International Journal of Translational Medical Research and Public Health (2020), Volume 4, Issue 2, 103-111

IJTMRPH

Available online at www.ijtmrph.org

INTERNATIONAL JOURNAL OF TRANSLATIONAL MEDICAL RESEARCH AND PUBLIC HEALTH
ISSN: 2576-9499 (Online)
ISSN: 2576-9502 (Print)
DOI: 10.21106/ijtmrph.146

ORIGINAL ARTICLE | SCHISTOMIASIS AND CHILDREN

Schistosomiasis and Associated Risk Factors Among School-Aged Children in Northern Nigeria

Musa M. Dogara, PhD[1]✉; **Saadatu Ahmad,** BSc[1]; **Babalola J. Balogun,** PhD[1]; **Salwa S. Dawaki,** PhD[1]; **Muzammil B. Mustapha,** BSc[1]; **Aminu U. Abdurrahman,** RN[2]; **Lawal Bala,** Diploma in Public Health[2]; **Abubakar Zakari,** BSc[1]; **David U. Livingstone,** BSc[1]

[1]Department of Biological Sciences, Faculty of Science, Federal University Dutse, P. M. B. 7156, Dutse, Jigawa State, Nigeria; [2]Jigawa State Ministry of Health, Block B, New Secretariat Complex, Takur Dutse, Jigawa State, Nigeria

✉**Corresponding author email:** musadogara2013@gmail.com

ABSTRACT

Background: The Jigawa State Ministry of Health in Northern Nigeria undertook a pilot intervention to control schistosomiasis through preventive chemotherapy by ensuring that each child swallows praziquantel once annually from 2009 to 2013 in five primary schools in Dutse metropolis. Previously, the overall prevalence for urinary and intestinal schistosomiasis determined using sedimentation and Kato-Katz methods was 22.9%. The objective of this study is to follow-up on this pilot effort.

Methods: A cross sectional study involving 150 randomly selected pupils, aged 6 - 15 years old was conducted using sedimentation and Kato-Katz methods to determine the prevalence of urinary and intestinal schistosomiasis respectively in three schools in July, 2018. Information on demographic and associated risk factors was collected using a structured questionnaire and the data generated were analyzed using SPSS statistics version 18.0.

Results: The overall prevalence was 10.00% with *S. haematobium* 8.00%, *S. mansoni* 2.67% and co-infection 0.67%. Males had higher prevalence (15.10%) than females (1.75%). The 11 - 15 years age group had higher prevalence, (10.10%) than 6 - 10 years, (9.68%). Nearly all the infections occurred among class 4-6 pupils with 12.10% and 2.94% in class 1-3. Based on parental occupations, children of unskilled laborers had the highest prevalence of 16.67% followed by children of civil servants (12.50%), and children of butchers (0%). Kachi School had the highest prevalence of 14.00% while Sir Muhammadu Sunusi had the lowest (4.00%). Schistosomiasis prevalence was found only to be significantly associated with gender; higher among males than females (15.10% vs 1.75%, p = 0.011).

Conclusion and Implications for Translation: Schistosomiasis is still endemic among school-aged children in Dutse metropolis, but with a drop in overall prevalence from 22.9% to 10.00%. Chemotherapy and health education should be sustained on both schooled and unschooled children in order to control the transmission.

Keywords: • Schistosomiasis • Tropical Diseases • Northern Nigeria • Chemotherapy • School-aged Children • Kato - Katz • Sedimentation

1. Introduction

1.1. Background of the Study

Schistosomiasis is the most prevalent neglected tropical disease (NTD) after malaria and intestinal helminthiases.[1] It is the third most devastating tropical disease in the world, being a major public health problem in many developing countries in Africa, South America and the Middle East. More than 207 million people are infected globally, 80% of these live in Africa and an estimated 700 million people are at risk of infection in 76 countries where the disease is considered endemic.[2] People in endemic areas were exposed to parasite-infested fresh water mainly through their agricultural work, domestic chores and recreational activities. Globally 200,000 deaths are attributed to schistosomiasis annually.[3] Nigeria is having the greatest number of cases of schistosomiasis worldwide, with about 29 million people at risk of infection and an overall prevalence of 9.5%.[4,5]

Schistosomiasis is a parasitic infection caused by blood trematodes of the genus *Schistosoma* and transmitted to humans by certain freshwater snails after skin contact with infected water.[6,7] The transmission occurs when the parasites deposit terminal spine eggs to the host during the infection, which block the venous plexus and prevent blood flow. This causes the veins to break, allowing blood and eggs to enter the urinary bladder.[8] The five species of *Schistosoma* that cause the disease worldwide are *S. haematobium*, *S .mansoni*, *S. japonicum, S. intercalatum* and *S. mekongi; S. haematobium*, and *S. japonicum* account for the largest percentage (95%) of all human cases of schistosomiasis found in the world.[6] In Nigeria, two species are pathogenic to man; *S. haematobium* and *S. mansoni*. The disease caused by *S. haematobium* is characterized by bloody urine, calcification of the bladder, kidney failure, and bladder cancer. It is also the major cause of female genital schistosomiasis (FGS).[9,10] On the other hand, intestinal schistosomiasis, which is caused by *S. mansoni,* can have symptoms such as abdominal pain and bloody diarrhea. In severe cases, liver enlargement that is often linked with a peritoneal fluid retention and abdominal blood vessel hypertension. In such cases there may also be enlargement of the spleen.[11]

According to the data gathered from peer-reviewed journals and nationwide geographical information system database, schistosomiasis is endemic in 35 of Nigeria's 36 states.[8] Schistosomiasis prevalence and morbidity is highest among school children, adolescent and young adult.[12] As a result, the negative effects on academic achievement and the infirmity caused by untreated disease demoralizes both social and economic progress in endemic areas.[13]

The global effort to eliminate schistosomiasis is enshrined in World Health Organization's (WHO) schistosomiasis plan with a vision of a "World Free of Schistosomiasis," with its end goal to eliminate the disease as a public health problem by 2025, and to interrupt transmission in many areas by the same time.[2] To control schistosomiasis, it is recommended that people become more educated about the effect and transmission of the parasites, improve sanitation, have access to basic amenities such as safe drinking water, and limit water contact activities.[14] In response to this global effort Nigeria came up with national program to eliminate schistosomiasis together with other NTDs. According to the Nigerian master plan for NTDs 2015 – 2020, all the 774 Local Government Areas (LGAs) in the country have been mapped; 603 are endemic for schistosomiasis and the provisional prevalence of the disease ranged between 0-84% nationwide.[15,16]

Prior to the development of the master plan there was a national effort to control schistosomiasis mainly through the provision of an antihelminthic praziquantel and health education to school-aged children. For instance, in Jigawa State a pilot control effort was carried out by the state Ministry of Health in five primary schools in Dutse metropolis from 2009 to 2013.[17] Based on WHO protocol for the control of schistosomiasis, all healthy children in the five schools were given the antihelminthic drug once a year to swallow under the supervision of their teachers and health officials from the ministry. The children were later observed for any side effects due to the administration of the antihelminthic. In addition, a health education campaign was undertaken on how the children could safeguard themselves from contracting the disease. Prior to the commencement of the control effort in these primary schools, the overall prevalence of

schistosomiasis using the sedimentation and Kato-Katz methods was 22.9%.[18] Unfortunately, there was no follow up on the progress made in such control efforts. The present work aims at conducting a post-intervention study on the prevalence and risk factors of schistosomiasis using the same methods on school-aged children in three primary schools in Dutse metropolis in order to determine the status of schistosomiasis following the intervention.

1.2. Objectives

To determine the prevalence of urinary and intestinal schistosomiasis among school aged children (6-15 years) in Dutse metropolis following preventive chemotherapy from 2009 to 2013. To determine the risk factors associated with prevalence of schistosomiasis among school aged children (6-15 years) in Dutse metropolis following chemotherapy from 2009 to 2013. Our specific aim was to conduct a post-intervention study of the prevalence of schistosomiasis and its associated risk factors among school aged children in Dutse metropolis, Dutse, Jigawa State, Northern Nigeria. We hypothesized that there is no significant difference in the prevalence of schistosomiasis among school aged children (6-15 years) between the pre and post-intervention periods in Dutse metropolis. The researchers hypothesize that there is no association between the prevalence of schistosomiasis and risk factors among school aged (6-15 years) in Dutse metropolis.

2. Methods

2.1. Study Area

The study was carried out in Dutse metropolis, Dutse Local Government Area, Jigawa State, Nigeria. Dutse is a city located in Northern Nigeria and is the capital of Jigawa State. It is situated between latitude 11 42'8.46'N and longitude 9 20'2.46"E or 11.702351 and 9.334016 respectively. Dutse is currently the largest city in Jigawa State with an estimated population of 153,000.[19] The population of Dutse is predominantly the Hausa and Fulani tribes practicing agriculture as the main source of livelihood.

2.2. Study Design, Sample Size and Population

A cross sectional study involving 150 school pupils, aged 6 -15 years old, was conducted in Dutse metropolis in July 2018. The sample size was determined using the formula for schistosomiasis.[20]

Where, N= Sample size, Z= the normal standard deviate (Z=1.96)
P= the frequency of occurrence of *Schistosomes* (P = 22.9%), Q= 1-p
D= degree of precision (0.05%).

Out of the five schools targeted for pilot schistosomiasis control in Dutse metropolis by the Jigawa State Ministry of Health in 2009 and 2013, three primary schools were selected for the post-intervention to study namely: Galadanchi, Dr. Nuhu Muhammad Sunusi and Kachi Special primary schools. A total of 150 pupils were randomly selected from classes 1-6, ages 6-15 years.

2.3. Questionnaire Administration

A validated structured questionnaire was used to obtain demographic and socioeconomic information such as water contact activity, source of drinking water, personal and environmental hygiene practices and contact with a fresh bodies of water.

2.4. Parasitological Examination

Three hundred (300) samples comprising 150 urine and 150 stool samples were collected by assignment of numbers to every randomly selected participant from the different classes. In appropriately labeled plastic screw cap urine and stool containers, the children were asked to collect 10mls of the urine sample and 5g of fresh stool samples at mid-day. The pupils were also instructed on how to collect the urine sample advising to include the first and last drops, for these drops often contain the highest number of the *Schistosoma* eggs.

Both stool and urine samples were taken in an ice container to the Biology Laboratory, Department of Biological Sciences, Federal University Dutse, Jigawa State, Nigeria for immediate processing. The urine samples were processed using sedimentation technique as described in previous studies.[21,22] The supernatant was discarded using syringe and needle, and the sediment was transferred to a plain slide with cover slip and the sediment was examined initially at ×10 and then × 40 magnifications

under the light microscope. Eggs were detected and identified by the shape and terminal spine characteristic of *S. haematobium*. The stool samples were analyzed as outlined in prior studies[21,23] using Kato-Katz kit. Malachite green was added to each of the processed slide and was examined under the microscope initially under ×10 and later ×40 for the presence of egg or ova of *S. mansoni*. The eggs were detected and identified by the shape and lateral spine characteristics of *S. mansoni.* Positive samples for both *S. haematobium* and *S. mansoni* were counted and recorded.

2.5. Data Analysis

The data generated were analyzed using SPSS version 18.0 (IBM corporation, NY, USA). The demographic characteristics and socioeconomic variables of the research participants were presented in the form of frequencies and percentages. Chi-square was used to test the association between demographic, socioeconomic and behavioral variables with infection. A linear regression analysis was used to identify the risk factors that significantly ($p < 0.05$) associated with schistosomiasis infection.

2.6. Ethical Approval

Ethical clearance was obtained from Jigawa State Ministry of Health via a letter with a reference number MOH/SEC/3.5/620/1 dated 21st April, 2018. Correspondingly the Jigawa State Universal Basic Education Board (JGSUBEB) consented to the study based on the MOH ethical clearance. The purpose of the study was explained to the Headmaster of the schools and informed consent and assent from the pupils, parent or guardian of the children was sought before the commencement of the work and kept confidential.

3. Results

3.1. Demographic and Socioeconomic Characteristics of the Participants

The demographic and social characteristics of the participants are presented in Table 1. The majority of participants were males (62%), while 38% were females. Participation according to age groups showed that the 11 – 15 years age group had the highest number 72% followed by 6 – 10 years age group with 28%. The same trend is maintained with regard to participation based on class of the pupils, children in class 4 – 6 were more in number than those in class 1- 3. Many of the pupils' parents were civil servants 48%, while 28% were farmers.

Table 1: Demographic and socio-economic characteristics of the participants

Variables	Number (%)
Gender	
Male	93 (62.00)
Female	57 (38.00)
Age group in years	
6-10	42 (28.00)
11-15	108 (72.00)
Classes of pupils	
1-3	34 (22.67)
4-6	116 (77.33)
Parent's occupation	
Farming	42 (28.00)
Trading	16 (10.67)
Civil servant	72 (48.00)
Unskilled laborer	18 (12.00)
Butcher	2 (1.33)
Residence of the pupils	
Urban	55 (36.67)
Rural	95 (63.33)

3.2. *Prevalence of Schistosomiasis among Primary School Pupils in Dutse Metropolis*

Table 2 presents the prevalence of infection among the participants. The overall prevalence of schistosomiasis was 10% with *S. haematobium* 8%, *S. mansoni* 2.67% and co-infection 0.67%. Males had an overwhelming prevalence of 15.10% over females with 1.75%. The 11 - 15 years age group had higher prevalence of 10.10% than the 6 - 10 years age group with 9.68%. Kachi Primary School had the highest prevalence 14.00% followed by Galadanchi with 12.00% while Sir Muhammadu Sunusi had the lowest 4.00%. Almost all the infections occurred among pupils in classes 4 – 6 with 12.10% and an infection among the class 1 – 3 pupils. Children

Table 2: Prevalence of schistosomiasis among primary school pupils according to gender, age group, school location, class and parents' occupation

Prevalence	No. Examined	No. Positive	%
Overall prevalence	150	15	10.00
S. haematobium	150	12	8.00
S. mansoni	150	4	2.67
Co-infection	150	1	0.67
Gender			
Male	93	14	15.10
Female	57	1	1.75
Age groups in years			
6-10	31	3	9.68
11-15	119	12	10.10
School location			
Galadanci	50	6	12.00
Dr.Nuhu Muhammad Sunusi	50	2	4.00
Kachi	50	7	14.00
Class of the pupils			
1-3	34	1	2.94
4-6	116	14	12.10
Parents' occupation			
Farming	42	2	4.76
Trading	16	1	6.25
Civil servant	72	9	12.50
Unskilled laborer	18	3	16.67
Butcher	2	0	0.00

whose parental occupation was unskilled laborer had the highest prevalence of 16.67% followed by civil servants at 12.50%, farming at 4.76%, trading at 6.25% and butcher at 0.00%.

3.3. Risk Factors of Schistosomiasis among the Study Population

Table 3 shows the univariate analysis to determine the association between infection with schistosomiasis and demographic characteristics, socioeconomic status and behaviors of the research participants. Apart from gender, all the other variables (age, parents' occupation, water contact activities, water source usage and personal hygiene) were found to be not significantly associated with schistosomiasis infection among the school aged children in the three primary schools. Schistosomiasis prevalence was found to be significantly higher among males than females (14.1% vs 1.7%, p = 0.011). When gender was considered for logistic regression analysis in Table 3, the level of significance was retained at p = 0.033 indicating that males were at higher risk of becoming infected than their female counterparts. The odds of infection was more than nine times higher in males than in females (OR = 9.38; 95% CI =1.19, 73.76).

4. Discussion

This study recorded an overall post-intervention prevalence of 10.00% for schistosomiasis among the pupils in three primary schools in Dutse metropolis, thus indicating that the disease is still endemic among school aged children in Dutse metropolis. However, the result revealed a considerable reduction in the disease prevalence from 22.9% before the intervention that was done from 2009 to 2013, to post-intervention prevalence of 10%. The lower prevalence observed during the post-intervention might be a reflection of the success of the intervention as well as increased availability of potable water sources from piped borne water and bore holes, as well as improved environmental sanitation provided by government at all levels (state, local and private). These efforts might have helped in reducing the pupils, contact with contaminated water that expose them to infection with schistosomiasis. This is also supported by the fact that previous studies in Dutse metropolis have reported much higher prevalence of infection with schistosomiasis. For instance, an overall prevalence of 37.33% was reported among primary school aged children in Dutse.[24] Another study observed an overall prevalence of 39.2% among patients attending a secondary health facility in Dutse.[25] It must be noted that the percentage from the Bashir et al. study was based on total incidents from all age groups. Moreover, they performed (and totaled) 3 types of analysis (chemical, physical and microscopic analysis).This study included adolescents that have been reported to be more susceptible to infection with schistosomiasis when compared with children or the aged.

Table 3: Univariate analysis of risk factors associated with schistosomiasis among school aged children (n=150)

Variables	Schistosomiasis					
	No. examined	No. infected (%)	Odds ratio (OR)	95% CI	*P*	X^2
Gender			9.38	1.19; 73.76	0.011*	6.470
Male	93	14 (15.10)				
Female	57	1 (1.75)				
Age groups			1.05	0.28; 4.03	0.585	0.585
6 -10	31	3 (9.70)				
11 - 15	119	12 (10.10)				
Residence			3.83	0.83; 17.80	0.068	3.331
Urban	55	2 (3.63)				
Rural	95	12 (12.63)				
Parents occupation			2.09	0.66; 6.55	0.200	1.641
Civil service	72	9 (12.50)				
Others	78	5 (6.40)				
Water contact			1.85	0.61; 5.62	0.273	1.199
Yes	65	8 (12.30)				
No	85	6 (7.10)				
Water source			1.24	0.37; 4.16	0.494	0.494
Safe (pump)	101	10 (9.90)				
Unsafe (&)	49	4 (8.20)				
Washing hand before meal			1.09	0.34; 3.43	0.551	0.551
Yes	51	5 (9.80)				
No	90	9 (9.10)				
Washing hand after toilet			2.2	0.55; 8.79	0.225	0.225
Yes	18	3 (16.70)				
No	132	11 (8.30)				
Open defecation			1.34	0.35; 5.18	0.451	0.451
Yes	124	11 (8.90)				
No	26	3 (11.50)				
Regular bath			1.64	0.54; 4.98	0.380	0.772
Yes	81	6 (7.40)				
No	69	8 (11.60)				

The overall prevalence obtained in this study was also much lower than many other previous findings such as those from neighboring Kano State of 25% and 17.8%.[26,27] A prevalence of 63.73% was observed in poor communities of Sokoto town, Sokoto State, Nigeria.[28] In another study urinary schistosomiasis from Riverine areas of Ondo State, Nigeria a prevalence of 48.4% was reported.[28] The difference between our finding and that of these studies could be attributed to the fact that no interventions were undertaken in the other populations where such studies were carried out. In addition, these studies were done in poor or rural communities without access to potable drinking water which exposed the population to higher risk of contracting schistosomiasis. However, the result in this study was higher than an overall prevalence of 1.55% reported in Bauchi State, Nigeria.[14] According to the researchers, the lower prevalence might be due to the nature of

subjects involved in the study, whom were mostly students and civil servants that lived in urban areas with improved water supply.

The prevalence of infection with *S. haematobium* was higher than that with *S. mansoni* in this study. This is consistent with findings from previous studies.[14,24,26,28] The explanation for this is that the vectors responsible for the transmission of *S. haematobium*, the *Bulinus species* have higher relative abundance than *Biomphalaria* species that transmit *S. mansoni* in local water bodies in Northern Nigeria.[29] This argument is further reinforced by the results of many previous studies on the ecology of freshwater snails, especially in dams which have reported that *Bulinus species* have higher relative abundance when compared with *Biomphalaria species*.[6] This also agrees with global reports that intestinal schistosomiasis is less prevalent than urinary schistosomiasis in tropical Africa.[2]

Males had higher prevalence than females in terms of infection with both urinary and intestinal schistosomiasis. This finding is consistent with many previous studies.[14,24,26,27,30] The higher prevalence rate among males might be associated with cultural practices of the inhabitants where the disease is endemic in tropical Africa and Nigeria in particular where it is mainly the males that are engaged extensively in activities such as swimming, fishing and farming that results in higher risk infection with schistosomiasis. However, findings from some studies have reported a slightly higher prevalence of the disease in female than male.[18,31] This might be because in settings where these studies were conducted both male and female are almost equally engaged in activities that predisposes them to infection.

Children within age group of 11-15 years had the highest prevalence of urinary and intestinal schistosomiasis. This outcome is consistent with the many studies.[24,26,27,30,14] The higher prevalence recorded among this age group was probably linked to the outdoor activities that they were more actively engaged in as compared to the younger children, the 6-10-years age group, especially swimming in contaminated water. The finding was also in agreement with previous reports.[26,28] Based on school location, Kachi had the highest prevalence followed by Galadanchi while Dr. Muhammadu Nuhu Sunusi had the lowest. The possible explanation for this could be Kachi and Galadanchi are located in the suburb of Dutse metropolis that enjoy less improved water supply and have the presence of environmental factors such as standing water bodies that expose children to infection with schistosomiasis.

4.1. Limitations

The major constrain was that the post-intervention study was done about five years after the index intervention. Therefore, the reported reduction in prevalence may not be solely attributed to the index intervention, it could also be associated with government programs especially improved water supply and environmental sanitation. In addition, among the risk factors considered only gender was controlled. There should be a more extensive study of schistosomiasis among both schooled and unschooled children covering the entire state in order to gather comprehensive data that could be used in planning and executing a more integrated schistosomiasis control program in the state.

Compliance with Ethical Standards

Conflicts of Interest: *None.* ***Financial Disclosure:*** *None.* ***Funding/Support:*** *The publication of this article was partially supported by the Global Health and Education Projects, Inc. (GHEP) through the Emerging Scholars Grant Program (ESGP).* ***Ethics Approval:*** *The research proposal was reviewed by the ethical board of the Jigawa State Ministry of Health, Block B, New Complex Secretariat, Takur Dutse, Dutse, Jigawa State, Nigeria.* ***Acknowledgments:*** *We hereby appreciate the support and understanding of the following during the course of this study: staff of Neglected Tropical Diseases Unit, Department of Public Health, Jigawa State Ministry of Health, Education Secretary, Dutse Local Government Education Authority, Headmasters, teachers and pupils of the three primary schools and the Laboratory staff of Department of Biological Sciences, Federal University Dutse, Dutse, Jigawa State.* ***Disclaimer:*** *The information, contents, and conclusions are those of the author(s) and should not be construed as the official position or policy of, nor should any endorsements be inferred by ESGP or GHEP.*

Key Messages

- Prior to index intervention, the overall prevalence of urinary and intestinal schistosomiasis determined using sedimentation and Kato-Katz methods respectively among school-aged children was 22.9%.
- The index intervention was mainly through preventive chemotherapy following WHO protocols by administering of praziquantel to each child once in a year from 2009 to 2013.
- A post-intervention study in 2018 revealed that the disease is still endemic with an overall prevalence of 10%, thus indicating a reduction which could be attributed to index intervention or other factors, such as improved clean water supply, environmental sanitation and personal hygiene in the study area.

References

1. Sturrock RF. Schistosomes and their intermediate hosts of schistosomiasis. In: Mahmud AA, editor. Schistosomiasis. *Tropical Medicine*: Science and Practice. Vol. 20. London, United Kingdom: Imperial College Press; 2001
2. World Health Organization. *Working to Overcome the Global Impact of Neglected Tropical Diseases: First WHO Report on Neglected Tropical Diseases*. Geneva: World Health Organization; 2010.
3. Verjee MA. Schistosomiasis: still a cause of significant morbidity and mortality. *Res Rep Trop Med*. 2019;10:153-163. doi: 10.2147/RRTM.S204345
4. Hotez PJ, Kamath A. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution and disease burden. *PLoS Negl Trop Dis*. 2009;3(8):e412. doi: 10.1371/journal.pntd.0000412
5. Global Network of Neglected Tropical Diseases. Government of Nigeria releases new data on the prevalence of schistosomiasis and intestinal worms. SABIN: Vaccine Institute, USA; 2015.
6. Agi PI, Okafor EJ. The epidemiology of Schistosomiasis haematobium in Odau Community in the Niger Delta area of Nigeria. *J Appl Sci Environ Manage*. 2006;9(3):37-43.
7. World Health Organization. Schistosomiasis. Geneva: World Health Organization. https://www.who.int/news-room/fact-sheets/detail/schistosomiasis. Accessed February 2020.
8. Ekpo UF, Hürlimann E, Schur N, et al. Mapping and prediction of schistosomiasis in Nigeria using compiled survey data and Bayesian geospatial modelling. *Geospat Health*. 2013;7(2):355-66. doi: 10.4081/gh.2013.92
9. Butterworth EA. Schistosomiasis, epidemiology, treatment and control. *Med Group J Trop Dis*. 1997; 25(2):70-81.
10. Norberg E. *Communicable Diseases: A Manual for Health Workers in Sub-Saharan Africa*. 3rd ed. Africa Medical and Research Foundation; 2004.
11. World Health Organization. *Schistosomiasis*. Geneva: World Health Organization; 2020. https://www.who.int/news-room/fact-sheets/detail/schistosomiasis. Accessed March 2020.
12. Hotez PJ, Fenwick A, Savioli L, Molyneux DH. Rescuing the bottom billion through control of neglected tropical diseases. *Lancet.* 2009;373(9674):1570-1575.
13. Dawaki S, Al-Mekhlafi HM, Ithoi I, et al. The menace of schistosomiasis in Nigeria: knowledge, attitude, and practices regarding schistosomiasis among Rural Communities in Kano State. *PLoS One*. 2015;10(11):e0143667. doi: 10.1371/journal.pone.0143667
14. Usman AM, Babeker EA. A study on aspects of epidemiology of urinary and intestinal schistosomiasis in Bauchi State, Nigerial. *Sci World J*. 2017;12(4):88-93.
15. Federal Government of Nigeria. Ministry of Health. *Neglected Tropical Diseases: Nigeria Multi-year Master Plan 2015-2020*. Federal Ministry of Health; 2015. https://espen.afro.who.int/system/files/content/resources/NIGERIA_NTD_Master_Plan_2015_2020.pdf. Published February 2015. Accessed February 2020.
16. Bishop HG. Menace of schistosomiasis: its true neglected nature in Nigeria. *MOJ Public Health*. 2017;6(5):421-426. doi: 10.15406/mojph.2017.06.00186
17. Abdurrahaman AU. Neglected Tropical Diseases Unit, Department of Public Health, Jigawa State Ministry of Health. Unpublished Data. 2016.
18. Ekpo UF, Laja-Deile A, Oluwole AS, Sam-Wobo SO, Mafiana CF. Urinary schistosomiasis among pre-

school children in a rural community near Abeokuta, Nigeria. *Parasite Vectors*. 2010;3:58. doi: 10.1186/1756-3305-3-58

19. National Population Commission. *2006 Population and Housing Census*. Abuja: Federal Government of Nigeria, 2006. Available at https://searchworks.stanford.edu/view/8626165. Accessed June 2020.
20. Thrusfield M. *Veterinary Epidemiology*. 2nd ed. Blackwell Scientific; 2005.
21. Cheesebrough M. *District Laboratory Practice in Tropical Countries*. Part 1. Cambridge University Press; 1998.
22. Dazo BC, Biles JE. Two new field techniques for detection and counting of Schistosoma haematobium eggs in urine samples, with an evaluation of both methods. *Bull World Health Organ*. 1974;51(4):399-408.
23. Feldmeier H, Poggensee G. Diagnostic techniques in schistosomiasis control. A review. *Acta Trop*. 1993;52(4):205-220. doi: 10.1016/0001-706x(93)90009-z
24. Ahmad MM, Abubakar MM, Lawan M, Shu'aibu I and Tijjani AM. Schistosomiasis among primary school aged children in Dutse, Jigawa State, Nigeria. *Int J Biol Sci.* 2015; 2(1): 15-22.
25. Bashir SF, Usman U, Sani NM, Kawo AH. Prevalence of *Schistosoma haematobium* among population aged 1-25 years attending Rasheed Shekoni Specialist Hospital, Dutse, Jigawa State, Nigeria. *IOSR J Pharm Biol Sci*. 2016; 11(6): 20-24.
26. Ahmad MM, Getso BU, Ahmad UA. Water contact patterns and urinary schistosomiasis transmission among school children in endemic area of Wudil, Kano State, Nigeria. *IOSR J Pharm Biol Sci.* 2014;9(3):1-4. doi: 10.9790/3008-09350104
27. Dawaki S, Al-Mekhlafi HM, Ithoi I, et al. Prevalence and risk factors of schistosomiasis among Hausa communities in Kano State, Nigeria. *Rev Inst Med Trop Sao Paulo*. 2016;58:54. doi: 10.1590/S1678-9946201658054
28. Singh K, Muddasiru D, Singh J. Current status of schistosomiasis in Sokoto, Nigeria. *Parasite Epidemiol Control*. 2016;1(3):239-244. doi: 10.1016/j.parepi.2016.08.003
29. Pukuma MS, Musa SP. Prevalence of schistosomiasis among residents of Waduku in Lamurde Local Government Area of Adamawa State, Nigeria. *Niger J Parasitol*. 2008;28(2):65-68. doi: 10.4314/njpar.v28i2.37877
30. Akeju AV, Ajayi OJ. Socio-economic and prevalence of urinary schistosomiasis infection in riverine areas of Ondo State, Nigeria. *Int J Trop Dis Health* 2018; 33(1): 1-7. doi: 10.9734/IJTDH/2018/43962
31. Nkegbe E. Prevalence of schistosomiasis among primary schoolchildren in the lower river Volta Basin in Ghana. *Gomal J Med Sci*. 2010; 8(1):54-56.