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Evaluation of indirect screening techniques for the detection of *Schistosoma haematobium* infection in an urban area, Dar es Salaam, Tanzania

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Summary

393 primary school children were screened for *Schistosoma haematobium* using four indirect techniques (a) history of haematuria, (b) visual appearance of urine and use of chemical reagent strips to detect presence of (c) blood and (d) protein in urine. Results showed that the use of chemical reagent strips for the detection of blood was the most specific and sensitive method, even in areas of lower prevalence and intensity. History of haematuria, protein in urine and visual appearance were respectively next in order in terms of specificity and sensitivity. The implications of these findings for further studies have been made.

Key words: haematuria; proteinuria; screening; *Schistosoma haematobium*; Tanzania.

Introduction

Haematuria and proteinuria have been used to diagnose *Schistosoma haematobium* infections (Gelfand, 1950; Wilkins et al., 1979; Pugh et al., 1980; Feldmeier et al., 1982; Taylor, 1982; Mott et al., 1983a, b) and to indicate *S. haematobium* related morbidity (Abdel-Wahab, 1982; Tanner et al., 1983; Doehring et al., 1984; Browning et al., 1984). The demonstration of schistosome ova remains the definitive diagnosis for the disease.

Community based morbidity studies in Tanzania have shown radiographic abnormalities of the urinary tract in individuals infected with *S. haematobium* (Forsyth and Bradley, 1964, 1966; Forsyth and MacDonald, 1965, 1966; Ruge-

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malila, 1979). Recent studies carried out in Ifakara (Tanner et al., 1983) and Dar es Salaam, Tanzania (Sarda et al., 1985) have shown that at low prevalence and low intensity the frequencies of haematuria and proteinuria are high.

History of haematuria, gross haematuria, levels of blood and protein in urine, have been used to screen for urinary schistosomiasis (Mott et al., 1983b). An earlier study by the authors has shown that urinary schistosomiasis affects about 19% of the school children in Dar es Salaam (Sarda et al., 1985). The present study was undertaken to evaluate the validity of each of the above four screening methods when compared to a quantitative urine filtration technique in order to determine a simple screening technique.

Materials and Methods

393 primary school boys and girls between 5 and 16 years of age were screened in two primary schools (Mabibo and Darajani) in the city of Dar es Salaam. Urine specimens were collected from these children between 10.00 and 12.00 noon, and they were asked in local language whether they had ever urinated blood. Their responses were noted to provide the history of haematuria. The urine samples were brought to the laboratory.

The appearance of urine was classified into four categories: clear, cloudy yellow, cloudy brown and bloody red. Gross haematuria was diagnosed if the urine was cloudy brown or bloody red. The presence of blood and protein was semi-quantitatively tested by chemical reagent strips (N-Multistix – Ames). The protein content was classified into four categories: negative, + (0.3 g/l), + + (1.0 g/l) and + + + (3.0 g/l). Similarly, blood was classified into five categories: negative, trace, +, + + and + + +. The prevalence of sickle cell trait in the adult population of Dar es Salaam is estimated to be 16% (Mitchell and Fupi, 1972). Figures for prevalence in children are not available. Egg counts were made on the same urine specimens using the syringe filtration technique with a 25 mm diameter Nytrel filter having a 20 micron pore size (Mott, 1983).

Results

Table 1 presents the frequencies, prevalence, intensity, sensitivity and specificity of each of the four screening techniques for each school and the combined population.

The results showed that blood in urine detected by chemical reagent strips was the best technique detecting 94.4%, history of haematuria was the second best technique detecting 88.3%, protein in urine was the third best technique detecting 83.3%, and the visual appearance of urine was the least sensitive technique detecting only 43.8% of infected children. Sensitivity values of the above four techniques were 94%, 88%, 84% and 44%, respectively. The specificity values of the above four techniques were 96%, 89%, 81% and 98%, respectively.

Analysis of data from the two schools was done separately to look at the relationship between validity of the four screening techniques, prevalence and intensity of infection. A series of chi-square tests was done to compare schools, with regard to the effectiveness of the screening techniques; the results are

Table 1. Results of *S. haematobium* prevalence, intensity and the number of infected children detected using the four techniques

	Darajani school	Mabibo school	χ^2	Combined
No. of children examined	204	189		393
No. of children infected	59 (29%)	103 (54%)	*	162 (41.2%)
Intensity: geometric mean egg count/ 10 ml urine (±SD)	23 (±6)	40 (±5)	*	46 (±8)
1. History of haematuria				
Infected with history of haematuria	45 (76.3%)	98 (95.1%)	*	143 (88.3%)
Infected with no history of haematuria	14 (23.7%)	5 (4.9%)		19 (11.7%)
Uninfected with history of haematuria	5 (3.4%)	20 (23.2%)	*	25 (10.8%)
Sensitivity	76%	95%		88%
Specificity	97%	93%		89%
2. Appearance of urine				
Infected with gross haematuria	15 (25.4%)	56 (54.4%)	*	71 (43.8%)
Infected with no gross haematuria	44 (74.6%)	47 (45.6%)		91 (56.2%)
Uninfected with gross haematuria	2 (1.4%)	3 (3.5%)	NS	5 (2.1%)
Sensitivity	25%	54%		44%
Specificity	99%	97%		98%
3. Protein in urine				
Infected with protein in urine	41 (69.5%)	94 (91.3%)	*	135 (83.3%)
Infected with no protein in urine	18 (30.5%)	9 (8.7%)		27 (16.7%)
Uninfected with protein in urine	31 (21.4%)	13 (15.1%)	*	44 (19.0%)
Sensitivity	70%	91%		83%
Specificity	79%	85%		81%
4. Blood in urine				
Infected with blood in urine	56 (94.9%)	97 (94.2%)	*	153 (94.4%)
Infected with no blood in urine	3 (5.1%)	6 (5.8%)		9 (5.6%)
Uninfected with blood in urine	4 (2.8%)	5 (5.8%)	NS	9 (5.6%)
Sensitivity	95%	94%		94%
Specificity	97%	94%		96%

χ^2 test: * = significant $2p < 0.0001$; NS = not significant

shown in Table 1. The number of *S. haematobium* infected children that were detected using each of the four screening techniques was significantly higher in Mabibo primary school. The number of uninfected children giving a positive response for each technique in the two schools was not significantly different for techniques 2 and 4 (appearance of urine and blood in urine). However, techniques 1 and 3 (history of haematuria and protein in urine) differed significantly.

Table 2 presents the number of infected children, intensity of infection (geometric mean of eggs/10 ml urine) and the degree of blood and protein in

Table 2. The degree of haematuria and proteinuria in relation to intensity of *S. haematobium* infection using reagent strips

	Reagent strip readings				
	negative	trace	+	++	+++
Blood:					
No. of children infected	9	24	33	48	39
Intensity of infection*	2	5	17	44	56
Protein:					
No. of children infected	18	20	35	42	18
Intensity of infection*	11	13	52	85	87

* geometric mean of eggs/10 ml urine

urine. It may be observed that, with increase in egg counts, consistent increases in the degree of haematuria and proteinuria also occur.

Discussion

In schistosomiasis control operations, urine filtration techniques have replaced the sedimentation method. The filtration technique use filter supports for Nucleopore, Nytrel or filter papers. These methods require equipment, trained personnel and time, anyone of which may not be available where schistosomiasis control campaigns are to be launched. The use of reagent strips for the detection and quantitative diagnosis of *S. haematobium* infections has the advantages of being simple, quick and cheap. Estimated cost of each strip is US $ 0.03–0.05 (Mott, pers. comm). The overall cost would be much lower when savings are considered in terms of personnel and equipment.

The detection of blood in urine using chemical reagent strips was found to be the best technique for the detection of *S. haematobium* infection in children, with a very high sensitivity and an equally high specificity. The use of reagent strips for the detection of blood in urine has been suggested by various workers as an indirect diagnostic test to identify heavily infected subjects, particularly school children (Wilkins et al., 1979; Feldmeier et al., 1982; Pugh et al., 1980; Mott et al., 1983a; Tanner et al., 1983). The results of the present study support their opinion.

History of haematuria was also found to be a good screening technique, identifying up to 88% of the infected children. In Mabibo school with a higher prevalence and intensity of infection, 95% of infected children could be detected by asking a simple question "have you ever urinated blood?". But only 76% of the infected cases were identified at Darajani school, which has a significantly lower prevalence and lower intensity of infection (Table 1). Haematuria, as

measured by the reagent strips, was shown to be correlated to the intensity of *S. haematobium* infection in our study (Table 2). These findings have also been reported from studies conducted in other *S. haematobium* endemic areas (Briggs et al., 1971; Wilkins et al., 1979; Pugh et al., 1980; Feldmeier et al., 1982; Mott et al., 1983a, b; Tanner et al., 1983). This would explain the high percentage of infected children that were detected at Mabibo school, using history of haematuria as a screening technique. The high frequency of history of haematuria among uninfected children at Mabibo school may be due to inadequacy in the interviewing technique. The children on seeing the health team visiting their school probably wanted to be treated and therefore, responded positively to the question "have you ever urinated blood?". This same question could be asked by a class teacher without revealing the objective of the exercise to the children.

The visual appearance of urine detected a small percentage of infected children. This screening technique had low sensitivity but high specificity. Studies have shown that presence of frank blood in urine is only evident in the last fraction of a micturition stream and then only in urine passed after mid day (Weber et al., 1967; Walker et al., 1970). Since no instructions were given to the children and the urine was collected before mid day, this could explain the low sensitivity of the technique. However, Rutasitara et al. (1984) using visible haematuria as a screening technique found it to be highly sensitive, detecting up to 96% of the cases. Further studies are needed to demonstrate whether the inclusion of sampling time and the fraction of the micturition stream required for analysis improves the sensitivity of the technique.

Protein in urine identified an overall 84% of the infected children, with good specificity and sensitivity. However, at Mabibo school 92% of the infected children were identified against 96% at Darajani school. Proteinuria correlated with the intensity of infection (Table 2). Similar findings have been reported from other areas (Briggs et al., 1971; Wilkins et al., 1979; Pugh et al., 1980; Taylor, 1982; Mott et al., 1983a; Tanner et al., 1983). During this study it was found that the colouration changes observed with the protein portion of the reagent strip were not as easily differentiated as those observed with the blood portion of the reagent strip. Some training is required to achieve a satisfactory reading of the level of protein in urine.

The results of the present study show that in Dar es Salaam, an endemic area for *S. haematobium* (Sarda et al., 1985), history of haematuria could identify a large proportion of the infected children prior to using chemical reagent strips. It is suggested that history of haematuria could be used first and then the remaining specimens examined using reagent strips, this would reduce the consumption of reagent strips by about 43% in this particular setting.

The present results also show that a history of haematuria may alone be sufficient to detect infected children. The development of a screening procedure using history of haematuria as a criterion for diagnosis would have a number of advantages. Care, however, must be taken on how and by whom the question is

posed. A health officer from the City's School Health Services, with minimal training, could visit schools, identify those infected by asking a simple question on the history of haematuria and administer the necessary treatment. This selective treatment of infected would have the further advantage of being simple, quick and cheap. Further studies are needed with improvements in the methodology as mentioned above, to replicate these findings in other areas of the city and to evaluate the shelf life and use of reagent strips under field conditions before wide scale use of this screening procedure is recommended.

Using haematuria and proteinuria as morbidity indicators, the results of the present study show that in the study area, urban Dar es Salaam with a low intensity of infection, there is expressed *S. haematobium* related morbidity. Similar findings have been reported from Dar es Salaam in a previous study (Sarda et al., 1985). Studies done in rural areas of Tanzania have demonstrated severe sequelae of *S. haematobium* infection (Rugemalila, 1979) and high levels of blood and protein in urine of infected subjects having low egg counts (Furrer, 1981; Tanner et al., 1982; Tanner et al., 1983). These studies in urban and rural endemic areas of Tanzania show a similar pattern, in that, infected subjects with low egg counts may have an expressed morbidity. Further studies are needed in other communities in Tanzania.

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