Canoeists and waterborne diseases in South Africa

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Summary

The prevalence of urinary schistosomiasis (*Schistosoma haematobium*) in canoeists in South Africa was estimated from examinations of urine samples taken from participants in the 1988 and 1989 Duzi Canoe Marathons on the Umsinduzi/Umgeni river in Natal. As an indicator of water quality during races, water samples were taken from the river for bacteriological analysis. Results showed a very low prevalence of *S. haematobium* and possible reasons for this are offered. Faecal coliform levels in the river water were unacceptably high during the races.

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Canoeing in South African rivers and dams is sometimes regarded as a high-risk activity with respect to waterborne diseases such as schistosomiasis, notably the urinary disease caused by *Schistosoma haematobium*[1] and also gastro-enteritis. This is not surprising because many of these rivers flow through areas endemic for waterborne diseases. In an attempt to quantify this risk we sampled the canoeing community for urinary schistosomiasis and took as our subjects volunteers participating in the 1988 and 1989 Duzi Canoe Marathons on the Umsinduzi/Umgeni river between Pietermaritzburg and Durban. In addition, using the river as an example of racing conditions, we took water samples during the races for bacteriological analysis, particularly for faecal coliform bacteria.

Materials and methods

Urine samples were taken between 11h00 and 15h00 after the first day's race in January 1988 and at the finish in January 1989. Two methods of diagnosis were used, the standard

centrifugation and sedimentation method and the Program for Appropriate Technology in Health (PATH) rapid filtration method.[2,3] Samples taken during the 1988 race were preserved as a 4% formalin solution and examined in the laboratory using both methods, while of those taken after the 1989 race, 100 were examined immediately using the PATH method and the remainder were preserved with thymol crystals and examined later using the standard method. Volunteers were also asked to complete questionnaires on whether or not they: (*i*) used antischistosomal drugs; (*ii*) had been diagnosed positive for schistosomiasis during the preceding year; and (*iii*) had experienced diarrhoea during and/or immediately after the race.

Water samples were taken from 11 stations on the river during the course of the 1988 and 1989 races. These were examined by membrane filtration using lauryl sulphate broth for the estimation of *Escherichia coli*.[4] Moore pads were also placed in the water at several stations for a period of 1 week, a few days either side of the races, and then cultured for salmonellae and vibrios.[5,6]

Results

Schistosomiasis

Table I shows the results of the 1988 and 1989 surveys. A prevalence rate of 1,8% ($N = 330$) was recorded in 1988 and 0% ($N = 170$) in 1989. All infections diagnosed were light ones with less than 14 *S. haematobium* eggs/10 ml urine using the standard method and < 5/10 ml using the PATH method. Both live and calcified eggs were found in 2/6 cases, the remaining 4 cases had only live eggs.

The results of the questionnaires are shown in Table II. From those data pertaining to schistosomiasis, it is apparent that 52% (17/33) and 35% (78/226) of respondents had been tested for schistosomiasis during the year before the 1988 and 1989 marathons respectively. Most were blood tests and of these, 70,6% and 48,7% respectively were diagnosed positive. Seventy per cent (23/33) and 27% (62/226) of respondents had taken antischistosomal drugs and of these, 69,6% and 43,6% respectively did so annually or, in some cases, more often. Close to half of these respondents (50% and 46,3% respectively) had done so within 6 months of the races. When analysed on a regional basis, these returns showed that 81,6% of canoeists who had contracted schistosomiasis came from Natal while the remaining 18,4% were from Transvaal clubs.

Bacteriology

Fig. 1 shows the positions of the water-sampling stations on the river and Table III lists the *E. coli* levels recorded during

TABLE I. URINARY SCHISTOSOMIASIS SURVEYS OF CANOEISTS PARTICIPATING IN THE 1988 AND 1989 DUZI CANOE MARATHONS

Year	Method	No. of canoeists	No. +ve	% +ve	No. of eggs/ 10 ml urine
1988	**Standard sedimentation method**	**330**	**6**	**1,82**	**2 - 14 (mean 6)**
	Nuclepore filtration method	**330**	**6**	**1,82**	**1 - 5 (mean 3)**
1989	**Standard sedimentation method**	**70**	**0**	**0**	**0**
	Nuclepore filtration method	**100**	**0**	**0**	**0**

TABLE II. SUMMARY OF THE RESULTS OF QUESTIONNAIRES COMPLETED BY PARTICIPANTS IN THE 1988 AND 1989 DUZI CANOE MARATHONS

		1988 ($N = 33$)		1989 ($N = 226$)	
		No.	%	No.	%
Schistosomiasis					
No. of respondents tested for schistosomiasis during previous year	**Urine test +ve**	**3**		**4**	
	−ve	**2**		**17**	
	Blood test +ve	**7**	**51,5**	**21**	**34,5**
	−ve	**2**		**17**	
	Test not stated +ve	**2**		**13**	
	−ve	**1**		**6**	
No. of respondents taking antischistosomal drugs	**Every 6 mo.**	**2**	**6,1**	**4**	**1,8**
	Every year	**14**	**42,4**	**23**	**10,2**
	Less often	**7**	**21,2**	**35**	**15,5**
Length of time before race that antischistosomal drugs were taken	**1 mo.**	**3**	**9,1**	**7**	**3,1**
	6 mo.	**8**	**24,2**	**24**	**10,6**
	Longer	**11**	**33,3**	**36**	**15,9**
Bacteriology					
No. of respondents suffering from diarrhoea during the race		**6**	**18,2**	**30**	**13,3**

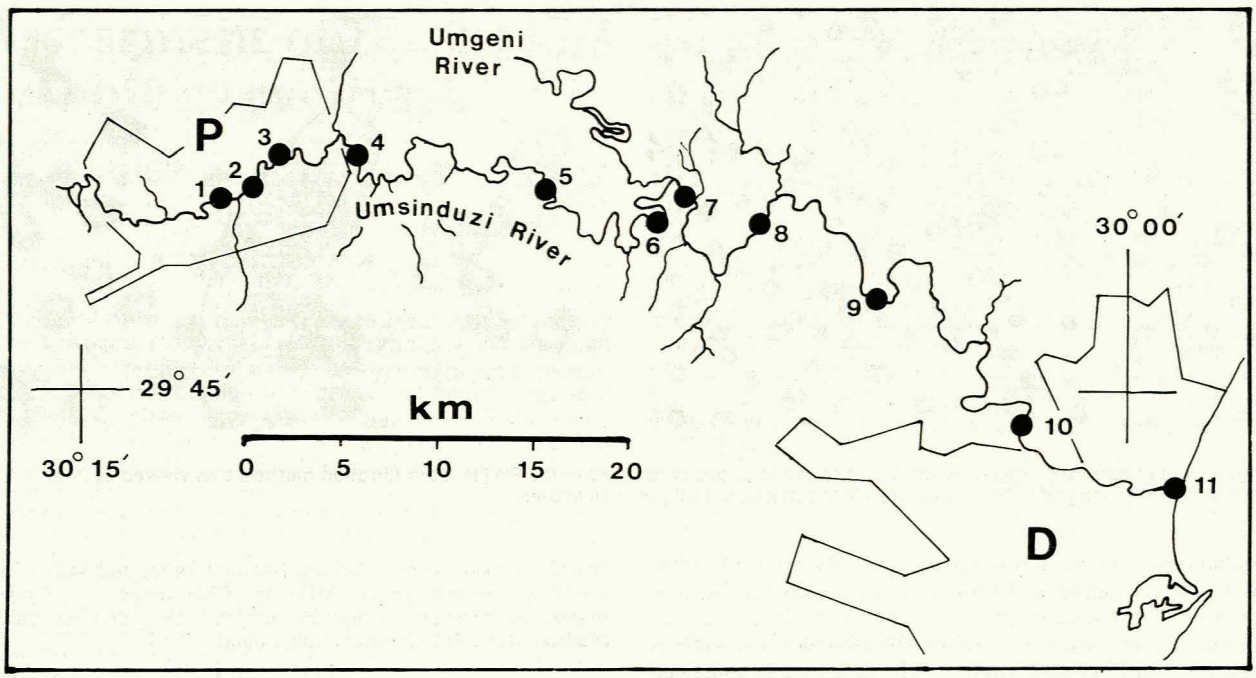

Fig. 1. Map of the Umsinduzi/Umgeni River between Pietermaritzburg (P) and Durban (D) showing the 11 water-sampling stations.

TABLE III. ESTIMATED *E. COLI* LEVELS (/100 ml) AT 11 STATIONS ON THE UMSINDUZI/UMGENI RIVER DURING THE 1988 AND 1989 DUZI CANOE MARATHONS

Station	Estimated *E. coli*/100 ml 1988		1989	
1	31 000		1 500	P
2	15 000	P	3 000	P
3	40 000		2 200	
4	40 000		Not sampled	
5	21 000	P	4 600	
6	10 000		10 600	P
7	39 000	P	3 900	P
8	6 300		1 300	
9	5 500		1 400	
10	8 600		2 300	
11	3 000		Not sampled	

See Fig. 1 for position of stations.
Levels of 1 000 - 10 000 = moderate health risk; 10 000 - 100 000 = serious health risk; > 100 000 = very serious health risk.
P = stations at which Moore pads were placed in the water.

the 1988 and 1989 races. It also identifies the stations at which Moore pads were placed for pathogen analysis. No salmonellae or vibrios were found in these samples.

Discussion

The reliability of the standard centrifugation and sedimentation technique for the recovery of *S. haematobium* eggs from urine samples has been soundly established in surveys carried out in this country and elsewhere. The PATH rapid filtration method is, however, relatively new but has been tested in the field and found to be both accurate and reproducible, although some clogging of the filter was reported.[2,3] This accuracy is, despite the small numbers of positive cases, confirmed by the results given in Table I. Samples took less than 5 minutes each to process. A criticism of this technique is that, particularly at a magnification of × 10, the pores (8 μm diameter) in the filter paper render the microscopic field somewhat confused with the result that eggs might be missed (Fig. 2). Further, it should be noted that at × 10 magnification, 7 passes of the microscope field are required to examine a filter paper, not 4 as stated by Peters *et al.*[2] At × 40, 28 passes are needed.

Canoeists are clearly aware of the possibility of contracting schistosomiasis but the low prevalence rates and egg counts recorded here are at variance with the contention that canoeing in South Africa is a high-risk sport. This is emphasised by the fact that the Umsinduzi/Umgeni and other rivers paddled by canoeists in Natal flow through *S. haematobium*-endemic areas and also harbour the parasite's snail intermediate host, *Bulinus africanus*.[7]

In an attempt to account for this anomaly, we have identified four factors that may play roles in maintaining a low prevalence of infection in canoeists. These are that: (*i*) a significant proportion of participants (27,4 - 69,7%) take antischistosomal drugs and most of them do so regularly; (*ii*) in the Umsinduzi/Umgeni river at least, the 1987/1988 floods removed marginal and emergent vegetation as well as the associated snail populations and these, including *B. africanus*, have not fully recovered (T.D. Brackenbury and C.C. Appleton — unpublished data); (*iii*) when canoeists capsize and come into direct contact with potentially infective water, they usually do so in fast-flowing and turbulent situations, such as rapids, where they are unlikely to contract schistosomiasis; and (*iv*) when canoeists do capsize, they climb back into their canoes as quickly as possible with the result that their exposure to river water is minimal in terms of time. These last two factors are important since it has been established not only that transmission along a watercourse is focal but that it is generally confined to calm and slowly flowing water, up to a velocity of approximately 1,3 m/s.[8] Further, the concentration of cercariae in natural waters is normally low, less than 1/l,[9,10] although close to actual foci this can be higher.[11] Presumably as a consequence of this, the water-contact activities that most frequently lead to infection are those which involve the immersion of most or all of the body for extended periods of time.[12,13]

E. coli is an indicator of faecal pollution and its presence in water demonstrates beyond doubt that the water has been

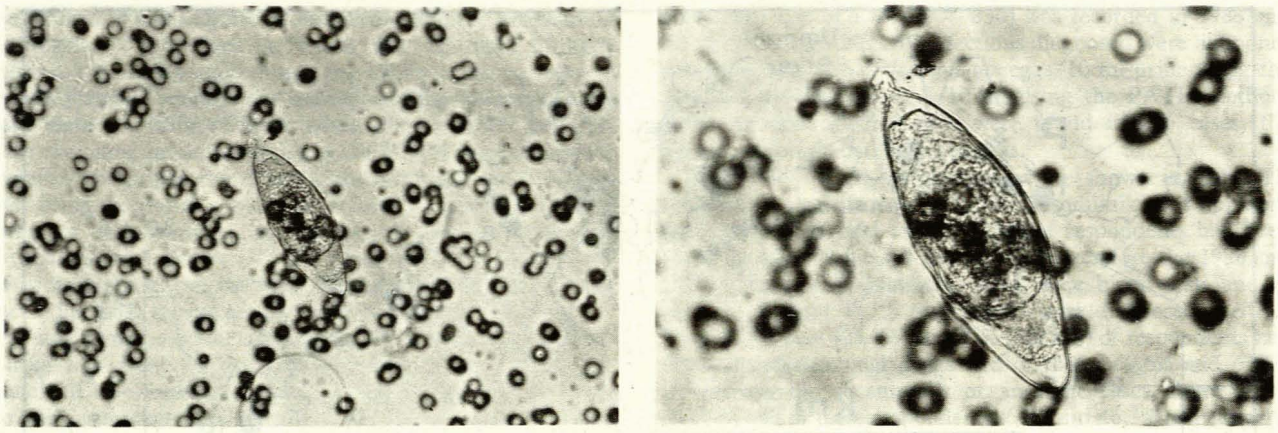

Fig. 2. *S. haematobium* egg lying on a Nuclepore filter paper as used in the PATH rapid filtration method and viewed at (left) × 10 and (right) × 40 magnification. The pores in the paper were 8 μm in diameter.

contaminated with faecal material and possibly excreted pathogens as well.[4] In an area of endemic gastro-intestinal diseases, such as the Umgeni catchment, levels above 10 000 *E. coli*/100 ml water can be considered a serious health risk if the water is consumed.[15] In 1988 water from 7 of the stations thus contained excessively high levels while in 1989 only 1 did. The drop shown in the 1989 data is not regarded as significant since *E. coli* levels vary considerably from week to week and have, in fact, risen again subsequently. While canoeists would not intentionally drink river water, this could become unavoidable if they capsize. Infection from splashing onto the face or trailing water-bottle tubes is possible but unlikely, since infective doses are around 10^5 for both salmonellae and vibrios.[14] However, this might be lower in the present context because the participants would be under considerable physical stress during the races.

An estimated 18,2% and 13,3% of respondents to the questionnaires suffered from diarrhoea during the 1988 and 1989 races, respectively. These figures may be too low because some gastro-intestinal pathogens have incubation periods extending to weeks and would therefore not have been accounted for in the survey. Conversely, stress and heat exhaustion may also manifest themselves with diarrhoeal symptoms.

Stations on the Umsinduzi/Umgeni River yielding high *E. coli* levels indicate areas of intense human water-contact activity and possible foci of schistosomiasis transmission as well, although the latter are, as noted above, usually localised. Although no pathogenic bacteria were found in the cultured swabs exposed during the races, they have been isolated on subsequent occasions (Umgeni Water — unpublished data). The technique used here is qualitative and approximate, but is the only reasonable method available when dealing with rivers such as the Umsinduzi/Umgeni where turbidity levels may be high and reach 800 nephelometric turbidity units (NTU). The mean for January 1989 was 150 NTU. The European Economic Community has set indicator-bacteria standards for body-contact recreational water of 100 *E. coli*/100 ml as a guideline value and 2 000 *E. coli*/100 ml as a mandatory limit[16] but few developing countries can satisfy standards as rigorous as these.

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