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Research Article

EXTENT OF SCHISTOSOMA HAEMATOBIUM INFECTION AND PERCEIVED CAUSES AMONG PRIMARY SCHOOL CHILDREN IN BAHI DISTRICT, CENTRAL TANZANIA: A CROSS-SECTIONAL STUDY

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Abstract

Schistosomiasis remains to be one of the most public health problems worldwide with an estimate of 200 million cases reported each year. Of the total cases reported annually, 85% occur in sub-Saharan Africa with over 150,000 deaths due to chronic infection with *Schistosoma haematobium*. In Tanzania, Schistosomiasis is known to be highly endemic across the country with published data indicating that all regions have some level of infection ranging from 12.7 to 87.6 %. The severe consequences of Schistosomiasis infection especially among children include poor health and nutrition, retarded cognitive development, and less educational achievement. This study aimed to examine prevalence and risk factors associated with Schistosoma infections among school children aged 9-13 years in Bahi District, Dodoma region, Central Tanzania. To attain this objective, 200 children were interviewed by trained Health Workers (HWs) using a structured questionnaire. In addition, children were asked to collect urine in supplied 20 ml screw top plastic containers between 0900 and 1100hours for laboratory examination. The primary outcome of the study was *S. haematobium* infection as diagnosed by microscopic examination. The results show that the majority of the children were children of peasants who are engaged in subsistence farming. This group constituted 132 (66 %) of the total studied children. Male children were more likely to wash their hands or take bath in a nearby surface water source than females: 49.0 % males against 23% females (p <0.001). Moreover, the results show that of the total children in the study, more than half, 124 (62.0 %) reported seeing red urine sometimes in their life. Of these, 94(76 %) reported seeing red urine in the past month, whereas the remaining 30 (24 %) saw red urine last year. Males were more likely to report seeing red urine in the past four weeks preceding the date of the survey than their female counterpart: 51.0 % males versus 42.9 % females. However, based on biological analysis results, the extent of *S. haematobium* infection was found to be 53.9 % for males and 43.9 % for females (p=0.155). *S. haematobium* infection is quite high among primary school children in Bahi district. Appropriate measures such as mass treatment is need to be done in order to limit the potential severe consequences of Schistosomiasis infection among school children in Bahi district.

Keywords: Bahi, Haematobium, Risks factors, Schistosomiasis, Urine, Infection.

INTRODUCTION

Schistosomiasis remains a significant public health problem globally with an estimate of 200 million cases reported each year. However, 85% of the cases reported annually occur in sub-Saharan Africa with over 150,000 deaths due to chronic infection with *Schistosoma haematobium* (Chala and Torben, 2018). The eggs of S. *haematobium* provoke granulomatous inflammation, ulceration, and pseudo-polyposis of the vesical and ureteral walls (Costain *et al.,* 2018). Hematuria is a very common sign of infection, but other signs include dysuria, pollakisuria, and proteinuria (Moudugil and Kosut, 2007). Kidney failure deaths due to urinary tract scarring, deformity of ureters and the bladder caused by S. haematobium infection have become less common due to modern drugs (Samuel *et al.,* 2000). New evidence from a recent review done by King and Dangerfield-Cha (2008), suggests a causative link between schistosome infection, anti-parasite inflammation, and risk for anaemia, growth stunting and under-nutrition, as well as exacerbation of co-infections and impairment of cognitive development and physiological capacities among infected individuals. The causal relationship between anaemia and schistosomiasis exists even after controlling for other co-infections and dietary factors among pregnant women and children. The underlying mechanisms proposed range from social determinants to complex immune interactions (Teesdale and Chitsulo, 1985). In Africa, three species of schistosomes infect man. These are S. mansoni (Sambon, 1907), S. haematobium (Weinland, 1858) and S. intercalatum (Fisher, 1935). S. intercalatum infection to man is not as pathogenic to man as the other two schistosomes (Kali, 2015). *S. mansoni* or intestinal schistosomiasis is endemic in the larger part of Africa (Chitsulo *et al.,* 2000). It is widespread in the Upper Sudan and Egypt, and occurs along the East African coast from Eritrea through Kenya, Tanzania and Malawi to the Zambezi River and Zimbabwe inland through Zambia and Tanzania to the Congo River, with some cases reported from South Africa (WHO, 1985). Schistosomiasis is a public health problem in Tanzania, but estimates of its prevalence vary widely (Mazigo *et al.,* 2012). In Tanzania the prevalence is estimated to be greater or equal to 50% in most 75% of the district (Steinmann *et al.,* 2006). The infection is a burden one especially to children by causing chronic severe infection leading to retarding child development, health, nutrition, cognitive development and educational success and achievement (Osakunor *et al.,* 2018). In Tanzania, schistosomiasis is endemic with S. *haematobium* being highly prevalent in the southern region of the country while *S. mansoni* predominates on the central plain and the northern regions (Mazigo *et al.,* 2012). The national schistosomiasis control program estimates that between greater or less than 50% of the total Tanzanian population is infected with schistosomiasis (Lengeler *et al.,* 1991; Guyatt *et al.,* 1999; Partnership for Child Development,

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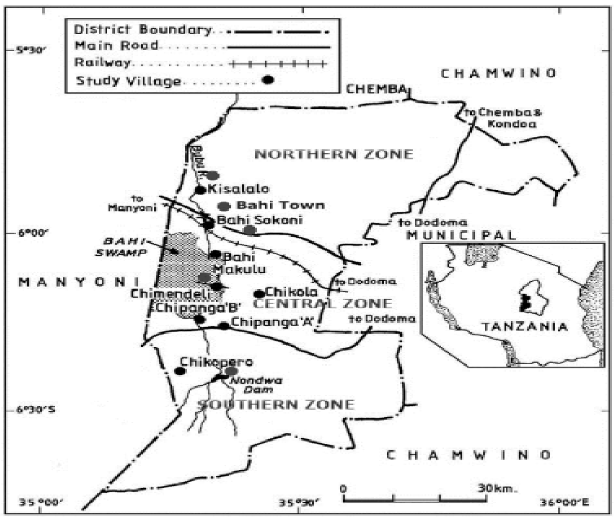
1999a; Partnership for Child Development, 1999b). Other studies have suggested that these national estimates may have been derived from studies conducted years ago that had some selection bias for high risk schools (Brooker *et al.,* 2001). However, most districts in Tanzania do not have local estimates to guide planning and implementation of control interventions at that level. The Ministry of Health, Community Development, Gender, Elderly and Children through the national schistosomiasis control program is currently undertaking a deliberate effort to have schistosomiasis prevention and control efforts integrated within district plans to encourage ownership and improve sustainability by engaging district teams (National Plan of Action for the Control of Schistosomiasis and Soil transmitted Helminthes five-year plan 2004–2008) (Massa *et al.,* 2009). Aquaculture and small-scale fisheries are important components of national and international programs concerned with the development of animal protein resources in developing countries. However, these activities are also perceived as increasing the spread of breeding sites for vector snails in countries where schistosomiasis is endemic (Lwambo *et al.,* 1997). In Bahi district, there is favourable environment which provide evidence for prediction of high prevalence of Schistosoma infection (URT, 2010).The socio-economic, environmental and health-seeking behavioural characteristics of the population are conducive to the spread of urinary schistosomiasis. The attitudes considered include knowledge of what causes the disease and how to control it, attitude toward the disease, care of oneself, hygiene and sanitation (Massa *et al.,* 2009). The risk factors include main household water source, child's knowledge of nearby open water sources (open water source defined as any open water body including lakes, springs, rivers, streams, ponds, swamps and dams), frequency of contact with open water sources, poor sanitation, history of passing blood in urine (haematuria) within the past month and presence of snail intermediate host of the infection Lengeler *et al.,* 1991). Other factors included urban or rural location, proximity of school to an open water source and household socio-economic status (SES) (URT, 2010).

MATERIALS AND METHODS

Study location

This cross-sectional study was carried out in Bahi district located in Dodoma region, centrally located in Tanzania (Map1).



Map 1. A Map of Bahi district, Dodoma region

Bahi district was selected because of the fact that it has conducive environment for the transmission of S. *haematobium* infection and that the district has not been intervened with the National initiative of mass treatment like other many districts in the country. The district has a total land area of 5,948 km^2 and it extends between 4^o and 8^o south and between longitude 35^o and 37^o east. According to the 2012 National Population and Housing Census, Bahi district had a population of 221,645 people who reside mainly in rural areas. Of the total population, 105,975 (47.8 %) were males and the remaining 115,670 (52.2 %) were females (URT, 2012). Majority of the population are farmers and cattle grazers. The rainy season is from November to April and the dry season from May to October.

Study population and recruitment

Three schools namely, Bahi Makulu, Bahi Sokoni, and Uhelela were selected based on geographical location and ecological risk areas for urinary schistosomiasis. In this study, a sample of 200 children was selected proportional to size of children in the three pre-specified classes in the three schools. The total sample of 200 children was pre-determined based on availability of resources to undertake the study. The target population of the study was children in Classes II, III and IV who were attending primary school during the time of execution of the study. According to the education system in Tanzania, the recommended age for children to begin primary school (Class I) is 7 years. In this regard, it was hoped that children in the aforementioned classes would be mostly in the age group 9-12 years considering that some children, especially in rural areas go to school comparatively late than their counterparts in urban areas. Furthermore, children in Classes II, III, and IV were considered appropriate for the study since children in these classes are more likely to engage in recreational water-contact behaviors compared to older children or those in Class V and above. Moreover, children in Class I or below 9 years of age were excluded as these were considered too young or not knowledgeable enough to be able to provide useful responses on various aspects of the study. However, during interviews, it was found that some (*n*=4, 2 %) of the total randomly selected children in the study were aged 13 years (above the expected age group of 9-12 years for children in classes II, III and IV). In order to avoid psychological hitches to these children that they could not be studied despite being selected because of age limit, they were still considered useful for the study, thus included in the sample. Sampling of children in each class in the three schools was also done proportional to size of children in the respective classes. This was achieved using the procedure *Survey Select* in the SAS system software using class as the stratification factor.

Data collection

Data collection took place for two days in August 2010 and was conducted by six health workers (three men and three women). Prior to beginning of data collection, the research team had a two-day training on various aspects of the study including the objectives of the study and data collection methods, which included among other things, interview technique that the study adopted and ethical issues related to the study. The data were collected through two different ways: (i) using a structured questionnaire that was administered face-to-face at the pupil's school and included items such as age (in years), main activity of father/mother/guardian, place where water for drinking and bathing at the child's home was obtained, if the pupil had a habit of taking bath or washing his/her hands in a nearby surface water source (such as spring, river/stream, pond/lake, dam, rainwater), frequency (per day) of bathing or washing hands in a nearby surface water source, availability of a toilet at the pupil's home. Moreover, children were asked to retrospectively recall whether they saw red urine at any time during the past four weeks preceding the date of the survey and the course of action that was taken by the parent or guardian in response to the condition, etc. The questionnaire was designed in English, but was later translated into Kiswahili (the language that is widely spoken in Tanzania) to facilitate the interviews. In order to ensure that the original meanings of the various items of the questionnaire were maintained, the Kiswahili version was sent to an independent university staff who was conversant in both English and Kiswahili to help translate it back into English (back translation). The two versions were examined systematically question-by-question to identify any discrepancies available especially with respect to wording or sentence formulation. Inconsistencies were checked and synchronized accordingly. Prior to administering to the respondents, the final version of the questionnaire was pre-tested to check among other things whether the questions were understood and conceptualized by all respondents equally. (ii) Each pupil was asked to collect urine in supplied 20 ml screw top plastic containers between 0900 and 1100hours.

Data quality

In order to ensure that the data were of good quality to meet the expected goal of the study, the principal investigator in collaboration with district health offers supervised the data collection exercise. Several strategies were adapted in order to ensure that the collected data were of acceptable quality to permit the achievement of the study objectives. The strategies included scrutiny of a randomly selected sample of questionnaires for each interviewer on daily basis beginning the first day of commencement of data collection. In addition, the data quality control team visited each interviewer while conducting the interview at the sampled schools in order to ascertain compliance by the interviewer to recommended interview technique thus, accuracy of the corrected information.

Data management

The collected data were double-entered in the Statistical Package for the Social Sciences for windows version 20. To verify the precision of data entry, the two versions of the data were compared through scrutiny of descriptive statistics of variables and discrepancies were corrected accordingly.

Ethical consideration

Ethical clearance was obtained from the Ministry of Health, Community Development, Gender, Elderly and Children. The permission to conduct the study in the district was granted by the District Executive Director (DED). The DED in turn informed the District Medical Officer who subsequently informed the head teachers of the selected schools about the study and requested their approval proceeding to data collection in their respective schools. In each school, selected children were informed about the objectives of the study, how the study was expected to be conducted, and the usefulness of the study. Selected children were further told that information to be collected was expected to be kept anonymous and treated with utmost confidentiality. Moreover, they told that participation in the study was entirely free and that they were free to withdraw from the study at any time. Preceding the interviews, selected children in all schools gave verbal informed consent.

Data analysis

Questionnaire responses: Data analysis was mainly descriptive and involved both graphical and numerical summary measures. For numerical descriptive measures, the arithmetic mean together with their corresponding standard deviation (SD) and frequencies together with their corresponding percentages were computed for continuous and discrete variables, respectively. The chi-square and student's *t* tests were respectively used to test for association and mean differences of various variables between males and females, respectively. All tests were considered significant at the 5 percent level of significance.

Urine sample: In this study, the primary outcome was S. *haematobium* infection as diagnosed by urinary microscopy examination. Samples of urine were tested for eggs by filtration method. Ten (10) mls of urine was filtered using paper filters (Gelman Sciences, Michigan USA) and the egg counts were recorded per each 10 mls of urine collected from each pupil.

RESULTS

Characteristics of study the respondents and settings in which there were fromvarious summary measures of the study respondents, disaggregated by sex, are summarized in Table 1. Of the total children in the study, 80 (40 %), 70 (35 %), and 50 (25 %) were from Bahi Makulu, Bahi Sokoni and Uhelela primary schools respectively. One hundred and two (51 %) of the total children in the study were males while 98 (49 %) were females. Their mean age (SD) was 10.6 (1.0) years with a range of 9-13 years and was evenly distributed between sexes (10.7, SD=1.0 for males vs. 10.6, SD=1.0, for females, p=0.415). About three-quarter, 149 (74.5 %) of the children in the study were in Class III compared to 39 (19.5 %) or 12 (6.0 %) who were in Classes II and IV, respectively. However, the difference in number of participating children across classes was independent of sex of child (p=0.637). In terms of occupation, the findings show that the majority, 157 (78.5 %) were children of parents/guardians who were practicing subsistence farming or cattle grazing. Only 30 (15.0 %) and 13 (6.5 %), respectively were children of parents/guardians who were engaged in business and employed, but not in agriculture. With reference to main source of water, the findings show that water used for drinking and bathing in the households where most of the children were from was fetched from open sources, which include river/stream, pond/lake, and spring. Open sources of water used for drinking and for bathing were reported by 70.5 % and 78.5 % of the children in the study, respectively. Piped water as a main source of both water for drinking and bathing, respectively was reported by 29.5 and 21.5 % of the total children in the study. There was no statistical associations between reported sources of water for both drinking and bathing and sex of the child ($p>0.05$). Concerning whether children had a habit of taking bath or washing their hands in an open water source, the findings show

Table 1. Characteristics of study population

Characteristics	Male (n=102)	Female (n=98)	Total (N=200)	*p* value
School where the child was from				**0.232**
Bahi Makulu	45 (44.1)	35 (35.7)	80 (40.0)	
Bahi Sokoni	30 (29.4)	40 (40.8)	70 (35.0)	
Uhelela	27 (26.5)	23 (23.5)	50 (25.0)	
Mean age (SD) of children	10.7 (1.0)	10.6 (1.0)	10.6 (1.0)	**0.415**
Class of children				
Class II	5 (4.9)	7 (7.1)	12 (6.0)	**0.637**
Class III	75 (73.5)	74 (75.5)	149 (74.5)	
Class IV	22 (21.6)	17 (17.4)	39 (19.5)	
Main occupation of child's father/mother/guardian	**0.702**			
Farming/cattle grazing	80 (78.4)	77 (78.6)	157 (78.5)	
Business	14 (13.7)	16 (16.3)	30 (15.0)	
Employed (not agriculture)	8 (7.8)	5 (5.1)	13 (6.5)	
Household's main source of water for drinking				**0.735**
Piped water	29 (28.4)	30 (30.6)	59 (29.5)	
Open sources	73 (71.6)	68 (69.4)	141 (70.5)	
Household's main source of water for bathing				**0.506**
Piped water	20 (19.6)	23 (23.5)	43 (21.5)	
Open sources	82 (80.4)	75 (76.5)	157 (78.5)	
If the child had a tendency of taking bath or washing his/her hands in an open water source				**<0.001**
Yes	50 (49.0)	23 (23.5)	73 (36.5)	
No	52 (51.0)	75 (76.5)	127 (63.5)	
	Male (n=50)	Female (n=23)	Total (n=73)	
Number of times (per day) the child used to take bath or wash his/her hands in a nearby open water source				**0.127**
Once	23 (46.0)	15 (65.2)	38 (52.1)	
Twice	27 (54.0)	8 (34.8)	35 (47.9)	
If there was a sanitation facility at the child's home				**0.396**
Available	90 (88.2)	90 (91.8)	180 (90.0)	
Not available	12 (11.8)	8 (8.2)	20 (10.0)	
	Male (n=12)	Female (n=8)	Total (n=20)	
Place where the child defecates				**0.400***
Open defecation	12 (100.0)	7 (87.5)	19 (95.0)	
Neighbor's toilet	0 (0.0)	1 (12.5)	1 (5.0)	

*Based on Fisher's Exact test

Table 2. Frequency of reported red urine in children and course of action taken

Characteristics	Male (n=102)	Female (n=98)	Total (N=200)	*p* value
Child observed red urine at any time during the past four weeks preceding the date of the survey				**0.250**
Yes	52 (51.0)	42 (42.9)	94 (47.0)	
No	50 (49.0)	56 (57.1)	106 (53.0)	
	Male (n=52)	Female (n=42)	Total (n=94)	
Course of action taken in response to the condition of red urine				**0.877**
Sought treatment	19 (36.5)	16 (38.1)	35 (37.2)	
No action	33 (63.5)	26 (61.9)	59 (62.8)	

that more than one-third, 73 (36.5 %) of the total children in the study reported to perform this conduct. Male children were more likely to take bath or wash their hands in a source water source as compared to female children (49.0 % vs. 23.5 %, $p<0.001$). Of the total children who reported taking bath or washing their hands in a nearby surface water source, 35 (47.9 %) reported to bath or wash their hands twice a day, with male children appearing to bath or wash their hands twice more frequently compared to their female counterparts (54.0 % vs. 34.8 %), though the association seems to be statistically not significant ($p=0.127$). With regard to availability at home of a sanitation facility, the results show that most (90.0 %) of the children were from homes in which there was a certain form of a sanitation facility.

Only 20 (10.0 %) of the total children were from households in which there was no any form of a sanitation facility. The reported responses about absence or availability of a sanitation facility was independent of sex of child ($p=0.396$). The results show further that, of the total children who were from households in which there was no any form of a sanitation facility, 19 (95.0 %) reported to practice open defecation, with all male children reporting this practice as compared to their female counterparts (100 %vs. 87.5 %). However, the difference was not statistically significant ($p=0.4$).

Reported episodes of red urine in children

Overall, 94 (47 %) of the total children in the study reported seeing red urine at any time during the past four weeks (Table 2). Male children were more likely to report seeing red urine at any time during the past four weeks preceding the date of the survey as compared to their female counterparts: 51.0 % vs. 42.9 %. However, the association between reporting of red urine at any time during the past four weeks preceding the date of the survey and sex of child was not statistically significant ($p=0.250$). Of the children who reported seeing red urine, only approximately one-third (37.0 %) sought treatment themselves or were taken for medical treatment by their parents/guardians. Female children were slightly more likely to seek medical care compared to male children: 38.1 % vs. 36.5 %. However, seeing or not seeking care was independent of sex of child ($p=0.877$).

Extent of S. *haematobium* infection in children

Biological test results revealed that of the total children in the study, 98 (49.0 %) were found to be positive for S. *haematobium* infection. Male children were more likely to be positive for S. *haematobium* as compared to their female counterparts: 53.9 % vs. 43.9 % (Figure 1).

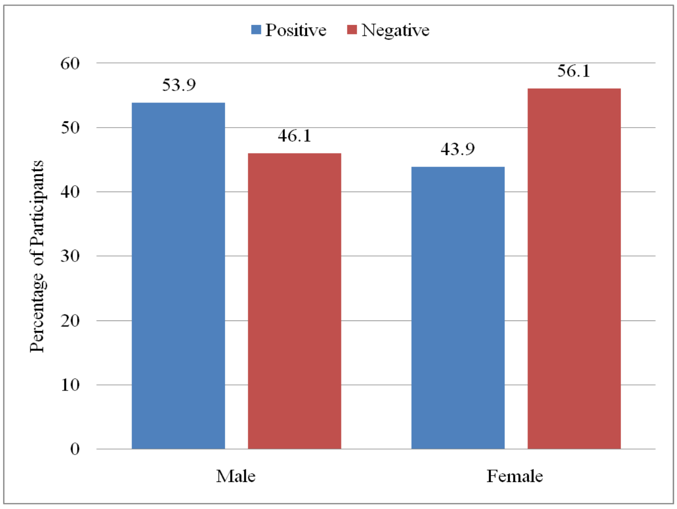


Figure 1. Urinalysis results for S. *haematobium* infection in children

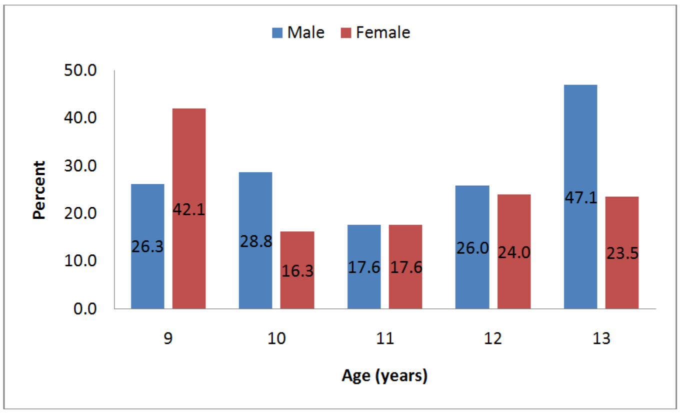


Figure 2. Urinalysis results for S. *haematobium* infection in children

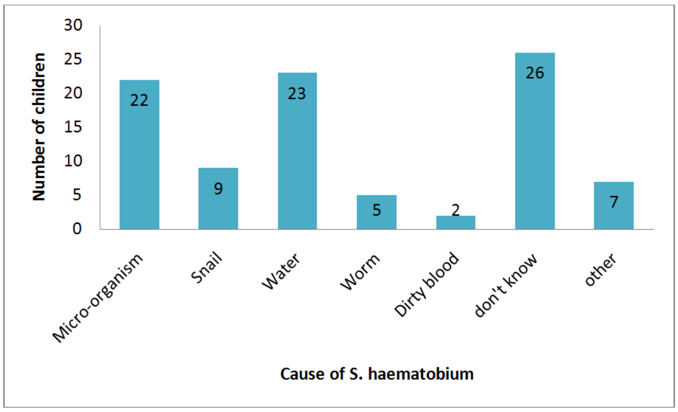


Figure 3. Proportion of children tested positive for S. *haematobium*

However, testing positive or negative was independent of sex of child (p=1.55). Furthermore, the results revealed that S. *haematobium* varied randomly between ages and sex at each age, with children at age 10 years more likely to test positive than at any other reported individual age (Figure 2).

Perceived cause of S. *haematobium* infection

Children were also asked about their perception of the cause of S. *haematobium* infection that they experienced either the past month or sometimes back in their life. The majority (37) of the infected children were unable to tell the primary cause of their infection which they experienced during the reference period. Thirty two (32) reported micro-organism as the major cause of the infection whereas water and worm were mentioned by 23 and 11 of the infected children. Snail was named by less than ten (9) of the infected children. Failure of the children to correctly tell what causes schistosoma *haematobium* infection suggests that more education is needed if a reduction in the prevalence of the disease is to be achieved in the study area.

DISCUSSION

The majorities of the studied children are in the age range 10-12 years (see Fig. 3) and are currently in standard III (see Table 1or Fig. 3). This shows that in the study area majority of children begin standard I at the age of 7 to 9 years; a typical age for beginning primary school education in many developing countries' settings. Difference b/n males and females is statistically insignificance which may be contributed by a small sample size. Age and class level could not give any statistical comparison due to the fact that the sample captured children of the same age and class. However, the class in which the pupil is currently studying is independent of his/her sex (Chi-square value=0.854, DF=2, P-value=0.653). As evident from the results in Table 1, with exception of the variable "time to bath and wash hand in a nearby water source" where bathing and washing hands depends on the sex of the pupil, in all the other variables, the responses are independent of sex of the pupil (p-value>0.05). Regarding occupation of pupil's parents, the majority of the children were children of peasants who are engaged in subsistence farming. This group constitute 132(66%) of the total studied children. Business was the second main occupation of pupil's parents in the study area. Nature of occupation of children's parents demonstrates the fact that the majority of Tanzanians work in the agriculture sector. However, the study based only on one social economic indicator which cannot precisely represent the true welfare of the household from which children come from. Water from well, followed by pipe and river were the three common sources of water for domestic use including bathing mentioned by the respondents. However, as stated above, the mentioned sources of water were independent of the sex of the pupil. Male children were more likely (p-value <0.001) to wash their hands or take bath in a nearby water source than females: 50(approximately 49%) males against 23 (approximately 23%) females. Of the total male children who were likely to wash their hands or bath in a nearby water source (50), well over half 27(54%) reported washing their hands or taking bath in nearby water sources twice a day compared to their female counterparts 8(35%). In contrast, female children were likely to wash their hands or bath in nearby water sources once a day: 15(65%) females against 23(46%) males.

Conclusion

The study findings conclude that there is high prevalence (51%) of the infection caused by *Schistosoma haematobium* among school children in Bahi District of which according to WHO requires mass treatment for the affected population. Further to that the risk factors described above contribute significantly to the persistence of the disease burden.

Recommendations

Based on the findings i.e (the prevalence of 51%) it is recommended by WHO that; When a village reports that more than 50 % of children have blood in their urine, everyone in the village receives treatment. When it is between 20 - 50 % of children have bloody urine, only the school-age children are treated. When less than 20 % of children have symptoms, mass treatment is not instituted.

- All primary school children under the study area receive mass treatment with praziquantile drug.
- Bahi district health authority must undertake detail survey to assess other contributing factor to the persistence of the disease incidences.
- Communities must be educated and sensitized on prevention and control measures against schistosoma infection
- Measures to control snail breeding must be employed to reduce the burden.
- The Ministry of Health through School Health Programme must provide a backup support to Bahi district to ensure sustained prevention and control measures.
- School health education on disease transmission and prevention is important among school children in Bahi district.

Abbreviations: DED: District Executive Director; HWs: Health Workers.

Competing interests: Authors declare that there is no competing interest.

Authors' contribution: HA: conceived the study, supervised data collection, and led the writing of the manuscript; SN: participated in interpretation of results and re-writing of earlier version of the manuscript; TK and JS carried out the analysis and revised the manuscript. All authors read and approved the final manuscript.

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