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Distribution Pattern of Human Urinary Schistosomiasis in Kwara State, Nigeria

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Abstract: Human urinary schistosomiasis is a severe parasitic infectious disease in many rural communities in tropical Africa. The status of infection in Kwara State is inadequately documented. We, therefore, investigated distribution pattern of infection amongst school-aged children in the three Senatorial Districts of the state. Of 3757 urine samples examined, 670 (17.8%) were infected with 8.9% in Central, 13.5% in South and 28.7% in the North Senatorial districts. The overall geometric mean intensity and mean population egg load were 347.3 and 61.9 eggs per 10 mL urine respectively. Generally, infection is age and sex dependent ($p<0.05$). Males had significantly higher prevalence and intensity of infections than the female (20.6%, 361 eggs/10 mL of urine vs. 14.3%, 340 eggs/10 mL of urine; $p<0.0001$). A high eggcounts of 412.25 eggs/10 mL urine was recorded among 16-20 years age group in Kwara central. In this study, 27.2 and 10.7% were moderately and heavily infected respectively. There is a significant association between intensity of infection and prevalence of haematuria and proteinuria among the infected population ($p<0.0001$). Our findings show that urinary schistosomiasis is endemic among kwaran schoolchildren and further study is recommended to reveal the essentials attributable risk factors of infection in the endemic communities.

Keywords: *Schistosoma haematobium*, Kwara State, Districts, Haematuria, Proteinuria

Introduction

Human urinary schistosomiasis is a water-dependent urogenital disease caused by the blood flukes (*Schistosoma haematobium*), acquired from freshwater bodies containing infected intermediate snail hosts, *Bulinus* species. The disease is of a major public health significance in many resource-constrained communities in sub-Saharan Africa (Adenowo *et al*., 2015; Birma *et al*., 2017; Houmsou *et al*., 2016). It is ranked second to malaria with regard to its prevalence and population at risk. Global estimate shows that approximately 230 million people are infected, with annual loss of 1.7-4.5 million Disability Adjusted Life Years (DALYs) (Boko *et al*., 2016; Colley *et al*., 2014; Njunda *et al*., 2017).

Transmission of urinary schistosomiasis is dependent on a wide range of socio-cultural and environmental factors including water developmental projects such as dam construction and irrigation schemes (Jamison *et al*., 2006). Haematuria is a classical symptom of human urogenital schistosomiasis and egg-induced inflammatory responses are characterised by T-helper-2 lymphocytes and other polymorphonuclear leukocytes (Grimes *et al*., 2014). Other severe pathological conditions include fibrosis of the bladder and urethral, hydronephrosis and possibly bladder cancer (Mostafa *et al*., 1999).

In endemic settings, chronic infection is common due to repeated exposure to infective stage, cercaria. Studies in many endemic regions have identified schoolchildren and young adults as the most susceptible groups. Eggs excretion reached a peak at this age group and decreased to relatively low levels in adulthood (Adenowo *et al*., 2015; Colley *et al*., 2014). In Nigeria, urinary schistosomiasis is widespread in the poor and marginalized communities, with varying prevalences, in all the cardinal zones of the country (Engels *et al*., 2002; Omonijo *et al*., 2013; Ugbomoiko *et al*., 2010) apart from the earlier studies

(Bello and Edungbola, 1992; Edungbola *et al*., 1988) in some selected locations in old Kwara State, information on the epidemiology of the disese is limited in our study area. Adequate data on the currenrt infection status are necessary for the planning and implementation of control strategies. This study is therefore conducted to bridge the gap on the current status of urinary schistosomiasis among the schoolchildren in Kwara State, North central Nigeria.

Materials and Methods

Study Area and Population

The study was carried out in Kwara state (8° and 10°N latitudes and 3° and 6° E longitudes), with a total land mass of 32,500 km^2. Kwara State comprises of 16 administrative local government areas in three distinct senatorial (north, central and south) zones. The climate is tropical, with an annual rainfall range of 1000-1.500 mm and average maximum temperature of 30-35°C but the natural vegetation is a derived savannah in the North and rain forest in the South. Generally, the sanitation condition in many of our study locations is precarious. Besides, portable water supply, electricity and toilet facilities were inadequately. During the dry months (November to April) inhabitants depend predominantly on natural water from the stream or pond for their household use.

Preliminary school-to-school visits were made to recruit schoolchildren of ≤20 years in the three randomly selected communities in each of the 16 local government areas. All volunteers were enlisted except the menstrating females and individuals who had stayed for less than 3 months in the community. Approximately 2985 school children, across the three senatorial districts of the state, were estimated to be sufficient for the investigation considering 80% power at 95% confident interval.

Data collection and Processing

Informed consent was obtained from the parents through Parent Teacher Association (PTA), community leaders and State Ministry of Health and Education after thorough explanation of the research protocol. All the consented schoolchildren were trained on how to handle urine sample before pre-labelled, wide-mouthed, screw-capped plastic containers were given to obtain their full bladder mid-day urine. At the point of submission of the urine sample, individual bio-data were obtained and the microhaematuria and proteinuria were immediately assessed using commercial reagent strips (Medi-test Combur-9; Analytic on Biotechnologies, Lichtenfels, Germany). Thereafter, the samples were transported to laboratory at the Department of Bioscience and Biotechnology, Kwara State University, Malate for the parasitological examination of *S. haematobium* ova. A 10 mL of each urine sample was filtered through a 12 μm polycarbonate filter (Millipore) and examined on ×100 light compound microscope. Intensity of infection was classified as heavy (>500 eggs/10 mL), moderate (51-499 eggs/10 mL) or light (50 eggs/10 mL) according to the guidelines of World Health Organisation. Randomly selected samples in each district were examined by an independent team of parasitologists for the purpose of quality control.

Ethical Considerations

The study protocol was approved by the University of Ilorin Research and Ethical Committee (Ref. No. UERC/ASN/2014/011), the Joint committee of Kwara State Ministry of Health and Education (Ref. No. MOH/KS/ECI/777/58) and the ad-hoc ethical committee of each Local-Government Authorities before the commencement of the study. Also, informed written consent was obtained from each volunteer and/or the caregivers before the subjects were enrolled in the study.

Statistical Analysis

Statistical analysis was performed using IBM.SPSS 21.0 (International Business Machine-Statistical Package for Social Sciences) and R Core Team (R Version 3.2.2-2015). Prevalence of infection and comparison of proportions with respect to sex and age of the participants were determined by Chi-square and proportional test. Differences between means were tested using independent samples t-test and one way ANOVA. Analysis of geometric egg counts was based on the infected individual in the population while mean population egg density was estimated as the burden of the infection in the investigated population. Comparisons across groups were done using Fisher's exact test and p values <0.05 were considered significant.

Results

Of the 3757 schoolchildren enrolled in the study, 670 (17.8%) were infected with urinary schistosomiasis (Fig. 1). The occurrence of infection statistically varies with location; in the north (28.7%), central (8.9%) and south (13.5%) ($p<0.0001$). There was a variation in the intensity of eggcount, with overall geometric mean intensity of 347.3 eggs/10 mL urine and mean population egg load of 61.9 eggs/10 mL (Table 1). Table 2 revealed that the males had higher infection and egg intensity than their female counterparts (20.6%, 361 eggs/10 mL vs. 14.3%, 340 eggs/10 mL of urine; $p<0.0001$). Overall, the prevalence and intensity of infection varied significantly ($p<0.0001$). Infection is high in schoolchildren within age bracket of 6-10 years in Kwara Central (11.8%) and South (15.8%) while 35.0% point prevalence was recorded among children within 16-20 year in Kwara North. The highest intensity of infection occurred in young children (6-10 years) in all the three senatorial districts (Table 3).

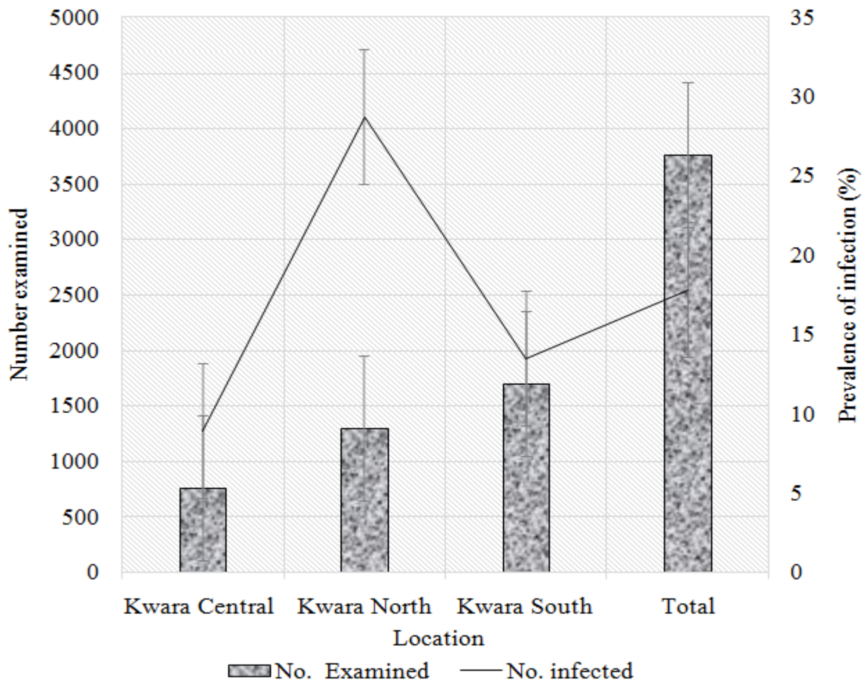

Fig. 1: Overall prevalence of infection with respect to locations; P. Value < 0.0001; Kwara Central = Asa, Ilorin East, Ilorin South, Ilorin East, Kwara North = Baruten, Edu, Moro, Patigi, Kaima; Kwara South = Ekiti, Ifelodun, Irepodun, Isin, Offa, OkeEro, Oyun

Table 1: Intensity of urinary schistosomiasis amongst schoolchildren in Kwara State

		Geometric mean intensity		Mean population egg density	
Senatorial district	Number examined	X ± SD	95% CI	X ± SD	95% CI
Kwara central	757	367.07±247.77	306.64-427.51	32.49±127.45	23.39-41.58
Kwara North	1301	351.76±256.96	325.60-377.93	100.85±210.28	89.41-112.29
Kwara South	1699	334.31±269.37	299.31-369.31	45.26±151.24	38.06-52.45
Total	3757	347.31±260.22	327.56-367.04	61.94±171.45	56.42-67.45
P. value		< 0.0001		< 0.0001	

Table 2: Prevalence and intensity of urinary schistosomiasis stratified with sex of schoolchildren in Kwara State

		Prevalence			Intensity geometric mean intensity	
Senatorial district	Gender	No. Examined	Nu. Infected (%)	95% CI	X±SD	95% CI
Kwara central	M	464	45(9.7)	7.23-12.86	365.73±240.41	293.51-437.96
	F	293	22(7.5)	4.9-11.3	369.82±268.01	250.99-488.65
	P. value		0.18		0.20	
Kwara North	M	800	254(31.8)	28.56-35.12	352.38±267.11	319.37-385.38
	F	501	119(23.8)	20.14-27.78	350.45±307.81	307.81-393.09
	P. value		0.001		0.051	
Kwara South	M	992	157(15.8)	13.64-18.28	315.01±271.67	272.19-357.84
	F	707	73(10.3)	8.23-12.86	375.81±261.37	314.83-436.79
	P. value		0.001		0.001	
Total	M	2256	456(20.2)	18.59-21.94	361.83±266.33	316.32-365.35
	F	1501	214(14.2)	12.55-16.15	340.09±246.75	327.84-394.34
	P. value		< 0.0001		< 0.0001	

Table 3: Prevalence and intensity of urinary schistosomiasis stratified with age of schoolchildren in Kwara State

		Prevalence			Intensity geometric mean intensity	
District	Age	No. Examined	No. Infected (%)	95% CI	X ± SD	95% CI
Kwara central	3-5	61	2(3.3)	0.57-12.36	89.50±116.67	-958.76-1137.76
	6-10	338	40(11.8)	8.68-15.88	412.25±240.78	278.75-431.60
	11-15	323	21(6.5)	4.17-9.91	407.57±267.83	285.66-529.49
	16-20	35	4(11.4)	3.73-27.68	355.18±238.98	29.12-795.38
	P. value		0.071		0.022	
Kwara North	3-5	79	8(10.1)	4.78-19.50	92.63±109.95	0.70-184.55
	6-10	549	163(29.7)	25.93-33.74	391.02±260.64	350.7-431.33
	11-15	496	140(28.2)	24.34-32.45	319.94±232.89	281.03-358.86
	16-20	177	62(35.0)	28.12-42.60	353.85±286.38	281.13-426.56
	P. value		0.01		0.01	
Kwara South	3-5	107	7(6.5)	2.89-13.48	118.57±99.05	27.01-210.14
	6-10	692	109(15.8)	13.16-18.73	373.58±259.71	324.27-422.89
	11-15	639	80(12.5)	10.1-15.40	326.11±277.55	264.35-387.88
	16-20	261	34(13.0)	9.31-17.87	272.12±278.33	175.00-369.23
	P. value		0.13		0.034	
Total	3-5	247	17(6.9)	4.18-21.83	102.94±99.99	51.53-154.35
	6-10	1579	312(19.8)	17.84-21.82	380.33±257.15	351.68-408.98
	11-15	1458	290(19.9)	17.89-22.05	329.63±251.67	297.69-361.56
	16-20	474	47(9.9)	7.45-13.05	328.40±282.65	272.32-384.48
	P. value		< 0.0001		<0.0001	

Table 4: Prevalence of haematuria and proteinuria stratified with egg intensity in schoolchildren in Kwara State

Egg counts /10 mL of urine	Number examined (%)	% with Haematuria at ($\times 10^6$ erythrocytes 1^{-1}) 0	+1	+2	+3	Gh	% with Proteinuria at ($g1^{-1}$) 0	+1	+2	+3
0	3088(82.2)	99.70	0.23	0.097	0.00	0.00	99.87	0.097	0.032	0.00
1-49	416(62.1)	37.62	58.42	3.960	0.00	0.00	54.46	42.540	2.970	0.00
50-499	182(27.2)	27.18	17.42	29.27	19.16	6.97	32.75	19.160	29.270	18.82
≥500	72(10.7)	0.00	2.24	36.54	41.35	10.26	6.73	10.260	36.220	36.86
				p<0.0001						p<0.0001

Key: Gh = Gross haematuria

In this study, 27.2% of moderate and 10.7% of heavy infections were recorded amongst the infected population. There was a significant correlation between intensity of infection and prevalence of haematuria and proteinuria (p<0.0001). Table 4 showed that haematuria increases with intensity of infection, approximately 41.4% of infected children had haematuria with egg count of ≥500. Similar trend was observed with prevalence of proteinuria with intensity of infection.

Discussion

The high prevalence and intensity of infection observed in this study confirmed a sustained long-term endemicity of urogenital schistosomiasis in Kwara state and the morbidity of the disease in Nigerian schoolchildren is grave (Ugbomoiko *et al*., 2010; Uneke *et al*., 2007). In our study area, activities such as laundry, fetching of water for domestic use and bathing/swimming in freshwater bodies are daily activities of schoolchildren that increase the risk of infection. In addition, occupational activities of the parents (e.g., fishing) and the behaviour of urinating in water bodies may help to maintain infection status (Ugbomoiko *et al*., 2010). This scenerio increases morbidity that may negatively impact on the affected children's wellbeing. The common morbidities associated with this infection, as previously reported by many researchers both within and outside Nigeria, include growth retardation, impairment of memory and cognitive reasoning, increased risk of anaemia, malnutrition and dismal learning capacity (Friedman *et al*., 2005; Gray *et al*., 2011).

In this study, prevalence of infection varies from 8.9% to 28.7%. This is similar to many reports in Nigeria (Atalabi *et al*., 2017; Uchendu *et al*., 2017) and other countries (Dahab and El-Bingawi, 2012; Negussu *et al*., 2013). The reports from Sokoto, Nigeria (Singh *et al*., 2016), Ethiopia (Geleta *et al*., 2015) and Senegal (Senghor *et al*., 2014) revealed considerable higher prevalent rates. The difference in the occurrence of infection may be attributed to the different environmental factors.

Although prevalence rates are uneven, infection was generally observed in all the three senatorial districts. The high burden of infection recorded in the poor-resource communities in Kwara North when compared with those from Kwara central particularly in Ilorin metropolis reflects the unequal distribution of infrastructural facilities and water supply in the state. Several reports have showed that transmission of water-borne parasites is limited in urban cities with available portable pipe-borne water than in rural areas. Unavailability of water supply in rural areas probably increases contact with the contaminated natural water bodies. This finding therefore shows the importance of portable water supply in the control and prevention of urinary schistosomiasis. Therefore, prompt government intervention in parasite disease control must complement the mass administration of drugs programme in our endemic areas and other areas with similar epidemiological conditions in the sub-Saharan Africa for meaningful outcome. Besides, variation in risk factors, distribution of infected snail intermediate hosts and differences in water contact activites may jointly determine the variation in infection.

Age and sex patterns of infection in the current study area were similar to many reports from schistosomiasis endemic communities in Nigeria and other African countries (Ahmed *et al*., 2012; Garba *et al*., 2010; Senghor *et al*., 2014). Typically, the overall prevalence and intensity of infection were significantly higher in the older age groups (6-15 years) than the youngest age group (>5 years). This conforms with the several reports (Njunda *et al*., 2017; Sady *et al*., 2013; Ugbomoiko *et al*., 2010). The intense water contact activites observed amongst these age groups possibly justified the high prevalence of infection recorded. However, the apparent socio-economic and cultural differences observed in the study groups and the age-related immunological changes may be a possible explanation for the decline of infection in the oldest age group (<16 years). Although the sex-related intensity of infection was slight in this study, the prevalence was significantly higher in males than the females. A possible explanation for this could be that the male children are freer to engage in boisterous water contact activities than the females. In many of our study areas, the males were predominantly involved in assisting parents in water-related agricultural practices like fishing. Nevertheless, the pathological consequences of infection in both sexes are severe. Generally, infection is marked with haematuria, frequent urination, burning micturition and suprapubic discomfort which may, at chronic stage, results in obstructive uropathy, squamous-cell carcinoma of the bladder, infertility and increased risk of abortion in females (Khalaf *et al*., 2012; Wamachi *et al*., 2004).

As indicated in several reports, the clinical pathologies diagnosed in many patients with urinary schistosomiasis correlates with the intensity of infection (Fatiregun *et al*., 2009; Magnussen *et al*., 2001). Haematuria and proteinuria are ascribed to the histopathological alterations induced by ova and have been widely used as indicators of urinary schistosomiasis (Mafe, 1997; Ugbomoiko *et al*., 2010; 2009). In limited population of schoolchildren, macrohaematuria are used as biomarkers where reagent strips are unavailable (Mafe, 1997). Proteinuria due to primary involvement of the bladder and lower ureter in urinary schistosomiasis has also been previously reported in studies (Doehring *et al*., 1985). Our data showed that approximately 94% of our infected schoolchildren had varied levels of microhaematuria and microproteinuria. This is comparably higher to the data reported by Ugbomoiko *et al*. (2009) and Ekpo *et al*. (2010) who reported 68 and 47% respectively in our geographical area. Chronic blood loss as seen in gross macrohaematuria may lead to serious medical conditions in some infected children. A high occurrence of microhaematuria observed in our study population calls for urgent treatment.

The status of infection in this study may be underestimated due to some limitations. Firstly, only one sample was collected from each participant which may give false status of infection compared to when two or three samples were collected at different day. Secondly, analysis of risk factors which may be used for better recommendation of control and preventive strategies in this study area were not investigated. Another limitation of the study is the small fraction of study populations selected from each Local Government. It is therefore recommended that community-based studies should be conducted to determine the true prevalence of urinary schistosomiasis for better documentation of infection status.

Conclusion

The outcome of this study underscores that urogenital schistosomiasis is not only endemic in Kwara state but it is a major health challenges among schoolchildren in resources-poor communities of the state. Although, infection is prevalent in both sexes but it is significantly higher in male and younger children. Our finding in this study also indicates long term transmission of infection amongst school children with severe impact on their intellectuals and academic performance. Therefore, the on-going mass administration of *Praziquantel* in most schools in the state is justifiable for the reduction of parasite in infected school children. However, chemotherapy option should be supplemented with public awareness campaign and provision of portable water facilities in most rural communities to forestall re-infection and transmission to area previously not endemic.

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Author's Contributions

Sunday Ojo Joseph: Involved in the design, collection of data and in the drafting of the manuscript.

Babamale Olarewaju Abdulkareem: Drafted the manuscript and also did the statistical analysis.

Ugbomoiko Uade Samuel: Designed, supervised the work and proofread the manuscript.

Ethics

This has been provided for in the ethic consideration section of the study. However, all the authors declare no conflict of interest in the publication of this study.

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