

Role of Diagnostic Testing in Schistosomiasis Control Programs in Rural Ghana

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Abstract

Background: Schistosomiasis affects an estimated 200-300 million people worldwide. Construction of dams has contributed to the high prevalence of urinary schistosomiasis in Ghana. To assist rural villages downstream from the Berekese dam in schistosomiasis control programs, this study evaluated possible detection methods of schistosomiasis.

Methods: A cross-sectional survey of volunteers was conducted in a rural setting of Ghana. Five hundred and thirty four (534) volunteers provided symptom information and urine samples for urinalysis. Microscopic egg count of 341 random samples was used to determine prevalence of disease and to analyze effectiveness of urinalysis and symptom information for diagnosing schistosomiasis.

Results: Schistosomiasis prevalence was 41.1 % for the village. The highest prevalence was in the 10-14 age groups (71.1 %). Sensitivity and specificity for hematuria was 76.1 and 77.7 % respectively, and proteinuria was 58.2 & 68.7 % respectively. The positive predictive value was highest for hematuria (71.1 %). The highest negative predictive value was among positive proteinuria or hematuria (84.0 %). From urinary symptom information, reporting pain and dark urine yielded the highest positive predictive value (72.0 %). Reporting pain, difficulty, or dark urine yielded the highest negative predictive value (75.8 %).

Discussion: The positive and negative predictive values of urine analysis and symptom information may be an inexpensive tool for diagnosing schistosomiasis in areas of high prevalence.

Introduction

Schistosomiasis is one of the world's most prevalent neglected infectious diseases. There are an estimated 200-300 million people living with schistosomiasis and 650 million people living in endemic areas [1]. The burden of this disease causes an estimated 8-60 million Disability Adjusted Life Year (DALY) every year [2]. Urinary schistosomiasis is especially a burden in Sub-Saharan Africa where *Schistosoma haematobium* is the most prevalent schistosoma in this region [1]. World eradication of urinary schistosomiasis has been a challenge for multiple reasons: female *Schistosoma* can produce 200 to 2000 eggs daily, difficult access to clean water, and water contact activities in endemic areas are a part of daily life. The burden of urinary schistosomiasis can cause glomerulonephritis, pulmonary hypertension, squamous cell carcinoma of the bladder, anemia and under nutrition [3-5]. Schistosomiasis and anemia in children has also been known to contribute to poor growth and reduced school performance [7]. Schistosomiasis as co morbidity is associated with worse outcomes with urinary tract infections and with higher HIV shedding [8,9].

In Ghana, communities have reported prevalence of *S. haematobium* infection as high as 60 percent [10]. Problems of schistosomiasis have been attributed to creation of habitat for *Bulinus*, *Globus* snails from damming of Lake Volta [11]. Because of the effect of the creation of Lake Volta, many studies on urinary schistosomiasis have been focused in this part of the country [10]. However, urinary schistosomiasis is also a problem among other regions in Ghana [10]. The village of Berekuma is located in the Ashanti region and receives water from the Offin River. The village is approximately 7 kilometres downstream from the Berekese dam. A previous assessment estimated that fifty-eight percent (58%) of school children in the Berekuma community had schistosomiasis [12]. The purpose of this study was to assess the prevalence of disease in Berekuma and evaluate inexpensive methods of urine analysis and

symptom information to aid in intervention efforts in schistosomiasis control.

Materials and Methods

Health and economic problems in Berekuma are being evaluated through a Community Based Participatory Research (CBPR) method. CBPR involves an equal partnership between investigators and the community. Power, resources, results, and knowledge from the project are shared with all involved. Community members and investigators are involved in the research design process, interpretation of results, and determining the action of the results [13]. The CBPR research provides the foundation theory of the collaboration of the Berekuma Community Collaborative Development Project (BCCDP). The BCCDP is a partnership of village members, medical professionals at the Komfo Anokye Teaching Hospital (KATH), Kwame Nkrumah University of Science and Technology, School of Medical Sciences, Atwiami Nwabiagya District Assembly and researchers at the University of Utah from the United States. The BCCDP is currently gathering data to aid the CBPR process with the village to help determining intervention

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strategies for schistosomiasis control. The BCCDP received approval for this study from the Kwame Nkrumah University of Science and Technology, School of Medical Sciences and the University of Utah Institutional Review Boards.

A village school was temporarily used as a research and laboratory facility where data and urine samples were obtained from participants. 534 participants from the village were first administered a questionnaire to obtain information about urinary symptoms such as pain, colour and difficulty and exposure to the river by frequency and activity. The survey was developed in English and administered in Twi by bilingual interviewers. Sterile urine cups were provided for samples. Urine analyses for proteinuria and hematuria were performed using Clinitek® (Bayer Corp. Leverkusen, Germany) dipsticks on site. Following urine analyses, all participants were seen by physicians from the Komfo Anokye Teaching Hospital and received specific instruction depending on the findings of urinalysis. Those with positive urine blood on dipsticks as well as positive egg count were given Prazinquantel at the Barekese health post.

A sample population of 341 urine specimens was randomly selected for microscopy for the presence of *S. haematobium* eggs and subsequent filtration and egg count at the Komfo Anokye Teaching Hospital parasitology laboratory. A positive egg count was considered the standard for a positive diagnosis of schistosomiasis.

Statistical methods

All data were entered into EpiInfo October 2004 version 3.3 (Centre for Disease Control and Prevention) and exported to Excel spreadsheet (Microsoft Corporation, Redmond, WA) and population characteristics and frequencies were determined using STATA 10 statistical software (Stata Corp., College Station, TX.). The frequency of schistosomiasis was stratified by age and sex. Sensitivity, specificity, positive predictive

Characteristic	N	Frequency
Sex	341	
Male	149	0.443
Female	192	0.557
Age	341	
5-9	80	0.235
10-14	76	0.223
15-29	75	0.220
30-54	73	0.214
55+	37	0.109

Table 1: Characteristics of participants, Schistosomiasis Urine Analysis and Egg Count, Barekuma, Ghana, 2007.

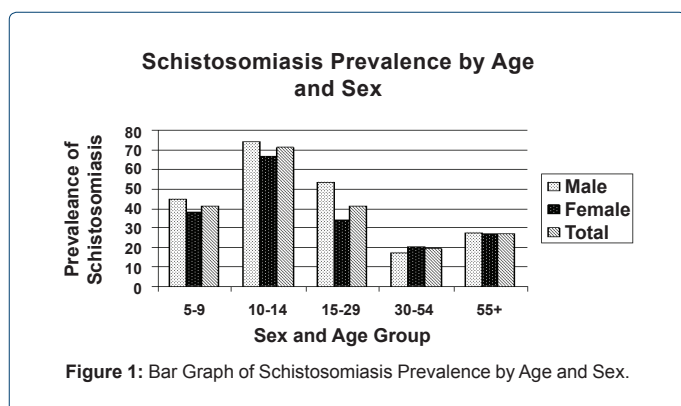


Figure 1: Bar Graph of Schistosomiasis Prevalence by Age and Sex.

values and negative predictive values was calculated for hematuria, proteinuria, either hematuria or proteinuria and different combinations of symptom information of dark, pain, or difficulty urinating compared to microscopy.

Results

More than half of the participants (56.3%) were females (Table 1 & Figure 1). Age distribution ranged from 10.9 to 23.5 % between the different age groups.

The highest prevalence of schistosomiasis was in the age group of 10-14 (71.1 %). The lowest prevalence was among the 30-54 age groups (19.2 %). The crude prevalence for the population was 41.9 %.

Sensitivity and specificity of the urine analysis with a positive hematuria was 76.1 & 77% respectively (Table 2). The sensitivity and specificity of urine analysis for proteinuria was 58.2 & 68.7 % respectively. The sensitivity and specificity among those who had a positive hematuria or proteinuria were 85.2 & 78.9 respectively. The positive predictive value was highest for hematuria (71.1%). The highest negative predictive value was for testing for proteinuria or hematuria (84.0 %).

The positive predictive values of symptoms reported by participants are also reported in Table 3. The highest positive predictive value was among those who reported pain and dark urine (72.0). The highest negative predictive value was among those who reported no pain, no difficulty, and no dark urine (75.8 %).

Discussion

Schistosomiasis continues to be a health concern in communities in developing countries. Using the Community Based Participatory

	Schistosoma Egg Microscopy Results					
	Positive	Negative	Sensitivity	Specificity	PPV	NPV
Hematuria						
Yes	108	44	0.761	0.777	0.711	0.818
No	34	153				
Proteinuria						
Yes	82	62	0.582	0.687	0.569	0.697
No	59	136				
Hematuria or Proteinuria						
Yes	121	86	0.852	0.566	0.590	0.840
No	21	112				

Table 2: Sensitivity and Specificity of Urinalysis.

Symptoms	Microscopy Results					
	Positive	Negative	Sensitivity	Specificity	PPV	NPV
Painful Urination						
Yes	76	66	0.535	0.668	0.535	0.668
No	66	133				
Difficulty Urinating						
Yes	57	51	0.401	0.744	0.528	0.635
No	85	148				
Dark or Bloody Urine						
Yes	87	45	0.617	0.774	0.659	0.740
No	54	154				
Painful and Dark Urine						
Yes	60	32	0.606	0.789	0.720	0.755
No	39	120				
Painful, Difficult and Dark Urine						
Yes	42	25	0.532	0.823	0.627	0.758
No	37	116				

Table 3: Sensitivity, Specificity, Positive Predictive Values, and Negative Predictive Values of Reported Symptoms.

Research method in schistosomiasis control, investigators from the Berekuma Community Collaborative Development Project have collected information on schistosomiasis prevalence and diagnostic testing to help the village of Berekuma discuss interventions strategies. The crude prevalence in the village was 41.9 percent. The most affected were adolescents ages 10-15 (71.1 percent) and lowest were among adults 30-54 (19.2 percent). This distribution of schistosomiasis in Berekuma based on age and sex is similar to what other prevalence studies have shown in other areas of the world. [10,14]. The decrease in prevalence as people age may be attributed to less exposure or increased immune response as shown in other studies [15]. The short term and long term complication associated with this disease makes these findings of high prevalence an important public health disease [16-18].

To determine possible economic diagnostic strategies for future intervention programs, urine analysis and symptoms for detecting urinary schistosomiasis were evaluated. Urinalysis for schistosomiasis detection showed that hematuria and proteinuria have a low sensitivity (76.1 & 58.2 % respectively) and low specificity (77.7 & 68.7 % respectively) compared to egg counts from filtration and microscopy. These results for sensitivity and specificity of hematuria and proteinuria were similar to other studies [19,20]. Although these tests may not be useful in communities with low prevalence, the negative predictive value of either hematuria or proteinuria is 84.0 % and positive predictive value for hematuria is 71.1 percent suggesting that it may be useful in Berekuma for detection for schistosomiasis. Similar to urine analysis, urinary symptom information sensitivity was low (highest was 61.7 % for reporting dark and painful urination.) Specificity for dark, painful or difficulty urine, however, was 82.3%. Urinary symptom information from patients in Berekuma, specifically reporting dark and painful urine or reporting normal urination can be useful for diagnosis because of the relatively high positive predictive values and high negative predictive values (72.0 & 75.8).

This study has some limitations. Because samples were taken from volunteers, people concerned about schistosomiasis might be oversampled in the population and those who were working were not able to participate. There is also a potential source of information bias because of the humid environment where the urine analysis was performed which may introduce some error into the results of the urine analysis. This information was presented to village leaders, educators, and community members of Berekuma, Ghana to stimulate discussion of possible intervention strategies and the roles of the community, government, and BCCDP in these interventions. Subsequently all the study participant with schistosomiasis were treated at the Berekese Health Centre.

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