------|---------------|-------|
| Canal tail end: | male | 0 | 4 | 77 | 81 |
| | female | 0 | 6 | 58 | 64 |
| | Total | 0 | 10 | 135 | 145 |
| Canal length: | male | 2 | 0 | 38 | 40 |
| | female | 0 | 2 | 6 | 8 |
| | Total | 2 | 2 | 44 | 48 |
| Total: | male | 2 | 4 | 115 | 121 |
| | female | 0 | 8 | 64 | 72 |
| | Total | 2 | 12 | 179 | 193 |

any *S. haematobium* or *S. mansoni* eggs excreted no chance of survival. One may expect that spontaneous micturation by children swimming and bathing in the canals will minimize the importance of this observation, however.

Defaecation

The results in Table 4 demonstrate the importance of privacy for the act of defaecation. Whilst 70% of observed urinations were in the fields, 93% of defaecations took place in the fields either in the cotton, the sorghum or the eucalyptus trees. This difference is even more marked when it is noted that many of the urinations occurred on roads at the sides of fields which are relatively public compared with the depressions and shrubs offered as cover in the centre of fields.

Far more defaecations were observed at the canal tail end (121) than down the canal length (72). For women the difference is particularly marked (64 against 8). Since, over the year, equivalent numbers of men and women were watched working and living in the fields along

the canal length, the difference would seem to reflect the value placed on modest behaviour by women in this culture. The field of eucalyptus trees near T16 village was a favourite site for defaecation and it was usual for both men and women walking to work in the mornings to make a detour into the trees.

The defaecations observed down the canal length tended to be associated with temporary dwellings in the field. There were few exceptions.

Post excretion behaviour (Table 5)

After excreting only 31% washed themselves. Of these, 28 washed either their bodies and/or their hands in the minor canal, while 72 selected an abueshreen. These 100 events were deemed to be contaminative since it was possible that some schistosome eggs could have been released into water containing snails. However, only 27 (7.1%) people actually washed their genital region directly into a water body. On 16 occasions an ablutions jar was used and the people washed on to dry land. Six people washed in abusittas - small field channels which only

Table 5. Post-excreti

| |
|-----------------------|
| Adult males |
| Adult females |
| Children |
| Total |
| Children: all persons |

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A total of 78

Table 5. Post-excretion activities

| | Contaminative | | Non-contaminative | | Total wash | No wash | Total |
|---------------|----------------|-----------|-------------------|-------|------------|-----------|-------|
| | in minor canal | in abu 20 | used jar | abu 6 | | | |
| Adult males | 15 | 47 | 8 | 3 | 73 | 142 | 215 |
| Adult females | 11 | 16 | 8 | 3 | 38 | 85 | 123 |
| Children | 2 | 9 | 0 | 0 | 11 | 49 | 60 |
| Total | 28 | 72 | 16 | 6 | 122 (31%) | 276 (69%) | 398 |

Children: all persons of estimated age under 14 years.

intermittently contain water and are considered to be snail free. It made no significant difference whether the site of excretion was near a water body or removed from it. Of the people who excreted near water 21 (29.2%) washed; of those who excreted away from water 85 (27.4%) washed.

There was no significant difference in behaviour between males and females, but adults (111, 32.8%) were observed to be significantly more likely to wash after excretion than children (11, 18.3%; $\chi^2 = 4.38$; $P = 0.05$). However, this difference between adults and children ceases to be significant when use of an ablutions vessel is discounted: adults and children were comparably likely to wash directly into a water body [children 11 (18.3%); adults 95 (28.1%)].

Ablution or washing, by men and by women, adults or children, is as likely to follow urination as defaecation.

Six men, three boys and one girl, bathed naked after defaecation. A significantly greater proportion of children than adults bathed naked after defaecation ($\chi^2 = 11.3$). Abueshreens and the minor canal were equally likely to be selected as bathing spots.

Females are, thus, as likely in their behaviour as males to contaminate the water by ablution or washing after excretion. However, because there were considerably more males observed excreting (and washing) 239 (77), than females 159 (45), and because males tend to have higher egg outputs they may be considered potentially more contaminative of this canal system.

Besides post-excretory washing, there was also observed additional behaviour which could potentially infect snails. It is here that the importance of males as greater contaminators than females is highlighted (Farooq & Mallah 1966).

A total of 78 ablutions (not necessarily after

Table 6. Ablutions

| | Into water body | Use ablution vessel |
|---------------|-----------------|---------------------|
| Adult males | 45 | 8 |
| Adult females | 12 | 8 |
| Boys | 2 | — |
| Girls | 3 | — |

Table 7. Swimming habits

| | Naked bathe | Swim |
|---------------|-------------|------|
| Adult males | 42 | 4 |
| Adult females | 2 | — |
| Boys | 10 | 18 |
| Girls | 1 | 1 |
| Total | 55 | 23 |

observed excretion) were observed (Table 6). Ablution is defined as the washing of the genital and anal area, which must be done by Moslems before praying.

Adult females were significantly more likely than adult males to use an ablutions jar when they ablated ($\chi^2 = 3.9$). The figures are really too small to contrast adult and child behaviour.

There was no difference in the selection of sites for ablution (either between males and females, or between adults and children), 45 (72.6%) ablutions in water bodies were in abueshreens, 12 (19.4%) were in the minor canal (notably at the tail and the bridges) and five (8%) were in abusittas.

Males were far more likely than females either to bathe naked, or to swim: 94.5% of naked bathes were by males whilst 5.5% were by females (Table 7).

Of observed swimming acts, 95.7% were by males (predominantly children) and 4.3% by girls. No adult female was ever seen to swim.

Snail infection rates

The contaminative actions were concentrated on 10 main water contact sites and in six of them snails infected by *S. mansoni* were subsequently discovered which could have resulted from the observed activities.

Sampling of snails in some 20 sites in which no contaminative activity had been observed revealed five with infected snails. All of these were near to human temporary or permanent dwellings. Thus though no post excretion activities had been observed, it is probable they did occur outside of the observation periods.

Discussion

By means of discrete observation and the interpretation of circumstantial evidence, a partial picture of the excretory behaviour of the residents and workers near Toba minor canal has been built up.

For all adults, privacy is an important consideration for the act of excretion, particularly for defaecation. Woods, standing cotton and sorghum all provide excellent cover; canal banks and depressions in the ground formed by abushreens and field channels (abusittas) provide some measure of privacy. Privacy can be achieved by other means: the time of day, or night, the cover provided by Arab garments, and if no other barrier exists, there is the assurance that others will avert their eyes.

In this particular study, the eucalyptus trees near the tail of Toba minor canal attracted people throughout the year from the nearby canal bank. A common assumption has been that people excrete inside canal banks in order to be near water for washing. Our results suggest that privacy is more important than the proximity of water. A visit to some other Gezira villages supported this finding superficially. Where the canal bank was used as a common latrine, it was realized that the villages were surrounded by open fallow fields, roads and/or cemeteries, i.e. the canal bank was the only, or the best, available privacy.

This study also suggested that post-excretion washing and ablution is not as commonly practised as might be expected. Only 31% of the excretors washed after their act leaving 69% who either continued working or passed from vision without subsequently washing their bodies or their hands.

Since no one was observed to defaecate in or even near to the minor canal and abushreens, and post-excretion washing was limited, it was concluded that there was not a continuous infinite supply of miracidia available to infect the Toba snails. Many millions of *S. mansoni* eggs are excreted daily by the population under study, but the only apparent contamination is by transfer of a few eggs from hands and anus during washing, ablution or bathing. The prevalence of infected snails in the water contact sites seems to support this conclusion. Infected snails were found, but they were few and far between.

It would appear that the contamination which occurs regularly from bathing and washing in recognized water contact sites is sufficient to lead to a few infected snails. Separate from this relatively low prevalence however there is a high potential for transmission which would be realized by any contamination by a large faecal deposit reaching the water. Down Toba canal with its woods as a latrine, such contamination may be rare. In other areas a high prevalence of infected snails may be the norm.

Summary

A 12-month study of the excretory behaviour of resident and migrant labourers in Gezira, Sudan, was undertaken to contribute base-line information towards the development of a new control strategy. Of 398 observed acts of excretion 70% of urinations and 93% of defaecations occurred in sites far removed from any water body. After excretion only 31% people washed themselves (and only 7.1% actually washed their genital region directly into a water body). People excreting far from water were as likely to wash afterwards as those excreting near a water body. This finding contradicted previous expectations based on the hygienic precepts of Islam. The results show that privacy is a more important consideration than proximity of water in the selection of a site for excretion, and suggest that there is only limited regular contamination by *S. mansoni* eggs under the observed conditions.

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