Current Status of Urinary Schistosomiasis Among Communities in Kurmuk District, Western Ethiopia: Prevalence and Intensity of Infection

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ABSTRACT

BACKGROUND: Schistosomiasis is a highly prevalent but neglected tropical disease, particularly in sub-Saharan Africa. In Ethiopia, urogenital schistosomiasis due to *Schistosoma haematobium* has been known to be endemic in several lowland areas. This study was designed to determine the current prevalence and intensity of the urogenital schistosomiasis among communities in Kurmuk District, western Ethiopia.

METHODS: Urine filtration technique and urine dipstick test were used to screen for *S. haematobium* eggs and hematuria, respectively. The data were analyzed with SPSS version 23. Logistic regression and odds ratio were used to measure associations and strength between prevalence, intensity, and independent variables. *P*-values <.05 at 95% CI were considered statistically significant.

RESULTS: The overall prevalence of *S. haematobium* infection as determined by urine filtration was 34.2% (138/403). In bivariate analysis, the most infected (45.4%) age groups were 5 to 12 years (odds ratio [OR] = 4.16, 95% CI: 1.36-12.67), followed by 13 to 20 years (OR = 3.23, 95% CI: 1.01-10.35) with higher significant mean egg count (MEC). The mean egg intensity ranged from 2.39 in Ogendu (CI: 1.05-3.72) to 14.1 in Dulshatalo (CI: 4.98-23.12) villages. The main predictor of infection was swimming habits (adjusted odds ratio [AOR] = 2.43 [CI: 1.19-4.94]). The prevalence of hematuria was 39.2% (158/403), the odds being 2.64 times higher among participants who resided in Dulshatalo than those who resided in Kurmuk (AOR 2.64 [95% CI: 1.43-4.87], *P* = .004).

CONCLUSION: To reduce the infection and interrupt transmission, the PC in place in the area using PZQ should be strengthened and continued, alongside with provision of sanitary facilities, safe alternative water supplies and health education. The Federal Ministry of Health of Ethiopia should also collaborate with the health authorities of the Sudan government for the control of trans-boundary transmission of the disease as the transmission foci are shared between the 2 countries.

KEYWORDS: Urinary schistosomiasis, prevalence, intensity, Kurmuk district, Ethiopia

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Introduction

Schistosomiasis is a highly prevalent and important neglected tropical disease in sub-Saharan Africa, the main burden of the disease being attributed to *Schistosoma mansoni* and *S. haematobium*.[1,2] *S. haematobium* is transmitted by freshwater snail species belonging to the genus *Bulinus*, which contains around 36 species within 4 species groups.[3]

Disease outcome in persons infected with *S. haematobium* varies dramatically, ranging from mild to severe damage of the kidneys and/or bladder.[4,5] The characteristic clinical presentation is terminal hematuria, usually associated with increased frequency of micturition and dysuria.[6] The pathology of urinary schistosomiasis is primarily caused by the eggs laid by female *S. haematobium* adult worm residing in the venous plexus of the bladder and other pelvic organs. On their way to exiting the body through the urinary stream, eggs transit through the bladder mucosal tissue *cause* substantial damage and initiate granulomatous inflammation that can progress over many years to complications including fibrosis and bladder cancer.[7-9]

Genital schistosomiasis is also common in areas endemic for urinary schistosomiasis in both females and males. Females are more prone to the disease and may result in serious complications including ectopic pregnancy and infertility[3,10] and this complication develops in 33% to 75% of infected females.[11] In addition, female genital schistosomiasis is suggested as a risk factor for HIV transmission.[10,12] There are also indications that cervical schistosomiasis lesions could become cofactors for HPV-cervical cancer.[7,13,14]

Urogenital schistosomiasis has been known to be endemic in several lower altitude areas of Ethiopia: in Afar, Gambella,

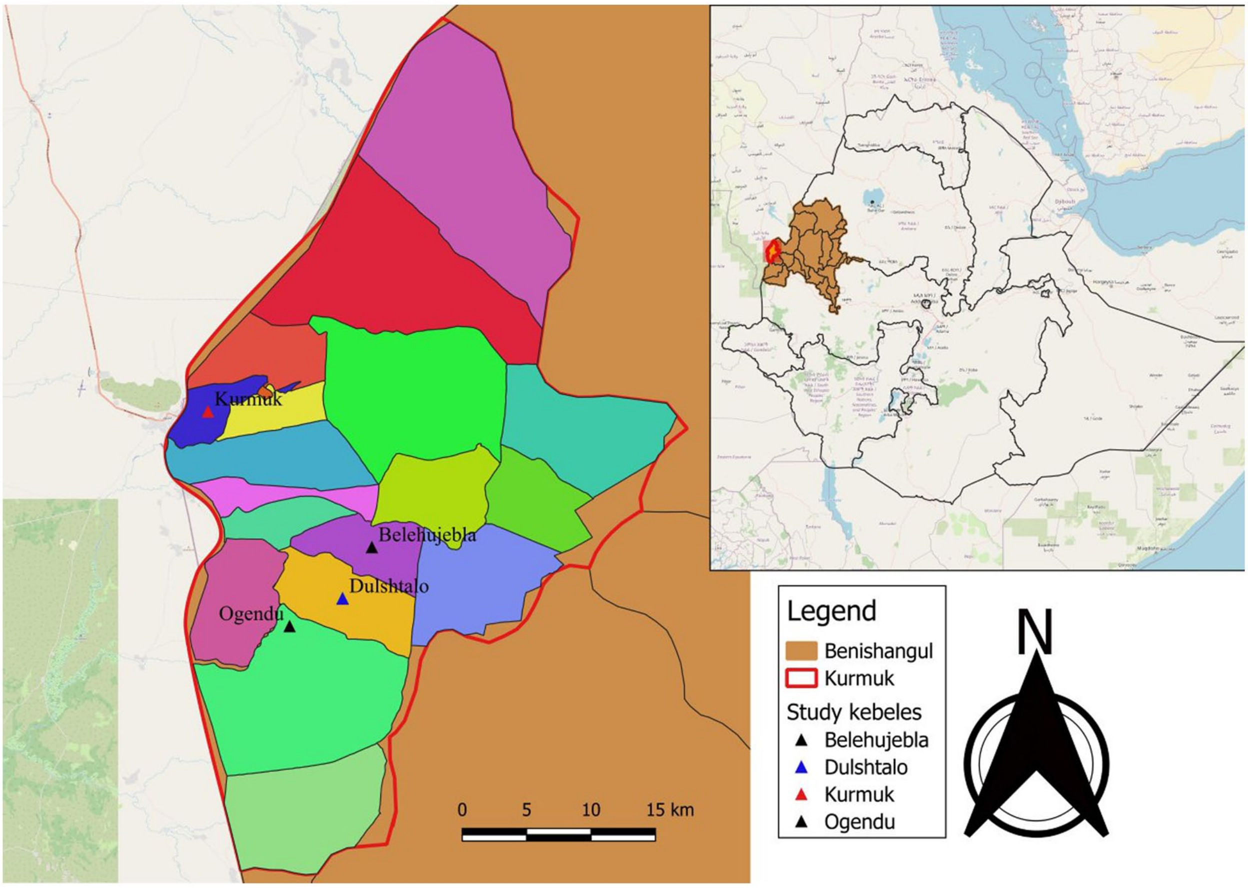

Figure 1. Map of Kurmuk District, western Ethiopia, showing the study sites.

Somalia, and Benishangul Gumz Regional States and the most affected groups are school-age children.[15-20] Few studies among school children also particularly showed endemicity of the disease in the Kurmuk area, with a prevalence ranging from 5.8% to 57.8%.[21,22] Though deworming/Preventive chemotherapy (PC) started in 2015 and was distributed for 4 years (2015-2019) in those areas, the disease remained prevalent.[15] No community-based studies have been conducted to determine the magnitude of the disease in Kurmuk area, recently. The present cross-sectional study was, therefore, conducted to determine the prevalence and infection intensities of *S. haematobium* among school-age children, adolescents, and adults in Kurmuk District, western Ethiopia.

Materials and Methods

Study area and population

The study was conducted in 4 villages in the Kurmuk District, on the Ethio-Sudan border, in western Ethiopia. Kurmuk is 1 of the 7 districts of the Assosa Zone, Benishangul Gumuz Regional State, and is located 762 km west of Addis Ababa (Figure 1). The district is bordered by Menge District in the east, Sudan, and South Sudan in the west, Sherkolle District in the north, and Komosha District in the southeast. The climatic conditions of the district are arid and semi-arid desert with 1000 to 1500 mm annual rainfall and 28°C to 42°C temperatures. Its altitude ranges from 650 to 1337 m above sea level. According to 2020 local health office demographic data, the population of the Kurmuk District was 24 346, of whom 12 051 were males and 12 295 were females and the total population in the 4 study villages was approximately 6378. The major income activities of the population are traditional gold mining, trade, and agriculture. Seasonal streams and dams are open water bodies that people mostly rely on for domestic use and occupational *activities* (Figure 1).

Study design and period

A community-based, cross-sectional study was applied in September 2021, in 4 villages that are endemic for urogenital schistosomiasis in the Kurmuk District, western Ethiopia.

Sample size determination

Sample size determination for study estimating population prevalence was calculated by using the following formula, $n = (Z\ \alpha½)^2\ p(1-p)/d^2$, where n = sample size, Z: alpha risk expressed in z-score, P = expected prevalence, and d = absolute precision.[23] In calculating the sample size, a 95% confidence interval and margin of error (d) of 5% and an expected prevalence of 50% were considered as a recent population-based study was not conducted. After the calculation, the sample size was found to be 384 and with a 5% non-respondent rate the final sample size became 403.

Sampling techniques

Dulshatalo, Belehu-jibla, Ogendu, and Kurmuk villages were purposively sampled based on schistosomiasis endemicity in the area[21,22] and after doing a consultation with the District Public Health Officer. The simple random sampling procedure used for participant enrollment is proportionate to their sizes of households. Aged 5 to 90 years who gave consent, had met the inclusion criteria. Children younger than 5 years old and those who were not willing to participate were excluded from the study. Dulshatalo village with the highest number of households had the highest number of study participants followed by Beleho-jibla, Ogendu, and Kurmuk.

Urine sample collection and analysis

Prior to the start of the sample collection, an announcement for the community about urine examination were done by *kebele* officers (local authorities), health extension worker and by instructors. Then the following days, first, socio-demographic information, and water contact behavior data were collected from study participants using a structured format with the help of health extension workers, who know the local language. Then at the end of the interview, the participants brought urine samples between 10:00 am and 2:00 pm, and to increase, the suspicion of infection with *S. haematobium*, the presence of blood in the urine was tested by using urinalysis reagent strips (LABOQUICK Urine Testing Strips, 10 Parameter Urinalysis Test Strips, Turkey). After that, the sample was preserved using formalin (0.1 ml for 10 ml of urine) and transported to Aklilu Lemma Institute of Pathobiology (ALIPB) laboratory for microscopic examination using syringe filtration technique, since the presence of egg in urine is a gold standard diagnosis. The presence, level and intensity were also determined per 10 ml of urine and categorized as light (⩽50 egg) and heavy infections (⩾50 egg).[24]

Data analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) software version 23.0. The summary of each variable and prevalence were done by Descriptive statistics. To estimate the association of socio-demographic characteristics and open water contact behavior like swimming/playing and washing clothes, with the prevalence, intensity of *S. haematobium* infection, and hematuria, logistic regression analysis was done. Odds ratio with 95% CI were used to measure the strength of association between variables. Two-tailed Mann-Whitney *U* test, Kruskal-Wallis test, were used to analyze the difference in mean egg count among groups. *P*-values <.05 were considered statistically significant. A fourfold table was used to evaluate the positive predictive value of urine dipstick strips and agreement between the 2 diagnostic tests (microscopic examination and urine dipstick test results) was determined using Kappa statistic.

Results

Socio-demographic characteristics

A total of 403 participants, older than 5 years were enrolled in this study. Among the participants, 296 (73.4%) were males, and 107 (26.6%) were females. The majority of them were Berta by ethnicity (71.7) followed by Amhara (13.6%) and Oromo (10.2%), also most of the participants were students (62.3%) by occupation (Table 1).

Prevalence and associated factors

The overall prevalence of *S. haematobium* infection by urine filtration technique was 34.2% (138/403), ranging from 27.8% in Kurmuk to 43% in Dulshatalo village (COR = 1.95, 95% CI: 1.06-3.59).

In bivariate analysis, the most affected (45.4%) age groups were 5 to 12 years (COR = 4.16, 95% CI: 1.36-12.67) followed by 13 to 20 years (COR = 3.23, 95% CI: 1.01-10.35) out of 4 individuals that were positive in age group ⩾45, only one individual was positive over the age of 53. Moreover, the odds of infection increased among students and those who washed clothes in river water.

In multivariable analysis, participants who had swimming/playing habits in open water were 2 times more likely to be infected than those who do not have open water contact activities (AOR –2.43, 95% CI: 1.19-4.94, *P* = .014).

The prevalence of the infection was comparable between male (33.1%) and female participants ([37.4%] [*P* = .092; AOR –1.48, 95% CI: 0. 89-2.46]) (Table 1).

Intensity of schistosoma haematobium infection

The mean egg count (MEC) of the study participants was 7.33 (95% CI: 4.35-10.31) with 30.45 standard deviation (SD), in 10 ml of urine. From 138 *S. haematobium* infected participants, 89.1% had a light infection and only 10.9% of them had a heavy infection. The minimum and a maximum number of eggs per 10 ml of urine were 1 and 500, respectively. Those who have swimming habit had a significant (*P* ⩽ .005) heavy infection compared to the participants with no swimming habit, who scored zero in heavy infection categories (⩾50 egg/ml).

There is a statistically significant MEC difference between villages (*P* = .028), ranging from 2.39 CI; 1.05 to 3.72 (in Ogendu) to 14.1, CI: 4.98 to 23.12 (in Dulshatalo) villages. According to age group, the highest MEC was seen in the 5 to 12 year age group, followed by 13 to 20 years (*P* ⩽ .001).

Table 1. Urogenital schistosomiasis and its association with demographic and water contact behavior among participants, Kurmuk district, Ethiopia, 2021.

VARIABLES	TOTAL PARTICIPANTS	POSITIVE (%)	COR (95% CI)	AOR (95% CI)
	403	138 (34.2)		
Sex				
Female	107	40 (37.4)	1.21 (0.76-1.91)	1.48 (0.89-2.46)
Male	296	98 (33.1)	1	
Age (y)				
5-12	174	79 (45.4)	4.16 (1.36-12.67)*	1.07 (0.59-1.94)
13-20	79	31 (39.2)	3.23 (1.01-10.35)*	0.59 (0.24-1.46)
21-28	72	13 (18.3)	1.10 (0. 32-3.77)	0.81 (0.27-2.39)
29-36	36	8 (22.2)	1.43 (0. 38-5.40)	0.44 (0.10-1.85)
37-44	18	3 (16.7)	1.00 (0. 19-5.15)	0.56 (0.16-1.97)
⩾45	24	4 (16.7)	1	
Villages				
Ogendu	87	26 (29.9)	1.10 (0.56-2.16)	1.02 (0.49-2.10)
Belehu-jebla	116	38 (32.8)	1.26 (0.68-2.36)	1.20 (0.61-2.38)
DulShatalo	121	52 (43)	1.95 (1.06-3.59)*	1.84 (0.96-3.52)
Kurmuk	79	22 (27.8)	1	
Occupation				
Student	251	110 (43.8)	11.70 (1.52-89.96)*	6.63 (0.75-58.84)
Farmer	71	10 (14.1)	2.46 (0.29-20.73)	2.24 (0.25-20.01)
Daily laborer	25	9 (36.0)	8.44 (0.95-74.85)	6.41 (0.71-57.84)
Merchant	22	5 (22.7)	4.41 (0.46-42.13)	3.23 (0.32-32.38)
Unemployed	18	3 (16.7)	3.00 (0.28-32.21)	1.99 (0.17-22.98)
Government employed	16	1 (6.3)	1	
Swimming				
Yes	247	110 (44.5)	3.67 (2.27-5.93)*	2.43 (1.19-4.94)*
No	156	28 (17.9)	1	
Washing clothes				
Yes	333	122 (36.6)	1.95 (1.07-3.56)*	1.05 (0.51-2.17)
No	70	16 (22.9)	1	

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio.
*Significant association.

In addition, mean egg count is significantly different across occupation, swimming, and washing habits. On the other hand, MEC and level of intensity were comparable among females 9.98 (CI: 0.38-19.59) and males 6.38 (CI: 4.21-8.54) (Table 2).

Hematuria

The prevalence of hematuria using urine dipstick test was 39.2% (158/403). The prevalence of *S. haematobium* infection based on the urine dipstick test was associated with village ($P \leqslant .05\%$).

Table 2. Intensity of *Schistosoma haematobium* infection and its association with demographic and water contact behavior among participants, Kurmuk district, Ethiopia, 2021.

VARIABLES	INTENSITY OF INFECTION		*P*-VALUE*	MEC	*P*-VALUE**
	1-49 EGG (N)	⩾50 EGG (N)			
Sex					
Male	86	11	.10	6.38	.492[a]
Female	36	4		9.98	
Age					
5-12	71	8	.59	11.47	.000[b]
13-20	25	6		7.76	
21-28	12	1		2.61	
29-36	8	0		1.67	
37-44	2	0		0.39	
⩾45	4	0		3.83	
Occupation					
Student	95	15	.098	10.76	.000[b]
Farmer	9	0		0.46	
Government employees	1	0		2.63	
Daily laborer	9	0		4.68	
Unemployed	3	0		2.89	
Merchant	5	0		0.41	
Villages					
Ogendu	25	1	.379	2.39	.034[b]
DulShatalo	45	7		14.90	
Belehu-jebla	32	5		4.97	
Kurmuk	20	2		5.96	
Swimming					
Yes	97	13	.019	10.78	.000[a]
No	27	0		1.88	
Washing clothes					
Yes	109	12	.940	6.85	.036[a]
No	15	1		9.64	

**P*-value: adjusted for age, sex, villages, occupation, and swimming and washing habits: results are generated from 1 multinomial logistic regression model.
***P*-value: determined by [a]Two-tailed Mann-Whitney *U* test, [b]Kruskal-Wallis test.

The odds of hematuria were 2.64 times higher among participants who resided in Dulshatalo than those who resided in Kurmuk (AOR 2.64, 95% CI [1.43-4.87], $P = .004$). Hematuria was not significantly different among males and females and as well among different age groups.

There was a significant association between hematuria and the presence of schistosome eggs in urine ($P = .000$). From those in whom urine egg of *S. haematobium* was detected, 108 of them had hematuria, thus resulting in 68.4% positive predictive value with 78.3% sensitivity and 81.1% specificity

Table 3. Prevalence of hematuria and its association with demographic and water contact behavior among participants, Kurmuk district, Ethiopia, 2021.

	POSITIVE CASES BY DIPSTICK	PREVALENCE (%)	*COR* (95% CI)	*AOR* (95% CI)
Sex				
Male	114	38.5	1.12 (0.71-1.75)	0.79 (0.49-1.28)
Female	44	41.1	1	1
Age group (y)				
5-12	74	42.5	1.48 (0.60-3.64)	0.56 (0.19-1.67)
13-20	38	48.1	1.85 (0.71-4.83)	1.00 (0.35-2.86)
21-28	21	29.2	0.82 (0.31-2.22)	0.78 (0.28-2.19)
29-36	11	30.6	0.88 (0.29-2.66)	1.07 (0.34-3.41)
37-44	6	33.3	1.00 (0.27-3.66)	0.87 (0.22-3.48)
⩾45	8	33.3	1	1
Villages				
Ogendu	30	34.5	0.96 (0.50-1.81)	0.99 (0.51-1.92)
Belehu-jebla	32	27.6	0.69 (0.38-1.28)	0.68 (0.36-1.31)
DulShatalo	68	56.2	2.34 (01.30-4.19)*	2.64 (1.43-4.87)*
Kurmuk	28	35.4	1	1
Occupation				
Student	113	45.0	1.80 (0.61-5.34)	1.87 (0.51-6.92)
Farmer	19	26.8	0.80 (0.25-2.62)	0.61 (0.17-2.19)
Daily laborer	11	44.0	1.73 (0.46-6.47)	1.34 (0.35-5.15)
Merchant	5	22.7	0.65 (0.15-2.77)	0.52 (0.11-2.40)
Unemployed	5	27.8	0.85 (0.19-3.71)	0.59 (0.12-2.94)
Government employed	5	31.3	1	1
Swimming				
Yes	114	46.2	2.18 (1.42-3.35)*	2.79 (1.43-5.45)*
No	44	28.2		
Washing clothes				
Yes	131	39.3	1.039 (0.61-1.75)	0.61 (0.32-1.17)
No	27	38.6	1	1

*P-value ⩽.05: AOR: adjusted for age, sex, villages, occupation status, swimming, and washing habit; results are generated from bivariate and multivariable logistic regression model.

(Table 3). Moreover, the agreement between the 2 methods in diagnosing the participants for the presence of hematuria and *S. haematobium* egg was moderate (Kappa = .57).[25]

Discussion

Population-based studies provide an overview of the pattern of schistosomiasis across age groups and prevalence and intensity of infection could indirectly estimate the morbidity, which is vital for decision about treatment strategies for schistosomiasis and to evaluate the effectiveness of mass drug administration. In this study, the overall prevalence of *Schistosoma haematobium* infection based on urine filtration was 34.2%, and the proportion of infection increased in children (45.4%) and adolescents (39.2%). The mean intensity of infection was 7.33 (SD-30.5), ranging from 2.39 to 14.1/10 ml of urine in the different study sites displaying the spatial heterogeneity that is, common for schistosomiasis.

The majority of *S. haematobium* infection was classified as light infection, which is in agreement with studies reported from different parts of Ethiopia[15-18] and the Sudan.[26] The overall prevalence rate of *S. haematobium* infection found in this study is higher than the studies done on school-age children in different parts of Ethiopia: Horzehab, Beshir, Kurmuk, Amenzibeni village of Benishangul Gumuz Regional State,[16] in Afdera Gode zones of Somali National Regional State (16.0%),[17] in the Middle and Lower Awash Valley (20.8%)[15] and Amibera District, Afar Regional State (7.4%),[27] and lower than in Gambella Regional State (35.9%)[18] and in Hassoba village, in Afar area (47.6%)[19] of Ethiopia. The prevalence is also higher than those observed elsewhere[28] across all age groups. This difference can be attributed to a variety of factors, including participant's age and environmental setting difference, population density, and WASH facilities and practices.

The prevalence of *S. haematobium* infection found in Dulshatalo (43%) is lower than the prevalence (57.8%) in 2007in this village[21] but the mean egg intensity is somehow related, 14.90 for 15.32, respectively. In addition, the prevalence of *S. haematobium* infection increased more than 4 times in Kurmuk town (27.8%), compared with the results of the study done in 1996[22] with a 5.8% prevalence. This indicates that the prevalence of *S. haematobium* infection remained high in these 2 villages, though mass drug administration had been implemented for 3-round in 2015, 2017, and 2019.[20] Since, the villages are located on the Ethio-Sudan border, trans-boundary transmission of schistosomiasis likely occurs. In addition, the higher level of dependence and exposure of the inhabitants on Shamade, Dinchaba river, and a dam (the nearest open water sources in the villages) for their domestic uses (bathing and washing clothes) and the means of their most livelihood depends on traditional gold washing in the river, which might result in infection and re-infection to continue in the area in spite of repeated PC.

The most affected age group by urogenital schistosomiasis in this study were children and adolescents, though in multivariable analysis after adjusting for socio-demographics and open water contact practice it becomes insignificant, which contradicts with a population study done in Tanzania[28] which remained significant after adjusting for confounders. The possible reason could be sample size and independent variable differences in the studies.

Infection with *S. haematobium* and mean egg intensity were statistically higher in those participants that swim/play in open water. On the contrary, despite the high prevalence and a significant mean egg intensity among participants that have washing clothes habit in open water, it is not a key significant predictor of schistosomiasis, in this study. This might be explained by the fact that detergent use and less skin exposure to the water while washing could be the reason for the difference, as described by other authors.[29,30]

In this study, sexes have a comparable association with *S. haematobium* infection and intensity, this is in agreement with the previous study in Dulshatalo (One of the villages where the present study was conducted) and with other previous studies[16,27,28,31,32] that reported similar prevalence rates for both genders. There are also studies reporting an increase in the prevalence in males than females[17,18,33] and in females than males.[34,35] Indeed, Females tend to have more frequent water contact either because of cultural beliefs or occupational reasons. Traditional gold mining was more of women's work in the area and housework and taking care of their younger siblings at home covered by their daughters (younger girls), this also resulted in *less* number of female participants in this study. But irrespective of this, the highest proportion of prevalence and mean egg intensity was observed in female than male participants.

The agreement between the findings of *S. haematobium* eggs in urine and hematuria detected by reagent strips, and their significant association is in accordance with other studies[16,22,29,36-38] this finding might further strengthen the recommendation that urine dipstick test is a legitimate for *S. haematobium* diagnosis tool at the community level.[39]

In the current study, a microscopic examination was done using a single urine filtration collected on a single day urine, which might reduce the sensitivity of detecting light infection and result in lower all-over prevalence. Another limitation of the present study is, although some of the risk and environmental factors are considered here, we could not be able to collect intermediate hosts because the study was conducted in the rainy season when snails would be flashed out of their habitats. Hence, the results should be interpreted with caution.

Conclusion

The present study confirms that urogenital schistosomiasis is prevalent in Kurmuk District with children and adolescents bearing a heavier burden of the disease. Even if preventive treatment with praziquantel is applied in the district for school-age children, expansion of treatment for other age groups and risk populations is also necessary to reduce the burden of the disease. In addition, construction of clean water sources and sanitary facilities and availing diagnostic tools in health centers will sustain a low parasite load and low prevalence of schistosomiasis in the area. The Federal Ministry of Health of Ethiopia should also collaborate with the health authorities of the Sudan government for the control of trans-boundary transmission of the disease as the transmission foci are shared between the 2 countries.

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Author Contributions

TM, BE, WE, and MA conceived and designed the study. TM and YG carried out sample collection and laboratory investigation. TM analyzed the data and wrote the first draft, all authors read and approved the final version of the manuscript.

Availability of Data and Materials

The corresponding author will provide the dataset used in the current study upon reasonable request.

Ethical Approval and Consent to Participate

The protocol of the study was reviewed and ethically approved (Ref No: ALIPB IRB/13/2019/20) by the Institutional Review Board (IRB) of Aklilu Lemma Institute of Pathobiology, Addis Ababa University and the methods used to collect the presented data followed the recommended standard operating procedures and the study was conducted according to Helsinki recommendation. Permission to conduct the study was gotten from the regional, the head of the district Health Offices and from local authority of the villages. Participants were informed about the objective of the study and written and verbal informed consent was obtained from the participants. For participants under age 16 informed consent and assent for children younger than 12 years of age were obtained from a parent and/or legal guardian. Participants who were positive for urogenital schistosomiasis were treated with praziquantel (at 40 mg/kg body weight).

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