integrity Research Journals

Journal of Public Health and Diseases
Volume 6(1), pages 1-9, July 2023
Article Number: D3EF5C301
ISSN: 2705-2214
https://doi.org/10.31248/JPHD2023.124
https://integrityresjournals.org/journal/JPHD

Full Length Research

Urinary schistosomiasis and associated microbial infections among pre-school aged and school-aged children in Ipogun, Nigeria

ONIYA Mobolanle Oladipo*, ADEWOLE Toluwalase Tejumade and AFOLABI Olajide Joseph

Parasitology and Public Health Unit, Department of Biology, Federal University of Technology, PMB 704, Akure, Ondo State, Nigeria.

*Corresponding author. Email: mooniya@futa.edu.ng

Received 9th April 2023; Accepted 27th June 2023

ABSTRACT: Urinary schistosomiasis is a parasitic infection caused by digenean trematode. In Nigeria, *Schistosoma haematobium* has been incriminated as the cause of urinary schistosomiasis infection and has been reported from different parts of the country with high prevalence especially in Ondo State. Endemicity in Ipogun village is over two decades due to cultural beliefs and behavioural attitude of the community dwellers to the disease. The study assessed the prevalence of urinary schistosomiasis and associated microbial infections among Pre-School Aged and School-Aged Children (SAC) in Ipogun, Ondo State. Urine samples were collected from 492 children in the village and analysed using the centrifugation method. Similarly, urine samples were cultured using standard microbial methods and examined for the presence of bacteriuria and fungi. The results showed that out of the 492 urine samples examined for parasitology, 306 (62.2%) were positive for urinary schistosomiasis with mean intensity of 22.3 in the sampled population. Haematuria was more prevalent among the male pupils (n =190; 12.2%) than the female (n =116; 6.5%). The prevalence peaked within the age group 16-20 at 82.2%. *Staphylococcus aureus, Escherichia coli, Proteus mirabilis, Pseudomonas aeruginosa* and *Klebsiella sp* were isolated as bacteria and *Aspergillus* sp and *Candida sp* as fungi solely from the schistosomiasis positive urine samples. This study revealed the prevalence of urinary schistosomiasis in the study area and the predisposition of the infected children to microbial infections. Results suggest routine uninterrupted chemotherapeutic control and the consideration of antibiotics in the treatment regime to control opportunistic microbial infections.

Keywords: Microbial infections, Pre-SAC, prevalence, SAC, urinary schistosomiasis.

INTRODUCTION

Schistosomiasis is caused by infection with highly infective fluke trematodes of the genus *Schistosoma* whose intermediate hosts are freshwater snails belonging to the family Planorbidae (Fenwick and Webster, 2006). In Africa and Asia region, *Schistosoma haematobium* causes urinary schistosomiasis, while intestinal schistosomiasis is caused by *S. mansoni* and *S. intercalatum*. The infection is one of the most prevalent neglected tropical diseases (Fenwick and Webster, 2006).

Schistosomiasis is ranked second to malaria, most common socio-economically devastating tropical parasitic disease. Parasite infestation has been reported in 78 countries of Africa, Asia, the Middle East and South America (WHO, 2013). The annual death rate is around 200,000 in sub-Saharan Africa alone, making the group of parasites which cause schistosomiasis the most lethal worms in the world. In Nigeria, *Schistosoma haematobium* infection had been found within the country with high prevalence rates, and incidence is believed to be on the increase (Oniya *et al*., 2013). In Ondo state, Nigeria, the disease is a public health problem where the prevalence rates in all 18 Local Government Areas was between 41-95.7% with Ipogun having 18% (Oniya *et al*., 2013). Although subsistence farming, inadequate water supply, poor public sanitation, rapid urbanization and dam construction are common predisposing factors, the endemicity of the disease will not abate for as long behavioural habits are not modified (Oniya, 2007).

Parasite infection has been reported in early infancy, while peak incidence occurs in early adolescence as a result of frequent bathing in contaminated pools of water. The exposure of adults to water is lower compared to children, also the capacity to resist new infection by eosinophil secretion of antigen-specific immunoglobulin E (IgE) is age-dependent (Ganley-Leal *et al*., 2006).

Urinary tract infections (UTIs) are a severe public health problem and are caused by a range of pathogens, but most commonly by *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis* and *Staphylococcus saprophyticus*. High recurrence rates and increasing antimicrobial resistance among uropathogens threaten to greatly increase the economic burden of these infections (Ana *et al.,* 2015). UTIs are some of the most common bacterial infections, affecting 150 million people each year worldwide and are a significant cause of morbidity in infant boys, older men and females of all ages (Stamm and Norrby, 2001). Malnutrition, poor hygiene, low socio-economic statuses are associated with urinary tract infections and these factors are rife in rural settings (Ojezele, 2020). Bacterial infections are persistent with some important complications of urinary schistosomiasis which may cause renal failure (Farid, 1993).

In schistosomiasis of the urinary bladder, secondary bacterial infections in men can involve the seminal vesicles, spermatic cord, and to a lesser extent, the prostate (Tonolini and Ippolito, 2016). Also, in women, the infection can involve the cervix and fallopian tubes and can cause infertility (Ifeanyi *et al*., 2009). Mostafa *et al*. (1999) stated that it is possible for farmers and others who are regularly exposed to contaminated water to be infected with both the schistosome parasite and pathogenic bacteria simultaneously. Schistosomiasis is a disease of significance and growing importance in Nigeria due to the level of poverty and poor/non-availability of potable water in rural settlements. Ipogun has been under focus for over two decades and the present study was carried out to assess the present prevalence of urinary schistosomiasis and associated microbial infections among school-aged children in the village.

MATERIALS AND METHODS

Study area

The research was carried out in Ipogun village (Figure 1) in Ifedore Local Government Area of Ondo State, south west Nigeria. Ifedore Local Government is one of the eighteen Local Government Areas in Ondo State. It has an area of 334 km^2 with a population of 421,100 and lies on latitude 7°19'N of the equator and the longitude 5°08'E of the Greenwich meridian. The two prominent seasons in Ipogun are the wet and dry seasons. The wet season runs from March to October and the dry season from November to April each year. The main source of water for agricultural and most domestic activities is the 'Aponmu' river, flowing through the village; this river serves as the contact site for transmission of the disease. Furthermore, the inhabitants being mainly farmers depend on and use water from the river in carrying out their daily activities such as bathing and washing.

Study design

Total population sampling was carried out where urine samples of all preschool and school aged children attending primary and secondary schools in Ipogun village were collected and examined to assess the prevalence of urinary schistosomiasis.

Study population and size

The study population comprised of all school aged children (SAC) in Ipogun, the schools were Muslim Primary School with 50 participants, Ayo Grammar School with 187 participants and St Jude's Primary School with 68 participants. Others include CAC Primary School with 31 participants, Evangel Primary School with 65 participants. Morohunkeji Primary School with 65 participants and Sancta Trinitas Catholic Primary School with 26 participants. In total 289 male and 203 female SAC were examined.

Collection of sample urine

Urine samples were collected between 09:00 and 12:00 pm {during the dry season, January – February 2022) which is the peak period for shedding of eggs (Cheesbrough, 2000). Each pupil was given a clean 20 ml universal bottle to urinate in with emphasis on the last drop. The bottle was labelled appropriately with a corresponding participant's identity number. The name, sex and age of each participant were recorded against the identity number given on submission of the samples. The urine samples collected were transported in ice packs to the Parasitology and Public Health Laboratory of Biology Department, the Federal University of Technology, Akure for analysis.

Urinalysis

Laboratory analysis of the urine was done using the centrifugation method. Each sample bottle was agitated to suspend the ova evenly in the urine after which 10 mls of urine was transferred into a centrifuge tube with a sterile syringe and was centrifuged at 1,500 rpm for 3 minutes. The residue was examined under the ×10 objective of the microscope for the presence of terminal spine ova of *S.*

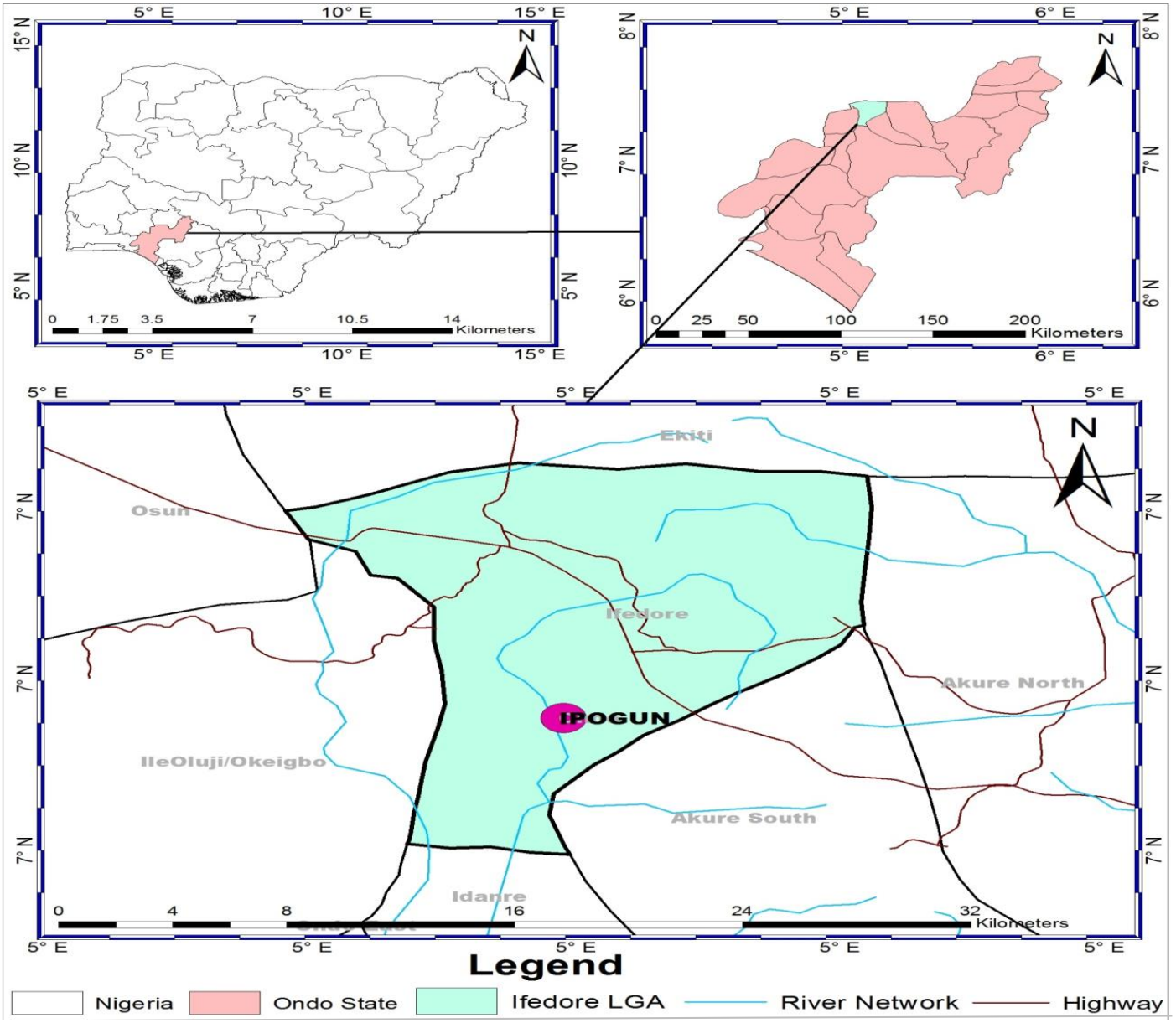

Figure 1. Map of the study area, Ipogun village.

haematobium. Eggs of *S. haematobium* were counted under light microscope at low magnification. Results were expressed as the number of *S. haematobium* eggs/10 ml urine. Cases of haematuria observed were recorded.

Microbial culture and examination of cultured plates for bacteria

0.002 ml of the urine was added onto sterile agar media for bacteriological examination. The media used were Nutrient agar medium, Cysteine lactose electrolyte deficient medium (CLED-BIOTEC, UK) and Cetrimide agar medium. While for fungi growth, 0.002 ml of urine sample was poured on Malt extract agar medium. The culture plates were incubated aerobically at 37°C for 24 hours for bacteria and malt extract medium was incubated for 7 days. The cultured plates were examined after 24 hours of incubation for microbial growth and colony count. Samples that showed growth of bacterial isolates in a count of ≥105 colony-forming units (cfu/ml of urine) after overnight incubation were considered to indicate significant bacteriuria. After incubation period, representative colony types (after careful examination) were picked and sub-cultured on surface-dried sterile nutrient agar. The culture plates were incubated at 37°C for 24 hours (Chessbrough, 2000).

Isolation of pure culture and identification of bacteria isolates

The observed colony of each bacterial isolate was then sub-cultured by streaking on freshly prepared nutrient agar plates twice until pure colonies were obtained according to the standard procedure (Fawole and Oso, 2007). Each isolate was then identified and characterized as described by Olutiola *et al.* (2000) and also biochemical tests were carried out to identify each bacteria species. Result of each bacterium was confirmed using Bergey's Manual of determinative Bacteriology as Standard. A smear was prepared on a clean grease-free glass slide with a loopful bacteria isolate. The isolate was emulsified to form a thin smear which was air dried then heat fixed. The slide was flooded with crystal violet stain and allowed to stay for 60 seconds before washing off the stain with distilled water. Lugol's iodine was then added for 60 seconds before stain was washed off with water. 99% absolute alcohol was used to decolourise the stain then the slide was counter stained with safranine red for 30 seconds and finally washed off with distilled water allowed to air dry. Using x 100 objective lens, the slides were examined for bacteria per oil immersion field.

Catalase and coagulase test

These tests were conducted to determine whether the gram-positive cocci observed were *Staphylococcus* or *Streptococcus*. For the catalase test, a drop of hydrogen peroxide was placed on a clean, dry glass slide, small amount of bacterial colony was transferred to the hydrogen peroxide and mixed using a wire loop and was observed. The coagulase test was performed by placing a drop of saline on a clean slide and a wire loop was used to emulsify a portion of isolated colony to obtain a smooth suspension. A drop of human plasma was added to the slide and mixed gently; the clumping was observed immediately.

Characterization and identification of fungal isolates

The cultured plates were examined after 7days of incubation for fungi growth. After incubation period, representative colony types (after careful examination) were picked and sub-cultured on sterile malt extract agar for pure culture. The colonial and microscopic characteristics of the fungal isolates were determined using the lacto-phenol cotton blue staining method. This was done by placing a drop of stain on clean slide with the aid of a sterile syringe; the mycelium was then transferred from the plate to the slide and covered with a covered slip. The slides were viewed using light microscope under x40 objective lens for morphological characteristics. Fungal isolates were then identified following the standard descriptions (Oyeleke and Manga, 2008).

Data analysis

The data generated were analysed using SPSS version 22 window based programme. Discrete variables were expressed as percentages and proportions were compared using the Chi-square test at 5% level of significance. The intensity of eggs was determined using geometric mean of infection.

Ethical considerations

Ethical clearance was sought from the Ethical review board, Ministry of Health Ondo State and a protocol number OSHREC17/11/2021/399 was assigned. Advocacy visits were paid to the health centre in the community, the village king and school authorities in Ipogun community for approval to conduct the study. Parental informed consent for inclusion of the children/wards in the study was obtained. Participation was entirely voluntary and the participants were made aware of the purpose and benefits of the study and their right to withdraw at anytime.

RESULTS

The result revealed that out of the 492 school-aged children examined across all the schools in Ipogun, 306 (62.2%) were positive for *S. haematobium* infection as shown in Table 1. Ayo grammar school recorded the highest prevalence rate of 28.7% while Caritas primary school had the least prevalence rate 2.6% (Table 1). There was significant difference ($p<0.05$) $x^2 = 28.342$, df = 6, p = 0.001 between the proportion of the students that tested positive across the schools. Gender prevalence showed 190 (38.6%) male and 116 (23.6%) female infected students. Although there was a higher count in the number of males tested positive as compared to females as seen in Table 2, there was no evidence of a statistically significant relationship at ($p = 0.112$ $x^2 = 2.522$, df = 1) between gender and infection with schistosomiasis.

A breakdown of the distribution of the disease against age groups is shown in Table 3. Among the age groups examined, the prevalence peaked at age group 11-15 (27.2%) followed by age group 6-10 with (26.2%) while age group ≤5 had the least prevalence (1.2%). Statistically, there was a significant difference at ($x^2 = 28.920$, df = 3, p= 0.001) between the age groups and prevalence of schistosomiasis among pupils in Ipogun.

The overall mean intensity of infection from the infected population was 82.1eggs/10ml urine. The highest egg mean count was seen in Muslim primary school with mean intensity of 22.7eggs/10 ml urine and St Paul's CAC primary school had the lowest mean intensity of 3.0eggs/10ml urine. Prior to the laboratory analysis, haematuria was observed in some samples. The result showed that not all infected samples had haematuria as

Table 1. Prevalence and intensity of urinary schistosomiasis among school-aged children in Ipogun.

School	Number examined	Number infected	Number negative	Prevalence by school (%)	Overall prevalence in the community (%)	Egg mean count
Ayo	187	141	46	75.4	28.7	11.2
CAC	31	19	12	61.3	3.9	3.0
Catholic	26	13	13	50.0	2.6	13.8
Evangel	65	28	37	43.1	5.7	13.1
Morohunkeji	65	39	26	60.0	7.9	9.8
Muslim	50	30	20	60.0	6.1	22.7
St. Jude	68	36	32	52.9	7.3	8.5
Total	492	306	186		62.2	82.1

x^2 =28.342, df = 6, p = 0.001 (p<0.05).

Table 2. Prevalence and intensity of urinary schistosomiasis by gender.

Sex	Number examined	Number infected	Number negative	Prevalence (%)	Egg mean count
Male	292	190	102	38.6	10.6
Female	200	116	84	23.6	11.2
Total	492	306	186	62.2	21.8

x^2 =2.522, df = 1, p = 0.112.

Table 3. Prevalence and intensity of urinary schistosomiasis among age groups in the examined population.

Age group	Number examined	Number infected	Number negative	Prevalence (%)	Egg mean count
≤5	26	6	20	1.2	5.7
6-10	223	129	94	26.2	10.3
11-15	198	134	64	27.2	11.3
16-20	45	37	8	7.52	11.2
Total	492	306	186	62.2	38.5

Table 4. Observed haematuria by gender in the examined population.

Sex	Number examined	Number infected	Number negative	Number with haematuria (%)	Number without haematuria
Male	292	190	102	60 (12.2)	130
Female	200	116	84	32 (6.50)	84
Total	492	306	186	92 (18.7)	214

x^2 =1.615, df = 1, p = 0.2044 (p>0.05).

shown in Table 4. There was no significant difference in the haematuria samples between male 190 (12.2%) and the female pupils 116 (6.5%) with p = 0.2044.

The predominant microbes associated with urinary schistosomiasis were *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella* species, *Pseudomonas aeruginosa* and *Proteus* species for bacteria and *Aspergillus* species and *Candida* species for fungi (Tables 5 and 6). Among the gender, there were no differences in the types of urinary bacteria pathogens. Across the gender, 29 infected female pupils (47.5%) had bacterial infection while 22 infected males (36.1%) were infected as shown in Table 7. Table 8 showed the occurrence of fungi which was higher in female (19.7%) than in male (9.8%) pupils, while the rate of occurrence for co-infection in female was 13.1% and 4.9% in male pupils.

Table 5. Diversity and occurrence of bacterial isolates in the urine samples.

S/N	Bacteria Isolate	Frequency of occurrence	% occurrence
1	*Escherichia coli*	98	36.9
2	*Staphylococcus aureus*	53	20.0
3	*Klebsiella aerogenes*	48	18.1
4	*Pseudomonas aeruginosa*	27	10.1
5	*Proteus* species	39	14.7

Table 6. Cultural characteristics of fungi isolated in the urine samples.

S/n	Fungi species	Hyphae type	Spore shape	Appearance on malt extract agar
1	*Aspergillus* species	Septate	Flask shaped	White
2	*Candida albican*	pseudo- hyphae	Oval	Creamy

Table 7. Occurrence of bacterial infections and co-infection in relation to gender.

Sex	Total number examined	No infected with bacteria (%)	No negative with bacteria (%)	No positive with schistosomiasis & bacteria (%)	No positive with schistosomiasis only
Male	27	22(36.1)	5(8.2)	18(29.5)	9
Female	34	29(47.5)	5(8.2)	25(40.9)	9
Total	61	51(83.6)	10(16.4)	43(70.5)	18

Table 8. Occurrence of fungi infections and co-infection in relation to gender.

Sex	Total no examined	No infected with fungi (%)	No negative with fungi (%)	No positive with schistosomiasis & fungi (%)	No positive with schistosomiasis
Male	27	6(9.8)	21(34.4)	3(4.9)	24
Female	34	12(19.7)	22(36.1)	8(13.1)	26
Total	61	18(29.5)	43(70.5)	11(18.0)	50

DISCUSSION

The result revealed that urinary schistosomiasis is a public health problem among school-aged children in Ipogun as the prevalence was 62.2%. Repeated exposure to infection is said to be a major reason for endemicity. The results of this study indicate a high prevalence of urinary schistosomiasis in the screened population with 18.7% of the sampled population having visible haematuria. The prevalence obtained in this study was higher compared to the findings in a south western village in Nigeria. Oniya and Odaibo (2006) reported 59% and another prevalence of 18% reported in Ondo State by Oniya and Olofintoye (2009). In other parts of the country, 15.6% was reported in Tafa LGA of Niger State (Nafiu *et al.,* 2016) while 48% was reported in Wamakko Local Government Area in Sokoto State (Muhammed *et al.,* 2019). Similarly, a prevalence rate of 41.6% was reported in Danjarima Kano State (Sarkinfada *et al*., 2009) and Ugbomoiko *et al.* (2000) reported a prevalence of 62.0% among people in two peri-urban communities (Eko-ende and Ore) in Osun State.

The prevalence reflects the seemingly high exposure of the pupils to cercaria-contaminated water bodies. The high prevalence rate observed in the study area may also be as a result of the interrupted efforts of the government and other agencies in control strategies deriving from poor political will. Similarly, decreased awareness and staggered interventions (Oniya and Olofintoye 2009; Oniya and Jeje, 2010); and inherent socio-cultural practices may continue to fester to favour infection/re-infection. The observed prevalence rate was higher among male subjects with 38.6% prevalence rate compared to female having 23.6% prevalence. Anya and Okoronkwo (1991) noted that male pupils were significantly more susceptible to school infection than female as observed in this study, and this is similar to previous studies (Awosolu *et al*., 2020). Akinneye *et al*. (2018) reported that prevalence was higher in male than female in Ondo State. Similarly, Onifade and Oniya (2018) also reported 23.3% prevalence of infection in male pupils while a prevalence

of 15.4% was recorded for the female from another local government area of Ondo State. This may be linked to the fact that male children engaged more in water contact activities during the peak hours of cercaria shedding by the snail hosts which are predisposing factors to infection while the female children carryout less water contact activities (Oniya and Odaibo, 2006).

The observed prevalence among age group showed that age group 11-15 years had the highest prevalence of infection (27.2%). It was also suggested that high prevalence of schistosomiasis among age group 11-15 years old is because of possible frequent visits to water bodies for recreational activities like swimming, than those in the other age groups. Worrell *et al.* (2016) also suggested that high prevalence of schistosomiasis among age group 11-15 years old is because of possible frequent visits to water bodies for recreational activities like swimming, than those in the other age groups. This can be attributed to their continuous indulgence in activities that bring them in contact with infected water bodies. Age group ≤ 5 years had the lowest rate (1.2%), the reason for this might be because the age group rarely engaged in activities that required going to the stream, then followed by age group 16-20 years which could be attributed to self-consciousness and prestige. There was significant difference among the age group $\chi^2 = 28.920$; $p = 0.001$. According to Oniya (2007), School-aged children in Ipogun performed recreational activities like swimming in "Aponmu" stream, giving frequent contact with the fresh water body. The occurrence of haematuria from this report (18.7%) showed there was significant difference between the schools examined and no significant difference was seen between the age, class, and gender ($p>0.05$). This is because haematuria is a characteristic symptom of urinary schistosomiasis in endemic communities (Ekpo *et al.,* 2010). This suggests that the pathology associated with *S. haematobium* as presented by haematuria is a function of intensity and frequency of exposure.

Five bacteria and two fungi were isolated from 61 schistosomiasis positive samples following standard procedure. Though it was noted that urinary tract disease is a trait of infection with *S. haematobium* (King, 2010), there was no significant difference ($p>0.05$) between bacteriuria and urinary schistosomiasis co-infection assessed in the study. Gallagher and Hemphil (2004) and Franz and Horl (1999) had equally noted that in general terms, urinary tract infection (UTI) is caused by pathogens along the urinary tract causing inflammation depicted by pyuria indicating significant inflammatory response to bacteriuria. Bacteria isolated were *S. aureus, E. coli, Klebsiella* sp*, Proteus* sp*,* and *Pseudomonas* sp*.* There was no significant difference ($p>0.05$) in bacteria isolated from male and female participants. The male had 36.1% rate of bacterial infection while female had 47.5% which could be as a result of wider surface area of female genitalia, and the shortness of the female urethra could predispose them to UTIs than male, thus the female gender may be more prone to UTI than the male (Ngong *et al., 2021*). The isolation of *Esherichia coli* (36.9%) occurred more frequently than other bacteria followed by *Staphylococcus aureus with* 20.0 *%* while the least organism was *Pseudomonas aeruginosa*. The occurrence rate of co-infection (70.5%) for bacteria recorded in this study was high compared to 53.7% reported in Enugu State (Ossai *et al.,* 2014) while fungi (18%) was low. The fungi isolated were *Aspergillus* sp and *Candida* sp. with *Aspergillus* having the highest occurrence. Therefore, the complimentary incorporation of antibiotic therapy appears essential and significant in the treatment and management of schistosomiasis, particularly in endemic communities.

Conclusion

The result revealed high prevalence and intensity of urinary schistosomiasis among school aged children in Ipogun which deserve urgent intervention from the government to control the disease. The children are at high risk of exposure to infection/reinfection due to the inherent socio-cultural behaviour and poor social amenities in the community. Also, the high water contact activities in Aponmu stream enhances disease transmission among the pupils and the community at large thus, the schistosomiasis control programme in endemic communities including Ipogun must be a continuous programme via enlightenment of residents on risk factors that predispose to infection. This must be done along with other interventions including routine chemotherapy and occasional molluscicide. For as long as the cultural perceptions and attitudes of dwellers in communities where the disease is endemic do not change, it will be an uphill task to achieving control, let alone elimination by the desired SDG agenda 2030. A lot more political commitment towards control is of essence as majority of the afflicted and affected are impoverished peasants who do not have enough resources to seek repeated medical intervention. For the disease to be eliminated, there must ownership of the control efforts at all levels of intervention.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENT

The authors acknowledge with thanks the contributions of Mrs. E.T. Ojo and Mr S.B. Jimoh during sampling and laboratory analyses. We also appreciate the cooperation of the King of Ipogun Village, staff of the schools and parents of the participants in the study.

REFERENCES

Akinneye, J. O., Fasidi, M. M., Afolabi, O. J., & Adesina, F. P. (2018). Prevalence of urinary schistosomiasis among

secondary school students in Ifedore local government, Ondo state, Nigeria. *International. Journal of Tropical medicine and infectious Diseases*, *1*(1), 1-6.

Ana, L. F, Walker, J. N., Caparon, M., & Hultgren, S. J. (2015). Urinary tract infections: epidemiology, mechanisms of infection and treatment options. *Nature reviews microbiology*, *13*(5), 269-284.

Anya, A. O., & Okoronkwo, F. O. (1991). Studies of infection with *Schistosoma haematobium* and its effects on the reproductive biology of Buliniid snails in South Eastern Nigeria. *Journal of the Nigerian Academy of Science,* 3, 14-25.

Awosolu, O. B., Shariman, Y. Z., Haziqah MT, F., & Olusi, T. A. (2020). Will nigerians win the war against urinary schistosomiasis? Prevalence, intensity, risk factors and knowledge assessment among some rural communities in southwestern Nigeria. *Pathogens*, *9*(2), Article number128.

Cheesbrough, M. (2000). *Microbiological Tests: District laboratory practice in tropical countries*, Cambridge University Press. Pp. 105-130.

Ekpo, U. F., Laja-Deile, A., Oluwole, A. S., Sam-Wobo, S. O., & Mafiana, C. F. (2010). Urinary schistosomiasis among preschool children in a rural community near Abeokuta, Nigeria. *Parasites & Vectors*, *3,* Article number 58.

Farid, Z. (1993). Schistosomes with terminal-spined eggs: Pathological and clinical aspects. In: Jordan, P., Webbe, G., & Sturrock, R. F. (eds.). *Human schistosomiasis.* Wallingford, UK, CAB International. Pp. 159-193.

Fawole, M. O., & Oso, B. A. (2007). *Characterisation of bacteria: Laboratory manual of microbiology*. (Revised Edition). Spectrum Book Limited. Pp. 24-33.

Fenwick, A., & Webster, J. P. (2006). Schistosomiasis: challenges for control, treatment and drug resistance. *Current Opinion in Infectious Diseases*, *19*(6), 577-582.

Franz, M., & Hörl, W. H. (1999). Common errors in diagnosis and management of urinary tract infection. I: Pathophysiology and diagnostic techniques. *Nephrology Dialysis Transplantation*, *14*(11), 2746-2753.

Gallagher, S. A., & Hemphil. R. R. (2004). *Urinary tract infections: Epidemiology, detection, and evaluation. Hot topies in healthcare*. Thomson American Health consultants, Inc. Pp. 1-9.

Ganley-Leal, L. M., Mwinzi, P. N., Cetre-Sossah, C. B., Andove, J., Hightower, A. W., Karanja, D. M., Colley, D. G., & Secor, W. E. (2006). Correlation between eosinophils and protection against reinfection with Schistosoma mansoni and the effect of human immunodeficiency virus type 1 coinfection in humans. *Infection and Immunity*, *74*(4), 2169-2176.

Ifeanyi, C. I., Matur, B. M., & Ikeneche, N. F. (2009). Urinary Schistosomiasis and concomitant bacteriuria in the Federal Capital Territory Abuja, Nigeria. *New York Science Journal, 2*(2), 1-8.

King, C. H. (2009). Toward the elimination of schistosomiasis. *New England Journal of Medicine*, *360*(2), 106-109.

Mostafa, M. H., Sheweita, S. A., & O'Connor, P. (1999). Relationship between schistosomiasis and bladder cancer. *Clinical Microbiology Reviews*, *12*(1), 97-111.

Muhammed, I. A., Abdullahi, K., Bala, A. Y., & Shinkafi, S. A. A. (2019). Prevalence of urinary schistosomiasis among primary school pupils in Wamakko Local Government, Sokoto State, Nigeria. *The Journal of Basic and Applied Zoology*, *80*, Article number 22.

Nafiu, S., Inuwa, B., Abdullahi, A., Alkali, Z., & Ibrahim, B. A. (2016). Prevalence of urinary schistosomiasis among primary school pupils in Kofa primary school, Tafa local government, Niger State, Nigeria. *Ewemen Journal of Epidemiology and Clinical Medicine*, *2*(1), 7-13.

Ngong, I. N., Fru-Cho, J., Yung, M., & Akoachere, J. K. T. (2021) Prevalence, antimicrobial susceptibility pattern and associated risk factors for urinary tract infections in pregnant women attending ANC in some integrated health centers in the Burea Health District. *BioMed Central Pregnancy and Childbirth, 21*, Article number 673.

Ojezele, M. O. (2020). Urinary tract infection: prevalence, isolated organisms and antimicrobial susceptibility pattern, South-south Nigeria. *Central African Journal of Medicine*, *65*(7-12), 57-61.

Olutiola, P. O., Famurewa O., & Sonntag, H. S. (2000). An Introduction to General Microbiology: A practical approach. Heideberger Verlagsanstalt and Drukerei GmBH Heldelberg Gmbh, Germany. Pp. 101-111.

Onifade, O. E., & Oniya, M. O. (2018). Prevalence of urinary schistosomiasis and efficacy of praziquantel; a case study of school pupils in Oke-Igbo, Ondo State, Nigeria. *South Asian Journal of Parasitology, 1*(1), 1-10.

Oniya, M. O. (2007). Socio-Cultural practices promoting the transmission of urinary schistosomiasis among School Aged Pupils in a South Western village in Nigeria. *Research Journal of Biological Sciences*, *2*(1), 1-4.

Oniya, M. O., & Jeje, O. (2010). Urinary schistosomiasis: Efficacy of praziquantel and association of the ABO blood grouping in disease epidemiology. *International Journal of Biotechnology and Molecular Biology Research*, *1*(13), 31-35.

Oniya, M. O., & Odaibo, A. B. (2006). Reinfection pattern and predictors of urinary schistosomiasis among school pupils from a Southwestern village in Nigeria. *International Journal of Tropical Medicine*, *1*, 173-177.

Oniya, M. O., & Olofintoye, L. K. (2009). The prevalence of urinary schistosomiasis in two endemic Local Government Areas of Ondo State. *Nigeria Journal of Parasitology*, *30*, 147-51.

Oniya, M. O., Ishola, M. A., & Jayeoba, O. D. (2013). Schistosomiasis in Ipogun: Update assessment on endemicity and efficacy of praziquantel in chemotherapy. *International Journal of Tropical Disease & Health*, *3*(1), 37-44.

Ossai, O. P., Dankoli, R., Nwodo, C., Tukur, D., Nsubuga, P., Ogbuabor, D., Ekwueme, O., Abonyi, G., Ezeanolue, E., Nguku, P., & Eze, G. (2014). Bacteriuria and urinary schistosomiasis in primary school children in rural communities in Enugu State, Nigeria, 2012. *The Pan African Medical Journal*, *18*(Suppl 1), Article number 15.

Oyeleke, A., & Manga, S. B. (2008). *Essential of Laboratory Practice* (3rd edition). Minna, Niger State, Nigeria. Tobest Publisher. Pp. 12-29.

Sarkinfada, F., Oyebanji, A. A., Sadiq, I. A., & Ilyasu, Z. (2009). Urinary schistosomiasis in the Danjarima community in Kano, Nigeria. *The Journal of Infection in Developing Countries*, *3*(06), 452-457.

Stamm, W. E., & Norrby, S. R. (2001). Urinary tract infections: disease panorama and challenges. *The Journal of infectious diseases*, *183*(Supplement_1), S1-S4.

Tonolini, M., & Ippolito, S. (2016). Cross-sectional imaging of complicated urinary infections affecting the lower tract and male genital organs. *Insights into Imaging*, *7*, 689-711.

Ugbomoiko, U. S. (2000). The prevalence, incidence and distribution of human urinary schistosomiasis in Edo State, Nigeria. *Australian and New Zealand Journal of Public Health*, *24*(6), 642-643.

World Health Organization (WHO) (2013). Schistosomiasis. World Health Organization, Geneva, Switzerland. Retrieved from https://www.who.int/news-room/fact-sheets/detail/schistosomiasis

Worrell, C. M., Wiegand, R. E., Davis, S. M., Odero, K. O., Blackstock, A., Cuéllar, V. M., Njenga, S. M., Montgomery, J. M., Roy, S. L., & Fox, L. M. (2016). A cross-sectional study of water, sanitation, and hygiene-related risk factors for soil-transmitted helminth infection in urban school-and preschool-aged children in Kibera, Nairobi. *PloS One*, *11*(3), e0150744.