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Original Article

Two Practical and Cost Effective Methods for Urinary Schistosomiasis Screening in Yemeni Schoolchildren

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Abstract

Background: The study was conducted to estimate and compare the validity and performance of two screening methods for urinary schistosomiasis: the interview – reporting blood in urine- and detecting microhematuria by reagent strip.

Methods: In year 2003, 515 schoolchildren from five schools in Abyan and Taiz governorates in Yemen, were interviewed by healtworker for hematuria, and then urine samples were collected and tested for microhematuria by urine strip and for the presence and count of *Schistosoma hematobium* by filtration method. Validity and performance indicators were estimated and compared for the two methods using the filtration method as the reference - standard – test.

Results: The mean age of the schoolchildren was 10.7±2.5 years. Boys represented 65% of the sample. The prevalence of the infection as determined by filtration, interview and reagent strip methods was 21.4%, 22.15, and 30.9%, respectively. Sensitivity, specificity, PPV, NPV of the urine strip was higher than the same indicators for the interview method. Combining the results of both screening methods increased all validity and performance indicators. A statically significant ($P<$ 0.001) association was found between urine strip positivity level and infection intensity.

Conclusion: The urine strip had higher validity and performance indicators than the interview method. For its low –cost, simple and rapid application, we recommend using it for screening infected schoolchildren in areas endemic with *S. hematobium* in combination with the interview method to enhance its performance.

Keywords: *Urinary schistosomiasis, Diagnosis, Evaluation, Yemen*

Introduction

Schistosomiasis is one of the major communicable diseases of public health and socioeconomic importance in the developing world, more than 600 million people in 74 countries- are at risk of infection. Despite control efforts in a number of countries, still an estimated 200 million people are infected 80% of them are children under the age of 15 yr of which 120 million are symptomatic and 20 million have severe debilitating disease (1). Schistosomiasis is a public health problem in Yemen. The number of people infected with both prevalent types- *Schistosoma hematobium* and *mansoni* is estimated to be in the range 2230000- 3 million (2, 3).

Yemen has the second most infected people in the Eastern Mediterranean WHO Region (the first is Sudan with 5 million people infected). Population growth, low access to health services and increased water development projects are among others the main contributing factors to this problem.

The prevalence rates vary considerably across different parts of the country. The prevalence of urinary schistosomiasis varied from 10% among school children in Sana'a, to 49% and 52% in Sada'a and Hajah, respectively (4), and up to 59% in Khemer north of Sana'a (5). Accordingly, there is a need for reliable and simple means of rapidly diagnosing endemic communities with schistosomiasis to provide a detailed map on the distribution of the disease in the country, in order to prioritize control activities, as well as to monitor the effectiveness of control measures.

We aimed to estimate and compare the validity and performance of two low-cost, simple and rapid screening methods for detecting infected schoolchildren with schistosomiasis *hematobium* in Yemen.

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Materials and Methods

The data used for this study were part of the data collected in the study about the application of a school questionnaire for schistosomiasis screening in Yemen.

Study area

The study was implemented in 2003 in two governorates: Abyan and Taiz (6). Abyan governorate is located in the southeast part of Yemen, with total area 21289 sq. km. The population was 433,819 (2004 census). The number of districts is 11 districts. The number of primary schools was 290. The number of health facilities: 7 hospitals, 8 health centers, 93 health units. The four schools selected for this study were in Khanfar district, which is located in the south west of Abyan governorate. Taiz governorate is located at the southwest part of Yemen. The population was estimated to be 2,393,425 (2004 census). One school was selected for this study: "Al Salah" school in AL-barah town in Magbanah district southwest of Taiz city.

Study population

Students of primary schools (grade 1-9) in Abyan and Taiz governorates were involved. The sample for validation of the two screening methods included 515 children from the five selected schools. These schools had not been examined for schistosomiasis before.

Educational and health authorities at the governorate and district level were contacted and briefed about the objectives and the procedures of the study. The interview and collection of urine samples were considered not invasive procedures and did not need written informed consent. The school headmasters, parents and the schoolchildren were informed about the aims and procedures of the study, and verbal consent was obtained.

Data collection

A questionnaire based on the questionnaire used in Kilosa-Tanzania- was translated and adapted to local situation and used after pretest, and making the necessary changes (7). The questionnaire was administered to individual schoolchildren by teachers.

The questionnaire contained structured questions (about 7 symptoms & sings including blood with urine, blood with stool and 7 diseases including bilharzias); as well as other identification data: school name and location, class, age, sex.

The urine samples were collected from children between 10:00 and 14:00 h. The healtworker asked each student about the presence of blood in urine. The collected urine samples were tested for microhematuria by reagent strips (Uriscan, GEN 9SG, YD Diagnostics, Korea)- this test is based on the peroxidase-like activity of hemoglobin which catalyses the reaction of hydroperoxidase and O- tolidine. The test is generally capable of 0.015 mg/100ml free hemoglobin or 5 to 15 intact blood cells per microliter of urine.

Within 30 min, each sample was tested for *S. hematobium* eggs in urine by filtration method, using polycarbonate membrane filters and Swinnex filter holders from Millipore Corporation, USA (8). Both tests in all five schools were done by two experienced laboratory technicians from the National Schistosomiasis Control program. The technician who performed the filtration method was blind to the result of the reagent strip method.

Data analysis

Data were checked for completeness and consistency and entered to a computer. The SPSS version 13.0 program was used for data eatery and analysis (9). Open Epi program version 2.2 was used to calculate test validity and performance indicators (10).

Sensitivity and specificity were calculated to determine test validity, and positive predictive and negative predictive values (PPV & NPV) and diagnostic accuracy to determine test performance. The filtration method was used as the gold standard to calculate the above-mentioned characteristics of the two screening methods. Then these indicators of the two screening methods were compared.

Results

The urine samples were collected and tested during September 2003. The sample for valida-

tion of screening methods was 515 schoolchildren. The number of selected children from each school was in the range 55-111. The mean, and median age was 10.7 (±2.5 SD), and 11 yr respectively. Age group 6-10 yr constitutes 48%, and the age range was 6-18 yr. Boys represented 65% of the sample. The prevalence of *S. hematobium* infection, based on the filtration method, was 21.4%. The arithmetic and geometric mean of *S. hematobium* egg counted for 110 positive cases were 123 and 72 eggs/10 ml respectively. Prevalence, based on hematuria detection by urine strip, was similar (22.1%). The prevalence of *S. hematobium*, based on reporting blood in urine to the healtworker was higher (30.9%). The percentages of detected cases by the urine strip positivity level were 34.2%, 36.8%, and 28.9% for level +1, +2 and +3 respectively. Results of both screening methods were statistically associated with the results of the urine filtration (the standard method) with X2 $P< 0.001$. The intensity of *S. hematobium* infection- as judged by number of eggs per 10 ml urine was positively associated with the percent of hematuria, detected by urine strip and reported by schoolchildren with X2 $P< 0.001$(Table 1).

The sensitivity, specificity, positive and negative predictive values, diagnostic accuracy, likelihood of positive test and likelihood of negative test of the urine strip screening method are higher than the same validity and performance indicators of the interview method (reporting blood in urine). Combining the results of the two screening methods increases all the validity and the performance indicators (Table 2).

The urine strip test has the ability to discriminate between different levels of infection intensity. Kendall's tau-b analysis indicated a significant association ($P< 0.001$) between urine strip positivity level and infection intensity, tau= 0.338 (medium or typical strength of relationship) (11). This means that strip test result with higher positivity level detects infections of higher intensity (Table 3). This ability is confirmed by calculation of the mean number of eggs/10 ml of urine for each urine strip positivity level. The mean number of eggs/ 10 ml urine was 36, 114 and 188 for the positivity levels 1+, 2+ and 3+ respectively (Fig. 1).

Table 1: Association between *S. hematobium* eggs, hematuria and reporting blood in urine among screened schoolchildren, Yemen, 2003

Filtration method	Number (%) children	Hematuria detected by strip		Reporting blood in urine	
		% positive	% negative	% positive	% negative
Positive (infected)	110 (21.4)	78	22	74	26
Negative (not infected)	405 (78.6)	7	93	19	81
X^2 value		255*		120*	
Number of eggs/ 10 ml					
0	405 (79)	7	93	19	81
1-49	38 (7)	55	45	53	47
50-200	47 (9)	85	15	85	15
>200	25 (5)	100	0	84	16
X^2 value		275*		132*	

*All X^2 values statistically significant, $P< 0.001$

Table 2: Comparison of validity and performance of two screening methods for screening schoolchildren, Yemen, 2003

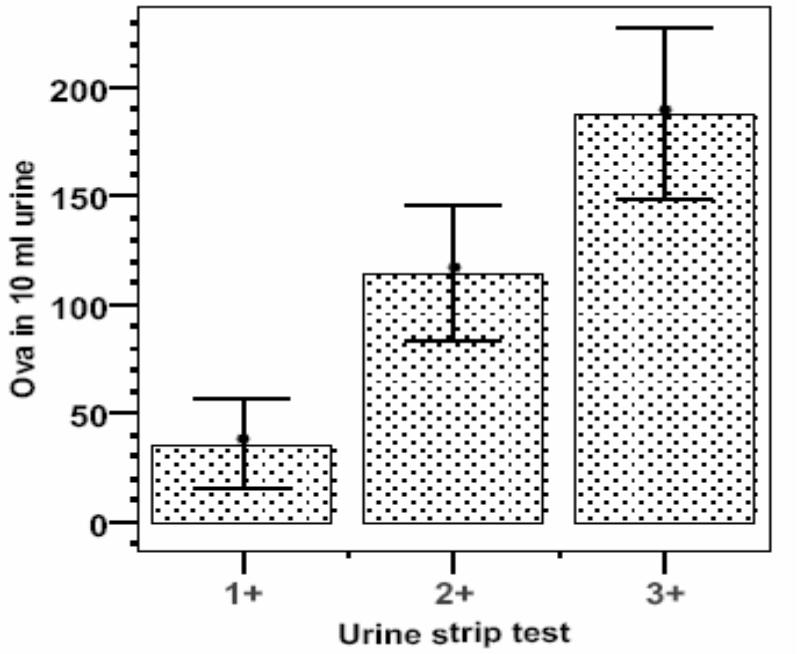
	Interview technique*	Urine strip test	Combination of interview technique & strip testing**
Sensitivity	73.6%	78.2%	82.8%
Specificity	80.7%	93.1%	96.3%
Positive predictive value	50.9%	75.4%	85.7%
Negative predictive value	91.9%	94.0%	95.4%
Diagnostic Accuracy	79.2%	89.9%	93.4%
Cohen's kappa	0.47	0.70	0.80
Likelihood ratio of positive test	3.8	11.3	22.3
Likelihood ratio of negative test	0.33	0.23	0.18

*Reporting blood in urine to the health worker
** Comparing concordant results of the two sceerning methods with the standard filtration method

Table 3: Results of the urine strip test positive level compared with the infection intensity, Yemen, 2003

	1-49 eggs/10 ml urine	50-200 eggs/10 ml urine	>200 eggs /10 ml urine	Total
Positive +1	1 (50%)	8 (40%)	2 (10%)	20 (100%)
Positive +2	6 (18%)	19 (58%)	8 (24%)	33 (100%)
Positive +3	5 (15%)	13 (39%)	15 (46%)	33 (100%)

Kendall's tau-b = 0.338 (*P* value < 0.001)



Error bars show 95% Confidence interval of mean.

Fig. 1: Mean number of eggs per 10 ml urine by strip positivity level, schoolchildren, Yemen 2003

Discussion

The results of this study confirmed the feasibility of using the interview and urine strip test methods as practical and inexpensive methods of screening schoolchildren for urinary schistosomiasis in Yemen by using Uriscan strip which is available in the local market. Comparing the two methods, urine strip test has higher sensitivity, specificity, PPV, NPV, diagnostic accuracy, Cohen's kappa, and likelihood ratio of positive test than the interview method. Using the combination of the two screening methods increased all these validity and performance indicators. However, the increase in NPV was small (Table 2). The ability of the urine strip to discriminate between children with different levels of infection intensity is another advantage of the strip method, this can be used to set a threshold of +2 results and higher as a criterion to treat the schoolchild who has such result. The increase in the validity and performance indicators when using the two screening methods in combination is of practical importance, as the interview method can be used without additional financial cost. The higher percentage (30.9%) of reporting blood in urine, compared to the almost similar percentage of detecting blood by the urine strip and filtration method (22.1% and 21.4% respectively), may be due to the fact that eggs excretion is not stable, and there are other causes of hematuria. This drawback of the reporting method can be minimized by asking about terminal hematuria and recent hematuria (in the same day or the last micturition).

The sensitivity of the interview method in our study was higher than the sensitivity reported by Mafe M.A (74% versus 44%), but the specificity is lower (81% versus 89%). For the reagent strip the sensitivity and specificity in our study (78% and 93%) was higher than that reported by Mafe M.A. (69% and 80%) (12). For the interview method the sensitivity is higher and the specificity is lower- in our study- than that reported by Michael D. French et al. (74% versus 12% and 98% versus 81%). For the reagent strip the sensitivity in our study is similar but the specificity is lower than that reported earlier (78% versus 77% for sensitivity, and 93% versus 97% for specificity) (13).

The reagent strip method performed better in detecting heavy infected children than the interview method. It detected all infected with >200 eggs per 10 ml urine compared with 84% infected with the same infection intensity. This result is in agreement with Mafe study (12). Van der Wert et al. evaluated the performance of the reagent strip and interview method for categorizing communities in the WHO recommended treatment strategies and found that they perform well (14). The reagent strip might be used to monitor ongoing control programs for schistosomiasis without loss in the method diagnostic ability with time (13). The urine strip test method is at least 3 times cheaper than the filtration method (7).

In conclusion, the reagent strip method is practical-cheap, fast, easy to perform in PHC setting-method for screening, and monitoring *S. hematobium* infection, its performance can be enhanced when used in combination with interview method without additional costs. We recommend using these methods in area endemic with *S. hematobium* to use the -already- limited resources efficiently.

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