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Urogenital schistosomiasis among adult male population in an endemic area of southern Tanzania: a descriptive cross-sectional study

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ABSTRACT

Background Urogenital schistosomiasis (UGS) caused by *Schistosoma haematobium* is endemic in Southern Tanzania. The disease has significant implications for both socioeconomic and public health. Because infections with *S. haematobium* usually peak in childhood, the majority of studies have concentrated on school-aged children leaving other groups such as males which might be continuous reservoir of infection transmission. However, despite its chronic consequences in the male population, the disease has received insufficient attention, especially in sub-Saharan Africa. This study was conducted to describe the previous and current schistosomiasis status among adult males living in high-endemic areas of southern Tanzania

Design, setting and participants A descriptive cross-sectional study was employed to gather data on the prevalence of UGS among adult men residing at schistosomiasis endemic in the Mtama District Council. Quantitative methods of data collection which included questionnaire and laboratory procedures were used.

Results Out of 245 participants, macrohaematuria and microhaematuria were found in 12 (4.9%, 95% CI 2.4% to 7.8%) and 66 (26.9%, 95% CI 21.6% to 32.7%) participants, respectively. *S. haematobium* ova were recovered from the urine samples of 54 (22.0%, 95% CI 16.7% to 27.3%) participants. The median intensity of infection was 20 eggs per 10 mL of urine ranging from 1 to 201 eggs per 10 mL of urine (IQR) 60.5). Out of 245 participants 33 (13.5% 95% CI 9.0% to 17.6%) had light intensity of infection and 21 (38.9%, 95% CI; 25.0% to 52.5%) had heavy intensity of infection. Overall, the prevalence of heavy intensity of infection was 8.6% (95% CI 4.9% to 12.6%). The prevalence and intensity of UGS varied significantly by age, marital status and village of residence.

Conclusion This study sheds light on the prevalence of UGS among adult males in endemic areas of southern Tanzania. The results highlight the urgent need for comprehensive intervention strategies to address the burden of the disease.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study focuses on a specific endemic area in southern Tanzania, which allows for a targeted assessment of the disease in a region where it is known to be prevalent. This can aid in tailoring interventions and resources to the specific needs of the population.
⇒ This study did not include a multivariate analysis.
⇒ Participants might not accurately recall or report their exposure to water sources where schistosomiasis transmission occurs, and recall their past urogenital schistosomiasis (UGS) history. This could lead to underestimation and overestimation of the true prevalence and intensity of infection.
⇒ This study employed urine filtration and urine reagent strip methods. The lack of a third and highly sensitive diagnostic technique such as PCR to validate the results of the urine reagent strips and filtration could potentially lead to an underestimation of the true prevalence of UGS in the studied population.

INTRODUCTION

Schistosomiasis is a neglected parasitic disease caused by the trematode belonging to the genus *Schistosoma*. Globally, about 779 million people are at risk of acquiring infection, and more than 200 million are infected with more than 90% of all cases occurred in Africa.[1 2] Schistosomiasis affects poor people living in remote and rural areas with limited resources. In Tanzania, two *Schistosoma* species are of public importance, *Schistosoma haematobium*; the main causative agent of urogenital schistosomiasis (UGS) and *Schistosoma mansoni*, the main causative agent of intestinal schistosomiasis.[1 2] The groups at considerably high risk include preschool and school children, women of reproductive age and occupationally exposed adults such as farmers fishermen, irrigational workers and car washers.[1] Tanzania is ranked second to Nigeria for the countries with a high prevalence of schistosomiasis in Africa. More than 50% of Tanzanian population lives in risk areas. Schistosomiasis is widely distributed in the country, *S. haematobium* is distributed at

the far end of the southern shoreline of Lake Victoria and coastal belt, while endemic areas for *S. mansoni* are mostly focal and all regions are endemic with at least one of the two *Schistosoma* species; *S. mansoni* and *S. haematobium*.[3 4]

The WHO published a 2021–2030 road map for neglected tropical diseases (NTDs) targets including the elimination of schistosomiasis as a public health problem by 2030.[5] The WHO strategy to control and eliminate human schistosomiasis includes preventive chemotherapy of at-risk groups, access to improved drinking water, improved sanitation, hygiene education, environmental management and snail control.[6] In 2022, the WHO released a new schistosomiasis control guideline which provides evidence-based recommendations to countries in their efforts to accomplish schistosomiasis morbidity control and elimination as a public health problem and to move towards interruption of transmission.[1] In line to that Tanzania Strategic master plan for the NTDs control programme (July 2021–June 2026) has also the national goal of eliminating schistosomiasis as a public health problem defined as <1% proportion of heavy intensity schistosomiasis infections by 2030. Among the strategies that will be used by the Tanzanian government to achieve this goal include threatening at least 75% of high-risk adults to all councils proved to have high-risk adult population.[7]

The guidelines for control and elimination set forth by the WHO advocate for the broadening of eligibility for preventive chemotherapy to encompass individuals of all age groups, including children aged 2 years and above. This represents a departure from the previous recommendations, which had limited preventive chemotherapy to school-aged children. This limitation was based on their elevated rates of infection and disease-related morbidity. Additionally, the constrained worldwide availability of praziquantel necessitated a targeted approach, prioritising therapy for the most at-risk groups.[8] There is an increase in evidence that chronic morbidity occurs even in population with moderate or low prevalence of infection.[9–11] In addition to that, the other age groups were suggested to act as an untreated reservoir within at-risk communities, which contributes to community-level transmission and reinfection of school-aged children.[8 12 13] These, together with the increased global supply of praziquantel, the equity and feasibility, and the evidence supporting the cost-effectiveness of community-wide treatment have led to the recommendation of expansion of treatment eligibility to the entire community.[8]

To effectively implement these recommendations, the current schistosomiasis status among this and other targeted age groups must be understood. Several studies have been conducted to learn more about the prevalence of schistosomiasis infection among preschoolers,[3 14 15] school-aged children,[16 17] adolescents[18] and women of reproductive age.[15 19] Adult males are also among the age groups most vulnerable to schistosomiasis infection.[20] Their increased risk of contracting schistosomiasis is due, in part, to occupational exposures such as fishing, irrigation work and car washing that increased their level of water contact.[20] In males, schistosomiasis causes significant pathologies which include enlargement, fibrosis, shrinkage and calcification of epididymis, spermatic cord, testes and prostate.[21] The pathologies may result in an increased risk of HIV infection and glandular tumour near the prostate (adenocarcinoma) among infected males.[21 22] In addition, the pathologies were reported to result in sexual and reproductive health complications such as low backache, burning micturation, painful erection and ejaculation, weak erection or rapid (premature) ejaculation, azoospermia, oligospermia, diminished sexual libido, sex hormones imbalance, haematospermia and finally male infertility (both primary and secondary).[2 22]

When it comes to understanding and controlling schistosomiasis, adult males have been largely ignored. As a result, in many endemic areas, there is a scarcity of data on schistosomiasis prevalence and control among adult males. The current study was conducted to describe the previous and current schistosomiasis status among adult males living in high-endemic areas of southern Tanzania. By elucidating the epidemiological profile, this study seeks to provide valuable insights into the unique challenges faced by adult males in these regions. Recognising the critical need to shift the focus of schistosomiasis research towards adult males, acknowledging their significance in the socioeconomic fabric of endemic areas. Through this research, we aim to bridge the knowledge gap and pave the way for evidence-based interventions that prioritise the health and well-being of adult males in the fight against schistosomiasis

METHODOLOGY

Study area

This study was conducted at Mtama District Council from May to June 2022. Mtama District Council is one of the six district councils of the Lindi region in southern Tanzania. The district council is bordered to the north by Kilwa District Council, to the south by Mtwara region, to west by Nachingwea District Council and to the east by the Indian Ocean and Lindi Municipal Council. Mtama District Council has an area of 5975 km² with an approximate population of 194 143 where females are 102 496 and males are 91 647. The ethnic groups are Mwera, Makua, Matumbi and Ngido. The district experiences tropical climatic conditions characterised by an annual average rainfall of 910 mm and an average temperature of 26.3°C. The economic activities are agriculture, livestock keeping and fishing. Mtama District Council has irrigation schemes that are used for agriculture and other domestic activities. The area has also been reported to have a high prevalence of UGS. Recent studies conducted in the areas have reported UGS prevalence of 16.9% and 52.7% among preschoolers and school-aged children, respectively.[14 17]

Study design and population

A community-based quantitative cross-section study using quantitative methods of data collection was carried out between May and June 2022. This study is part of a large study that investigated genital schistosomiasis and its association with infertility among males of reproductive age in high-endemic areas of Lindi region, Tanzania. Study participants were adult males living in highly schistosomiasis endemic wards identified and selected based on the findings of previous studies or surveys conducted in the district council.

Sample size and sampling technique

The sample size for this study was calculated from a formula which was given by Daniel.[23] The study used the prevalence of 17.1% recorded among the population of adult males in the neighbouring country of Malawi,[24] a tolerated margin of error of 5% and an SD at 95% CI (1.96) to calculate the minimum sample size. The estimated sample size for this study was 245 after adjusting for a non-response rate of 10%. Three endemic villages were selected by simple random sampling. These were Nyengedi A, Mtua Longa and Mahumbika villages. The number of participants for each village was calculated based on the total number of adult males registered in each village. In each village, two community health workers (CHWs) were provided with training on the study protocol. Then, the CHWs were asked to visit each household in the village that had males who met our predefined criteria to invite them to participate in the study. The invited participants were further screened if they met the study eligibility criteria before being provided with detailed information about the study.

Eligibility criteria

The study includes male community members in the selected villages aged ≥18 years, willing to provide written informed consent, stayed at the village for at least 6 months and willing to give urine sample. Participants who were unable to give sociodemographic information and have received praziquantel treatment during the last 3 months were excluded from the study because they were more likely to have no schistosomiasis infection.

Data collection

Individual questionnaires

Interviewers were trained for 2-days prior the study to be familiar with the questionnaire. A structured questionnaire developed in English and then translated to Kiswahili was administered to all participants by the well-trained interviewer. The questionnaire was pretested to 10% of the sample size calculated in this study. The pretesting was conducted in different village from those selected during the study but within Lindi region. The pretested structured questionnaires were administered to study participants to collect data on sociodemographic characteristics and previous schistosomiasis experience.

Urine samples collection and analysis

All participants were provided with prelabeled urine containers and required to put about 50 mL of urine between 10.00 and 20.00 hours. The participants were asked to bring the urine sample at the prespecified centre where we set up our temporary laboratory for analysis. On arrival at the centre, the urine was first examined macroscopically for the presence of visible haematuria (macrohaematuria). Then urine dipstick (URIT Medical Electronic, No. D-07 Information Inductry District, High-Tech Zone, Guilin, Guangxi 541004, P.R China) was dipped in the urine to test for the presence of nonvisible blood (microhaematuria). The two procedures were then followed by urine filtration for the detection and quantification of *S. haematobium* eggs. Briefly, the polycarbonate filter was placed in a filter holder, and then the urine sample was shaken and mixed before drawing 10 mL into a syringe. The filter holder was then attached to the end of a 10 mL syringe, and the plunger of the syringe was pulled down to push all the urine through the filter to a bucket containing disinfectant. The syringe was detached from the filter unit, then unscrewed and with the use of tweezers the filter was removed and placed inverted, onto the glass microscope slide. One drop of Lugol's iodine was added to make eggs easily visible under the microscope. The slide was examined under a microscope using an ×40 objective. The eggs of *S. haematobium* were identified based on their characteristic large size and shape with a terminal spine. Infection loads were recorded as the number of eggs per 10 mL of urine. The intensity was established for all positive samples and was considered light when the number of eggs was <50 and heavy when they were ≥50.[25]

Patients and public involvement

Patients and/or the public were not involved in the conceptualisation, design, conduct, reporting or dissemination plans of this research.

Data analysis

Data were entered into IBM SPSS V.20 for analysis. Continuous variables were summarised by median and IQR, and categorical variables were summarised by frequency and percentage. The diagnostic tests performed were determined using sensitivity and specificity. The level of agreement between the standard method and screen tests was measured using the Cohan's kappa statistical test with the kappa (k) of ≤0.20 indicating poor, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 good, 0.81–0.99 very good and 1.0 perfect agreement.[26] The χ^2 or the Fisher's exact statistical tests were used to test for the significant differences among categories in each variable. The p values less than 0.05 were considered significantly different.

RESULTS

Participants' demographic characteristics

The study included 245 adult males with a median age of 32 years ranging from 18 to 84 years (IQR 25.5) (age was

Table 1 The demographic characteristics of study participants

Variables	Categories	No of participants	% (95%CI)
Age group	18–34 years	131	53.5 (47.3 to 59.6)
	35–49 years	60	24.5 (18.8 to 29.8)
	50–65 years	41	16.7 (12.7 to 22.0)
	>65 years	13	5.3 (2.9 to 8.2)
Marital status	Married	107	43.7 (38.0 to 49.8)
	Cohabiting	11	4.5 (2.0 to 7.3)
	In relationship	85	34.7 (29.0 to 40.0)
	Divorced/Widower	14	5.7 (3.3 to 9.0)
	Single	29	11.4 (7.8 to 15.5)
Education	Never	40	16.3 (11.8 to 21.2)
	Primary	164	66.9 (60.4 to 72.6)
	Secondary	40	16.3 (12.2 to 20.8)
	Postsecondary	1	0.4 (0/0 to 1.2)
Occupation	Peasants	184	75.1 (69.4 to 80.8)
	Petty business	26	10.6 (6.9 to 14.7)
	Other self-employment	22	9.0 (5.7 to 12.7)
	Employed	3	1.2 (0.0 to 2.4)
	None	10	4.1 (1.8 to 6.9)
Village	Mahumbika	64	26.1 (20.4 to 31.8)
	Mtua Longa	115	46.9 (40.4 to 53.5)
	Nyengedi A	66	26.9 (21.2 to 33.1)
Time stayed in the village	0.1–1 year	4	1.6 (0.4 to 3.3)
	2–5 years	11	4.5 (2.0 to 7.3)
	6–10 years	10	4.1 (2.0 to 6.5)
	Above 10 years	220	89.8 (86.1 to 93.5)

categorised according to Petry[27]). The median time of staying in the villages was 20 years ranging from 6 months to 74 years (IQR 20.0). About half (53.5%, 95% CI 47.3% to 59.6%) were young adults aged between 18 and 34 years (table 1). A high proportion of participants were married (43.7%, 95% CI 38.0% to 49.8%), attained primary level of education (66.9%, 95% CI 60.4% to 72.6%), were peasants (75.1%, 95% CI 69.4% to 80.8%), come from Mtua Longa village number (46.9%, 95% CI 40.4% to 53.5%) and have lived in the respective village for more than 10 years (89.8%, 95% CI 86.1% to 93.5%).

Prevalence and intensity of UGS

Out of 245 participants, macrohaematuria and microhaematuria were found in 12 (4.9%, 95% CI 2.4% to 7.8%) and 66 (26.9%, 95% CI 21.6% to 32.7%) participants, respectively. *S. haematobium* ova were recovered from the urine samples of 54 (22.0%, 95% CI 16.7% to 27.3%) participants. 70 participants (28.6%) were found positive with at least one of the three diagnostic methods. 11 participants were found positive with all of the 3 diagnostic methods while 40 participants were found positive by filtration and dipstick (microhaematuria) methods and 4 were found positive by urine filtration alone. 19 participants were found positive with only 1 of the 3 diagnostic methods, and 1 was positive with macrohaematuria alone (figure 1).

When compared with the filtration technique (the standard diagnostic tests for UGS), the sensitivity and

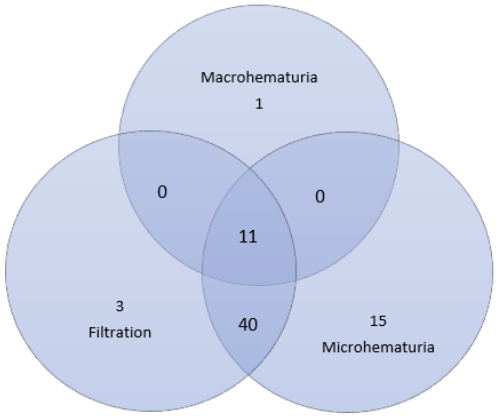

Figure 1 Venn diagram presents the number of participants diagnosed with urogenital schistosomiasis using the three diagnostic methods.

Table 2 Prevalence and intensity of urogenital schistosomiasis by demographic characteristics of participants

Variables	Tested, N	Eggs positive, n (%)	χ2 or Fisher's exact test	Intensity of infection		χ2 or Fisher's exact test
				Light, n (%)	Heavy, n (%)	
Age group						
18–34 years	131	37 (28.2)	χ2=7.6 P=0.048	21 (16.0)	16 (12.2)	Fisher's=11.3 P=0.049
35–49 years	60	10 (16.7)		5 (8.3)	5 (8.3)	
50–65 years	41	4 (9.8)		4 (9.8)	0 (0.0)	
>65 years	13	3 (23.1)		3 (23.1)	0 (0.0)	
Marital status						
Married	107	14 (13.1)	χ2=9.8 P=0.044	12 (11.1)	2 (1.9)	Fisher's=28.8 P<0.001
Cohabiting	11	3 (27.3)		2 (18.2)	1 (9.1)	
In relationship	85	4 (28.6)		7 (8.2)	16 (18.8)	
Divorced/widower	14	23 (27.1)		4 (28.6)	0 (0.0)	
Single	28	10 (35.7)		8 (28.6)	2 (7.1)	
Education						
Never attended	40	14 (35.0)	Fisher's=5.3 P=0.126	8 (20.0)	6 (15.0)	Fisher's=7.2 P=0.342
Primary	164	34 (20.7)		22 (13.4)	12 (7.3)	
Secondary	40	6 (15.0)		3 (7.5)	3 (7.5)	
Postsecondary	1	0 (0.0)		0 (0.0)	0 (0.0)	
Occupation						
Peasants	184	40 (21.7)	Fisher's=1.3 P=0.905	27 (14.7)	13 (7.1)	Fisher's=6.9 P=0.456
Petty business	26	5 (19.2)		3 (11.5)	2 (7.7)	
Other self employed	22	6 (27.3)		3 (13.6)	3 (13.6)	
Employed	3	1 (33.3)		0 (0.0)	1 (33.3)	
None	10	2 (20.0)		0 (0.0)	2 (20.0)	
Village						
Mahumbika	64	5 (7.8)	χ2=12.6 P=0.002	3 (4.7)	2 (3.1)	χ2=21.7 P<0.001
Mtua Longa	115	27 (23.5)		21 (18.3)	6 (5.2)	
Nyengedi A	66	22 (33.3)		9 (13.6)	13 (19.7)	
Time of stay in the respective village						
0.6–1 year	4	0 (0.0)	Fisher's=2.1 P=0.557	0 (0.0)	0 (0.0)	Fisher's=3.5 P=0.668
2–5 years	11	4 (36.4)		2 (18.2)	2 (18.2)	
6–10 years	10	2 (20.0)		2 (20.0)	0 (0.0)	
Above 10 years	220	48 (21.8)		29 (13.2)	19 (8.6)	

specificity of macrohaematuria were 20.4% (95% CI 10.63% to 33.53%) and 99.5% (95% CI 97.12% to 99.99%), respectively, while the sensitivity and specificity of microhaematuria were 94.4% and 92.1%, respectively. The macrohaematuria method showed fair agreement with the urine filtration method, k=0.275 (p<0.001) while microhaematuria method showed very good agreement with the filtration method, k=0.81 (p<0.001). The median intensity of infection was 20 eggs per 10 mL of urine ranging from 1 to 201 eggs per 10 mL of urine (IQR 60.5). Out of 245 participants 33 (13.5%, 95% CI 9.0% to 17.6%) had light intensity of infection and 21 (38.9%, 95% CI 25.0% to 52.5%) had heavy intensity of infection. The overall prevalence of heavy intensity of infection was 8.6% (95% CI 4.9% to 12.6%).

Table 2 shows the prevalence and intensity of UGS by participants' demographics. The prevalence and intensity of UGS varied significantly by age, marital status and village of residence. According to age, the prevalence of UGS was found to be 28.2% for those between the ages of 18 and 34, 16.7% for those between the ages of 35 and 49, 9.8% for those between the ages of 50 and 65, and 23.1% for those over the age of 65 (χ^2=7.6, p=0.048). Regarding marital status, participants who were single had a greater prevalence (35.7%), followed by those who were in a relationship (28.6%), cohabiting (27.3%), divorced and widowed (27.1%), and finally married (13.1%) (χ^2=9.8, p=0.044). Concerning village of residence, participants residing in Nyengedi A were found to have high prevalence of UGS (33.3%), followed by those residing in

Table 3 The history of participants' urogenital schistosomiasis infection

Variables	Categories	No of participants	% (95%CI)
Have you ever experienced UGS?	Yes	171	69.8 (64.1 to 75.5)
	No	74	30.2 (24.5 to 35.9)
How many times have you suffered from UGS?	None	74	30.2 (24.5 to 36.7)
	1–2	130	53.1 (46.5 to 59.6)
	3–4	31	12.7 (8.6 to 17.1)
	5+	10	4.1 (1.6 to 6.5)
When was your last urogenital schistosomiasis infection?	Now/currently sick	8	3.3 (1.2 to 5.7)
	Within 12 months	13	5.3 (2.9 to 8.2)
	More than 12 months ago	146	59.6 (53.5 to 66.1)
	I don't remember	4	1.6 (0.4 to 3.3)
	Never been infected	74	30.2 (24.5 to 36.3)
What schistosomiasis symptoms did you observe?	Blood in urine	24	9.8 (6.1 to 13.5)
	Dysuria	8	3.3 (1.2 to 5.7)
	Blood in urine and dysuria	43	17.6 (13.1 to 22.4)
	Blood in urine, dysuria and fever	46	18.8 (13.5 to 23.7)
	Blood in urine, dysuria and itching	9	3.7 (1.6 to 6.1)
	Blood in urine, stomach ache and dysuria	6	2.4 (0.8 to 4.5)
	I don't know	35	20.4 (15.5 to 28.1)
Did you seek for treatment?	Yes	161	65.7 (60.4 to 71.4)
	No	10	4.1 (1.6 to 6.5)
	Never got infected	74	30.2 (24.5 to 36.3)
Where did got treated?	Health facility	106	43.3 (36.7 to 49.8)
	Drug retailer shops	39	15.9 (11.8 to 20.4)
	School	8	3.3 (1.2 to 5.7)
	Traditional herbs	4	1.6 (0.4 to 3.7)
	I don't remember	4	1.6 (0.4 to 3.7)
	Not applicable	84	34.3 (27.8 to 40.4)

UGS, urogenital schistosomiasis.

Mtua Longa (23.0%) and Mahumbika (7.8%) (χ^2=12.6, p=0.002). The heavy intensity of UGS infection was higher among participants aged between 18 and 34 years (12.2%), in relationships (18.8%), and residing in Nyengedi A village (19.7%) (p<0.05).

Participants' history of UGS infection

The information on the participants' prior history of UGS infection and treatment seeking is summarised in table 3. Over half of the participants (69.8%, 95% CI 64.1% to 75.5%) reported ever experiencing UGS (based on symptoms and signs or diagnosis), and more than a third said they had experienced it once or twice. Eight (3.3%, 95% CI 1.2% to 5.7%) participants reported having schistosomiasis infection while taking part in the study. The most frequent symptoms indicated by more than half of individuals were dysuria and blood in the urine. However, 37 participants 20.4 (15.5–28.1) who had ever experienced UGS before said they had never seen or heard any of UGS symptoms. A total of 161 people (65.7%, 95% CI 38.4% to 51.0%) reported seeking treatment for UGS infection, and many of them (43.3%, 95% CI 36.7% to 49.8%) did so in health facilities such as hospitals, health centres or dispensaries.

Table 4 shows that the prevalence and intensity of UGS varied significantly by the number of previous UGS infections, the last time the participant reported having UGS infection and treatment-seeking behaviour. According to the number of prior UGS infections, it was discovered that the prevalence of UGS was 14.9% in those who reported never having the infection, 21.5% in those who reported having had it once or twice, 32.3% in those who reported having it three or four times and 50.0% in those who reported having it five times or more (χ^2=8.7, p=0.034). Regarding the most recent instance of UGS infection that a participant reported, those who reported having it at the time of study participation had the highest prevalence (87.5%), followed by those who reported having it within the previous year (30.8%), more than a year ago (21.9%), never having had it before (14.9%) and those

Table 4 Prevalence and intensity of urogenital schistosomiasis by the history of participants' urogenital schistosomiasis infection

Variables	Tested, N	Eggs positive, N (%)	χ2 or Fisher's exact test	Intensity of infection		χ2 or Fisher's exact test
				Light, n (%)	Heavy, n (%)	
Have you ever suffered from UGS?						
Yes	171	43 (25.1)	χ2=3.2 P=0.075	28 (16.4)	15 (8.8)	χ2=4,3 P=0.118
No	74	11 (14.9)		5 (6.8)	6 (8.1)	
How many times have you suffered from UGS?						
1–2	130	28 (21.5)	χ2=8.7 P=0.034	22 (16.9)	6 (4.6)	Fisher's=16.7 P=0.006
3–4	31	10 (32.3)		4 (12.9)	6 (19.4)	
5+	10	5 (50.0)		2 (20.0)	3 (30.0)	
None	74	11 (14.9)		5 (6.8)	6 (8.1)	
When was your last urogenital schistosomiasis infection?						
Now	8	7 (87.5)	Fisher's=18.8 P<0.001	4 (50.0)	3 (37.5)	Fisher's=21.7 P=0.002
Within 12 months	13	4 (30.8)		3 (23.1)	1 (7.7)	
More than 1 year ago	146	32 (21.9)		21 (14.4)	11 (7.5)	
I don't remember	4	0 (0.0)		0 (0.0)	0 (0.0)	
Never been infected	74	11 (14.9)		5 (6.8)	6 (8.1)	
What schistosomiasis symptoms did you observe/know?						
Blood in urine	24	6 (25.0)	Fisher's=2.2 P=0.916	4 (16.7)	2 (8.3)	Fisher's=6.7 P=0.867
Dysuria	8	3 (37.5)		3 (37.5)	0 (0.0)	
Blood in urine and dysuria	43	12 (27.9)		7 (16.3)	5 (11.6)	
Blood in urine, dysuria and fever	46	10 (21.7)		5 (10.9)	5 (10.9)	
Blood in urine, dysuria and itching	9	3 (33.3)		3 (33.3)	0 (0.0)	
Blood in urine, stomach ache and dysuria	6	1 (16.7)		1 (16.7)	0 (0.0)	
I don't know	35	7 (20.0)		10 (9.2) 5 (14.3)	9 (8.3) 2 (5.7)	
Did you seek for treatment?						
Yes	161	37 (23.0)	χ2=10.7 P=0.005	26 (16.1)	11 (6.8)	χ2=18.1 P=0.001
No	10	6 (60.0)		2 (20.0)	4 (40.0)	
Never got infected	74	11 (14.9)		5 (6.8)	6 (8.1)	
Where did got treated?						
Health facility	106	24 (22.6)	Fisher's=2.4 P=0.802	15 (14.2)	9 (8.5)	Fisher's=7.7 P=0.555
Drug retailer shops	39	11 (28.2)		9 (23.1)	2 (5.1)	
School	8	2 (25.0)		2 (25.0)	0 (0.0)	
Traditional herbs	4	0 (0.0)		0 (0.0)	0 (0.0)	
I don't remember	4	0 (0.0)		0 (0.0)	0 (0.0)	
Not applicable	84	17 (20.2)		7 (8.3)	10 (11.9)	

UGS, urogenital schistosomiasis.

who cannot recall the most recent instance (0.0%) (Fisher's=18.8, p 0.001). Participants who reported having UGS infection but never seeking treatment were found to have a high prevalence of UGS (60.0%), followed by participants who reported having UGS infection but seeking treatment (23.0%), and finally participants who reported having never had UGS infection (14.9%) (χ^2=10.7, p=0.005). Participants who reported having UGS more than five times (30.0%), reporting having UGS currently (37.5%) and reporting not seeking treatment for UGS despite being aware of having UGS (40.0%) had higher rates of heavy intensity of infection (p<0.05).

DISCUSSION

Many epidemiological studies on schistosomiasis have been conducted with school-aged children, preschool-aged children and the female population, but limited studies have focused only on male populations. This is the first study to assess the prevalence of UGS and the history

of infection among adult male ≥18 years in Southern Tanzania. The prevalence of UGS was 22.0% and this is slightly higher than expected because adults in endemic have average prevalence rates of less than 20.0%.[28] The findings of this study indicated that the prevalence of UGS among adult males in Mtama is higher than the recently 16.9% reported among preschool children[14] and lower than the 52.7% reported among school-going children in the same area.[17] The prevalence is also higher compared to another study conducted among women of reproductive age in Mbogwe district which is also endemic area, where they reported a prevalence of 4.5%.[29] The recorded high prevalence of UGS in this study group is due to the endemicity of the study area, ecological factors such as the presence of suitable snail hosts and warmer temperature and humidity and water contact activities as the study population were young and middle-aged men who spent most of their lives getting into repeated contact with water bodies. It can also be due to the absence of preventive chemotherapy programme targeting this group. The observed prevalence in this study was higher compared with the study from Malawi where the prevalence was 17.1%.[30] This adds to the growing need to include male in current schistosomiasis preventive chemotherapy.

The median intensity of infection (20 eggs per 10 mL of urine) was higher than that reported among adult male in Malawi.[24] The intensity of infection was defined as heavy (≥50 eggs per 10 mL urine) and light (≤50 eggs per 10 mL urine). The overall prevalence of heavy-intensity infections was 8.6%, this is much lower compared with 12.3% which was reported among adult male in Ghana.[31] The intensity of infection has been used as an indicator of the level of schistosomiasis morbidity, with people having heavy-intensity infections being more likely to have schistosomiasis morbidities. The WHO classifies schistosomiasis status of a population based on prevalence of heavy-intensity infection. Population with prevalence of heavy-intensity infections of less than 5% are classified as having controlled schistosomiasis morbidity while the population with prevalence of heavy-intensity infections of less than 1% has eliminated schistosomiasis as public health problem.[32] The WHO as well as Tanzania Ministry of Health target to eliminate schistosomiasis as a public health problem by 2030.[5 7] From our findings, the prevalence of heavy intensity of infections shows that Tanzania is far behind from eliminating schistosomiasis in this study population and area henceforth we should focus to control morbidity so that we can achieve the 2030 target for elimination.

The study's findings suggest that microhaematuria is a highly sensitive diagnostic method for urinary schistosomiasis, outperforming macrohaematuria, similar results have been reported among school-aged children in area with the same level of UGS endemicity (moderate).[33] However, for the specificity contrary, results have been reported for macrohaematuria and microhaematuria. The kappa agreement between microhaematuria and urine filtration technique in this study population was better than that reported among primary school children in Ethiopia[34] and similar to that reported among children below 18 years in Cote d'ivoire and Chad[35] this indicates the potential of microhaematuria as a reliable screening tool for detecting UGS in endemic regions. In this study, one participant was positive for macrohaematuria but negative for filtration and microhaematuria, this could be due to the red colour in blood which can be due to biochemical contents in the urine caused by drugs or foods.

With regard to demographics, the age-related prevalence of UGS has been shown to decrease as the age increases, peaking in young adults and old age. The high prevalence (28.2%) and heavy intensity (12.2%) of UGS infection among the age group of young adults (18–34 years) and participants who were single, may be due to high frequency of water contact activities especially economic activities compared with other age groups because this is the most active age group compared with others. This can also be due to some cultural practices that exclude older men from domestic activities and hence reduces chances of contacting infested water. Young adults are more likely to be single and the elderly are also more likely to be widower, therefore, these two groups attend themselves with domestic activities they do not get assistance with household chores compared with other age groups (middle-aged adults and adults) who are more likely to be married. This is similar in Ghana where younger adults (15–29 years) had a high prevalence than older counterparts due to the increased risk of fetching water in lake, washing, bathing and swimming.[31] A study from Cameroon[36] reported the same results where single women were twice as likely to be infected with *S. haematobium* than their married counterparts because marriage has positive impacts on the health outcomes of individuals. A high prevalence of UGS was reported among residents of Nyegedi A (33.3%), followed by those residing in Mtua Longa 23.5% and Mahumbika 7.8%, this is not consistent with the two studies conducted in Mtama[14 17] where Mtua Longa had the highest prevalence followed by Nyengedi A. This can be due to the fact that the identified hotspots for urogenital schistosomiasis transmission in the Nyengedi community are the Nyengedi River and rice paddy fields[17] since this study was conducted during May and June which is the heavy rainfall and rice plantation season hence high exposure rate to UGS among the study population.

Furthermore, those who never attended school had a high prevalence of infection and the prevalence decreases as education level increases. Although the difference is not statistically significant, education is supposed to contribute towards changes in behaviour regarding schistosomiasis transmission and prevention. Hence, there is a need for comprehensive health education including WASH in order to promote behaviour change. Those who reported to have suffered more than five times, had higher prevalence and heavy intensity of infections compared with their counterparts. Frequent UGS

episodes and infection positivity and intensity may be attributed to several factors. First, repeated exposure to contaminated water sources, where the parasite-carrying snails thrive, can lead to higher chances of infection. Individual activities which frequently engage them in activities such as bathing, fishing or farming in infested water. Additionally, weakened immune responses resulting from recurrent infections could render individuals more susceptible to subsequent infections.

Only eight participants had reported to having symptoms of infection during the time of the study, out of them seven were found positive by urine filtration. This indicates that those who were aware of their current status of infection had the knowledge of disease symptoms. However, the proportion of this group is low (12.9%) compared with all participants diagnosed with UGS during the study. This is confirmed by only 30.7% of all participants who had replied correctly on symptoms of schistosomiasis (table 3). Henceforth, comprehensive health education is required focusing on increasing awareness about UGS symptoms, transmission routes, and available diagnostic and treatment option.

Among those who claimed to not seek treatment, more than half of them had infection through confirmatory diagnostic tests. This study has exposed a hidden burden of untreated UGS infections within affected communities. This may be due to poor treatment-seeking behaviours among this study group due social and economic barriers, including limited healthcare access, lack of awareness about available treatments, and cultural beliefs and the implications for disease control efforts which mainly target school-aged children. This is similar to the study done by Mushi *et al*,[37] which found that the reasons for poor self-seeking health treatment were the cost of modern treatments while traditional treatments relieve the symptoms shortly and are less costly.

This study has the following limitations. The reliance on urine filtration and urine reagent strip methods only as diagnostic tools present inherent limitations that affect the precision of the findings during diagnosis. The lack of a third and highly sensitive diagnostic technique such as PCR to validate the results of the urine reagent strips and filtration could potentially lead to an underestimation of the true prevalence of UGS in the studied population, thus compromising the accuracy of the study's outcomes. Moreover, using cross-sectional data presents several limitations, notably in establishing causality between variables. While the study offers valuable insights into associations and correlations among different factors at a specific moment, they inherently lack the ability to establish the causality

CONCLUSION

Considering the prevalence and intensity of infection observed in the study area, it showed that UGS is still a disease of public health importance in Mtama with the young adults being more prone to the continuation of transmission of the infection and hence more at risk for chronic schistosomiasis infection and complications. The reasons why Mtama still has a high transmission for UGS among adult males may be due to factors such as environmental, behavioural and socioeconomic which continue to pose this study population with the continuous risk of infection. Therefore, these results support recommendations from the WHO to include all age groups including male adults in MDA campaigns, as these groups may represent reservoirs for the transmission of UGS within communities. Further studies may be conducted to design and implement interventions focused on health education and behavioural change among adult males. To evaluate the effectiveness of these interventions in reducing risky behaviours related to water contact and improving knowledge about schistosomiasis prevention.

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Ethics approval The study protocol was reviewed and approved by the Muhimbili University of Health and Allied Sciences Ethical Review Board (reference no. DA. 282/298/01.C/1048). Permission to conduct the study in the Mtama district was requested from the President's Office—Regional Administration and Local Government, the Regional Administrative Secretary of the Lindi region and District Executive Director of Mtama district. In the beginning, participants were given information about the study and potential risks and benefits involved. Their willingness to voluntarily participate in the study was sought and written informed consent was requested and documented. All participants were informed of their schistosomiasis testing results, and all Schistosoma-infected participants were offered free treatment (single 40 mg/kg dose of praziquantel).

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