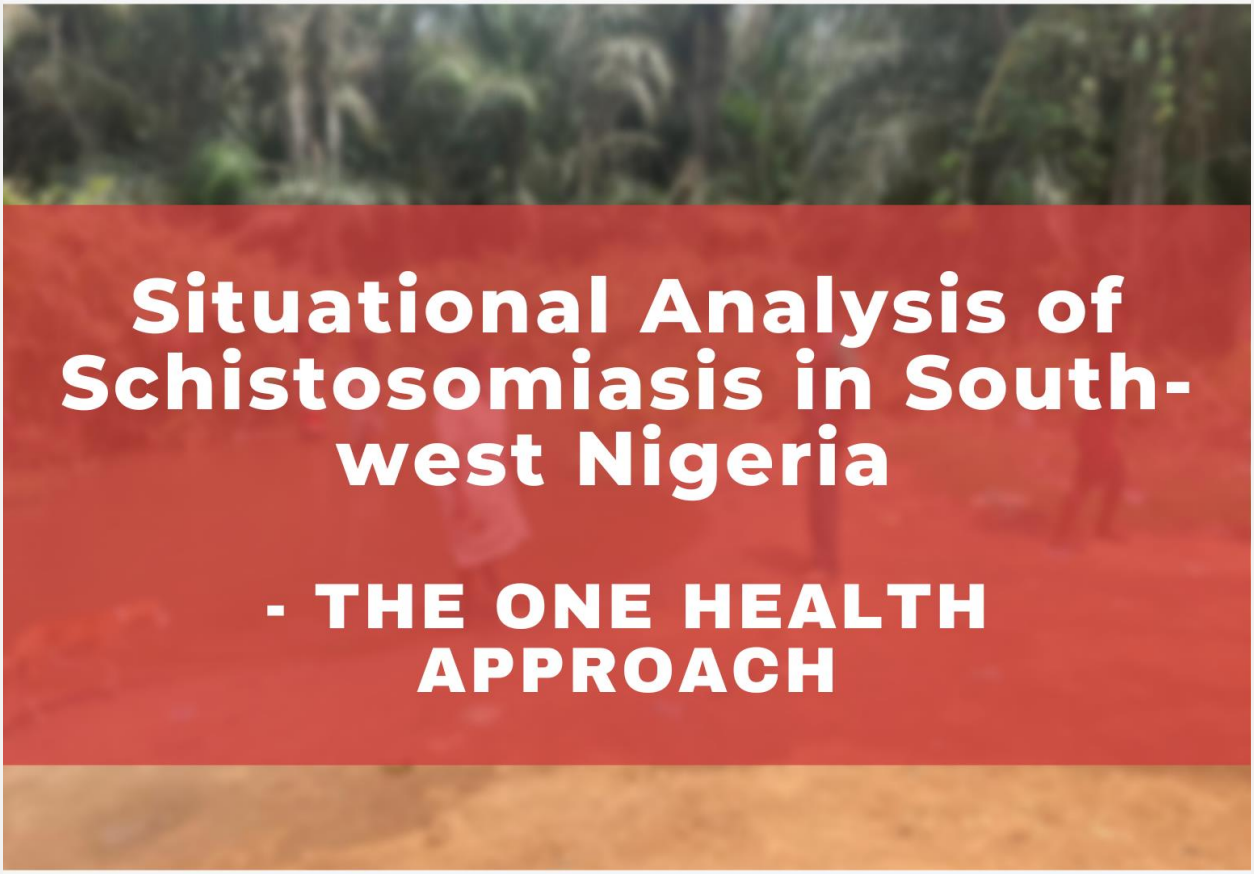
HDI

One Health & Development Initiative



Situational Analysis of Schistosomiasis in South-west Nigeria

- THE ONE HEALTH APPROACH

A TECHNICAL REPORT

COPYRIGHT STATEMENT

CONTRIBUTORS

Dr. Kikiope O. Oluwarore
Dr. Abiodun Wahab
Christianah Oki
Damilola Adesuyi
Dr. Abdullah Al-Awal
Dr. Franklyn Oluwadare
Prof. Alexander Odaibo

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This report was developed with the support and contribution of dedicated public health and One Health professionals and institutions many of whom work to address Neglected Tropical Diseases (NTDs) and specifically, schistosomiasis. This includes the project team at One Health and Development Initiative (OHDI), researchers, ad-hoc staff, community leaders, amiable NTD and public health officials in the government spaces, and funders.

We acknowledge the efforts and contribution of the OHDI team, led by **Dr. Kikiope Oluwarore** who conceptualized and supervised the project, leading the project team and stakeholders from project initiation to completion and documentation; **Dr. Abiodun Wahab** (RSTMH Grantee) and **Christianah Oki** who provided key support in project operations, stakeholder engagement; data collection, supervision of data collectors and report development; **Idris Otun Olasubomi, Dr Edward Olajide, Tolulope Ibiyemi, Ajakaye Peace**, **Foluke Oluyemi** and **Damilare Dauda** who facilitated data collection across the 6 south-west states; **Damilola Adesuyi** who contributed to analyzing, integrating and finalizing the research documentation process; other OHDI staff and volunteers **Dr. Franklyn Oluwadare**, **Adekola Adebiyi, Abdullah Adedeji Al-Awal** for research documentation; and **Ilunamien Eric Aisedion** for copy-editing the report.

We appreciate Project Consultants/Researchers - **Prof. Alexander B. Odaibo** and **Dr. Ayodele Majekodunmi** for their close guidance and technical support in the project implementation.

Gratitude to the leadership and staff of the NTD Units and Public Health Divisions of the Federal Ministry of Health, and State Ministries of Health in Lagos, Ogun, Oyo, Osun, Ondo and Ekiti who responded to surveys and requests for interviews, facilitated engagement with community-level stakeholders and provided information and data which supported and contributed to the development of this report. We appreciate:

- **Dr. Obiageli Nebe**, Director and Programme Manager; National Schistosomiasis/STH Elimination Programme, Federal Ministry of Health, Nigeria
- **Gideon Uduak**; National Schistosomiasis/STH Elimination Programme, Federal Ministry of Health, Nigeria
- **Oladoyinbo Tunji Oloyede**, SNTD Coordinator; Oyo State Primary Health Care Board

- **Jenrola Olanrewaju Idris**, Lagos State NTD Coordinator and Deputy Director Medical Laboratory Services, Lagos State Ministry of Health,
- **Ojo Herbert Kayode**, NTDs Program Coordinator, Ekiti State Ministry of Health,
- **Mrs Olufunke Ajomole**, Ondo State NTDs Elimination Program Coordinator, and
- **Dr. Ismailat Soneye**, Public Health Physician and NTDs Elimination Program Coordinator, Ogun State Ministry of Health

Finally, we appreciate **Conservation, Food and Health (CFH) Foundation** and **Royal Society of Tropical Medicine and Hygiene (RSTMH)** who provided funding support for this project.

Thank you from One Health and Development Initiative (OHDI).

EXECUTIVE SUMMARY

Nigeria has the largest burden of schistosomiasis in the world with an estimate of 29 million people affected by the disease and over 100 million people (especially women and children) still at risk of infection (Dawaki *et al*, 2016; Ezeh *et al*, 2019). Though there have been several efforts by government institutions and civil society organisations in the country to treat, control, and prevent the disease, the high prevalence persists. Several research reports (Oyeyemi *et al.*, 2020; Dawaki *et al.*, 2016; Ezeh *et al.*, 2019), have established that these efforts have been largely hindered by poor disease surveillance and inadequate comprehensive and coordinated open-access data on the disease distribution. Also, interventions have relied largely on the implementation of mass drug administration (MDA) and this does not holistically address risk of re-infection and the impact of animal reservoirs, snail intermediate hosts, zoonosis, poor environmental and sanitation outcomes, and sociocultural risk-factors associated with the disease's spread. This necessitates a need to adopt an integrated and holistic approach for schistosomiasis control. This south-west region of Nigeria seems to be one of the most affected regions (Oyeyemi *et al.* (2020); Ezeh *et al.* (2019)) and has been declared a hyper-endemic zone for schistosomiasis (Abdulkadir *et al*., 2017; Ezeh *et al*., 2019).

One Health utilises a collaborative integrated approach to address cross-cutting health issues occurring at and affecting the human, animal, environment and ecosystem interface to achieve sustainable, optimised health and development (WHO, 2017). In light of the peculiarities and multi-factorial challenges identified with schistosomiasis, the One Health approach is appropriate to be applied for research and intervention. This will help to inform, plan, design and develop direct, specific and cost-effective strategic solutions that can effectively control and prevent the disease, and consequently reduce prevalence. Therefore, this research sought to retrieve and assess information on the current distribution of schistosomiasis in south-west Nigeria, identify peculiar community-relevant environmental health, animal health and sociocultural risk-factors that facilitate the disease's prevalence, while recommending One Health intervention strategies.

The research was conducted across the six south-west Nigerian states - Lagos, Ogun, Oyo, Osun, Ondo and Ekiti, and sought to provide updated comprehensive information on the current situation, trends, and risk-factors of schistosomiasis in south-west Nigeria. More importantly, the research also sought

to inform the development of next-level intervention strategies for the control and prevention of the disease – particularly in line with utilising the integrated One Health approach that can be adopted, implemented, and replicated across all Nigerian states.

The data collection process utilised a mixed-methods qualitative approach which included conducting a desk review of existing peer-reviewed research, grey literature, and health data records, key informant interviews (KII) and focus group discussions with relevant stakeholders, and evaluating communities identified to have high prevalence of schistosomiasis in the 6 respective south-western states. Ethical approvals were received across all states, data were stored and managed via restricted access platforms and analyzed using qualitative analysis tools.

Results show that schistosomiasis is still prevalent in South-west Nigeria, with varying levels of prevalence in many LGAs and communities across the 6 south-western states, ranging from 3.2% to 80%. A significant level of knowledge on schistosomiasis was observed among community respondents who were able to identify the local names, and most health officials understood the disease's predisposing factors, causative agent, mode of transmission and the organism's life cycle. Across all states, age and gender was considered a risk factor, with infections affecting children - especially male children.

Causative organisms included *Schistosoma mansoni and Schistosoma haematobium*, transmitted by a variety of snail intermediate host species - *Bulinus truncatus*, *Bulinus globosus*, *Biomphalaria pfeifferi* and *Bulinus camerunensis*. While there were reports of little to no diagnostic equipment in health centres for confirmatory diagnosis, research studies reviewed utilized a variety of diagnostic tools such as microscopy, chemical reagent test strip, and PCR-based testing. Among these, PCR was determined to be the best and most accurate method for testing. In the absence of diagnostic equipment in health centres, presenting clinical signs such as visual inspection for hematuria and complaints of abdominal pain is often relied upon for diagnosis.

The primary treatment and control measure for schistosomiasis is an annual/biannual MDA (Mass Drug Administration) of anthelmintics such as Mebendazole, Praziquantel and Albendazole. However, some reports indicate that the use of herbal and traditional remedies are still rampant, while some communities engage in spiritual baths and cleanses in a bid to get cure.

Furthermore, myths and beliefs about schistosomiases are still rife, some of which include the belief that the disease is a normal for human growth, is a sign of puberty or maturity, prevents bedwetting, that it's a sexually transmitted disease like HIV and gonorrhea, can be acquired from stepping on or urinating near dog's urine, or it is a sign of evil afflictions. Some of these beliefs have led to the stigmatization of the disease, thereby discouraging infected persons from seeking treatment and hindering effective disease surveillance.

Major environmental risk factors included recreational swimming behaviours and absence of potable water sources and WASH facilities. These have inadvertently facilitated the reliance of community members on proximate (albeit unclean) water bodies for domestic and recreational use, leading to poor sanitary conditions, poor hygiene practices, indiscriminate urination around water bodies, open defecation, dirty environments, and washing from faecal matter and wastes into the streams and rivers. Socioeconomic activities such as fishing were also indicated as presenting high risk of transmission of schistosomiasis.

While vector-borne transmission of the disease has been well established, there are concerns of possible risk of co-infection and/or cross-infection from commonly kept domestic animals such as pigs and dogs, and cattle. These concerns stemmed from the fact that many areas and communities affected often keep pets and livestock animals, which utilize the same (unclean) water sources as humans. Additionally, some key informants (in Ogun State) indicated probable cases of bovine transmission of the disease to humans. However, there is little data yet to prove a definite transmission of schistosomiasis between animals and humans in Southwest-Nigeria.

Respondents also indicated past intervention activities in their communities, such as awareness campaigns, frequent environmental sanitation practices with inspections by environmental sanitation officers, provision of hand-washing facilities, wells and boreholes, and referral to modern medical institutions. Several challenges were indicated, and key ones include lack of/inadequate boreholes and sources of potable, people's aversion to necessary medications due to reported side effects, inadequate engagement between health officials and community members, and lack of enthusiasm towards getting necessary medical attention.

The One Health approach implemented in this study, presents an opportunity, and need to design, plan, and implement interventions that can cohesively

address all these disease drivers and risk factors, leverage on inter-sectoral resources and skills, and provide sustainable long-term solutions. Utilisation of this approach has been reported to be successful in countries like China and Brazil (Oyeyemi, 2020; Sun *et al*., 2017). And in a 2022 report, the World Health Organization (WHO) recognized the inadequacies of the previously recommended intervention strategy of Mass Drug Administration (MDA) and emphasised the need a more comprehensive approach to combating schistosomiasis, incorporating human health and activities, animal health, and environmental health factors (WHO, 2022).

Key recommendations to combating schistosomiasis span the implementation of effective strategies such as improving community awareness and action; provision of WASH facilities; effective low-cost diagnostics, consistent surveillance and treatment regimen; vector control and good animal health practices; periodic evaluation and re-assessment of interventions, stakeholder collaboration and alignment with other NTD programs and the important need for publication of open-access data to inform other stakeholders and share lessons learned. These several intervention strategies will greatly benefit from integrating the One Health approach. Such benefits include:

1) Supporting inter-sectoral cross-disciplinary efforts to address all risk factors, with gve stakeholders the opportunity to leverage, learn, utilize, and adapt sectoral information, skills, and resources.

2) With all risk-factors (human, vector/animal, environmental, sociocultural, socioeconomic) identified and addressed cohesively, sustainability of interventions is guaranteed and most importantly, the persistence prevalence, re-emergence or incessant outbreaks of the disease can be mitigated or reduced

3) There will be improved cost-effectiveness of interventions as sectors leverage on each other's strengths and resources with the common goal of addressing the same disease.

4) There will be improved stakeholder engagement and ownership of interventions and solutions which enhance sustainability of results.

INTRODUCTION AND BACKGROUND

Nigeria has the largest burden of schistosomiasis in the world with an estimate of 29 million people affected by the disease and over 100 million people (especially women and children) still at risk of infection (Dawaki *et al*, 2016; Ezeh *et al*, 2019). Though there have been several efforts by government institutions and civil society organisations in the country to treat, control, and prevent the disease, the high prevalence persists. Several research reports (Oyeyemi *et al.*, 2020; Dawaki *et al.*, 2016; Ezeh *et al.*, 2019), have established that these efforts have been largely hindered by inadequate comprehensive and coordinated open-access data on the disease distribution – including inconsistent data-driven updates on identification of key specific schistosomiasis hotspot communities. Also, while recognizing several laudable efforts by government institutions and partners at both national and subnational levels, disease surveillance is still inadequate at national, state, and LGA levels, and there is little to no coordinated report since the last country programme to map Neglected Tropical Diseases (NTDs) (schistosomiasis included) was conducted in 2015. Other scientific research and peer-reviewed reports available on schistosomiasis are mostly isolated research endeavours, localised to specific thematic areas of schistosomiasis, and cannot be generalised to the larger population of Nigeria or schistosomiasis endemicity.

This inadequate data is particularly of concern in the south-west region which, according to Oyeyemi *et al.* (2020) and Ezeh *et al*. (2019), seems to be one of the most affected regions in Nigeria with prevalence ranging from 44.8% to 71.5% in endemic areas of Osun and Ogun States, respectively. In addition, Oyeyemi *et al.*(2020) reports that the south-western region seems to have lesser concentration of control interventions compared to other regions of the country. It is therefore of little surprise and of great concern that the south-western region was declared to be a hyper-endemic zone for schistosomiasis (Abdulkadir *et al*., 2017; Ezeh *et al*., 2019). With these problems of insufficient data, it is difficult to accurately identify specific schistosomiasis-endemic communities and the accompanying risk-factors that drive the prevalence of the disease. Thus, this has limited efforts to inform, plan, design and develop direct, effective, and accurate strategic interventions that can effectively control and prevent the disease, and consequently reduce prevalence.

Furthermore, where efforts are being made to address schistosomiasis, the focus is often only on the implementation of mass drug administration (MDA). However, with the persistent transmission of schistosomiasis in affected communities, it is

evident that MDA implementation only cannot protect people from re-infection; neither can it holistically address the impact of animal reservoirs, snail intermediate hosts, zoonosis, poor environmental and sanitation outcomes, and sociocultural risk-factors associated with the spread of schistosomiasis. In fact, in 2022, the World Health Organisation (WHO) updated the previously recommended intervention strategy of Mass Drug Administration (MDA) to a more holistic approach that should include preventive chemotherapy, WASH interventions, environmental interventions, focal snail control, and behavioural change interventions (WHO, 2022).

Nigeria, like many sub-Saharan African countries, still depends largely on chemotherapy for the control of schistosomiasis. In this regard, Oyeyemi *et al.* (2020) corroborates and echoes the need to adopt an integrated and holistic approach for schistosomiasis control. They mention that the control of schistosomiasis must advance from sole dependence on chemotherapy to include "*interventions informed by appropriate and reliable mapping of the disease, snail control, provision of safe water, and evidence-based decision making in policy development*".

RESEARCH JUSTIFICATION

The combined challenges of high prevalence of schistosomiasis in south-west Nigeria, inadequate data, and need to utilise and deploy a holistic, integrated and coordinated intervention approach justifies the need to secure holistic and accurate information via the One Health approach on the current situation and trends of schistosomiasis in the region. One Health utilises a collaborative integrated approach to address cross-cutting health issues occurring at and affecting the human, animal, environment and ecosystem interface to achieve sustainable, optimised health and development (WHO, 2017). In light of the peculiarities and multi-factorial challenges identified with schistosomiasis, the One Health approach is appropriate to be applied for intervention. Therefore, in addition to retrieving and assessing information on the current distribution of schistosomiasis in south-west Nigeria, this research sought to identify peculiar community-relevant environmental health, animal health and sociocultural risk-factors that facilitate the disease's prevalence. The research was conducted across the six south-west Nigerian states - Lagos, Ogun, Oyo, Osun, Ondo and Ekiti with the following clear objectives:

- To identify areas and/or communities with comparably higher prevalence levels of schistosomiasis

- To identify peculiar environmental health risks and WASH-related practices or factors that drive the continuous prevalence of schistosomiasis in these identified communities.
- To identify animal and intermediate snail-host related risk-factors that perpetuate the existence and prevalence of schistosomiasis in the identified communities
- To identify peculiar socio-cultural perceptions, norms, beliefs, behaviours, and practices that drive the persistent prevalence of schistosomiasis in the identified communities.

The results of this research will provide updated comprehensive information on the current situation, trends, and risk-factors of schistosomiasis in south-west Nigeria. More importantly, this research will inform the development of next-level intervention strategies for the control and prevention of the disease – particularly in line with utilising the integrated One Health approach that can be adopted, implemented, and replicated across all Nigerian states.

METHODOLOGY

DATA COLLECTION

The data collection process utilised a mixed qualitative approach which included conducting a desk review of existing peer-reviewed research, grey literature, and health data records, key informant interviews (KII) and focus group discussions with relevant stakeholders, and evaluating communities identified to have high prevalence of schistosomiasis in the 6 respective south-western states. This mixed-methods approach helped to improve the reliability and validity of the study. Ethical approval of the study, data collection tools, and research process were secured from each state's Ministry of Health. In developing data collection tools (ANNEX 2-5), key research questions on the level of knowledge and distribution of schistosomiasis, environmental health factors, snail intermediate host, animal reservoir, and sociocultural risk-factors were well represented. Subsequently, key stakeholders and potential respondents in the states were mapped, identified, and engaged over the course of the data collection process. Such stakeholders included local, state, and national level health officials, representatives of Neglected Tropical Disease (NTDs) Units, community health workers, community members, and representatives of civil society organisations that have worked on schistosomiasis in the states.

DESK REVIEW

The systematic desk review was adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Moher *et al.*, 2015) via the following processes:

1. A systematic database search for potentially relevant original research articles and grey literature was conducted.
2. Titles and abstracts of research articles and grey literature were screened and evaluated based on predefined inclusion and exclusion criteria.
3. Full texts of shortlisted research articles and grey literature were screened and evaluated based on predefined inclusion and exclusion criteria.
4. Data extraction, collation, and analysis of all final selected articles were conducted.

For original research articles, we searched six databases with the largest repertoire of research articles in human health and disease between October

2021 and May 2022. The databases included Scopus, PubMed, Science Direct, Directory of Open Access Journals (DOAJ), JSTOR, and Google Scholar. On these databases, we searched for publications that reported on schistosomiasis in the English language across the six states. For grey literature, we searched 10 websites of national and international organisations responsible for health matters and NTD research and interventions relevant to Nigeria. These websites were searched for documents and articles reporting on schistosomiasis in English language across the six states. These included websites of the Federal Ministry of Health Nigeria (FMoH), State Ministry of Health (NTD Unit), Nigerian Center for Disease Control (NCDC), African Center for Disease Control (ACDC), United States Center for Disease Control (US CDC), the World Health Organization (WHO), The Carter Center, Uniting to Combat NTDs, NTD NGO Network, and Sightsavers.

On all databases and websites, where needed, we used Boolean logic, truncation, and filters to enable an optimised retrieval of relevant studies and reports. We then conducted an initial review of article abstracts, titles, keywords, report summaries and tables of content (as relevant) against our predefined inclusion and exclusion criteria listed in the complete study protocol (ANNEX 1). This was done to determine the relevance of each article to research objectives.

A full text review was conducted for all reports that met the inclusion criteria or contained insufficient information to determine exclusion or inclusion. Data was then extracted from the final list of reports and collated on Microsoft Excel.

KEY INFORMANT INTERVIEWS (KIIS)

Questionnaire guides that addressed the key study evaluation questions were developed for KIIs sessions, and these were deployed via in-person and/or virtual meeting platforms to identified stakeholders. Key stakeholders engaged in KIIs include health officers of the local, state and national-level NTD department, community health workers, and representatives of civil society organisations that have worked on schistosomiasis in some of the states. Evaluation questions included inquiries on knowledge of schistosomiasis, prevalence, and distribution of schistosomiasis in the states/communities, population(s) considered the most vulnerable, perception of residents in affected communities towards schistosomiasis, perceived environmental, animal reservoir/ snail intermediate hosts and sociocultural risk factors, and recommendations on combating schistosomiasis.

FOCUS GROUP DISCUSSIONS (FGDS)

Questionnaire guides that addressed the key study evaluation questions were developed for community FGD sessions and these were deployed via in-person meetings to community members in communities that have been identified by state-level NTD officials to have high prevalence of schistosomiasis. Evaluation questions included inquiries on knowledge of schistosomiasis, prevalence, and distribution of schistosomiasis in the states/communities, population(s) considered the most vulnerable, perception of residents in affected communities towards schistosomiasis, perceived environmental, animal reservoir/ snail intermediate hosts and sociocultural risk-factors, and recommendations on combating schistosomiasis.

COMMUNITY EVALUATION

To support information received during KIIs and FGDs, risk-factors associated with schistosomiasis were evaluated during physical visits to the community. We identified indicator guides for the community evaluation exercise and these included: presence or lack of clean water sources, toilets, waste disposal facilities and practices, and sanitation and hygiene practices. Other factors considered include presence of water bodies and snail intermediate hosts, frequency of use of water bodies and presence of domestic animals. The assessment was done in line with the focus group discussions and key informant interviews carried out, and pictures were taken (with informed consent) to corroborate these evaluations.

DATA STORAGE

Data from literature review were stored and managed via restricted access folders on Google drive platforms. Data collected from KIIs and FGDs which included voice recordings, virtual meeting recordings (via zoom), pictures and videos were also stored and managed on restricted access folders on Google drive platforms. Also, all survey respondents were anonymized in line with the informed consent and research ethic commitments approved by the respective states.

DATA ANALYSIS

Qualitative data collected from all data collection tools utilised were evaluated through content analysis and supported with the use of the qualitative analysis tool NVIVO.

RESULTS

GENERAL FINDINGS ACROSS NIGERIA

Schistosomiasis is very much prevalent in Nigeria. It is known as *Sangiya* in Hausa; *Ito-eje* in Yoruba; and *Oyanemem* in Igbo; all meaning "blood in urine". From 2013 till date, much progress has been made in mapping the disease distribution and this can be attributed to the support received from state and federal government with support from partner organisations such as the WHO, USAID, Sightsavers and Global Schistosomiasis Alliance (GSA).

Highest prevalence of schistosomiasis was reported in Northern Nigeria, particularly the North-West and North central which had some LGAs with prevalence levels between 93-100%; almost all children being infected. However, in Southwest Nigeria, Ogun state was reported to have the highest prevalence, with some LGAs having 84-87% prevalence values.

Presently, about 773 local government areas (LGAs) have been mapped and about 75% (582) of these local governments are endemic. Further disaggregation of this data into ward-level which revealed several endemic wards previously overlooked showed; 252 wards that are highly endemic; over 2000 wards that are moderately endemic; and another 3,130 wards with low endemicity. This includes several endemic wards previously overlooked.

LAGOS STATE

DESK REVIEW

Three articles were shortlisted, having met the inclusion criteria to be deemed eligible data sources on the situation of schistosomiasis in Lagos State. The articles included a survey on *Schistosoma haematobium* infection in Epe community, Lagos, Nigeria (Akinwale *et al*., 2011); a study comparing diagnostic methods to determine the prevalence of urinary schistosomiasis in Badagry (Ibidapo *et al*., 2005); and a study on the epidemiology and prevalence of urinary schistosomiasis in pre-school children in Ajegunle (Pako Estate), Zion (Sari Igamu), Orile Iganmu, Badir and Epe in Lagos, Nigeria (Adewole and Fafure, 2012). All studies were case-study reports, carried out on children (Akinwale *et al*., 2011; Adewale and Fafure, 2012) and out-patients (Ibidapo *et al*., 2005). To complement the data provided by the reviewed articles, 3 reports published by the Federal Ministry of Health, from 2013 to 2015, with information on schistosomiasis in Lagos State, were retrieved

and analysed. The articles include "Neglected Tropical Diseases Nigeria Multi - Year Master Plan"; "Report on Epidemiological Mapping of Schistosomiasis and Soil Transmitted Helminthiasis in 19 States and the FCT, Nigeria"; and "Lagos sets to Eradicate Schistosomiasis in 7 Endemic LGS".

Most of the grey reports (FMOH, 2015; FMOH 2015b), which covered up to 20 LGAs in Lagos State, provided information on the distribution and prevalence of schistosomiasis, and efforts being made to improve prevention and control in the state. Furthermore, some of the reports serve as reference materials for subsequent surveys or epidemiological studies on schistosomiasis as it provides guidelines for a proper epidemiological survey while also enumerating environmental risk factors associated with schistosomiasis. For one of the studies, FMOH (2015), the study population included 2437 females, 2337 males, with the age distribution 5-10 years (1712) and 11-16 years (3062) and the results showed 55% prevalence of schistosomiasis amongst 11-16 year olds, with 65% of the infected being males and 35% females. The study showed that the prevalence of schistosomiasis in communities evaluated (which includes Ibeju-Lekki, Amuwo-Odofin, Eti Osa, Ajeromi-Ifelodun, Lagos Mainland, Surulere, Lagos State, Ifako-Ijaiye, Agege, Kosofe, Ikorodu, Ikeja, Oshodi-Isolo and Alimosho) ranged from 3.2 to 41%. Another report (FMOH, 2013) surveyed 50 school children from each LGA (Local Government Area) in Lagos State and the results reported "prevalence amongst 11–16-year-olds", with no specific quantitative measure of the prevalence.

The research studies and grey literature showed that the prevalent causative pathogen species in the sampled locations include *Schistosoma mansoni and Schistosoma haematobium*, with the snail intermediate host species, *Bulinus truncatus* indicated. Both urine samples and stool samples (specifically for *Schistosoma mansoni*) were evaluated across the studies. From results obtained in the research papers, dirty water was identified as important sources of infection, and activities such as bathing, fishing, washing, swimming, fetching water, crossing water and others were identified to increase frequency of contact with infested water bodies.

Reported symptoms of infection included micro and macro-haematuria, and itching sensation, and all infections were diagnosed through the analysis of urine samples collected; using different diagnostic tools such as microscopy (Adewole and Fafure, 2012), visual inspection for hematuria, diagnostic chemical reagent test strip (Ibidapo *et al.,* 2005) and PCR-based testing (Akinwale *et al*., 2011). The

study conducted by Akinwale *et al.* (2011), suggests that the PCR-based test is more effective compared to other diagnostic techniques since it revealed infections that were not detected by those techniques.

The results from research studies showed prevalence of 12.5%, 40.8% and 48.5% in sample groups of 200, 1402 and 200 individuals respectively (Ibidapo *et al*., 2005; Adewole and Fafure, 2012; Akinwale *et al*., 2011). From the prevalence values recorded in Akinwale *et al*., (2011); Adewale and Fafure, (2012), it is inferred that schistosomiasis is more prevalent in children than in adults and the likely reason being higher exposure of children to water-related activities such swimming, fishing, and laundry (Akinwale *et al*., 2011; Adewale and Fafure, 2012). This is consistent with the reports of previous studies done on schistosomiasis by Amazigo *et al*. (1997); Ekpo *et al*. (2010); and Stothard and Gabrielli (2007). This difference in affinity for water-related activities might also be a reason for the higher prevalence of schistosomiasis amongst male children compared to female children as indicated by all research and grey literature reviewed.

The likely risk factors associated with the prevalence of schistosomiasis in the affected communities include proximity to freshwater habitats, disposition to water-related activities such as swimming, fishing and other related recreational activities, lack of proper drainage systems, poor sanitary habits and deplorable roads which become flooded with water thereby becoming sites of possible infestations (Ibidapo *et al*., 2005; Adewole and Fafure, 2012; Akinwale *et al*., 2011). Also, from the survey conducted by Ibidapo *et al*. (2005), an obvious lack of knowledge on schistosomiasis was observed amongst the evaluated children. This low level of awareness on schistosomiasis amongst school aged children has been corroborated by other studies conducted in other parts of Nigeria such as Chidozie and Daniyan (2008) and Noriode *et al*. (2017) in Minna and Edo respectively.

Reports indicated that the risk factors can be addressed through public health orientation programs on schistosomiasis, provision of safe recreational water sources for children and provision of pipe borne water systems for households (Ibidapo *et al*., 2005; Akinwale *et al*., 2011). Furthermore, Adewole and Fafure (2012) recommended that protective shoes and gloves should be worn by mothers during water-related activities and that children in the endemic areas should be prevented from going to bath, play or fish in streams, stagnant waters, and other affected water bodies in the communities. Also, in endemic areas, drinking water should be boiled before use (Adewole and Fafure, 2012).

Recommendations for further studies were indicated by Akinwale *et al*. (2011) who suggested that subsequent studies on schistosomiasis in the state should include and engage parents/guardians and out-of-school children to provide an accurate status of urinary schistosomiasis prevalence and knowledge in the state.

KEY INFORMANT INTERVIEW (KII) AND FOCUS GROUP DISCUSSIONS (FGD)S

Interviews and FGDs were conducted with government health officials including NTD officers and surveillance officers, community health workers and community members in Epe, Surulere and Badagry for information on schistosomiasis. These communities were identified by state-level health officials as key communities identified with having some of the highest prevalence of schistosomiasis in the state.

Picture 1 - OHDI Data collectors with the Oba of Badagry, Lagos – one of the KII respondents

KNOWLEDGE OF SCHISTOSOMIASIS

All respondents had knowledge of the disease and indicated that it was locally called '*Itoeje*" (literal translation - urination with blood). They also had knowledge of the causative agent and mode of transmission. However, a health official mentioned that sometimes, it was compared or confused with gonorrhoea.

"***Its causative agent is a trematode, it is water borne***" - PHC coordinator, Epe LGA

"***Yes, it is a disease related to water…. Bloody urine, hematuria***" – Anonymous, Surulere LGA

"***It is called "Itoeje", usually happens when children play with dirty water or rivers***" - Community Leader, Surulere LGA.

"***The common sign is haematuria hence the local name is called Itoeje. Some people confused it with gonorrhoea, but gonorrhoea is different, because it is pus that comes out (pyuria) and not blood***" - PHC Health Official, Epe LGA

A respondent mentioned that Epe LGA is particularly endemic for schistosomiasis because it is a riverine area. It was stated that out of the 19 political wards in the LGA, 2 of them (Mayunre and Olugbokere) were purely riverine. Therefore, schistosomiasis infections were common and rampant in the areas.

PREVALENCE, DISTRIBUTION AND RISK FACTORS

Respondents indicated that the disease is no longer commonly seen in Lagos as before and is on a continuous decline with only isolated cases reported in the state. It was also mentioned by many health officials that there was a lack of case reports and inadequate data on the disease in the state. However, based on the sole perception and personal experience, a respondent indicated that the prevalence of schistosomiasis in the state is about 2%.

"***The prevalence of this disease since 2009 is about 2%, it's not commonly seen***" - Medical Officer of Health, Badagry LGA

"I would say prevalence is decreasing because of interventions of mass drug administration carried out in various LGA's especially amongst school children" - Disease Surveillance and Notification Officer, Surulere LGA

"***No, there's no concrete data because of poor reporting and neglect. Only isolated cases are seen***" - PHC Health Official, Epe LGA

"***We do not have any concrete data on schistosomiasis, none of them have been reported***" - Health Education Officer, Epe LGA

In places where incidents of schistosomiasis were reported, it was mostly prevalent in the riverine areas in Lagos state and it affected mostly school aged children. Children are considered the most vulnerable population to this disease because of their recreation activities around infected water bodies. Another risk factor indicated by respondents is that residents' daily household activities revolve around the river locations, including the utilisation of the water for drinking purposes. They also mentioned that the intermediate hosts (water snails) are present in the environment and these frequent visits to the rivers perpetuate and increase the risk of infection.

"***.. it is more common among people that reside in the riverine areas….. Children are the most vulnerable and they will have a lot of things to say on this disease***" - PHC Health Official, Epe LGA

"***It is a worm infestation that mostly affects children, it is more common among people that reside in the riverine areas***" - Health Educational Officer, Epe LGA

"***Vulnerable people are children who play and swim in stagnant water bodies***" - Medical Officer of Health, Badagry LGA

"***School age children are the most vulnerable because they play around streams and water bodies"*** - Disease Surveillance and Notification Officer, Surulere LGA

SYMPTOMS AND DIAGNOSIS

Most health officials interviewed mentioned that there were little to no laboratory tests conducted to confirm the disease due to inadequate equipment. Therefore, clinical signs, primarily haematuria, were often used as disease indicators. Other signs mentioned by health officials and community members included skin peels, fever, and muscle pain. There were also reports of loss of memory and inability to learn.

"***We often diagnose from history, clinical signs and symptoms; little or no laboratory tests are carried out here***" - Medical officer of Health, Badagry LGA

"***The individual's skin will be peeling off***" - Community Leader, Surulere LGA

"***We see clinical signs and symptoms of fever and muscle pain, especially people from riverine areas***" - Disease Surveillance and Notification officer, Surulere LGA

"***It can lead to death, loss of memory and inability to learn***" – Anonymous, Surulere LGA

Picture 2 - OHDI Data collectors with a Health Official at the Lagos State Ministry of Health – one of the KII respondents

TREATMENT AND INTERVENTIONS

There were varying comments on the treatment and interventions that were implemented and utilised to combat the disease in the communities affected. These included providing free treatment of affected persons with the anthelmintic - Mebendazole, conducting mass community campaigns, and organising

frequent environmental sanitation exercises with inspections by environmental sanitation officers.

"*... **anthelmintic, Mebendazole' is administered for treatment of schistosomiasis***" - Medical Officer of Health, Badagry LGA

"***We did a mass community campaign on NTDs earlier***" - PHC Health Official, Epe LGA

"***Yes, we participate in environmental sanitation and other practices particularly with COVID-19... we also do environmental sanitation, we clean our drainages. We teach ourselves hand washing, chlorination of wells, and encourage individuals in water-logged areas to put on rain boots during the rainy season. We also try to educate the members of the communities that the disease is curable and anybody can be infected. Some people visit hospitals and some also seek herbal medicine… but treatment is affordable, the government has introduced free medical treatment***" - Community Leader, Surulere LGA

A lot of them discussed challenges that they encounter in implementing these treatment and control interventions. These included the lack of or inadequate boreholes and sources of potable water.

"***A lot of them don't have standard WASH facilities; most of them use well water. However, the government is now providing them with boreholes but they are not enough. The government should also try and provide more health facilities. Public campaigns and dialogue should be carried out***" - Health Officer, Epe LGA

"***I won't really say we have enough facilities here for everyone but environmental inspectors educate individuals in these communities.***" - Community Leader, Surulere LGA.

ENVIRONMENTAL HEALTH RISKS

A myriad of environmental health risks factors was discussed by respondents in Lagos state. These include absence of potable water sources, absence of WASH facilities in many communities, poor environmental sanitation. There were also reports on the presence of large water bodies particularly canals and rivers, and poor drainage system causing some areas to be waterlogged and serve as possible breeding grounds for freshwater snails (the intermediate host of schistosomiasis).

"***Yes, access to water and health care services is poor particularly in the riverine areas, they do not keep animals, they are majorly fishermen, they drink, bathe, and do everything in the same water bodies. There are no WASH facilities in these communities and the environment is dirty***" - PHC Health Official, Epe LGA

"***... We do not urinate in water or drink water from the river but we play in the river***" – Anonymous, Surulere LGA

"*T**he disease is endemic here because it is a water-logged area, and there are canals with poor drainage… dirty environment and water play a major role***" - Disease Surveillance and Notification Officer, Surulere LGA

VECTOR AND ANIMAL HEALTH RISKS

Animals are kept in some communities in Lagos state. However, respondents indicated that there is no documented evidence for the zoonotic transmission of schistosomiasis in Lagos State. Furthermore, they mentioned the presence of freshwater snails in the drainages and canals, and cited the harvesting and consumption of these snails as potential transmission routes for schistosomiasis.

"***No animals are kept in this community, but there are several water snails in the drainages and canals, in fact people pack them***" - Female community leader Surulere LGA

"***Some individuals do… they keep goats, chicken and sheep; it's possible that there may be zoonotic transmission, there is however no established facts in Lagos that these animal have been infected with this disease***" - Disease Surveillance and Notification Officer, Surulere LGA

PERCEPTIONS AND SOCIOCULTURAL NORMS OF SCHISTOSOMIASIS

Though Lagos is considered an urban city with a comparably higher literate population, some respondents indicated that there were still socio-cultural beliefs and norms that were associated with schistosomiasis, while others indicated otherwise. Respondents who reported such sociocultural beliefs stated that some people still regard it as a metaphysical and spiritual affliction, and that infected individuals are sometimes stigmatised which often prevents them from seeking orthodox medical treatments. It was also believed by some other people that haematuria - one of the main symptoms of schistosomiasis - is a normal occurrence and that infected individuals will outgrow it.

"***There are no sociocultural beliefs here, residents of Badagry are averagely educated***" said Medical Officer of Health; Badagry LGA

"***it is believed to be a spiritual affliction by some, hence they do not seek help in health centers***" - Anonymous Health worker

"***Schistosomiasis is neglected in Epe and they believe its normal and it is believed they will grow out of it***" - PHC Health Official, Epe LGA

"***There are no local beliefs, we will only advise infected individuals to visit primary health centers for treatment***" - Community Leader, Surulere LGA

"***There are no myths associated with Schistosomiasis but the individual might be stigmatized***" - Disease Surveillance and Notification Officer, Surulere LGA

RECOMMENDATIONS PROFFERED

Recommendations proffered include provision of social amenities such as primary health care facilities, WASH facilities and potable water sources (particularly boreholes) by the government; carrying out sensitization campaigns to educate the public about schistosomiasis; surveillance and active case search and management to be instituted by the government; and compulsory environmental sanitation exercises enforced by the government.

"***Make Sanitation exercise paramount and also improvement of health education***" - Medical Officer of Health, Badagry LGA

"***The government should provide potable water supply and WASH facilities also, primary health care facility should be provided, and all these should be sustained***" - PHC Health Official, Epe LGA

"***Government should work on surveillance of this disease using community case search, health education and sensitization and advocacy***" - Health Educational Officer, Epe LGA

OGUN STATE

DESK REVIEW

The desk review on schistosomiasis in Ogun state was based on 54 articles that were shortlisted and considered eligible for our study and data extraction. The studies included 43 observational studies, 6 qualitative studies and 5 experimental studies. To complement the research studies reviewed, 1 grey literature, a newspaper interview report with the Ogun State Commissioner for Health - "80% Ogun Residents May Suffer Neglected Tropical Disease" (Olukoya, 2021) published by the Tribune newspaper was also reviewed. According to the article, 80 percent of residents in the state are at risk of contracting a Neglected Tropical Disease (NTD). She stated this at a press conference to commemorate the 2020 World NTD Day, emphasising that 1.4 million school-aged children are at risk of contracting schistosomiasis and soil-transmitted helminthiasis. It was further reported that each Local Government in Ogun state was endemic for one or more NTDs, with Abeokuta North and Odeda LG regions having the highest prevalence in Nigeria. This was corroborated by Ezeh *et al.* (2019), who conducted a 50-year review study (1961-2011) of the prevalence and distribution of schistosomiasis in Nigeria. In his paper, he mentioned that Ogun state had the highest prevalence of schistosomiasis in Nigeria, followed by Ekiti state, both in the south-western part of the country.

The reported symptoms of schistosomiasis in many studies were haematuria and proteinuria (Ajayi *et al*., 2015; Oyeyemi and Odaibo, 2017; Amoo *et al.,* 2017). In one study, proteinuria was especially found in younger pregnant women (Oyeyemi and Odaibo, 2017). Various diagnostic tools were reported to be used for confirmation of the disease and these included microscopy, visual inspection for hematuria, diagnostic chemical reagent test strip, cytopathological examinations to screen exfoliated cells for squamous cell abnormalities (Akinwale *et al.,* 2008), and PCR-based testing which is sensitive enough to detect the presence of *S. haematobium* in endemic communities. These diagnostic tools also vary on their use depending on positivity level, infection intensity and age (Amoo *et al.,* 2017; Akande and Adetola, 2011; Ajayi *et al.,* 2015). Nevertheless, Akinwale *et al.* (2011) corroborates that PCR-based test is more effective than other diagnostic approaches since it recognizes infections that were not detected by other diagnostic procedures.

Some studies reported unusual cases and clinical signs of schistosomiasis discovered during their respective research. For example, Segun *et al*. (2006) described an unusual case of schistosomiasis which presented as a pseudo-tumour in a 58-year-old from Imala-odo community near Oyan Dam in Abeokuta North LGA, who had complained of recurring stomach pain and an abdominal lump for a year. Also, Morenikeji *et al*. (2014) reported a co-infection of *S. haematobium* and *P. falciparum* in school children in Yewa North LGA which induced kidney impairment in addition to hematuria and proteinuria.

With the aid of polymerase chain reaction (PCR) amplification of *Schistosoma*, Ajayi *et al*. (2015) identified Ijebu Ogbere (Ijebu East LGA), Fidiwo (Obafemi Owode LGA), Sabo (Shagamu LGA), Iweke (Yewa South LGA), Ketu/Adiowe (Ado Odo/Ota LGA), Abule-titun (Odeda LGA), Itori (Ewekoro LGA) and Ijoun (Yewa North LGA) of Ogun State, Nigeria to be endemic for schistosomiasis. *S. haematobium* and *S. intercalatum* infection were reported particularly in Abeokuta South, Obafemi/Owode, and Yewa North LGAs. These three LGAs contained about 56% of high-risk schools in the state (Ekpo *et al.,* 2004). Schistosomiasis was also confirmed in Abeokuta North, Ibaro, Abule titun, Ebute Igbooro (Yewa North LG, Obafemi Owode, Abeokuta south, Ijebu East, LGAs), and the prevalence was 50%, 71.8%, 80%, and 88.3% in sample groups of 83, 566, 209, and 107 subjects, respectively (Ekpo *et al*., 2011; Adewoga *et al*., 2019; Amoo *et al*., 2017, Mafiana *et al*., 2003, Ofoezie *et al*., 2009). In many studies, infection was higher in the male than the female as high as 70% or more. This was also corroborated by Mafiana *et al*. (2003); Morenikeji *et al*. (2011), Sam-Wobo *et al*. (2013); Alabi *et al*. (2018); Anumudu *et al*. (2016) who also discovered a persistent prevalence of urinary schistosomiasis in preschool children under the age of five in the Oyan reservoir, Ijebu East LGA, Eggua community in Yewa North LGA, with infections in males higher than in females. There is a considerable disparity in age and gender profiles of school pupils in relation to schistosomiasis in Yewa LG, Ogun state. Infection patterns were substantially age-dependent in two lakeside villages at the Oyan reservoir in Ogun state between 1991 and 1992, with peak prevalence in children aged 10-14 years (Ofoezie *et al*., 2016). This implied that schistosomiasis was more prevalent in children than in adults, due to the children's increased exposure to water-related activities, such as swimming, fishing, and laundry (Agbolade *et al*., 2004; Agbolade *et al*., 2007; Ofoezie *et al*., 2009; Ugbomoiko *et al*., 2009; Ugbomoiko *et al*., 2009; Ekpo *et al*., 2011; Olorunlana *et al*., 2016; Adewoga *et al*., 2019). However, According to Salawu and Odaibo (2013) and Salawu and Odaibo (2016), younger women and primigravidae are

at the highest risk of *Schistosoma* infection in Yewa Local Government in Ogun State. This supports the findings of Oyeyemi and Odaibo (2017), that women in their first trimester of pregnancy had the most severe infection of schistosomiasis. Sam-Wobo *et al*. (2017) and Onile *et al*. (2016) also found higher prevalence of urinary schistosomiasis in females (69.2%) than in males (31.8%), and this was associated with bladder and kidney diseases in Eggua community, Ogun state.

Snails, the intermediate host of schistosomiasis, were collected from water bodies, analyzed, and tested in endemic communities of Yewa North, LG. It was discovered that *B. jousseaumei* with *B. globosus* could transmit schistosomiasis in the endemic rural area after monthly sampling of snails in the area (for 12 months at Isopa river, Ijoun, Yelwa North) (Salawu and Odaibo, 2012). Conversely, in Shokori stream (a tributary of the Ogun River), snail species *Bulinus forskalii*, *Physa waterlotti*, and *Melanoides voltae* were discovered and none were naturally infected with cercariae (Mafiana and Beyioku, 1998). Furthermore, *Bulinus camerunensis*, was reported for the first time in Nigeria by Salawu and Odaibo (2014) after sampling four water bodies in Yewa North Local Government Area. The study recommended the integration of snail control using competing organisms into schistosomiasis management programs in endemic areas (Salawu and Odaibo, 2014).

Many of the studies discussed several interrelated risk factors that contribute to the prevalence of the disease. These include, but are not limited to; contact with infected water, contact with stagnant water, knowledge of the disease; swimming in rivers; rainfall; lack of potable water and poor waste disposal procedures; and lack of WASH facilities. For example, Morenikeji *et al*. (2016), in a key informant interviews and focus group discussions study, reported that persistent transmission of schistosomiasis was facilitated by human activities including, going to the streams to drink, bath, wash, and get water for cooking. They recommended concrete behavioural change in the affected communities as part of the control strategies. Several studies have also shown that the prevalence of schistosomiasis persists in endemic communities because preschoolers and school children are exposed to infested water bodies as early as after birth (Ekpo *et al*., 2010, Oyeyemi *et al*., 2020; Adeneye *et al*., 2007; Salawu and Odaibo, 2013; Morenikeji et al., 2016; Oluwole *et al*., 2018; Otuneme *et al*., 2019). Occupation, age, and gender have also been identified as key demographic and socio-cultural risk factors. Additional risk factors that contribute to the persistent prevalence of schistosomiasis include rainfall, vegetation, temperature, soil types, attitude, and land use (Ekpo *et al*., 2008). However, in all

of the research reviewed, no animal health risk factors or incidence of cross-infection were identified.

Many studies reported cases of co-infection and comorbidities of schistosomiasis with other health conditions and diseases in the state. Amoo *et al*., 2017 reported the prevalence schistosomiasis and bacteriuria, while (Ofoezie *et al*., 2009; Olorunlana *et al*., 2016; Ugbomoiko *et al*., 2009, Mafiana *et al*., 2001; Adewole *et al*., 2020; Agbolade *et al*., 2007) and Agbolade *et al*., 2004 reported the co-infections of schistosomiasis with intestinal helminthiasis, particularly in rice growing communities of Ewekoro and Obafemi Owode Local Government Areas. Furthermore, Otuneme *et al*. (2014) recorded the endemicity and co-infection of *S. haematobium* with *S. intercalatum* in Apojola community which is close to Oyan reservoir's bank in Abeokuta North LGA, Ogun state. These co-infections have seemingly caused more deleterious impacts on the infected individuals. As co-infection of schistosomiasis and malaria led to a higher risk of low hemoglobin concentration, and schistosomiasis with intestinal helminthiasis co-infection led to poor nutritional status in the communities of Ago-Ika, Ikereku-Idan, Itun-Seriki, and Adebowale-Abowaba in Abeokuta, Ogun State (Morenikeji *et al*., 2014; Adeniran *et al*., 2017)

Praziquantel, a drug of choice for combating schistosomiasis, was highly efficient in controlling schistosomiasis in infected people (Sam-Wobo *et al.*, 2017; Adeneye *et al*., 2006), and families in some communities were always eager to acquire the drug for the treatment of the disease (Sam-Wobo *et al.*, 2017).

To prevent schistosomiasis from spreading further, Oso *et al*. (2020) recommended that governments at all levels should provide alternative sources of water for domestic and recreational purposes alongside chemotherapy using Praziquantel (Oyeyemi and Odaibo, 2017), and that PCR be used as a valuable diagnostic tool to study the incidence and prevalence of *S. haematobium* infection amongst snail intermediate hosts rather than the traditional conventional cercariae shedding method (Akande *et al*., 2012). To reach the ultimate goal of reducing this disease in endemic communities, efforts must be initiated and continued, to guarantee that all families have access to praziquantel drugs (Adeneye *et al*., 2006). Water control, sanitation, and snail control, as well as community-based programs, were also recommended for reducing the prevalence of schistosomiasis. For example, Mafiana and Beyioku (1998) conducted a survey ten years after the initial report of a schistosomiasis outbreak in the neighborhood of Sokori stream (a tributary of the Ogun River) in Abeokuta,

Ogun state, and discovered a significant decline in the prevalence of the infection as a result of improved water supply observed in the city, as well as increased alternative recreational sites, which may have reduced the propensity of the children to swim in the stream.

Provision of safe drinking water in the community is also necessary and effort should be made to prevent the infection through integrated control measures like the snail hosts eradication (Mafiana *et al*., 2001; Ekpo *et al*., 2012; Adewole *et al*., 2017). In addition, a continuous long term re-evaluation of post-intervention programmes are recommended (Oyetunde *et al*., 2018).

Also, effective public-private partnership was mentioned as a way to improve treatment, control and prevention efforts for schistosomiasis. In the newspaper interview report - "80% Ogun Residents May Suffer Neglected Tropical Disease" - published by the Tribune newspaper, the Ogun State Commissioner for Health stated that controlling these diseases would be doable if the government solicits support from private partners to stop the disease from spreading across the state.

KEY INFORMANT INTERVIEW (KII) AND FOCUS GROUP DISCUSSIONS (FGDS)

Interviews and FGDs were conducted with an NGO representative and LNTD coordinators of Obafemi Owode LGA, Abeokuta North LGA, Ewekoro LGA and REMO LGA. Community leaders and residents of Abule Titun (Abeokuta North LGA), Abule Olosun and Momoh, Akaka and Orile Oko communities, and a schistosomiasis patient were also interviewed.

KNOWLEDGE OF SCHISTOSOMIASIS

Generally, respondents indicated a significant knowledge of the disease; and locally referred to schistosomiasis as "*Atosi-aja*". Respondents also had knowledge of transmission of the disease through the mollusc intermediate hosts and the aetiological agent's life cycle. Mythical belief associating the transmission of the disease with dog's urine was also expressed; this belief gave rise to the local name of the disease, "*Atosi-aja*" (which means in local Yoruba dialect "*to be acquired from association with Dog's urine*")

"***It is called Atosi-aja, from the name they believe it is transmitted when an individual urinates in close proximity to where a dog urinated, it is usually transmitted by contact with contaminated water, water containing the infective stage of the organism (cercaria)"*** -NGO representative and Health Official, Remo North LG

'Community members popularly call Schistosomiasis Atosi-aja or Atosi-eje, they believe the disease is contracted from urinating where dog has urinated. However, schistosomiasis is transmitted by contact with contaminated water with infective stage cercaria. This disease is common here because community members often visit the river to do their daily business of washing, drinking and bathing.'

- *NTD Official, Ogun State*

"***When people bathe/swim in the river, they get infected by the disease***", - Community Leader - Abule Osun

"***I heard about it at the Centre, the individual urinates blood (haematuria)***"- Community Member - Abule Mohmoh

"The local name of the disease is "Atosi aja" - Health Official, Obafemi Owode LGA.

"Yes, if a dog urinates and another individual urinates on it or in close proximity to where the dog urinated, the individual will have hematuria (bloody urine)", - Community Leader, Abule Titun

DIAGNOSIS AND SYMPTOMS

Clinical signs and symptoms indicated include presence of blood in urine (haematuria); painful urination (dysuria); persistent genital pain (dyspareunia); itchy genitals (genital pruritus); and lower abdominal pain, are the major presentation of this disease. However, the clinical sign of haematuria is the single major basis for diagnosis by health care workers.

"***Symptoms of painful urination/micturition, females particularly complain of painful sexual intercourse and abdominal pain, some individuals complain of itching around their private part"***- Health Official, Abeokuta North

'***Often times, there have been complaints of painful urination and bloody urine from the infected individuals,'***

- *NTD Official, Ogun State*

"***Haematuria (bloody urine), I also had to educate a particular patient's father. There was no medication at that time, so I had to refer the patient to my colleague at Ifo"*** – Health Official, Ewekoro

"I had lower abdominal pains then" - Anonymous Schistosomiasis patient

AVAILABILITY OF DATA

There were mixed responses on the availability and type of data on schistosomiasis in the state. Respondents from NGOs and health officials indicated an availability of research publications on schistosomiasis and seemed to rely mostly on these studies to understand prevalence of the disease. However, primary health records as unavailable as the disease is not included in the list of reportable diseases deemed for routine surveillance

"Well yes, there are publications on Schistosomiasis" - NGO Representative

TREATMENT AND PREVENTION

Schistosomiasis is treated in these communities with the anthelmintic Praziquantel. Furthermore, it is believed that treating rivers and water bodies will help prevent the continuous transmission of this disease.

'***We have had to collaborate with some NGOs for the prevention and control of FGS in the state with drugs provided by the project team. However, the drug that has proven effective and has been in use both for treatment and prophylaxis of urinary schistosomiasis during MDA in schools is Praziquantel.'***

- *NTD Official, Ogun State*

"Schistosomiasis is treated with Praziquantel given to us by the government at the required dosage" - Community Leader, Abule Olosun

"With the use of Praziquantel Q.I.D" – Anonymous, Abule Osun

"We treat with Praziquantel" – Health Official, Abeokuta North

"We administer Praziquantel" - Community Leader, Abule Titun

"Provision of clean drinking water by the government, this will prevent community members to go to the streams, and this will in turn reduce schistosomiasis" – Health Official, Remo North

"By treating the river"- Community leader, Abule Olosun.

SCHISTO PREVALENT AND MOST VULNERABLE POPULATION

There are twenty (20) Local Government Areas in Ogun state. Schistosomiasis is highly prevalent in five (5) local government areas; Abeokuta North, Odeda, Ijebu East, Yewa North and Yewa South, therefore, the disease can be said to be endemic in 25% of Ogun state LGAs. There were mixed reactions concerning the current trend of the disease in Ogun state, some quarters believed the disease prevalence is decreasing while others believe it's on the rise. Enu gada, Olorunda, Imala Odo, Shoyoyi, Iyana Lapeleke are some communities identified with relatively high prevalence of schistosomiasis. School aged children are the most vulnerable population to this disease because of their recreation activities around infected water bodies.

"***There is a high prevalence of Schist in Abeokuta North, Odeda, Yewa North, Yewa South, Ijebu East"*** - NGO Representative

'***Thus far, we have every reason to believe that there has been a reduction in the prevalence of schistosomiasis in Ogun state due to the mass drug administration programs that we conduct in schools, although a new survey has not been carried out. The most vulnerable to this disease are children''***

- *NTD Official, Ogun State*

"***There have not been much intervention against schistosomiasis in the state, they just started some sought of intervention in 2017 when Evidence Action came in. before then there was no systemic mass drug administration, Evidence Action came in and started the drug administration for school children but they however will miss out of school children and adults affected", for the most vulnerable population, basically I will say school aged children because of their lifestyle and activities, like swimming in water bodies"*** - NGO Representative

"I will say the prevalence is decreasing, as a matter of fact I haven't come across any patient with the disease since I started working here. We administer Praziquantel yearly during the Mass Drug Administration Scheme to school children; we also administer them to out of school children. Children age 5 to 14 years" are the most vulnerable population to Schist"- Health Official, Obafemi Owode

"The disease is most prevalent in "Enu gada, Olorunda, Imala Odo, Shoyoyi, for the prevalence It is increasing" - Health Official, Abeokuta North

"Prevalence is decreasing" - Community leader, Abule Titun

"*Prevalence of schistosomiasis that had been on such a high level started decreasing when the MDA was introduced to school children*" - Community Leader, Remo North.

"Children between the ages of 5 upward that go to the river to swim are the most vulnerable. Iyana Lapeleke area is the community with the highest prevalence; however, prevalence is decreasing. The Massive Drug administration scheme has proven to be effective" – Health Official, Ewekoro

PERCEIVED ENVIRONMENTAL HEALTH RISKS

Numerous environmental health risks were identified in Ogun State communities and they included absence of WASH facilities especially toilet facilities which will result in indiscriminate urination and defecation around water bodies, absence of potable water sources, socioeconomic activities such as fishing and laundry, dirty environments and lack of environmental sanitation practices.

Some of the indiscriminate practices by community members, such as washing, urinating, and defecating in the water bodies that serve as their drinking water sources, poses great risk and increase the prevalence of schistosomiasis in these areas. These communities were provided with some WASH facilities, but they still favor the water from the rivers over that from boreholes.

- *NTD Official, Ogun State*

"The presence of water bodies and areas which lack toilet facilities, especially where there is indiscriminate urination and defecation around water bodies… Socio economic activities such as fishing makes individuals have contact with

these water bodies even in communities with pipe borne water… are environmental factors to this disease" - NGO Representative.

"We take our bath in the river. But it's mostly dried up now" –Anonymous, Abule Momoh

"Swimming/Bathing at the river is the cause of the disease" - Anonymous, Abule Olosun

"The use of stream water, and also dirty environment are the causes of the disease" – Health Official, Obafemi Owode

"I drink, and bathe twice daily from the river. I also fetch from the river, I believe we adults have a level of immunity to this disease. Some individuals are into fishing, and we eat the fish, we try as much as possible to cook the fish very well. We have also been told in the past that boiling and filtering water from the river makes it clean enough to drink" - Community leader, Abule Titun

"We bathe/swim, we do our laundry there, we also fetch water from there, yes we have newly built taps, but water supply is epileptic so we fetch from the river when there's no water" Anonymous, Oluke Community, Ewekoro.

"Absence of potable water supply, especially during dry seasons, so there are usually large numbers of cases at this time also, dirty environment plays significant role in this disease, most of these factors communities don't have toilet facilities especially from that Igi iroko down to the main road" – Anonymous, Ewekoro

PERCEIVED ANIMAL HEALTH AND VECTOR RISKS

There is a possibility of zoonotic transmission of schistosomiasis particularly from cattle since bovine schistosomiasis was indicated among some respondents in Ogun state. Furthermore, freshwater snails, the known intermediate hosts for schistosomiasis, are present in water bodies in Ogun state. Some respondents indicate that the snails are often hunted, cooked and ingested by community residents in certain communities in Ogun state. However, it is unclear if the snails they collect for cooking and consumption are the pulmonate snail species which are the specific intermediate hosts that transmit schistosomiasis.

"There is schistosomiasis affecting cattle. These Cattle later graze close to water bodies" - NGO Representative

"We all have heard of freshwater snails, in fact we pick them up, they are usually big, we eat them, we were told at the centre that it causes Schist"- Anonymous, Abule Olosun

"We get it after it rains, when that particular river overflows we pick the snails with our bare hands, some individuals swim in the river too"- Anonymous, Ewekoro, "

PERCEPTIONS AND SOCIOCULTURAL NORMS OF SCHISTO

A myriad of sociocultural norms and myths surround schistosomiasis in Ogun State. These myths include the belief that schistosomiasis is a spiritual or metaphysical affliction, that haematuria is a sign of puberty, and that its transmission is associated with urinating in close proximity to a dog's urine.

"Some believe it's a metaphysical or spiritual affliction, some other individuals believe its normal especially in males that have attained sexual maturity (puberty)" - NGO Representative

"They believe if an adolescent is urinating blood he/she has attained puberty" – Anonymous, Abule Momoh

"There is a cultural factor. They would rather drink from the dam, fish, and do their laundry there, they also fetch water from there" – Anonymous, Abule Titun

"Locally here, there is myth that associates the condition with dogs urine, it is believed that if an individual urinates where a dog has urinated before, such individual will succumb to this disease" –Anonymous, Ewekoro

RECOMMENDATIONS PROFFERED

The following recommendations were proffered to curb the spread and menace of schistosomiasis, continuous and periodic mass drug administration, and provision of WASH facilities and sources of potable water. Furthermore, government should champion campaigns to create awareness and educate constituents on schistosomiasis and other NTDS. Also, rivers and other large water bodies should also be treated with molluscicides periodically while also providing health facilities in affected communities.

"Creation of awareness, mass drug administration and introduction of WASH components to institute behavioral changes and improve sanitation and hygiene… Encourage individuals to use the drug despite its side effects; also the

medication must not be used on an empty stomach. There is a need to create more awareness about… the disease, the drugs and also the implications of this disease. Government should also provide pipe borne water to every community to reduce contact of individuals with infected water bodies. Borehole and WASH facilities should be provided, if they must drink water from the river, they should treat the water by boiling and filtering it" - NGO Representative.

"Government should also provide health facilities and toilet facilities for them" – Anonymous, Abule Momoh.

"**Government should provide basic amenities such as borehole water and electricity."** - Community Leader, Remo North LGA

"The Government can help by treating the rivers periodically, and the Government should provide a source to clean and potable water" – Anonymous, Abule Titun.

"We want our schools renovated and other social amenities renovated, we also want them to build big companies here so we can have jobs. What is needed in this community is potable water supply" – Anonymous, Ewekoro.

"I will recommend that awareness and sensitization be created about this disease"- Health Official Abeokuta North LGA.

CHALLENGES

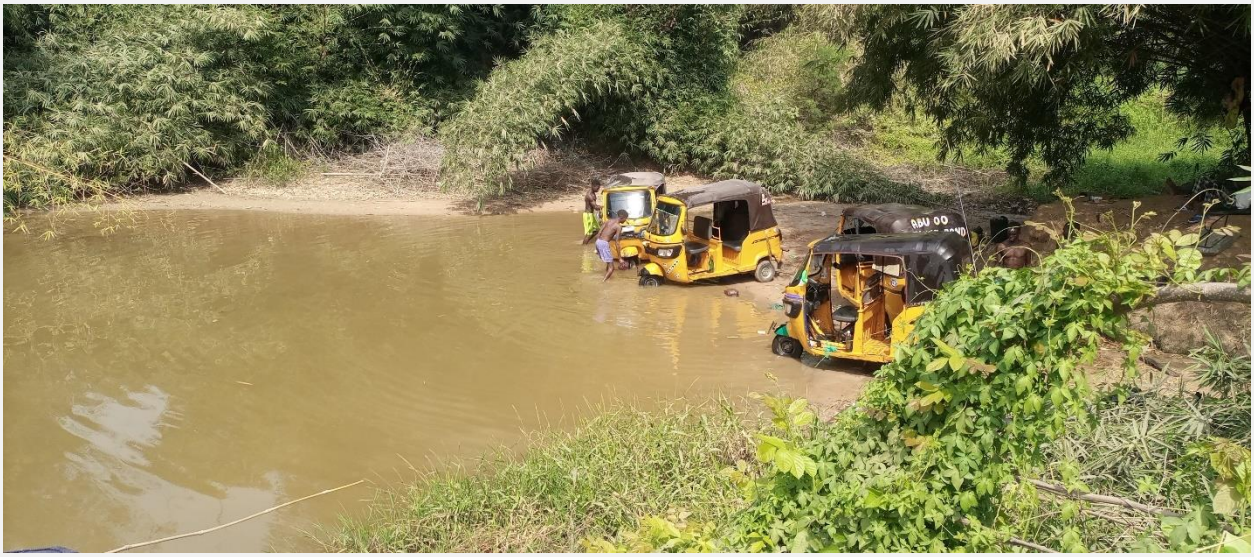
A Major challenge to curbing the spread of schistosomiasis in Ogun state is the procurement of Praziquantel, the medication's side effects and the individuals' sociocultural beliefs that prevent eradication and control of schistosomiasis. Furthermore, members of some communities were reported to be indifferent to sensitizations and awareness campaigns.

'Yes, several times. They have however chosen to turn deaf ears to all our pleas.' - Health Official, Abeokuta North.

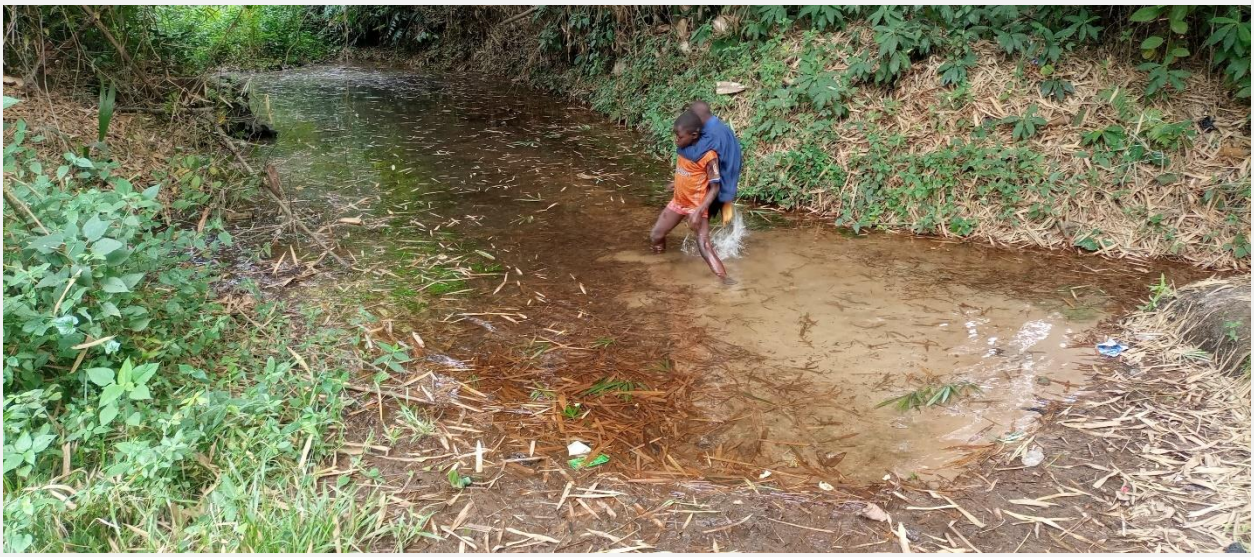
'Yes they have some sociocultural beliefs about borehole water, they just won't use it.' - Health Official, Abeokuta North.

'The community's reluctance to quit visiting water bodies, particularly infected ones, especially after awareness/sensitization is one of the main challenges to curbing the spread of this disease. - NTD Official, Ogun State

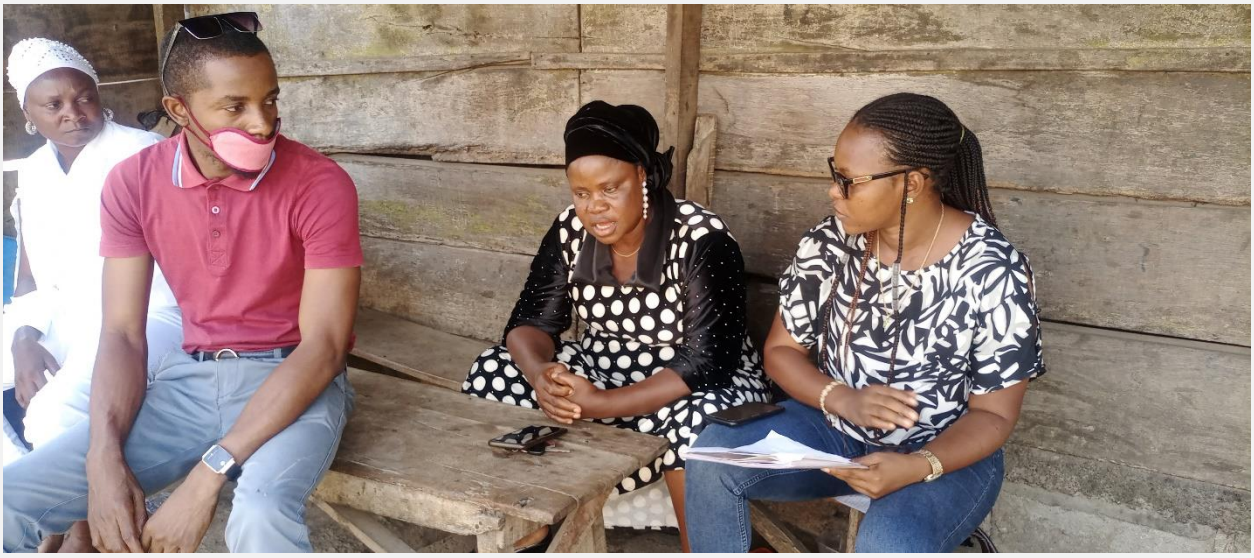
"The major challenge is the procurement of praziquantel and also its side effects, this side effects discourage individuals from using the medication, also the need to get individuals to change their attitudes and behaviours" - NGO Representative



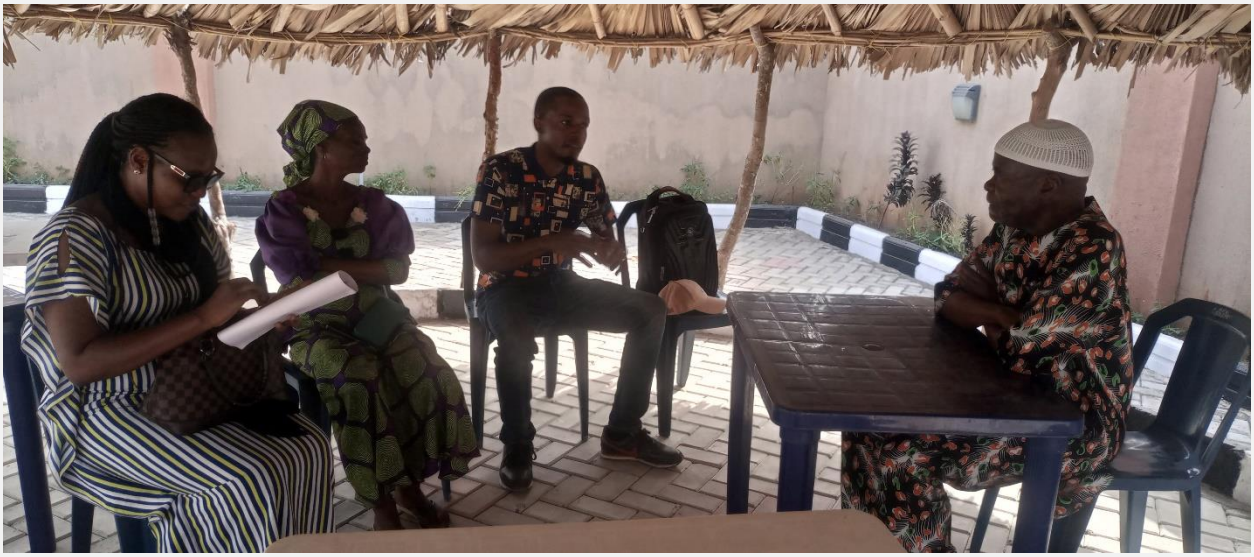
Picture 3 - Riverbank in Akibo Town, Ewekoro LGA in Ogun State. Community members use rivers like these for their household, leisure, and socioeconomic activities. With the possible presence of schistosoma vectors in these rivers, they are predisposed to transmission and infections



Picture 4 - Riverbank in Oluke Community, Ewekoro LGA in Ogun State. Community members use rivers like these for their household, leisure, and socioeconomic activities. With the possible presence of schistosoma vectors in these rivers, they are predisposed to transmission and infections.



Picture 5 – KII with LNTD Health Official, Obafemi Owode Community



Picture 6 - Focus Group Discussions (FGD) with community members and leaders

Picture 7 – After KII with Health Official

OSUN STATE

DESK REVIEW

Nine articles were shortlisted and deemed eligible for review and data extraction, 1 review study and 8 observational studies. These formed the basis of our data retrieved on the situation of schistosomiasis in Osun State.

In Nigeria, schistosomiasis, caused predominantly by the species *Schistosoma haematobium*, is highly endemic in resource-poor communities (Ugbomoiko *et al.*, 2009). It is an environmentally-mediated disease, contracted by swimming or wading in freshwater bodies harboring the snail intermediate hosts of the genus *Bulinus*. From existing literature, the following communities in Osun state have high prevalence of this disease; Ilie, Ore, Ajasse ipo, Bacita, Eko-ende, Ilobu, and Erin-Osun. Furthermore, the prevalence of schistosomiasis over the years ranged from 12.70% to 72.03%. (Bolaji *et al.*, 2014; Adedeji, 2018). Across all shortlisted articles, over 9000 individuals were screened for schistosomiasis in Osun state between 1990 and 2021, with a mean prevalence of 53.44%. This provides some insights to the persistent endemic nature of schistosomiasis in Osun state. The prevalence and intensity of infection also increased significantly over the years and this indicates that its transmission has remained unchecked in many communities in

Osun state (Oladejo and Ofoezie 2006). The disease is more prevalent among school - aged children, especially aged 4-20 years, and both male and female individuals are usually affected.

The research studies showed that the prevalent causative agents of the disease in Osun State include the trematode worms, *S. haematobium* and *S. mansoni* (Ojo *et al.*, 2021). However, there is evidence to believe that some form of interspecific interactions exists between *S. haematobium* and S. *mansoni,* which may produce potentially significant consequences for developing disease morbidity (Ojo *et al.*, 2021). Also, there are records of multiple concurrent infections of intestinal helminths and urinary schistosomiasis in Osun State (Ugbomoiko *et al.*, 2012).

The major clinical sign or symptom of the disease is hematuria. Prevalence studies mostly examined school children to confirm presence of schistosomiasis through various diagnostic methods which included urine and stool sample microscopy, spectrophotometry-based kit, urine reagent strips, FLOTAC filtration device, single radial immunodiffusion and polymerase chain reaction (PCR). However, the microscopic examination of schistosome eggs in urine specimens for egg count by sedimentation quantitative technique is considered the gold standard for diagnosis of schistosomiasis in Osun state. (Ugbomoiko *et al.*, 2009).

Studies confirm that freshwater snails *Bulinus globosus* and *Biomphalaria pfeifferi* are the main intermediate hosts of human schistosomes in Osun state. (Oladejo and Ofoezie 2006). It is believed that transmission is on the increase with consequent adverse effects on children's health and school attendance. (Oladejo and Morenikeji 2019).

Environmental risk factors that perpetuate the endemic nature of this disease in Osun State include persistence of water contact activities namely washing; occupations such as farming and fishing; poor sanitation; and absence of potable water supply in these communities. Swimming has the highest relative index of exposure and spiritual bath the least rate of exposure, research shows that 49.7% of the human contacts were from swimming, then fishing (32.2%), cloth-washing (10.1%) and spiritual/ritual bath (8.0%) (Adeleke, 2017). Interestingly, studies in Osun state demonstrate an inverse relation between land topography and disease prevalence, thus implying that the higher the topography, the lower the prevalence of the disease, and vice versa. This demonstrates the influence of geographical variation (topography/altitude) on infection pattern and prevalence (Oladejo and Morenikeji 2019). Multiple infections were significantly

more common among children from households with more playmates, absence of toilet facilities and low-income level (Ugbomoiko *et al.*, 2010).

A myriad of sociocultural beliefs contributes to the perpetuation of the endemicity of schistosomiasis in Osun state. However, the most relevant of them is the customary and habitual spiritual baths and religious practices in rivers by people within and outside the community (Adeleke, 2017). Treatment, interventions, and control measures of schistosomiasis in Osun state has largely focused on chemotherapy and advocacy. Infected persons were treated with single dose anthelmintic praziquantel at 40 mg/kg and this has been found effective against schistosomiasis in the state (Justin *et al.*, 2015; Ugbomoiko *et al.*, 2009). School children are also taught to regard haematuria as a potentially dangerous condition for which early treatment should be sought and this is expected to facilitate a behavioural change with possible tremendous effects in stemming the tide of this NTD (Onayade *et al.*, 1996).

Recommendations to tackle this neglected disease include; scaling up mass administration of praziquantel; provision of potable water supply for domestic use at a reasonable distance from households; and proper health education which will have significant impact on its transmission and morbidity amongst school-age children in the study community (Ojo *et al.*, 2021, Awosolu *et al.*, 2020, Ugbomoiko *et al.*, 2009).

OYO STATE

DESK REVIEW

Six research articles were shortlisted and deemed eligible for review and data extraction having met the inclusion criteria on the situation of schistosomiasis in Oyo State. 5 of these articles were case studies that highlighted the prevalence of urinary schistosomiasis among school children, while the other was an observational study. The articles include a cross-sectional study on urinary schistosomiasis among vulnerable children in a rehabilitation home in Ibadan, Oyo state, Nigeria (Uchendu *et al.*, 2017); a study highlighting morbidities associated with malaria co-infection with schistosomiasis among children in

South-West Nigeria, specifically Omi-Adio, Iddo LGA, Oyo State (Oladele *et al.*, 2014); a study on the relationship between water contact frequency and infectivity of schistosomiasis among secondary school students in Ibadan, Nigeria, specifically Akinyele LGA, Oyo state (Akinboye *et al.*, 2011); a study on the Community Diagnosis and Intervention in Controlling Urinary Schistosomiasis in Oke-oloro and Inalende-bola communities in Ibadan, Nigeria (Olaseha and Sridhar, 2004), and a study on the Prevalence and severity of urinary schistosomiasis in Ibadan, Nigeria (Arinola, 1995). The sixth of these research articles was an observational survey aimed at identifying the prevalence, knowledge and preventive practice of schistosomiasis among selected secondary school students in Oluyole LGA, Oyo state, Nigeria (Hamid, 2016). No grey literature was deemed eligible for review and data extraction for this study as none met the selection criteria for review on schistosomiasis in Oyo state. All studies were conducted on school children between 5 - 19 years of age. However, Arinola (1995)'s study included two other age groups 18-28 and 25-47.

The research studies showed that the prevalent causative agent of the disease in the sampled locations, as stated above, was predominantly *Schistosoma haematobium* and sparsely *Schistosoma mansoni*, with the snail intermediate host species, *Bulinus globosus* present in two of the studies. The prevalence of schistosomiasis from all the studies conducted amongst the school children were 14 (21.2%), 59 (24.6%), 8 (5.52%), 120 (82%), 45 (21.1%) and 110 (26.2%) from sample sizes of 66, 240, 145, 147, 218 and 420 children respectively (Arinola, 1995; Olaseha and Sridhar, 2004; Akinboye *et al.*, 2011; Oladele *et al.*, 2014; Hamid, 2016; Uchendu *et al.*, 2017). All the studies reported similar trends of schistosomiasis prevalence as being much more predominant in male than their female counterparts. The studies conducted by Oladele *et al.* (2014) and Akinboye *et al.* (2011) showed the prevalence figures between males and females as [31 (29.8%) male, 28 (20.6%) females] and [7(6.7%) males, 1(2.5%) female] respectively.

From studies conducted by Akinboye *et al.* (2011) and Olaseha and Sridhar (2004), the prevalence of schistosomiasis in the studied communities was attributed to the presence of snails at streams in close proximity of the sampled locations. These snails, *Bulinus* sp upon examination, were seen to have *Schistosoma* sporocysts, thus confirming infectivity. Urine samples were collected and evaluated in all studies reviewed except in that of Hamid (2016). Clinical signs of infected persons in these studies were micro and macro-haematuria, which were confirmed through urine analysis.

From the results obtained in the research papers, dirty and infected waters were identified as reservoirs and high frequency of contact with these waters were reported. Activities that were identified to increase contact with these contaminated waters include bathing, swimming, playing, washing, fetching water, fishing, farming as well as other domestic uses such as for drinking and cooking.

Uchendu *et al*. (2017), Oladele *et al*. (2014) and Akinboye *et al*. (2011) gave strong recommendations to help curb the prevalence of schistosomiasis and these include health education, provision of mass chemotherapy while involving NGOs and faith-based organizations, introduction of sanitary standards and practices, integrated control programs and provision of pipe-borne water. Olaseha and Sridhar (2004) shared an interesting perspective on the impact of combating schistosomiasis through research and use of research results as evidence to facilitate active community participation, stakeholder engagement and effective intervention. In this study, the authors conducted a prevalence study amongst the community members and used the evidence provided to support community members in writing letters to both government and non-governmental organizations, soliciting for help with combating schistosomiasis in their community. As a result, the Federal Ministry of Health as well as the Oyo State Ministry of Health received formal reports on this and thereafter organized MDAs to treat all infected pupils while completing the long overdue water scheme project to provide a potable source of water for the affected community. The step taken by these authors significantly points to possible intervention measures that can be applied to other Nigerian states characterized with high prevalence of schistosomiasis infection.

KEY INFORMANT INTERVIEW (KII) AND FOCUS GROUP DISCUSSIONS (FGD)S

Government health officials including NTD officers, community health workers and community members of Akinyele (Moniya, Jarija) and Atisbo (Irawo-Owode) LGAs were interviewed and FGDs were conducted for information on schistosomiasis. These communities were identified by state-level health officials as key communities having some of the highest prevalence of schistosomiasis in the state.

KNOWLEDGE AND DISTRIBUTION OF SCHISTOSOMIASIS

All respondents confirmed knowledge of the disease and indicated that it was locally called "Atosi aja" and/or "Atosi eje" (literal translation - urination with blood). Confirmations were also made on the causative agent and mode of transmission.

"The name schistosomiasis which is locally called Eje, Elegbe etc, cannot be transmitted sexually, this can be contracted by entering into contaminated water bodies or swimming in contaminated rivers which has the water snail (infected). The worm thus passes through the skin and infects the new host, the new host harbours it in the bladder and the worm migrates, starts developing and laying eggs that reach maturity(adult), and the infected person starts to manifest symptoms like bloody urine. The disease is endemic in these communities because we have seen cases of bloody urine samples and we have referred many to higher institutions" – LNTD Health Officer

"***Atosi Aja is the common name everybody knows it as; I really do not know much about it but I can say it may have to do with dirty things one eats or dirty things in the environment***" - Community Leader

"***The local indigenes call it Atosiaja, and contract this when they bathe in contaminated water that has these bizarre worms. It is the transmission of those bizarre worms from the snail which is the causative agent to humans through the penetration of the epidermal wall. Being a coordinator, I have had many experiences with schistosomiasis cases and on one such occasion, the Federal Ministry of Health investigated some communities in 2014 (it was the last time they investigated). Some of the communities investigated were highly infected, some moderately infected, some slightly infected while other communities had no infection at all. So far, out of 33 Local Government Areas in Oyo state it has been found out that 30 communities are either highly, moderately or slightly infected which indicates only 3 L.G.A are free from schistosomiasis infection***" - Health Official, Oyo state

"***It is called 'Atosi-aja' because it is compared to a dog that urinates frequently and the urine is red in colour which similarly occurs with someone who has schistosomiasis, he or she will urinate frequently but small amounts of urine will be passed and the process painful hence the name Atosi-aja***" - Health Official, Oyo state

PREVALENCE, DISTRIBUTION AND RISK FACTORS

Respondents indicated that the disease is still very much prevalent, and it seems to continue to increase with only isolated cases reported in the state. It was also mentioned by many health officials that there is a lack of case reports and inadequate data on the disease in the state.

"***The children and men are more vulnerable because they are usually the ones that go to the river to swim and perform daily activities such as fishing. In addition, mostly children of 5-15 years of age or school aged children are affected***" - Community Member

"***In my opinion, everyone that can be found around dirty environments is vulnerable. It is however mostly more common amongst males than females and people who are affected usually have difficulty in urination and some level of kidney damage***" - Community Leader

"***The most vulnerable are children because they like bathing in the river. In Ogo oluwa Local Government, Otamokun ward, is highly endemic. In Atisbo Local Government there is a community called Irawo and it is highly endemic. In Oyo state, there are 355 wards - 4 Wards are highly endemic, 91 Wards are moderately endemic, over 80 are low while the rest are free. Rivers in the state are plenty and the majority of them are contaminated like Irawo. The Ofiki River originated from that place and people like bathing there. The Otamokun has big rivers in which children, adults and even the farmers have their baths.***" - Health Official, Oyo State

The prevalence;

"***Since we have not carried out any tests recently, we can't tell if it is increasing or decreasing. The last time when we did, the results showed it was over 5 in 100 then, so definitely it is quite high***" - Health Official, Oyo State

"***I cannot ascertain the prevalence if it is on the increase or decrease. The Year 2014 was when the Federal Government last assessed schistosomiasis and in the country there is no praziquantel, had it been there was adequate and frequent provision of praziquantel in the country and if this is down yearly the Federal Government can now go back to assess to know if the prevalence rate has decreased or remain intact but since there is no drug in the country we cannot***

say whether the prevalence is increasing or decreasing" - Health Official, Oyo State

"***The areas in the community with the highest prevalence are Omidun, Omu-aran, Opeyemi, Ogundeji, Jarija, Sango-Ibon and even Ojedeji***" - Anonymous

"***For this particular community there is no specific area where the disease is more prevalent. The indigenes of this community don't drink the water from the river we have here. However, due to unavailability of toilets (only the health centre has toilets) which makes everyone engage in open defecation, I believe everyone is at risk of being infected***" - Health Official, Oyo State

DIAGNOSIS AND SYMPTOMS

Most health officials interviewed mentioned that there were little to no laboratory tests conducted to confirm the disease within these communities due to inadequate medical/laboratory equipment. Therefore, clinical signs primarily of haematuria were often used as indicators of the disease. Other signs mentioned by health officials and community members included itching of the skin, painful and frequent urination, and lower abdominal pain.

"***We recognize the disease through historical signs and symptoms. The person may have lower abdominal pain tendencies and most importantly passes out blood in the urine. Once it is confirmed that a person has haematuria, schistosomiasis is suspected and we send the victim for laboratory investigations of the urine sample to confirm suspicions. We do not have or use test kits, therefore we refer them to the General hospital. Although I am familiar with only urinalysis, with more development and new technologies evolving, we pray for rapid diagnostic tests like the Malaria RTD, HIV and the rest will soon be made available***" - Health Official, Oyo State

"***We can diagnose it in two ways; the clinical diagnosis and laboratory diagnosis. For laboratory diagnosis you take the urine sample to the laboratory while the clinical diagnosis are the signs the patient exhibits like frequent urination, blood in the urine. It can also be diagnosed through complaints of the patient (complaining about frequent urination and blood in the urine)***" - Health Official, Oyo State

Treatment and Prevention and Awareness

There were varying comments on the treatment and interventions implemented and utilized to combat the disease in the affected communities. Some included providing treatment for affected persons with praziquantel and referral to modern medical institutions. Some of the respondents mentioned the use of herbal medicine by affected individuals.

"***Most of them go to herbal doctors or take concoction, some go to the clinic to receive modern treatment and they are referred to higher health facilities***" - Health Official, Oyo State

"***Our forefathers believed in herbal medicine, however they lacked the knowledge of dosage, expiration and measurement. Also, people do visit health centers a lot and we have two health centers in this community. However, if there is an increase in facilities, I believe there would be more patronage***" - Community Leader

"***Laboratory diagnosis is required for a boy who complained 6 months ago about painful urination and blood in the urine. He was given praziquantel three times without any improvement. In such a situation, laboratory diagnosis helps to ascertain if he has schistosomiasis or not and would lead to proper treatment with the right medication***" - Health Official, Oyo State

PERCEIVED ENVIRONMENTAL HEALTH RISKS

A variety of environmental health risks were discussed by respondents in Oyo state. These included absence of potable water sources, absence of WASH facilities in many communities and poor environmental sanitation. There were also reports of contaminated water bodies particularly streams and rivers which were frequently visited by indigenes of these communities for use in domestic activities.

"***The easy accessibility of the river within the community contributes to the endemicity through major factors that revolve around domestic activities such as washing clothes, cooking, bathing, etc. Therefore, a lot of effort will need to be put into place to discourage people from going to the river to fetch water, swim, and wash clothes. Additionally, hygiene practices which contribute about 40% to the endemic situation is due to lack of public toilets, people still defecate in the***

surrounding even though they claim to do it far inside the bushes or outskirts of the town. Notwithstanding it is still open defecation and needs to be discouraged" - Health Official, Oyo state

"***Majority of the rivers are contaminated. Like Irawo, the Ofiki river also originates from that place and people like bathing in that river. The Otamokun community also has big rivers that children, adults and even farmers take their bath in. Furthermore, dirty environments also play a significant role in the endemic situation. This occurs as a result of improper water sanitation and hygiene. Therefore, with the provision of clean water facilities, proper waste disposal measures, adequate toilets in order to stop open defecation, proper food and personal hygiene, the occurrence of the disease will significantly reduce***" - Health Official, Oyo state

"***This disease can be gotten from the river through the snail that lives in the river. Indigenes of the surrounding communities drink from these rivers which contributes to the endemic situation of the disease. Communities like Jarija, Ssanu and Bamidele are endemic because they drink from infected rivers like the Ose river amongst others***" - Health Official, Oyo state

PERCEIVED ANIMAL HEALTH AND VECTOR RISKS

Respondents also commented on potential animal health and vector risks. Some indicated that although there is no evidence for zoonotic transmission of schistosomiasis in Oyo state, presence of freshwater snails around the water bodies is a potential vector-borne transmission route. Furthermore, they mentioned the possibility of animals within the communities also getting infected since they drink from these contaminated water bodies.

"***I currently do not have any evidence in that regard. During the rainy season, people usually pick up these snails for personal reasons and I am sure that if we look critically (just like Guinea worms affect humans and animals) we will establish a connection to these snails and the endemic situation. Also, animals in these communities can also be affected such as Dogs as a result of also drinking from contaminated river***" - Community Member

"***Eggs can be laid on the ground, an infected dog might urinate anywhere and if such contaminated areas are not properly fumigated, anyone can pick up this infection especially children who play in such areas***" - Health Official

PERCEPTIONS AND SOCIOCULTURAL NORMS OF SCHISTO

Respondents reported some sociocultural beliefs which include the characterization of schistosomiasis as a metaphysical and spiritual affliction. Furthermore, some people were reported to believe that haematuria is a normal occurrence and a sign of maturity while others believe that it is a sexually transmitted disease like HIV.

"***There are usually misconceptions that witches are the cause of infected individuals passing bloody urine, having elephantiasis or having all these diseases***" - Community Member

"***Our forefathers thought it to be a sexually transmitted disease just the way HIV can be contracted from several sources***" - Community Leader

"***Some people believe that when a boy is passing blood in urine it is a sign of maturity. Others believe that it is a sign of sufficient blood in the system where the excess is being passed out. Most times, a boy that sees blood in his urine is quick to tell his peers about it so they can affirm his maturity while others look forward to the same occurrence so they can also be seen as fully matured***" - State Health Official

RECOMMENDATIONS PROFFERED

Recommendations proffered include, an urgent improvement on personal and environmental hygiene; an increase in the number of primary health care facilities and medical aids by the government; health education and awareness campaigns for indigenes of these communities should be made available on schistosomiasis; provision of social amenities such as WASH facilities and potable water sources particularly boreholes by the government; and immediate reporting of symptoms to health centres for prompt treatment. The Oyo state government should also make environmental sanitation exercises compulsory.

"***The indigenes of these affected communities should try to improve on environmental hygiene and personal hygiene. Rearing of animals should be done intensively in each household to prevent animals roaming about in the street or visiting infected streams and contaminating everywhere. Drugs should be provided, Test kits should be made available in health centres, and other sources of water should be made available asides from the one well where almost everyone in the community fetches water from. Furthermore, people should learn***

to open up about the disease irrespective of what other members of the community may think before the infection gets out of hand. From experience people rather shy away than open up to avoid any form of stigma especially from insinuations that the disease was contracted as a result of sexual promiscuity" - Community Member

"***Since the major source of infection is the river, the government should provide boreholes that can also be powered with the power supplied to the primary health care centres. Other sources of water will help. Also seeing cattle were drinking, people washing their motorcycles, and people washing clothes from the same water source, there definitely would be contamination. Even if deep research is being carried out and it might not really be schistosomiasis, many other diseases can also occur and cause serious infection in the community. We hope things get better and we are here so we can know the necessary intervention***" - Health Official

"***There are two approaches to this. One is for the citizens and the other is for the government. The government needs to make available more boreholes, more public toilets with supervision and also create job opportunities. The government also needs to reinforce the weekly and monthly environmental sanitation that was previously embarked upon and routinely check-up on our health facilities to ensure everything is in order and up to standard. Citizens need to engage in more personal hygiene and cleanliness, ensuring the already existing water wells we have are properly secured. They also need to visit the healthcare facilities as often as possible for routine check-ups. Furthermore, infected persons should learn to speak up about their being infected so they are given immediate medical attention and so the real prevalent rate can be established***" - Community Leader

"***These people need information; they need to be mobilised and awareness created. They should be informed and educated on the disease; the government should also integrate WASH in our communities. If wash can be integrated in all the communities naturally, the disease will go away. Another thing is the introduction of Molluscicide in the rivers and pools where they bathe, UNICEF has been helping us in that area, WASH promotions have been done with the help of UNICEF in 15 out of 33 Local Government areas. If water sanitation and hygiene can be implemented in the remaining 2 LGs it will reduce the infection because all the 5 domains of hygiene (Environmental hygiene, Food hygiene, Personal hygiene, proper waste disposal and water hygiene) will be taught as they see them practising it. My advice is that they should not swim in rivers or any pool of***

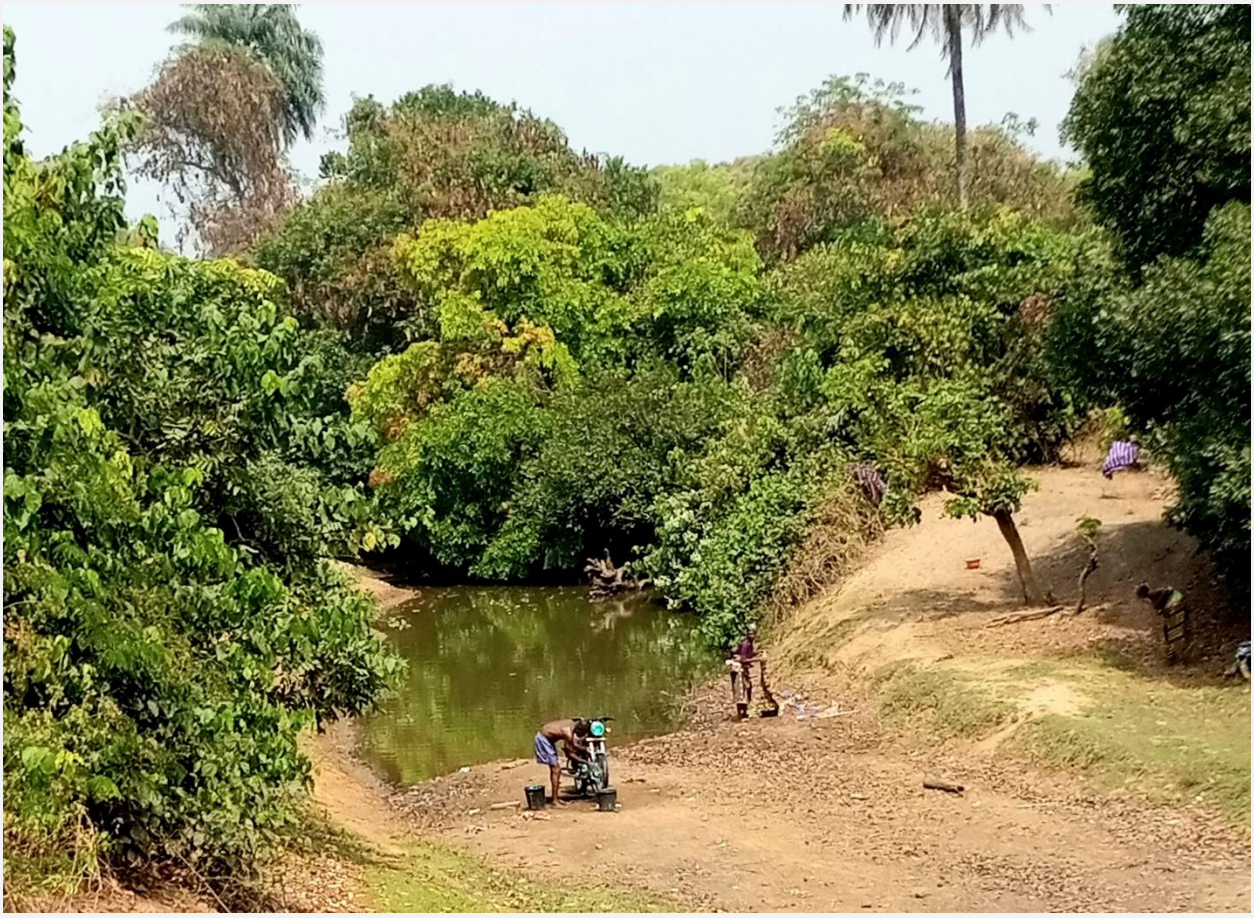
water, they should not urinate in the river or bank of the river, they should practice WASH precautions and they should observe the 5 domains of hygiene, they should fetch water from bore hole to bath instead of rivers" - Health Official, Oyo state

"***Since there are cases, we could inform the Government to provide drugs which are usually given to us by organisations (Supportive programmes). Indigenes should avoid going to the river, maintain proper hygiene, each household should have their own toilets and children should not be kept on the ground to play. Government should provide Test kits for schistosomiasis, as it will let us know those who have the disease because some people may have the disease but will show no clinical signs and symptoms. This will really help because people get discouraged to run a test due to financial constraints and the distance from the community to a laboratory. In addition, awareness needs to be created on the importance of getting proper treatment for the disease and not waiting to find out if drugs are available through radio programs before reporting symptoms to health officials. For instance, there is this organisation that does school-based deworming in Oyo state, and any day praziquantel is to be administered some students will not go to school. Aside from the effectiveness of the drug, some children who are infected prefer for the worms to remain inside them because they know by the time they take the drug they will pass out the worms in urine or stool, and it scares them***" - Health Official

"***We need more borehole water and more drugs at the healthcare centre as it would encourage more patronage***" - Anonymous

"***We would appreciate any efforts to build more toilets for us because we do not have enough. A lot of people do use the bush***" - Community Member

Picture 8 – Ose River in Moniya Jarija Community in Oyo State. Community members use rivers like these for their household, leisure, and socioeconomic activities. With the possible presence of schistosoma vectors in these rivers, they are predisposed to transmission and infections.



Picture 9 – Ofiki River in Irawo Owode Community in Oyo State. Community members use rivers like these for their household, leisure, and socioeconomic activities. With the possible presence of schistosoma vectors in these rivers, they are predisposed to transmission and infections.

ONDO STATE

DESK REVIEW

A total of 11 articles were shortlisted and deemed eligible for review and data extraction which formed the foundation for our data review on schistosomiasis in Ondo State. These ranged from cross-sectional studies (8), to a cohort study (1), and case studies (2). These papers included Ajakaye *et al*. (2017), which discussed the transmission of schistosomiasis in Akure North LGA as modelled by satellite derived environmental data; Awosolu *et al*. (2019), which reported on the efficacy of chemical reagent strip in the diagnosis of urinary schistosomiasis in Ikota, Ifedore LGA; Onifade and Oniya (2018), which discussed the prevalence of urinary schistosomiasis and efficacy of praziquantel amongst school pupils in Oke-Igbo; Peletu *et al*. (2018), in which studies were conducted on the transmission of urinary schistosomiasis among school aged children in Owena, Kajola and Baiken communities; Akeju and Ajayi (2018), which discussed the socioeconomic effects and prevalence of urinary schistosomiasis infection in riverine areas of Ondo state; Oniya *et al*. (2013), an update study on endemicity of schistosomiasis and efficacy of praziquantel in chemotherapy in Ipogun; Adeneye *et al*. (2021), in which studies on the factors promoting schistosomiasis infection in endemic rural communities of ifedore and Ile-Oluji/Oke-Igbo local government areas Nigeria were undertaken; Ogefere and Osuolale (2017), who studied the risk factors associated with urinary schistosomiasis among school-age children in Owo local government area; Dada and Alagha (2021), who conducted a study amongst individuals of the Ipogun community on urinary schistosomiasis and asymptomatic bacteriuria for the detection of predominant microorganisms and antibiotics susceptibility; Ajakaye *et al*. (2016) which reported a study on the environmental factors and the risk of urinary schistosomiasis in Ile-Oluji/Oke-Igbo local government area; and Peletu *et al*. (2020), who conducted a study on the transmission of uro-genital schistosomiasis and human water contact patterns in Aponmu-Iona river basin area of Idanre.

All 11 studies examined school-age children and adults to confirm the presence of schistosomiasis, utilizing diagnostic methods such as microscopical detection of the eggs of *Schistosoma* species, and chemical dipsticks. Urine samples were collected for analysis in all the studies except for Peletu *et al*. (2020) who determined transmission amongst snail samples, and Adeneye *et al*. (2021) where the samples collected were not explicitly stated. Sample population ranged from

52 – 2052 individuals with Adeneye *et al*. (2021) using the smallest sample population of 52 individuals and Akeju and Ajayi (2018), using the largest sample population of 2052 individuals.

In the reports reviewed, the prevalence of schistosomiasis ranged from 2.87% - 48.40% with Ogefere and Osuolale (2017) recording the lowest prevalence in Owo Local Government Area and Akeju and Ajayi (2018) recording the highest prevalence of 48.40% in riverine areas of Ondo state. A 16.6% prevalence was recorded by Ajakaye *et al*. (2016) in Ile-Oluji/Oke-Igbo community; 24.0% prevalence by Awosolu *et al*. (2019) in Ikota community; 19.9% prevalence in Oke-Igbo community by Onifade and Oniya (2018); 41.0% prevalence in Owena, Baiken and Kajola communities by Peletu *et al*. (2018); 18.0% prevalence in Ipogun community by Oniya *et al*. (2013); and 38.53% prevalence in Ipogun community by Dada and Alagha (2021). Awosolu *et al.* (2019) recorded a high prevalence among female school children (27.03%) than their male counterparts (21.05%) in contrast to Onifade and Oniya (2018) and Peletu *et al.* (2018) where prevalence in male school children (23.30% and 71.86% respectively) was higher than in female school children (15.40% and 57.09% respectively).

Many of the prevalence studies indicated haematuria as one of the classical clinical signs encountered and others included dysuria and proteinuria (Oniya *et al.*, 2013; Awosolu *et al.*, 2019). Dada and Alagha (2021) reported signs of bacteriuria coupled with haematuria with a high prevalence (48.62%) in female subjects. They attributed bacteriuria to the anatomically short urethra in the female population. However, there was no statistical data evidence to prove a causal connection between Schistosomiasis and bacterial UTI. Akinneye *et al.* (2018), in their studies, observed that the prevalence of haematuria was significantly higher in male schoolchildren (22.7%) than the female gender (14.4%).

Key risk factors identified for all studies included unsanitary habits; contact with stagnant and flowing water bodies like rivers and streams in the communities (Peletu *et al*., 2018; Awosolu *et al*., 2019; Adeneye *et al*., 2021); degree of rainfall (Ajakaye *et al*., 2016); lack of potable water; and improper waste disposal methods (Onifade and Oniya, 2018). Over 60% of the studies shortlisted (7 out of 11) identified proximity to water bodies such as rivers, streams, and lakes as the major source of *Schistosoma* infection. The major demographic risk factors identified include; occupation, age and gender (Ajakaye *et al*., 2016; Akeju and Ajayi, 2018; Onifade and Oniya, 2018). Onifade and Oniya (2018), in their studies,

discovered that the age group 6-10 years had the highest frequency of schistosomiasis infection which they attributed to water-contact activities such as snail-hunting and swimming. Fishermen and farmers with their farmlands close to water bodies were also discovered to be more predisposed to schistosomiasis. No animal health risk factors were highlighted in all the studies reviewed. However, snails like (*Bulinus* spp and *Biomphalarian* spp) were found around water bodies and implicated as the intermediate hosts for the transmission of schistosomiasis. (Akeju and Ajayi, 2018).

Ajakaye *et al*. (2016), in their study, tried to determine the effects of environmental factors on the prevalence of schistosomiasis by using regression analysis to analyze the correlation of environmental factors to prevalence of schistosomiasis. There was a positive correlation between vegetation, rainfall, slope, temperature and prevalence of infection and a weak negative correlation between proximity to water body and prevalence.

To combat schistosomiasis prevalence, Onifade and Oniya (2018), Akeju and Ajayi (2018), Adeneye *et al*. (2021), and Dada and Alagha (2021), in their studies, recommended extensive health awareness to be conducted by the government in communities where there are high prevalence and risks of infection and reinfection of schistosomiasis. Awosolu *et al*. (2019), Peletu *et al*. (2018), Oniya *et al*. (2013), Ogefere and Osuolale (2017), and Dada and Alagha (2021) recommended that active and routine mass administration of drugs in endemic communities should be implemented, alongside routine elimination of snails present in water bodies in these communities.

KEY INFORMANT INTERVIEW (KII) AND FOCUS GROUP DISCUSSIONS (FGD)S

Interviews and Focus Group Discussions (FGDs) were conducted with health officials at the local government levels, community health workers and community members of Ifedore, Ikoko, Ile-Oluji and Ipogun for information on schistosomiasis. These communities were identified by local and state government level health officials as key communities identified as having some of the highest prevalence of schistosomiasis in the state.

KNOWLEDGE OF SCHISTOSOMIASIS

A major percentage of interviewees affirmed the local name to be '*Atosi-aja*' while others called it '*Ito-eje*' due to the presence of blood in the urine.

"***I am not sure but I know there will be blood in the infected individual's urine and it is caused by unclean water. Wherever there's a water body, there will be Schistosomiasis, and as long as children continue to bathe in the unclean water bodies, they will be infected. Therefore, we advised them against bathing in unclean waters.***" - Community Leader; Ogbese, Akure North

"***It is called "Ito Eje. From what I heard, I believe this disease is often in water bodies like lakes"*** - Community Member

"***We know it as 'Ito-Eje' but we also call it 'Atosi-aja'***'" - Community Leader

PREVALENCE, DISTRIBUTION AND RISK FACTORS

It was reported that schistosomiasis has been occurring in the state as far back as 2001 with an overall prevalence of 46% in 2003. According to respondents, schistosomiasis has been present in communities like Ipogun, Ifedore, Ile Oluji Oke-Igbo, Ikoko communities and Akure North and Owo local governments in the last 10 years, with school-age children being more susceptible to schistosomiasis than adults as they mostly play, bathe and swim around streams, rivers, and other water bodies. It was also stated that among adults, men are more susceptible than females. Though some respondents mentioned increasing numbers of cases in communities like Ipogun, others commented that some other communities have had a declining number of cases due to governmental intervention through mass drug administration and several awareness programs.

"***Anyone can be infected as long as they bathe in waters containing the pathogens, men can have it, children can also have it. However, children are more prone to it***" - Health Official

"Children who go to river banks to bathe are most prone to the disease. It was quite common initially but after the government distributed medications to students, the numbers of cases have gradually reduced. Presently, we have a lower number of cases than before. In fact, it has been a while since I heard of a new case" - Community leader

"I can't say with certainty because the children with this disease do not identify themselves because they are ashamed. However, we recorded the incidence of

one or two cases in a Nursery and Primary school, but I think children, especially those that bathe at lake shores are mostly infected. Pregnant women are exposed to it, they might also be infected." – Community member

"Only children are susceptible irrespective of their gender." - Community Leader

"As a student in 2017, in one of our lectures, Ipogun was mentioned to have the highest prevalence and I was embarrassed to mention that I was from Ipogun due to this….. It is common amongst male and female children but not adults. I have never heard about it in pregnant women and it has been ongoing for more than 10 years. Even as a kid, I was always warned by my mother to not go the river unless I would start urinating blood" – Health Official, Ipogun community

"It is mostly prevalent in Ipogun but also present in other communities, mostly men and women with little number of pregnant women. However, I cannot confirm until they visit a health facility that I am involved with. But mostly, men and also many among school-aged children are usually infected." – Health official, Akure

"It is a problem in the Ifedore local government and cases are increasing in Egboku and Egule wards." - Anonymous from the Ikoko community.

"As at 2003, we had about 46% total prevalence in the whole state. The rates differ from one local government to the other. So we moved from double digit prevalence now to a single digit prevalence, Okay, the data we have in Ondo states shows that male are more predisposed to infection, the male school children because of their habits." – Researcher and Ondo State Health Official

"***Some local governments would have a prevalence as high as 70% but we were able to bring some down to single digits.***" – Researcher and Ondo State Health Official

DIAGNOSIS AND SYMPTOMS

Most officials stated that little or no confirmatory laboratory tests are done as such equipment are not available. Therefore, hematuria has served as the main indicator of schistosomiasis infection. Other symptoms reported include itching and muscle pains. However, it has been reported that some of the patients appear to be asymptomatic.

"***We mostly diagnose through their urine itching of the body, as we do not have facilities to examine the urine so we diagnose visually. We also see itching and muscle pains as additional symptoms.***" – Health official, Ipogun Ifedore Community.

"We do not have diagnostic kits here but if there is need for a laboratory confirmation, there are private labs for those tests." – Health Official, Ile-Oluji Community

"***The hematuria sign is more or less chronic, because most of the time, many of them that are actually infected are asymptomatic***." - Researcher and Ondo State Health Official

"***The infected show bloody urine. Sometimes, the blood comes out after he/she urinates. For children, their parents will look for nurses and report the symptoms after which medication is given to them. We also confirm by asking questions about his/her symptoms and ask the parent if the child recently bathed in the river, and, if yes, we ask about the last time he/she did so.***" – Health Official, Ile-Oluji Community

Comments were also made on the availability of data to corroborate information and understand the true prevalence or trends of the disease in Ondo state. However, respondents (health officials) state that there is little to no data or surveillance on schistosomiasis in the state, except for independent research endeavors that are carried out by researchers interested in the disease. It was also stated that there are no physical or virtual data banks for the collation of all research or data from governmental assessments. This makes it harder for researchers and other institutions to get credible and verified data for their works.

"There should be an NTD bank in every state. On the state level, once data is collected and available, we bank it there. Also, when the Federal Ministry's officials come for assessments and provide data, it can also be banked there. The bank should operate as a library for both health officials and researchers so that the data can be available with no sweat. This can be done online but there are no staff to do that on a routine basis due to zero funding. – Researcher and Ondo State Health Official

TREATMENT AND INTERVENTIONS

Respondents provided information on the treatment and interventions activities conducted and these largely included mass drug administrations (MDA) with the anthelmintic, Praziquantel, and extensive awareness programs implemented by both local and state government health officials. Health officials also reported that during these outreach programs, community members were often encouraged to visit health centers in their vicinity for treatment and use the recommended anthelminthic drugs, instead of resorting to herbal concoctions. This was because an initial apathy towards MDA programs were observed as community members were skeptical/suspicious about the drugs provided by the health centers and were more familiar with using herbal concoctions to take care of ailments. To facilitate and support these community outreaches, an instance was provided where an influential state leader and politician was engaged to make a public commitment and demonstrate that the anthelminthic drug was safe to use. Now, based on reports by health officials, corroborated by statements from community members, this hesitancy associated with praziquantel use has since changed.

"They go to the Basic Health Center to get necessary medications. People no longer use herbs, they were only effective in the olden days and are no longer effective now… our people are more enlightened now" - Community Leader, Akure North.

"We have an outreach programme facilitated by all the 28 health facilities in Ifedore. We do health talks in our outreaches and we tell them that anybody urinating blood should visit the hospital. We assure them that the information given would be kept confidential." – Health Official, Ifedore

"There was this disdain or apathy towards the drug when we started intervention. The pupils were given drugs at different schools once after they were analyzed or checked or doing mass average of medicines. The pupils in the schools will take the medicine, put it in their mouth, drink a cup of water but not swallow it and this is because they are under instructions from their parents at home… In 2017, I championed the kind of campaign which was led by the Speaker of the Ondo State House of Assembly, we focused on Ifedore and we invited all the paramount rulers of all the committees in the local government to improve the homestead programme. So I was able to educate the community about the danger of treatment-seeking behavior and the apathy they have towards the drug. The Speaker demonstrated it as he collected his own dose in their presence and swallowed it and that accounted for something. So since we had that campaign,

the idea was to reproduce these in all local government areas in the state but the funds were unavailable. For Ipogun, the treatment seeking behavior has changed and there were no side effects or whatever in the case of Praziquantel. There was generally suspicion borne out of ignorance"

– Researcher and Ondo State Health Official

A health official also indicated misgivings about the use of dose-pooling to determine eligibility of recipients for MDAs as this method reportedly excludes younger and older people who are equally infected and should receive medication for schistosomiasis.

"The initial method used was a dose of 40 mg/body weight, but later on the dose pole was introduced. And I still have my reservations about that. I don't like it, because the dose poll will not pick you up if you're less than three feet tall so those poles cut off even people who are infected and old enough to be treated because heights vary. I've seen people who have stunted growth but are old. It excludes children from three years and below." – Researcher and Ondo State Health Official

PERCEIVED ENVIRONMENTAL HEALTH RISKS

Various environmental health risks and issues were indicated by respondents and most of these conversations revolved around environmental sanitation, WASH facilities and proximity to dirty rivers and streams. Though community members had varying comments about the availability of toilets, all respondents agreed that toilets were inadequate, and that open defecation was still common practice. Respondents also mentioned that there are little to no established waste disposal systems and sites leading to environmental pollution and washing off of fecal matter and waste into the streams and rivers which were concurrently also being utilized for domestic and recreational activities. All of these challenges increase the risk of contracting schistosomiasis.

"People no longer defecate in bushes, they use toilets, there might be some people that still do so, for example, farmers coming back from the farmland might need to defecate and in the absence of a toilet, defecating in the bushes will be considered." - Community Leader, Akure North

"Dirty environment plays a role especially when people bathe in the river, especially the Apomu river. In this community, we have no waste dumping site.

Waste is dumped into the bush. So, rain and erosion can carry it into the river. Some even defecate into the river and others wash in that same river" - Health official, Ipogun Community

"Houses without toilets are not common and those who do not have toilets rush to the farmland to defecate. They dig, defecate and then cover the area" - Community Leader

"In my community here, there are no refuse dumpsites. They throw it in the river or along the farm roads and when they are going to the farms they just throw it into the bush. As I said earlier, there are no toilets and open defecation is not very good. During the rainy season, or it may not be during the rainy season, erosion may carry the feces (dry or wet or even the fresh ones) into the river which is used as a source of drinking water, bathing, washing and so on and so forth. The last time we visited the rivers with a white man, we met a woman who was washing her cassava." – Health Official, Ifedore Community

VECTOR AND ANIMAL HEALTH RISKS

In addition to the established transmission cycle perpetuated by the presence of snails in adjoining rivers and streams, risk of co-infection and/or cross-infection from domestic animals were considered. Some health officials indicated that it is common to see domestically-raised pigs and dogs go to the streams or stagnant water for a bath or to drink water, and that this may lead to the infection of these animals, possibly making them carriers of the infective stages of certain zoonotic diseases and ectoparasites. However, there is little or no statistical data or research to prove a causal connection or transfer of schistosomiasis between animals and humans in Ondo state; and further research is being considered in this regard.

"Pigs do go to the river and they love farrowing so they can be infected with Schistosomiasis. They, alongside, dogs carry lice and ticks on the body." – Health Official, Ifedore Community

"We have not done any research to that effect in the state. I'm not aware of any research being done by someone else. However, we have written a proposal to that effect to find more about Schistosoma hybridization. We are requesting for a grant from TETfund and I am leading the team as Principal Investigator as we try to look at Schistosoma in three states; Ondo, Kano and Bayelsa. With this, we can

establish that we have actually formed Schistosoma hybridization, where the animals are also involved in the transmission cycle and this would provide insights to endemicity." – Researcher and Ondo State Health Official

PERCEPTIONS AND SOCIOCULTURAL NORMS OF SCHISTOSOMIASIS

According to reports from community respondents, there was some level of stigma associated with schistosomiasis. Some people regard it as a shameful thing to have and due to the stigma attached, infected persons are discouraged from visiting health centres or even telling others about their condition. Some believe it is as a result of a spiritual attack and are more likely to visit traditional herbalists than the health centres. Such stigma and sociocultural beliefs often led to challenges in acquiring samples and data in order to gauge the true incidence and prevalence of schistosomiasis in these communities. However, it is believed by most respondents that more people are now educated and can associate the disease to its primary causative agent. Also, extensive awareness programs are still ongoing in many communities on schistosomiasis.

"Before, people did not believe Schistosomiasis could be gotten from the river but around 2007, our Governor came and samples were collected. The people were informed not to go to the river again as it was the cause of the bloody urine. In 2018, the same process was repeated." - Community Leader, Akure North

"Some believe that it is not a disease. Some believe that Schistosomiasis has spiritual implications and they go to visit the native doctors while others visit the clinics." – Health Officer, Ifedore Community

"60 percent of the people feel shy to open up about their being infected with Schistosomiasis. Irrespective, we try to educate people about the dangers associated with having Schistosomiasis." – Health official 2, Ifedore Community

"There was a Newsline report that Ipogun is a village where men menstruate. That statement was made by the late Frank Oliseh. We had a problem in the earlier years of intervention but I think people are sufficiently educated now. Although they say that the etiology of the disease is water insects, called "kokoro omi" in Yoruba, at least they now know that disease is linked to water. In 2001, some believed the disease was a sign of puberty, others thought it was witchcraft from neighbours and others more or less submitted to it as the will of God but they now know to associate it with water." – Researcher and Ondo State Health Official

RECOMMENDATIONS PROFFERED

To reduce the incidence and prevalence schistosomiasis in their communities, respondents generally recommended that more awareness programs should be conducted to educate the state residents about the dangers of swimming and bathing in unclean water bodies; that more public toilets, potable water, and WASH facilities should be provided; and there should be an increase in the number and capacity of health officials and staff at the health centres. Health officials also recommended an increase in the frequency of the Mass Administration of Medicine (MAM) programs with improvement in diagnostic laboratory equipment in order to increase accuracy in diagnosis rate and surveillance of schistosomiasis in the state. Furthermore, there was a call for a multi-pronged approach and concerted funding to intervene and address the prevalence of schistosomiasis in the state.

"The lessons from my experience are; this disease is caused by water. Therefore, people should not bathe at river banks anymore." - Community Leader, Akure North,

"The infected ones should go to the basic health centre for proper treatment, also, the government should ensure that the borehole is working regularly since availability of clean water will dissuade the children from going to rivers to bathe." - Community Leader 2, Akure North

"They should stop people from going to that river, and they should stop walking barefooted, they should increase the distribution of the drug to twice in a year, yes, they should give us borehole water, public toilets and also do something about the river and more enlightenment programs and environmental sanitation officers every month." – Health official, Ifedore Community

"I will implore the state government and NGOs to come to the assistance of the people. They should construct more boreholes in addition to the ones on ground. I will suggest that public toilets in different locations should be constructed." – Health official 2, Ifedore Community

"***My advice for the community is that the infected ones should seek a doctor rather than self-medicating. The government should please provide the medications for us so that the infected can easily access them and get treated, the government should help us with our hospital. We are more or less indigenes of***

this town and we've spent much more time here than in our hometown." - Community Leader, Ifedore Community

However, unlike our hospitals in Osun State, we have fewer medications here. For example, when my child was injured and I took him to a hospital in Ikirun, he was treated immediately and he was given a tetanus vaccine free of charge, and he was also given enough medications. So, please help us plead to them to pity us and bring more medications to our health centres." - Community Leader, Ipogun Community

"Intervention should be focused in the rural areas as they are the hotspots for Schistosomiasis there but there is a lack of health staff there. Most times, you find only one doctor attached to 3 different communities and they go on rotational visits. So, there is a lack of medical personnel, no adequate amenities so they feel uncomfortable. If the government can make the areas more comfortable and possibly give additional stipends to those that take up this assignment, they would be physically present. Also, the health centres also need to be worked on as they are dilapidated… Drug procurement in Nigeria relies mainly on donations from external bodies such as pharmaceutical bodies. We need to start purchasing drugs instead of waiting at the mercy of NGOs. There was a time in 2016 when we could not find the expiry date on containers of drugs donated. So, we have become a literal dumping ground. Hence, NGOs are championing the control of Schistosomiasis with little intervention from the government… Schistosomiasis should be declared as a Public Health emergency. With uninterrupted multi-pronged intervention efforts, I can claim that we can eradicate it in 2 years. With chemotherapy and molluscicides, public enlightenment and provision of social amenities, we can halt the transmission in Nigeria. However, we require funds. The funding for Schistosomiasis control is a joke." – Researcher and Ondo State Health Official

Picture 10 - Abandoned dysfunctional borehole in Ogbese Community, Ondo State

EKITI STATE

DESK REVIEW

Four articles were reviewed to provide information on the situation of schistosomiasis in Ekiti state. The articles include a prevalence study done on 191 students at Ogbese-Ekiti (Ologunde, 2009); a prevalence study with sample size 1049, done on primary school pupils across 19 LGAs in Ekiti state (Ariyo *et al*., 2004); a case study of sample size 172, evaluating the efficiency of controlling schistosomiasis with chemotherapy (praziquantel, 40 mg/kg body weight) among school pupils in Ogbese-Ekiti, Ekiti state, Nigeria (Ologunde, 2020); and a cross-sectional study investigating the pattern of infection for each established intermediate host species while relating it to sample group's water contact patterns to identify the risky water contacts as well as a transmission site at Ureje River in Ado-ekiti LGA, Ekiti State (Omonijo *et al*., 2013).

Three of the studies identified the causative organism as *Schistosoma haematobium* and the intermediate snail host species as *Bulinus globosus* (Ariyo *et al*., 2004; Ologunde, 2009; Ologunde, 2020). The transmission sites identified include Ogbese River (Ologunde, 2009; Ologunde, 2020), Ureje River (Omonijo *et al*., 2013) and 1,025 streams across the 16 local governments investigated and confirmed for the presence of *Bulinus globosus* by Ariyo *et al*. (2004). Ologunde (2009) further reported the predominant snail species in his study area (Ogbese-Ekiti) to include, *Bulinus globosus*, *Bulinus forskalii*, *Potadoma moerchi* and *Pila ovata*. The snail species identified at another study area (Ureje River) include *Bulinus globosus*, *Bulinus truncatus*, *Potadoma freethi*, *Melanoides tuberculata*, *Lanistes varicus* and *Biomphalaria pfeifferi*. *Bulinus globosus*, *Bulinus truncatus* and *Biomphalaria pfeifferi* were established as the intermediate hosts (Omonijo *et al*., 2013) of various species of human schistosomes.

The samples collected for analysis were urine samples (Ariyo *et al*., 2004; Ologunde, 2009; Ologunde, 2020) and snail samples (Omonijo *et al*., 2013). Also, haematuria was identified as a main symptom of the disease (Ologunde, 2020) and diagnosis was done via microscopy (Ologunde, 2009; Ologunde, 2020) and haematrix strips (Ariyo *et al*., 2004).

The results from the study by Ologunde, (2009) presented a total prevalence of 89% (170 out of 191), with the prevalence amongst secondary school students tested being 97.4% and that of primary school pupils at 87.5%. Other studies reported prevalence of 42.2% (Ariyo *et al*., 2004) and 75.6% (Ologunde, 2020). Ariyo *et al*. (2004) showed higher prevalence amongst males compared to females with their respective prevalence rates being 50.9% and 36.9% respectively.

The results from Ologunde, (2020) shows that mass chemotherapy (with Praziquantel) and elimination of the intermediate host is a more effective method to reduce transmission of *Schistosoma haematobium* in the study area compared to selective treatment.

Risk factors identified by studies reviewed include water-related activities such as swimming, fetching, washing (of clothes, motorcycles, vehicles, vegetables, and dishes), bathing and fishing (Ariyo *et al*., 2004; Ologunde, 2009; Omonijo *et al*., 2013). Omonijo *et al*. (2013) further investigated infection patterns and water contact patterns at Ureje River in Ado-ekiti LGA, Ekiti state. They reported that the water-related activities including fetching of water, bathing, washing of farm produce, watering of vegetables, washing of limbs, washing of cloth, fishing, washing of farm tools, swimming, walking, and washing of motorcycles were common risk activities. The duration of these activities ranged between 2 mins - 2 hours and the most common activities were washing of limbs, washing of farm produce, and bathing. Also, the article stated that out of the contacts recorded (277), males made 196 contacts with the studied water body, Ureje River (70.8%) while females made 81 contacts with it (29.2%). This suggested that the likely reason for higher prevalence of schistosomiasis in males compared to females in the study area is as a result of higher water contacts among males compared to females. Also, it is noted that persons in the age range 10-19 years had the highest number of contacts (88), followed by ages 0-9 years with 17 contacts. This corroborates information that school children, teenagers and young adults are mostly at risk of schistosomiasis infection in the study area. The article, Omonijo *et al*., 2013, also showed the variations in contacts in relation to season; the highest number of contacts was during the rainy season, especially August. This may be due to the increase in economic activities (such as fishing and washing of vegetables), personal activities (such as fetching water and laundry), and recreational activities (such as swimming) during the rainy season.

Another important risk factor is social-cultural perceptions on the disease such as the belief that schistosomiasis can be transmitted when a black dog urinates in a stream and such stream is crossed by an individual (Ariyo *et al*., 2004).

Recommendations provided for combating schistosomiasis include basic health education on schistosomiasis and its transmission, provision of pipe-borne water, and mass treatment of infected individuals (Ariyo *et al*., 2004). Ologunde (2009) also recommended that focal molluscicide be used to control intermediate hosts and that alternative sources of clean water should be provided to reduce the possibility of being infected. He further supports the implementation of an integrated approach to combat schistosomiasis in Nigeria. Omonijo *et al*. (2013) recommended reduction in the frequency and duration of water-related activities. And then, there were final recommendations for further studies to be carried out in the study areas and across the state to detect prevalence of schistosomiasis (Omonijo *et al*., 2013)

KEY INFORMANT INTERVIEW (KII) AND FOCUS GROUP DISCUSSIONS (FGD)S

KNOWLEDGE OF SCHISTOSOMIASIS

Interviews and FGDs were conducted with government health officials, community leaders and community members in Ekiti West, Ise and Gbonyin for information on schistosomiasis. These LGAs were identified by the state-level health official as LGAs with communities having some of the highest prevalence of schistosomiasis in Ekiti state. The community leaders and government health officials confirmed knowledge of the disease and indicated that it was locally called "Atosi Aja". They also mentioned the predisposing factors to infection and mode of transmission.

"***The local name for schistosomiasis is "Atosi Aja, there are no other names***" - Community Leader, Gbonyin LGA

"***Yes, if an infected person urinates in a stream and another individual bathes in that stream. But from person to person? No***" - Community Leader, Ekiti West LGA

"***Adults are susceptible though if they swim in infected streams and other water bodies***" - Community Leader, Ekiti West LGA

"***Schistosomiasis still exists…. because they still use streams for domestic purposes in the farms***" - Health Official, Gbonyin LGA

However, based on personal experience, a state level official claimed that some of the community members are still ignorant of this disease.

"***Some people are ignorant of these diseases and have diverse opinions and perceptions. With time, I believe these people will be convinced to regard the health implications of this disease***" - State Health Official, Ekiti State

PREVALENCE, DISTRIBUTION AND RISK FACTORS

There are diverse opinions on the disease's prevalence in communities evaluated. According to some respondents, the disease is no longer as common as before, with only reports of a few cases. However, some respondents reported that there are some cases in remote areas in Ekiti. Furthermore, some respondents also commented that fewer cases might be reported because people try to hide disease incidence.

"***.... Schistosomiasis is not as common as it used to be. I am usually surprised about people doing research on Schistosomiasis***" - Community Leader, Gbonyin LGA

"***Schistosomiasis still exists, especially, some parts of Ijan Ekiti inhabited by non-indigenes such as places inhabited by Tapa, Igede and Tiv people. We have adults asking for drugs that are supposed to be for children between 5-14 years…***" - Health Official, Gbonyin LGA

"***Not in recent times and not among town-dwelling people, mostly those in remote settlements***" - Community Leader, Gbonyin LGA

"***There is a relative of mine who still suffers from it*** " - Community Leader, Gbonyin LGA

"***You know in Yoruba land people hide the fact that they are sick so no one gets to know***" - Community Leader, Ekiti West LGA

"***They hide the fact that they are sick…***" - Community Leader, Ise LGA

A state-level health official also provided mixed opinions and uncertainty about the prevalence of schistosomiasis in the state. It was mentioned that poor data

availability and lack of evaluation studies to show progress led to this uncertainty about the true prevalence and distribution of the disease in Ekiti state.

"***In 2004, the Federal Ministry of Health carried out research on Schistosomiasis. It was adjudged that 15 LGAs are endemic to Schistosomiasis. In 2008, the Ekiti State government carried out research on the prevalence of schistosomiasis in the state. It was discovered that 16 LGAs are endemic to Schistosomiasis. Though there have been no official evaluations except personal evaluation during my Masters in Public Health programme in which I worked on schistosomiasis and its risk factors. I worked in Ise Orun and found out that there is a reduction in schistosomiasis prevalence***" - Health Official, Ekiti State

Low availability of data on incidence was also identified.

"***DSNOs are responsible for reports at the LGA but their focus is basically on polio and measles. Disease reporting is not being done the way it should. They don't take cases of other NTDs into consideration nor do they report them. I wouldn't entirely blame them because there could be logistic challenges… It should be tackled from the federal level so that it will be universal. If there are documented cases, it will hasten response***" - Health Official, Ekiti State

Children and adults living close to water bodies are identified as the most vulnerable population. Children are considered the most vulnerable population to this disease because of their frequent water recreation activities around infected water bodies. Other risk factors indicated by respondents included the fact that residents' daily household and recreational activities revolve around the river locations, including the utilization of the water for drinking and bathing. They also mentioned the presence of the disease's intermediate hosts (water snails) in the environment and that frequent visits to the rivers perpetuate and increase the risk of infection.

"***Children are most susceptible***" - Community Leader, Gbonyin LGA

"***Children are the most vulnerable. Adult in close contact with water bodies such as fishermen and farmers growing rice or cucumber in riverine areas are also vulnerable***" - State Health Official, Ekiti State

SYMPTOMS AND DIAGNOSIS

The primary symptom mentioned is bloody urine. Painful and difficult urination was also reported. For disease confirmation, stool and urine analysis were reported as diagnostic tests.

"***The most recognizable symptom is bloody urine***" - Health Official, Ekiti State

"***Bloody urine***" - Community Leader, Ise LGA

"***I know of painful urination***" - Community Leader, Ekiti West LGA

"***I had it when I was 15… I used to feel discomfort especially when urinating***" - Community Leader, Ise LGA

TREATMENT AND INTERVENTIONS

Primary treatment options reported is the annual/biannual MDA (Mass Drug Administration) of Praziquantel and Albendazole. However, a community member indicated a belief in the efficacy of the use of herbal traditional medicines. Other interventions reported include awareness campaigns on the disease, provision of hand-washing facilities, wells and boreholes, and better transportation mediums.

"***Through FMOH and WHO, we receive drugs for treatment annually. The 5 LGAs with the highest prevalence have annual MDA while the remaining 10 LGAs receive MDA biannually***" - Health Official, Ekiti State

"***Please let him be treated as soon as another round of Mass Drugs Administration starts. We would be administering Praziquantel and Albendazole***" - Health Official, Gbonyin LGA

"***Yes, there are lots of herbs that can be used to treat schistosomiasis but people don't pay much attention to it.***" - Community Leader, Ise LGA

"***An awareness campaign was carried out some time ago and people were told that they could get infected with Schistosomiasis if they swim in rivers***" - Community Leader, Ekiti West LGA

"***There are hand-washing facilities in health facilities, schools and churches***" - Community Leader, Gbonyin LGA

"***Boreholes and wells… Since we no longer make use of the streams, we all have wells in our homes***" - Community Leader, Gbonyin LGA

"***... Because of better transportation, people no longer sleep in the farms so they don't have to make use of streams for domestic purposes in the farms***" - Community Leader, Gbonyin LGA

Some health officials mentioned some challenges that have been previously faced during dispensation of treatment and interventions to combat schistosomiasis. These included people's aversion to necessary medications due to reported side effects and lack of cordial relationship between health officials and community members. Also, a lack of enthusiasm towards getting necessary medical attention was mentioned.

"***Due to some side effects of the drugs administered, there were some hesitations and rejections but with much persuasion that they eat well and drink lots of water, there is increasing acceptance***" - State Health Official, Ekiti State

"***When we bring these drugs, we would tell them to eat well so that there won't be side effects such as dizziness. A lot of people refuse the drug for this reason.***" - Health Official, Gbonyin LGA

"***There are flaws. Health workers are trying but people don't respond to them. The people still need more awareness. A nearby community Ajegunle has good relationships with health officials who in turn respond to them well. That doesn't happen here.***" - Community Leader, Ise LGA

"***They hide the fact that they are sick… Some visit the hospital maybe when the symptoms get very disturbing.***" - Community Leader, Ise LGA

ENVIRONMENTAL HEALTH RISKS

Respondents also mentioned environmental risks that predispose them and their communities to schistosomiasis. These include inadequate alternative water sources, lack of toilets, hand-washing facilities and water purifiers, poor waste disposal and haphazard littering of the environment.

"***There are no hand washing facilities… Currently there is a borehole. Before the borehole, the only source of water was the Ogbese stream. We drink it. We bathe***

iit… No, we do not use water purifiers…. No, there are no toilets" - Community Leader, Ise LGA

"***There are no toilet facilities, no water sanitation and hygiene facilities hence children have to go to the streams to get water needed for domestic purposes… Yes, it does. Waste is being dumped at any available bush. Defecation also takes place at these dumpsites.***" - Health Official, Ekiti State

"***No. We dump waste in dumpsites and canals***" - Community Leader, Gbonyin LGA

"***Yes, we believe such places breed stagnant water which could also aid the breeding of schistosomiasis vectors***" - Community Leader, Ekiti West LGA

VECTOR AND ANIMAL HEALTH RISKS

It was noted by respondents that there were no reported cases of disease transmission via household animals and no research has verified this. However, snails are present in the communities, and they are identified as vectors of schistosomiasis. Also, little or no animal care was reported including non-vaccination of household animals including dogs.

"***No, I don't think our animals have schistosomiasis. But we believe they also carry dangerous bugs that can cause other diseases. We all breed animals here… No, we do not vaccinate our animals***" - Community Leader, Ekiti West LGA

"***Yes, there are snails in this neighborhood… Yes, they transmit schistosomiasis… Yes, dogs have rabies. Most people don't believe in vaccinating dogs. Although I believe if vets are nearby vaccination of animals would increase.***" - Community Leader, Gbonyin LGA

"***Such hasn't been researched or taken into consideration***" - Health Official, Ekiti State

"***Yes but People don't respond to them. There is a need for more awareness regarding health and animal welfare… No, people don't tend to animals until they are at the point of death. Most people don't do the right thing.***" - Community Leader, Ise LGA

PERCEPTIONS AND SOCIOCULTURAL NORMS OF SCHISTOSOMIASIS

Several socio-cultural beliefs associated with schistosomiasis were mentioned by the respondents. In some communities, it is believed that the pain associated with schistosomiasis is meant to remind children to urinate and prevent them from bedwetting. It is also seen as a sign of puberty and maturity in some communities.

"***Some people believe children having the pain of Schistosomiasis is a sign to remind or prevent them from bed-wetting.***" - Community Leader, Ise LGA

"***In 2010, The National Emergency Management Agency, NEMA conducted a survey and found that old aged people regard bloody urine as a sign of puberty and maturity. A particular mother said it's only a "bastard" in this community that will do without having bloody urine. They see it as a rite of passage to adulthood and they are not aware of it having any health implications. They see it as normal.***" - Health Official, Ekiti State

RECOMMENDATIONS PROFFERED

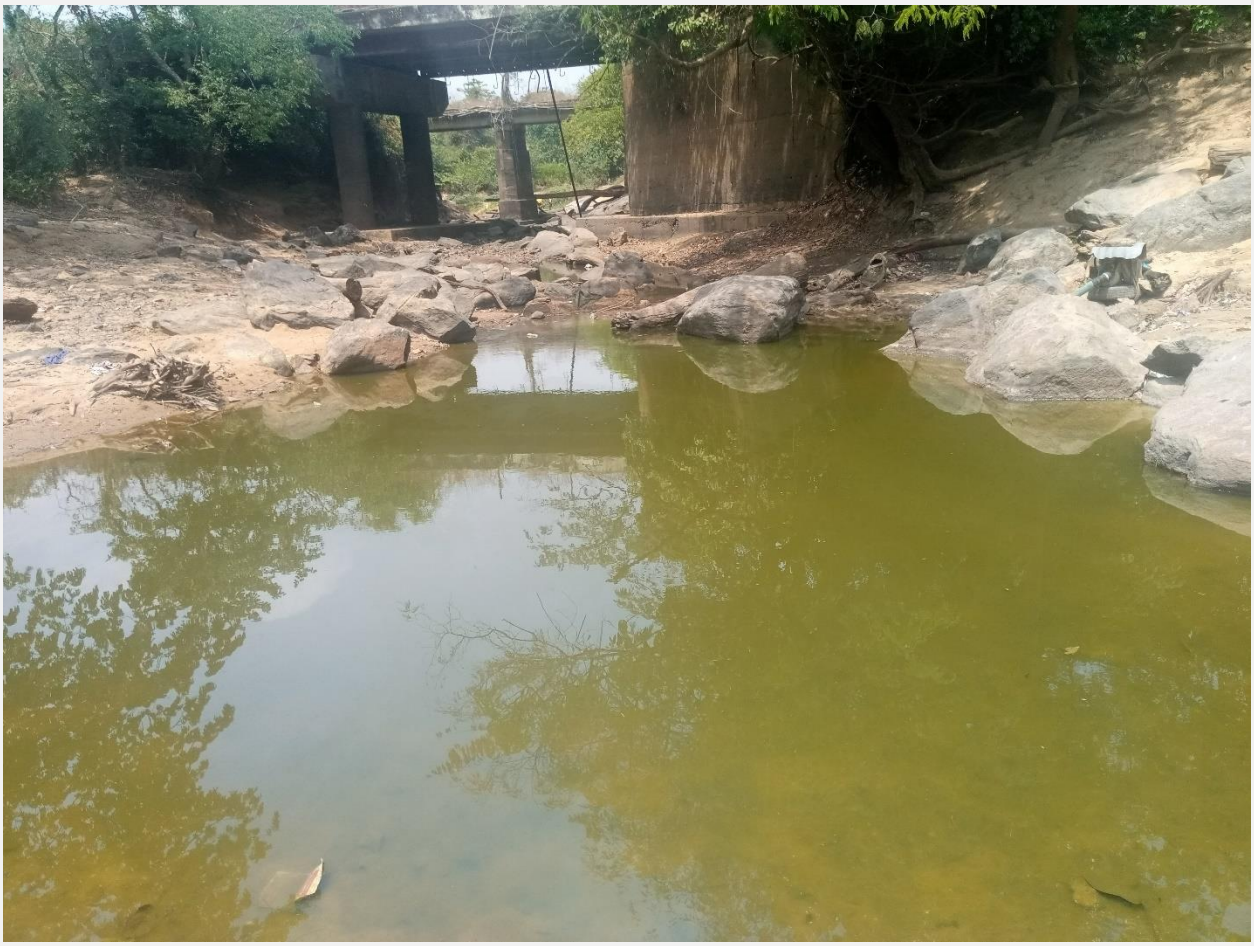
Recommendations offered include provision of pipe borne water and public toilets, intensified sensitization of people on schistosomiasis and MDAs through awareness campaigns, radio and television stations, communal meetings and door-door campaigns, and continuation of MDA to both adults and children. Also, some community respondents indicate that proven traditional medicines should be considered and researched as an alternative treatment source. It is also recommended that updated data and surveillance systems for schistosomiasis should be established.

"***There should be a way of making these leaves that are available for treatment public knowledge or to make them commercial so that they can be readily used by people… Pipe borne water should be provided… MDAs… Public toilets should also be constructed. Awareness should also be intensified because prevention is better than cure.***" - Community Leader, Ise LGA

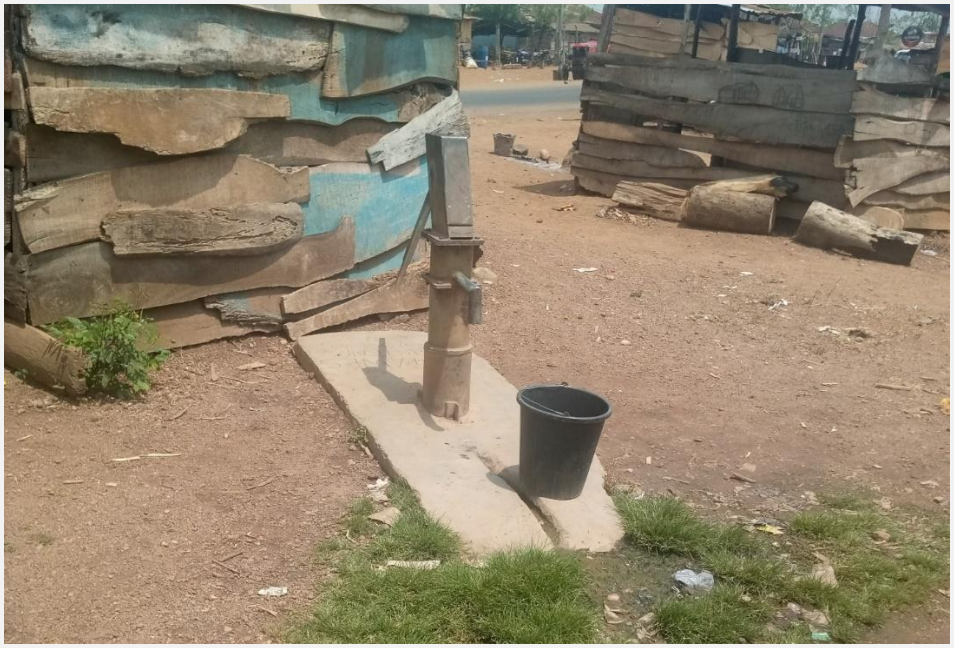
"***Media awareness on the radio, television. We should also educate ourselves in all communal meetings between women. These would work even more than the media because not everybody has televisions. House to house awareness will also be beneficial***" - Community Members, Gbonyin LGA

"***Provision of pipe-borne water-bodies...***" - Community Leader, Ekiti West LGA

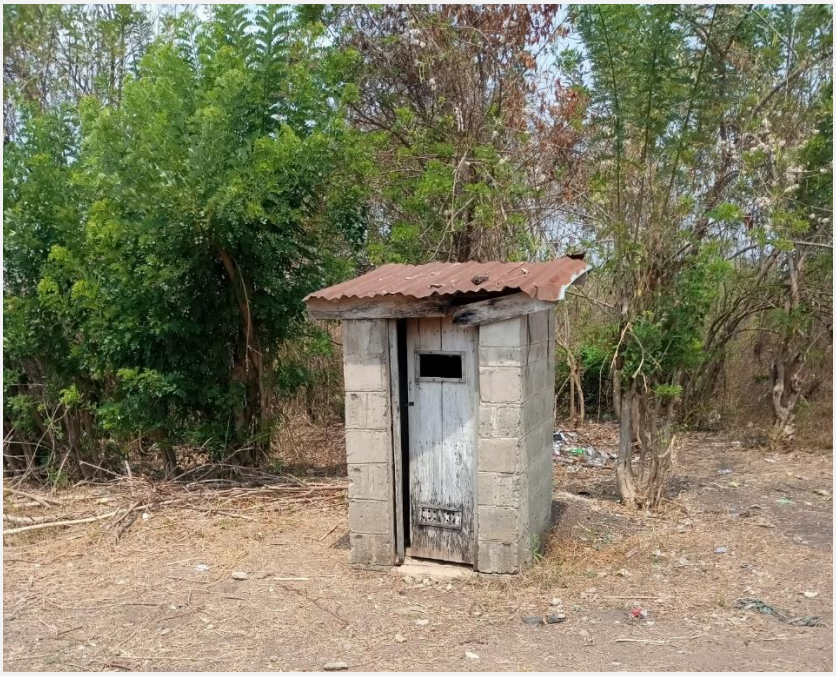
"***DSNOs are responsible for reports at the LGA but their focus is basically on polio and measles. Disease reporting is not being done the way it should. They don't take cases of other NTDs into consideration nor do they report them. I wouldn't entirely blame them because there could be logistic challenges… It should be tackled from the federal level so that it will be universal. If there are documented cases, it will hasten response***" - Health Official, Ekiti State



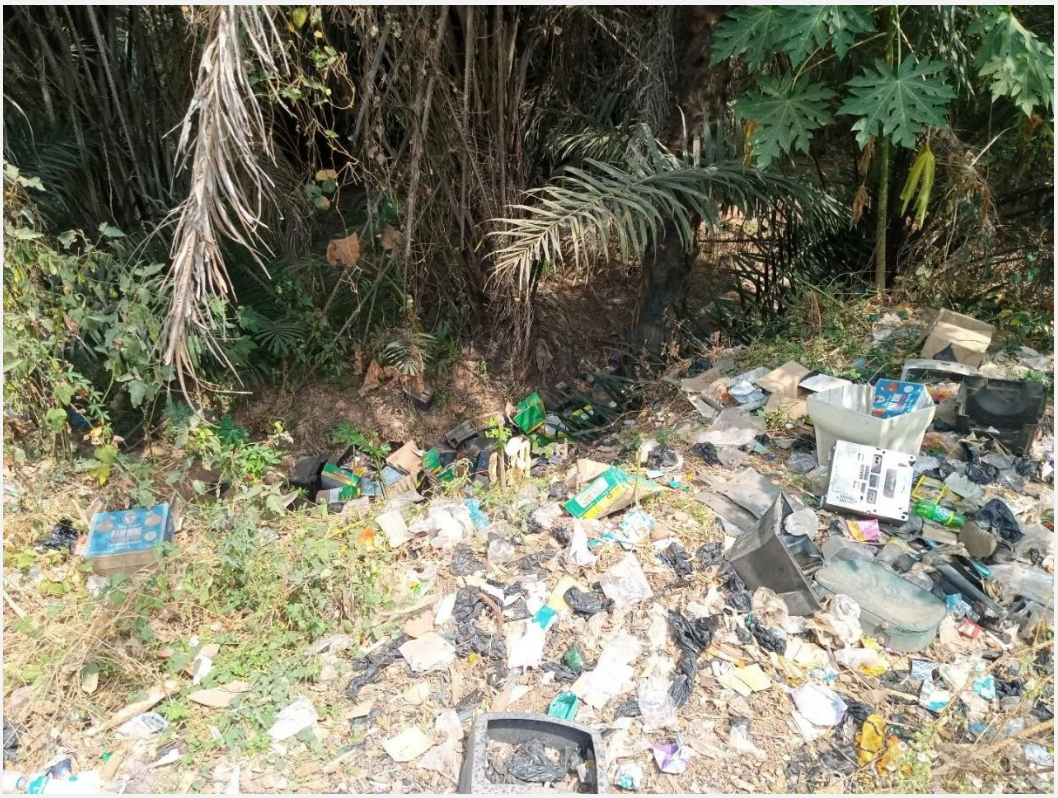
Picture 11 – Ise-Orun River in Ekiti State. Community members use rivers like these for their household, leisure, and socioeconomic activities. With the possible presence of schistosoma vectors in these rivers, they are predisposed to transmission and infections.



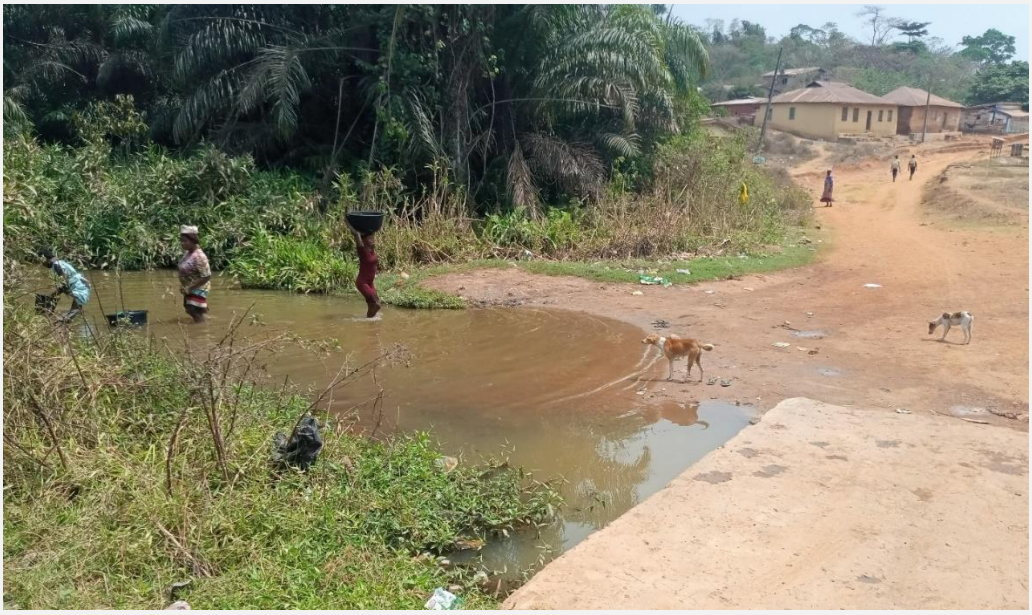
Picture 12 – Malfunctioning borehole in Ise Orun Community, Ekiti State. If this malfunction continues, the community members who depend on this borehole for source of water will be forced to resort to the unhygienic neighbouring rivers and streams which are often infested with Schistosoma vectors.



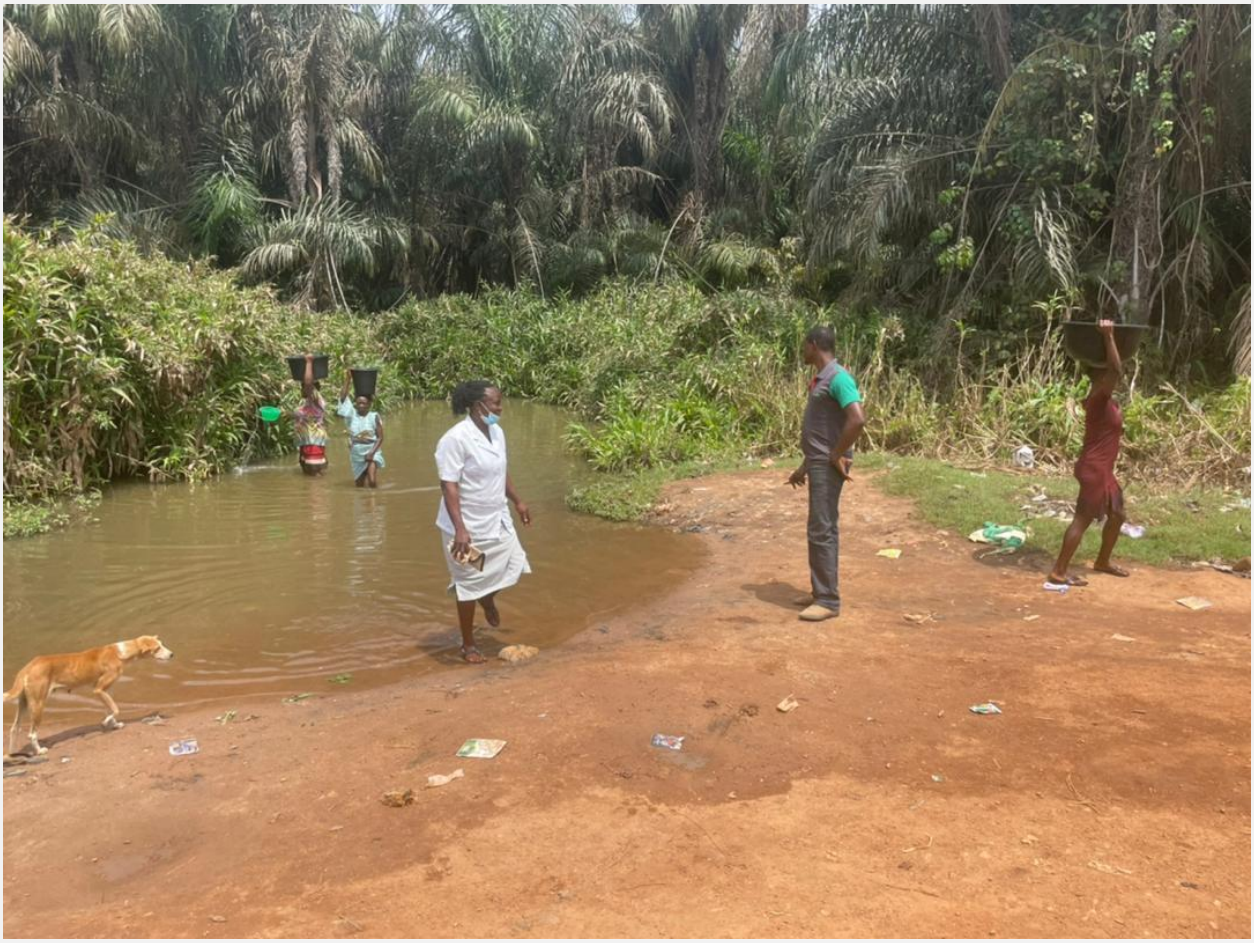
Picture 13 – Abandoned toilet facility in Ise Orun Community, Ekiti State. Often in cases like this, community members will be forced to resort to open defecation in bushes and in the unhygienic neighbouring rivers and streams which are often infested with Schistosoma vectors



Picture 14 – Indiscriminate dumping of refuse and poor waste management in Gboyin LGA, Ekiti



Picture 11 – River in Ekiti West LGA in Ekiti State. When both humans and animals concurrently use rivers like these for drinking, household, leisure, and socioeconomic activities, there is high risk of both Schistosoma vectors co-infections and zoonotic disease transmission.



Picture 11 – River in Ekiti West LGA in Ekiti State. When both humans and animals concurrently use rivers like these for drinking, household, leisure, and socioeconomic activities, there is high risk of both Schistosoma vectors co-infections and zoonotic disease transmission.

DISCUSSION

Schistosomiasis is still prevalent in Nigeria - especially in the South-west region. Across all 6 south-western states, a significant level of knowledge on schistosomiasis was observed in most of the respondents. They were able to identify the predisposing factors and the local names for schistosomiasis in the Yoruba language, which is the predominant language and tribe. These names included *Ito-eje, Atosi-eje* (literal translation - urination with blood) *Itosi-aja* and *Atosi-aja* (which is associated with mythical belief that the disease is transmitted via proximity to dog urine). Also, many respondents who are health officials, had knowledge of the causative agent, mode of transmission and the organism's life cycle. This contrasts with a previous study by Awosolu *et al*. (2020), which reported a relatively low level of awareness on schistosomiasis in rural communities in Southwest, Nigeria. This increase in awareness can be attributed to intensified awareness campaigns on schistosomiasis in the last few years.

Also, results show varying levels of prevalence in the 6 south-western states. Prevalence, especially at community/LGA levels, ranged from as low as 3.2% in Lagos State to as high as 72% and 80% in Osun and Ogun states, respectively. Also, research reports and KII respondents indicate variations in the increase and decrease per time of the disease's prevalence. For example, while reports from Lagos indicate decreasing prevalence, other states indicate increasing or persistent prevalence of the disease. This report variation can be attributed to the lack of updated or open-access surveillance data or health records on prevalence and distribution of schistosomiasis. In addition, reluctance of some infected persons to report disease incidence could also limit accuracy of prevalence data on schistosomiasis.

Across all states, age and gender was considered a risk factor, with infections affecting children - especially male children. This is attributed to the greater affinity of children to engage in water-related recreational activities such as swimming, fishing, and bathing. This corroborates previous studies in other parts of Nigeria (Duwa *et al*., 2009; Ivoke *et al*., 2014; Dawaki *et al*., 2016; Awosolu *et al*., 2020), while in contrast, some studies have reported higher susceptibility in females compared to males (Kazibwe *et al*., 2010; Hassan *et al*., 2014).

Causative organisms included *Schistosoma mansoni and Schistosoma haematobium*, largely transmitted by several snail intermediate host species - *Bulinus truncatus*, *Bulinus globosus*, *Biomphalaria pfeifferi* and *Bulinus camerunensis*. While there were reports of little to no diagnostic equipment in health centres for confirmatory diagnosis, research studies utilized a variety of diagnostic tools such as microscopy, chemical reagent test strip, and PCR-based testing. However, across many studies, PCR was determined to be the best and most accurate method for testing. In the absence of diagnostic equipment in health centres, presenting clinical signs such as visual inspection for hematuria and complaints of abdominal pain is often relied upon for diagnosis. Other signs and symptoms reported by affected persons include dysuria, dyspareunia, Inguinal and genital pruritus, frequent urination, lower abdominal pain, skin peels, fever, and muscle pain. However, asymptomatic cases were also reported. Similar asymptomatic cases were also observed in a study on schistosomiasis prevalence amongst European travellers and migrants (Lingscheid *et al*., 2017).

In Southwest Nigeria, the primary treatment and control measure for schistosomiasis is an annual/biannual MDA (Mass Drug Administration) of anthelmintics such as Mebendazole, Praziquantel and Albendazole. Similar conclusion was stated by Oyeyemi (2020) in a study focused on schistosomiasis control in Nigeria, and Van *et al.* (2020). However, some reports indicate that the use of herbal and traditional remedies are still rampant, while some engage in spiritual baths and cleanses as reported in Osun State. Similar reports were given by related studies in Brazil, China, Mali, South Africa and Egypt (Sparg *et al*., 2000; Mølgaard *et al*., 2001; Bah *et al*., 2006; Yousif *et al*., 2012; Duarte Galhardo de Albuquerque *et al*., 2020). Previously, reliance on traditional medicine was found to have impeded community members' accepting anthelmintics provided during MDAs, thus negatively impacting efforts to control schistosomiasis in affected communities. However, it is reported that this has been addressed through outreach programs in which community members are now encouraged to visit health care centres in their vicinity for treatment rather than resorting to herbal concoctions.

Furthermore, myths and beliefs about schistosomiases are still rife including the belief that the disease is a normal occurrence, a sign of puberty or maturity, prevents bedwetting, that it's a sexually transmitted disease like HIV and gonorrhea, can be acquired from stepping on or urinating near dog's urine, or it is a sign of evil afflictions. This corroborates with beliefs identified in a study of

knowledge and practices on schistosomiasis in Kano State, Nigeria (Dawaki *et al*., 2015), and a study on schistosomiasis in northern Côte d'Ivoire and southern Mauritania (Koffi *et al*., 2018). Some of these beliefs have led to the stigmatization of the disease and due to this, infected persons may not visit health centres for medical treatment or even tell people about their condition. It has also resulted in challenges in acquiring samples and data to gauge the true incidence and prevalence of schistosomiasis in Southwest, Nigeria. Studies in Delta State, Nigeria and Cameroon also reported related results in their respective study communities (Onyeneho *et al*., 2010; Takougang *et al*., 2004).

The most consistent environmental risk factors identified across all the states included recreational swimming behaviors and absence of potable water sources and WASH facilities. These have inadvertently facilitated the reliance of community members on proximate (albeit unclean) water bodies for domestic and recreational use, leading to poor sanitary conditions, poor hygiene practices, indiscriminate urination around water bodies, open defecation, dirty environments, and washing from faecal matter and wastes into the streams and rivers. Other risks reported particularly for Lagos state which is a mega-city included presence of canals and rivers, and poor drainage systems which resulted in waterlogged areas hence providing potential breeding sites for freshwater snail intermediate hosts. Socioeconomic activities such as fishing are also potential risks for transmission of this disease since they increase frequency of contact with water bodies.

While vector-borne transmission of the disease has been well established, there are concerns of possible risk of co-infection and/or cross-infection from commonly kept domestic animals such as pigs and dogs, and cattle. These concerns might have stemmed from reported cases of bovine transmission in Ogun state by key informants, and because the areas and communities affected often keep pets and livestock animals, which utilize the same (unclean) water sources as humans. Similar cases were reported in China, Indonesia, and Philippines (Xu *et al*., 2012; Van Dorseen *et al*., 2017). However, there is little or no statistical data or research yet to prove a causal connection or transfer of schistosomiasis between animals and humans in Southwest-Nigeria.

Past and current interventions indicated to combat schistosomiasis include awareness campaigns, frequent environmental sanitation practices with inspections by environmental sanitation officers, and referral to modern medical institutions. These interventions were reported to have resulted in the decline in

the prevalence of schistosomiasis in Lagos and Ondo states. In some states, provision of hand-washing facilities, wells and boreholes were also reported to reduce the prevalence of schistosomiasis.

A key challenge indicated and emphasized in communities with high prevalence of schistosomiasis was the lack of/inadequate boreholes and sources of potable water. This challenge hampered the effectiveness of treatment and control interventions as a lack of WASH facilities meant community members are left with no choice but to use alternative sources of water -which are the main sources of infection and re-infection with schistosomiasis. Other challenges indicated include people's aversion to the MDA treatment regimen due to reported side effects, poor engagement between health officials and community members, and lack of enthusiasm towards getting necessary medical attention.

SIGNIFICANCE OF ONE HEALTH

The incidence and prevalence of schistosomiasis is influenced by a myriad of factors including prevalence of vectors, human anthropogenic activities, water, and environmental health risks. This has been further complicated by suspected cross-infection in high-risk areas between domestic animals and the humans that keep them. Therefore, it is necessary to consider and implement the holistic One Health approach to address the public health threat of schistosomiasis.

Several reports have shown that strategies focused on treatment only for combating schistosomiasis such as implementation of only Mass Drug Administration (MDAs) have proven inadequate to control and reduce the prevalence of schistosomiasis in Nigeria (Oyeyemi *et al.*, 2020; Onasanya *et al.*, 2021). Additionally, in 2022, the World Health Organization (WHO) published a report that recognized the inadequacies of the previously recommended intervention strategy of Mass Drug Administration (MDA) and emphasised the need a more comprehensive approach to combating schistosomiasis, incorporating human health and activities, animal health, and environmental health factors (WHO, 2022). The One Health approach recognizes these interconnections between human health and activities, animal health, and environmental health, and seeks to address health threats at these interfaces, thus, providing an effective integrated approach to combating neglected tropical diseases like schistosomiasis (Peterson *et al.*, 2021; Molyneux *et al.*, 2017).

This study implemented the One Health approach, providing a thorough and holistic evaluation of related risk factors that drive the prevalence of schistosomiasis. The results findings indicate a plethora of risks that include environmental risks (such as absence of WASH facilities, presence of contaminated water bodies, absence of alternative clean water sources, etc.); animal health risks (including presence of snails, cohabitation and resources sharing between animals and humans, and possible zoonotic transmission); and sociocultural norms and anthropogenic activities (including awareness levels on schistosomiasis, disposition to MDAs and awareness campaigns, water-related activities that increase exposure to contaminated waters, etc.) in endemic communities in Southwest Nigeria. This presents an opportunity and need to design, plan, and implement interventions that can cohesively address all these disease drivers and risk factors, leverage on inter-sectoral resources and skills, and provide sustainable long-term solutions. Key benefits to implementing the One Health approach include:

1) Inter-sectoral cross-disciplinary efforts to address all risk factors, with the opportunity to leverage, learn, utilize, and adapt sectoral information, skills, and resources.

2) With all risk-factors identified and addressed cohesively, sustainability of interventions is guaranteed and most importantly, the persistence prevalence, re-emergence or incessant outbreaks of the disease can be mitigated or reduced

3) Improved cost-effectiveness of interventions as sectors leverages on each other's strengths and resources with the common goal of addressing the same disease.

4) Improved stakeholder engagement and ownership of interventions and solutions which enhance sustainability of results.

RECOMMENDATIONS AND CONCLUSIONS

Though schistosomiasis remains an endemic disease with high prevalence in several communities in Southwest Nigeria, solutions to reducing and/or elimination of the disease is achievable. Interventions must leverage on the current advocacy movement to end all NTDs by 2030. However, as mentioned earlier, a One Health approach must be employed for effective, efficient, and sustainable long-term solutions. Utilisation of this approach has been reported to be successful in countries like China and Brazil (Oyeyemi, 2020; Sun *et al*., 2017)

For effective schistosomiasis control in Nigeria, there's a need for a national reassessment to identify and prioritise schistosomiasis endemic communities for control and prevention interventions. Periodic reassessments can also be conducted to monitor and evaluate action plans and implementations, and corresponding results disseminated on open-access platforms, thus promoting accountability, and learning in the process of curtailing schistosomiasis in Nigeria.

Basic health and social amenities such as health services, WASH facilities, and environmental management tools should be provided to endemic communities. Also, to aid diagnosis, low-cost test kits and equipment should be provided to healthcare facilities, particularly in rural settings (Van *et al*., 2020; Colley *et al*., 2017). Regular surveillance studies on schistosomiasis should also be conducted to provide relevant data on its prevalence and incidence in these communities (Aula *et al*., 2021). Subsequently, it is recommended that such data be made available in open-access repositories to aid researchers and private organisations or individuals in research efforts, decision-making and implementation of interventions, thus improving dissemination of lessons learned and preventing repetition of research efforts and interventions. To further facilitate this, it is highly recommended that schistosomiasis be included in the Integrated Disease Surveillance and Response (IDSR) system (or relevant surveillance platforms) to ensure effective real-time surveillance.

Additionally, vector control should be prioritized by controlling snail populations using humane environmentally friendly methods, reducing breeding sites such as stagnant water bodies, and conducting regular sanitation exercises. To reduce the risk of potential zoonotic transmission, animal owners and keepers should employ good animal health and welfare practices.

Other important recommendations to combating schistosomiasis is to implement continuous sensitization via media campaigns and outreaches using channels that are well utilised by target communities such as radio and television stations, communal meetings, and door-door campaigns. Also, effective collaborations with stakeholders are important - these include community leaders and members, government stakeholders and partners. In conclusion, national and international guidelines on schistosomiasis control should be adapted and disseminated to all stakeholders to ensure that their work is jointly coordinated and well aligned with other NTD control programs to meet the global targets to eradicate NTDs by 2030 (WHO, 2022b).

STUDY LIMITATIONS

The coordination of an efficient data collection process for this schistosomiasis research in the south-west of Nigeria faced a number of important challenges. These challenges included little or no responses from some health officials, thus affecting data gathering from stakeholders in affected communities. Also, there is a dearth of primary data on cases of schistosomiasis in hospitals across the states, and some important data were restricted and not open access, thus limiting our ability to provide a more accurate assessment of incidence and prevalence. Furthermore, information on assessments of past interventions in communities are either restricted or unavailable. Furthermore, it is important to note that just a few carefully selected highly endemic communities in Southwest Nigeria were evaluated in the study based on guidance from health officials on communities with perceived high prevalence of the disease.

REFERENCES

Abdulkadir, A., Ahmed, M., Abubakar, B. M., Suleiman, I. E., Yusuf, I., Imam, I. M., Sule, A. A., Tela, U. M., Dogo, H. M., Yakasai, A. M., Musa, B. M., & Musa, B. M. (2017). Prevalence of urinary schistosomiasis in Nigeria, 1994–2015: Systematic review and meta-analysis. African *Journal of Urology*, 23(4). https://doi.org/10.1016/j.afju.2016.11.004

Adedeji, O. C. (2018). Intensity of Blood in Urine (Urinary Schistosomiasis) Among School Children in Osun State. *African Journal of Educational Management*, 19(01), 163-171. https://www.journals.ui.edu.ng/index.php/ajem/article/view/369

Adeleke, M. A. (2017). Delineation of potential urban urogenital schistosomiasis transmission areas in Osogbo, south-west Nigeria. *Nigerian Journal of Parasitology*, 38(2), 165-168. https://doi.org/10.4314/njpar.v38i2.6

Adeneye, A. K., Akinwale, O. P., Idowu, E. T., Adewale, B., Manafa, O. U., Sulyman, M. A., Omotola, B. D., Akande, D. O., Mafe, M. A. & Appelt, B. (2007). Sociocultural aspects of mass delivery of praziquantel in schistosomiasis control: The Abeokuta experience. *Research in social and administrative Pharmacy*, 3(2): 183-198 https://doi.org/10.1016/j.sapharm.2006.07.001

Adeneye, A. K., Mafe, M. A., Appelt, B., Idowu, E. T., & Akande, D. O. (2006). Willingness to pay for praziquantel treatment in a hyperendemic community of Ogun State, Nigeria. *Research in social & administrative pharmacy : RSAP*, 2(1), 83–95. https://doi.org/10.1016/j.sapharm.2005.12.004

Adeneye, A., Sulyman, M. A., Akande, D. O., & Mafe, M. A. (2021). Factors promoting schistosomiasis infection in endemic rural communities of Ifedore and Ile-Oluji/One Igbo local government areas in Ondo State, Nigeria. *Global Journal of Infectious Diseases and Clinical Research*, 7 (1), 021-032.

Adeniran, A. A., Mogaji, H. O., Aladesida, A. A., Olayiwola, I. O., Oluwole, A. S., Abe, E. M., Olabinke, D. B., Alabi, O. M., & Ekpo, U. F. (2017). Schistosomiasis, intestinal helminthiasis and nutritional status among preschool-aged children in sub-urban communities of Abeokuta, Southwest, Nigeria. *BMC research notes*, 10(1), 637. https://doi.org/10.1186/s13104-017-2973-2

Adewoga, T. O. S., Akinboade, O. A., Emikpe, B. O., Morenikeji, O., & Sobande, A. I. (2019). Prevalence and Intensity of Urinary Schistosomiasis in School-age Children in Yewa North Local Government Area of Ogun State, Nigeria. *Annual Research & Review in Biology*, 31(3), 1-6. https://doi.org/10.9734/arrb/2019/v31i330051

Adewole, A., Faparusi, F., & Fantola, F. (2017). Prevalence of Schistosomiasis among the School Pupils Attending Community Primary Schools Ebute-Igbooro, Yewa North Local Government of Ogun State, Nigeria. In: National Conference of School of Pure and Applied Sciences and Communication & Information Technology (SPASCIT), 4th – 7th December, 2017, The Federal Polytechnic, Ilaro.

Agbolade O.M., Akinboye D.O., Awolaja A. (2004). Intestinal helminthiasis and urinary schistosomiasis in some villages of Ijebu North, Ogun State, Nigeria. *African Journal of Biotechnology*, 3(3), 206-209. 10.5897/ajb2004.000-2038

Agbolade, O. M., Agu, N. C., Adesanya, O. O., Odejayi, A. O., Adigun, A. A., Adesanlu, E. B., Ogunleye, F. G., Sodimu, A. O., Adeshina, S. A., Bisiriyu, G. O., Omotoso, O. I., & Udia, K. M. (2007). Intestinal helminthiases and schistosomiasis among school children in an urban center and some rural communities in southwest Nigeria. *The Korean journal of parasitology*, 45(3), 233–238. https://doi.org/10.3347/kjp.2007.45.3.233

Ajakaye, O. G., Olusi, T. A., & Oniya, M. O. (2016). Environmental factors and the risk of urinary schistosomiasis in Ile Oluji/Oke Igbo local government area of Ondo State. *Parasite epidemiology and control*, 1(2), 98–104. https://doi.org/10.1016/j.parepi.2016.03.006

Ajakaye, O.G., Adedeji, O.I. & Ajayi, P.O. (2017). Modeling the risk of transmission of schistosomiasis in Akure North Local Government Area of Ondo State, Nigeria using satellite derived environmental data. *PLoS neglected tropical diseases* 11(7), e0005733. https://doi.org/10.1371/journal.pntd.0005733

Ajayi, J. B., Sam-Wobo, S. O., & Agbeyangi, A. O. (2015). Prevalence of urinary schistosomiasis in part of Ogun state, Nigeria. *Journal of Natural Sciences Research*, 5(5), 62-68. https://www.iiste.org/Journals/index.php/JNSR/article/view/20726

Akande, I. S. & Odetola, A. A. (2011). Comparative studies of two fresh water snail distributions and physico-chemical parameters in selected human schistosomiasis endemic sites in Nigeria. *Nigerian Journal of Parasitology*, 32(2): 169-174 https://www.ajol.info/index.php/njpar/article/view/99206

Akande, I. S., Odetola, A. A., Osamudien, D. O., Fowora, M. A. & Omonigbehin, E. A. (2012). Polymerase chain reaction (PCR) investigations of prepatent *Schistosoma haematobium* cercariae incidence in five water bodies, South West, Nigeria. *Afr J Med Med Sci.* 41: 75-80. PMID: 23678640. . https://pubmed.ncbi.nlm.nih.gov/23678640/

Akinboye, D. O., Ajisebutu, J. U., Fawole, O., Agbolade, O. M., Akinboye, O. O., Amosu, A. M., Atulomah, N. O. S., Awodele, O., Oduola, O., Owodunni, B. M., Rebecca, S. N., Falade, M., & Emem, O. (2011). Urinary Schistosomiasis: Water contact frequency and infectivity among secondary school students in Ibadan, Nigeria. *Nigerian Journal of Parasitology*, 32(1). https://www.ajol.info/index.php/njpar/article/view/99168

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 Diseases*, 1(1):1-6. https://doi.org/10.23937/IJTD-2017/1710004

Akinwale, O. P., Oliveira, G. C., Ajayi, M. B., Akande, D. O., Oyebadejo, S. & Okereke, K. C. (2008). Squamous cell abnormalities in exfoliated cells from the urine of Schistosoma haematobium-infected adults in a rural fishing community in Nigeria. *World Health Popul*. 10(1): 18-22. doi: https://doi.org/10.12927/whp.2008.19581

Akinwale, O., Akpunonu, V., Ajayi, M., Akande, D., Adeleke, M., Gyang, P., Adebayo, M., & Dike, A. (2011). Urinary schistosomiasis transmission in Epe, an urban community of Southwest Nigeria. *Tropical parasitology*, 1(2), 99–103. https://doi.org/10.4103/2229-5070.86944

Alabi, P., Oladejo, S. O., & Odaibo, A. B. (2018). Prevalence and intensity of urinary schistosomiasis in Ogun state, Southwest, Nigeria. *Journal of Public Health and Epidemiology*, 10(11), 413-417. https://doi.org/10.5897/JPHE2014.0647

Amazigo, U., Anago-amanze, C., & Okeibunor, J. (1997). Urinary schistosomiasis among school children in Nigeria: Consequences OF indigenous beliefs and water contact activities. *Journal of biosocial science*, 29(1), 9-18. https://doi:10.1017/S0021932097000096

Amoo, K. J., Amoo, O. A. J., Oke, A. A., & Adegboyega, T. T. (2017). Prevalence of urinary tract infection (UTI) and concomitant urinary schistosomiasis among primary school children in Remo north local government, Ogun state, Nigeria. *IOSR Journal of Dental and Medical Sciences*, 16(11), 68-73. 10.9790/0853-1611026873.

Anumudu, C., Onile, O., Oladele, V., Adebayo, A., & Awobode, H. (2016). Determining the environmental, social and cultural contexts of a proposed schistosomiasis health education intervention in Eggua, Yewa North Local Government area, Ogun State Nigeria. *BMJ Global Health*, 2(Suppl 2). http://dx.doi.org/10.1136/bmjgh-2016-000260.175

Arinola, O. G. (1995). Prevalence and severity of urinary schistosomiasis in Ibadan, Nigeria. *East African Medical Journal*, 72(11), 746-748. https://europepmc.org/article/med/8904071

Ariyo, O., Olofintoye, L. K., Adeleke, R. A., & Famurewa, O. (2004). Epidemiological Study of Urinary Schistosomiasis among Primary School Pupils in Ekiti State, Nigeria. *African Journal of Clinical and Experimental Microbiology*, 5(1):20-9. https://doi.org/10.4314/ajcem.v5i1.7356

Aula, O. P., McManus, D. P., Jones, M. K., & Gordon, C. A. (2021). Schistosomiasis with a Focus on Africa. *Tropical medicine and infectious disease*, 6(3), 109. https://doi.org/10.3390/tropicalmed6030109

Awosolu, O. B., Shariman, Y. Z., Farah, H. M. T. & 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): 128. https://doi.org/10.3390/pathogens9020128

Awosolu, O.B., Adesina, F. P., Eke, O. S., Akinnifesi, O. J. (2019). Efficacy of Chemical Reagent Strip in the Diagnosis of Urinary Schistosomiasis in Ikota, Ifedore Local Government Area, Ondo State, Nigeria. *Journal of bacteriology and parasitology*, 10, 354. 10.4172/2155-9597.1000354.

Bah, S., Diallo, D., Dembélé, S., & Paulsen, B. S. (2006). Ethnopharmacological survey of plants used for the treatment of schistosomiasis in Niono District, Mali. *Journal of ethnopharmacology*, 105(3), 387–399. https://doi.org/10.1016/j.jep.2005.11.026

Bolaji, O. S., Adeyeba, O. A., Ojurongbe, O., Ukaga, C. N. & Ojo, J. A. (2014). Epidemiological Studies on Urinary Schistosomiasis in Osun State, Nigeria. *International Journal for Pharmaceutical Research Scholars (IJPRS)*, 3(1), 2014.

Colley, D. G., Andros, T. S. & Campbell, C. H. (2017). Schistosomiasis is more prevalent than previously thought: what does it mean for public health goals, policies, strategies, guidelines and intervention programs? *Infectious diseases of poverty*, 6, 63. https://doi.org/10.1186/s40249-017-0275-5

Dada, E. O. and Alagha, B. (2021). Urinary Schistosomiasis and Asymptomatic Bacteriuria among Individuals of Ipogun, Nigeria: Detection of Predominant Microorganisms and Antibiotic Susceptibility Profile. *Journal of medical and health studies*, 2(2), 70–80. doi: 10.32996/jmhs.2021.2.2.8.

Dawaki, S., Al-Mekhlafi, H. M., Ithoi, I., Ibrahim, J., Abdulsalam, A. M., Ahmed, A., Sady, H., Nasr, N. A., & Atroosh, W. M. (2015). The Menace of Schistosomiasis in Nigeria: Knowledge, Attitude, and Practices Regarding Schistosomiasis among Rural Communities in Kano State. PloS one, 10(11), e0143667. https://doi.org/10.1371/journal.pone.0143667

Dawaki, S., Al-Mekhlafi, H. M., Ithoi, I., Ibrahim, J., Abdulsalam, A. M., Ahmed, A., Sady, H., Atroosh, W. M., Al-Areeqi, M. A., Elyana, F. N., Nasr, N. A. & Surin, J. (2016). Prevalence and Risk Factors of Schistosomiasis among Hausa Communities in Kano State, Nigeria. *Revista do Instituto de Medicina Tropical de Sao Paulo*, 58, 54. https://doi.org/10.1590/S1678-9946201658054

Duarte Galhardo de Albuquerque, R. D., Mahomoodally, M. F., Lobine, D., Suroowan, S., & Rengasamy, K. R. (2020). Botanical Products in the Treatment and Control of Schistosomiasis: Recent Studies and Distribution of Active Plant Resources According to Affected Regions. *Biology*, 9(8), 223. https://doi.org/10.3390/biology9080223

Duwa, M., Oyeyi, T. I., & Bassey, S. E. (2009). Prevalence and intensity of urinary schistosomiasis among primary school pupils in minjibir local government area of Kano state. *Bayero Journal of Pure and Applied Sciences*, 2(1):75-8. https://doi.org/10.4314/bajopas.v2i1.58469

Ekpo, U. F., & Mafiana, C. F. (2004). Epidemiological studies of urinary schistosomiasis in Ogun State, Nigeria: Identification of high-risk communities. *Nigerian Journal of Parasitology*, 25(1), 111-119. 10.4314/njpar.v25i1.37717

Ekpo, U. F., Fafunwa, T. S., Oluwole, A. S., Abe, E. M., & Mafiana, C. F. (2012). Prevalence and factors associated with urinary schistosomiasis among infants and preschool-aged children in settlements around Oyan reservoir in Ogun State, Nigeria. *Journal of Natural Sciences Engineering and Technology*, 11(1), 82-92. https://journal.unaab.edu.ng/index.php/JNSET/article/view/1422

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, 58. https://doi.org/10.1186/1756-3305-3-58

Ekpo, U. F., Mafiana, C. F., Adeofun, C. O., Solarin, A. R., & Idowu, A. B. (2008). Geographical information system and predictive risk maps of urinary schistosomiasis in Ogun State, Nigeria. BMC infectious diseases, 8, 74. https://doi.org/10.1186/1471-2334-8-74

Ekpo, U., Alabi, O., Oluwole, A., & Sam-Wobo, S. (2011). *Schistosoma haematobium* infections in preschool children from two rural communities in Ijebu East, south-western Nigeria. *Journal of Helminthology*, 86(3), 323-328. doi:10.1017/S0022149X11000459

Ezeh, C. O., Onyekwelu, K. C., Akinwale, O. P., Shan, L., & Wei, H. (2019). Urinary schistosomiasis in Nigeria: a 50 year review of prevalence, distribution and disease burden. La schistosomiase urinaire au Nigeria : un bilan de 50 ans sur la prévalence, la distribution et le fardeau de la maladie. *Parasite (Paris, France)*, 26, 19. https://doi.org/10.1051/parasite/2019020

Hamid, J. B. (2016). Prevalence, Knowledge And Preventive Practice Of Schistosomiasis Among Selected Secondary School Students In Oluyole Local Government, Oyo State, Nigeria (Doctoral dissertation). https://library.adhl.africa/handle/123456789/12204

Hassan, A. O., Amoo, A. O. J., Deji-Agboola, A. M., Akinwale, O. P., Gyang, P. V., & Adeleke, M. A. (2014). Status of urinary schistosomiasis around Erinle and Eko-Ende dams and implications for schistosomiasis control in Nigeria. *Southern African Journal of Infectious Diseases*, 29 (4), 137-140. https://doi.org/10.1080/23120053.2014.11441588

Ivoke, N., Ivoke, O. N., Nwani, C. D., Ekeh, F. N., Asogwa, C. N., Atama, C. I., & Eyo, J. E. (2014). Prevalence and transmission dynamics of Schistosoma haematobium infection in a rural community of southwestern Ebonyi State, Nigeria. *Tropical biomedicine*, 31(1), 77–88.

Koffi, A. J., Doumbia, M., Fokou, G., Keita, M., Kone, B. & Abe Noel N' doumy. (2018). Community knowledge, attitudes and practices related to schistosomiasis and associated healthcare-seeking behaviours in northern Côte d'Ivoire and southern Mauritania. *Infect Dis Poverty* 7, 70. https://doi.org/10.1186/s40249-018-0453-0

Li, Y., Ross, A. G., Hou, X., Lou, Z., & McManus, D. P. (2011). Oriental schistosomiasis with neurological complications: case report. *Annals of clinical microbiology and antimicrobials*, 10, 5. https://doi.org/10.1186/1476-0711-10-5

Lingscheid, T., Kurth, F., Clerinx, J., Marocco, S., Trevino, B., Schunk, M., Muñoz, J., Gjørup, I. E., Jelinek, T., Develoux, M., Fry, G., Jänisch, T., Schmid, M. L., Bouchaud, O., Puente, S., Zammarchi, L., Mørch, K., Björkman, A., Siikamäki, H., Neumayr, A., … TropNet Schistosomiasis Investigator Group (2017). Schistosomiasis in European Travelers and Migrants: Analysis of 14 Years TropNet Surveillance Data. *The American journal of tropical medicine and hygiene*, 97(2), 567–574. https://doi.org/10.4269/ajtmh.17-0034

Mafiana, C. F., & Beyioku, Y. O. (1998). *Schistosoma haematobium* infection in Abeokuta. *African journal of medicine and medical sciences*, 27(1-2), 5–7. https://pubmed.ncbi.nlm.nih.gov/10456120/

Mafiana, C. F., Ekpo, U. F., & Ojo, D. A. (2003). Urinary schistosomiasis in preschool children in settlements around Oyan Reservoir in Ogun State, Nigeria: implications for control. *Tropical medicine & international health : TM & IH*, 8(1), 78–82. https://doi.org/10.1046/j.1365-3156.2003.00988.x

Mafiana, C. F., Momoh, S., Shopeju, J. O., Dipeolu, A. O., & Amoa, A. O. (2001). Structured questionnaires as a tool for rapid diagnosis of urinary schistosomiasis: a case study of three Local Government Areas of Ogun State, Nigeria. *Asset 1*. https://scholar.google.com/citations?view_op=view_citation&hl=en&user=sUl0ZxcAAAAJ&citation_for_view=sUl0ZxcAAAAJ:eQOLeE2rZwMC

Mølgaard, P., Nielsen, S. B., Rasmussen, D. E., Drummond, R. B., Makaza, N., & Andreassen, J. (2001). Anthelmintic screening of Zimbabwean plants traditionally used against schistosomiasis. *Journal of ethnopharmacology*, 74(3), 257–264. https://doi.org/10.1016/s0378-8741(00)00377-9

Molyneux, D. H., Savioli, L., & Engels, D. (2017). Neglected tropical diseases: progress towards addressing the chronic pandemic. *Lancet* (London, England), 389(10066), 312–325. https://doi.org/10.1016/S0140-6736(16)30171-4

Morenikeji, O. A., & Idowu, B. A. (2011). Studies on the prevalence of urinary schistosomiasis in Ogun State, South-Western Nigeria. *West African journal of medicine*, 30(1), 62–65. https://doi.org/10.4314/wajm.v30i1.69921

Morenikeji, O. A., Atanda, O. S., Eleng, I. E., & Salawu, O. T. (2014). *Schistosoma haematobium* and *Plasmodium falciparum* single and concomitant infections; any association with hematologic abnormalities? *Pediatric infectious disease*, 6(4), 124-129. https://doi.org/10.1016/j.pid.2014.11.001

Morenikeji, O. A., Eleng, I. E., Atanda, O. S., & Oyeyemi, O. T. (2016). Renal related disorders in concomitant *Schistosoma haematobium-Plasmodium falciparum* infection among children in a rural community of Nigeria. *Journal of infection and public health*, 9(2), 136–142. https://doi.org/10.1016/j.jiph.2015.06.013

Ofoezie, I. E., & Asaolu, S. O. (1997). Water level regulation and control of schistosomiasis transmission: a case study in Oyan Reservoir, Ogun State, Nigeria. *Bulletin of the World Health Organization*, 75(5), 435–441. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2487010/?page=2

Ofoezie, I. E., Asaulu, S. O., Christensen, N. O., & Madsen, H. (1997). Patterns of infection with Schistosoma haematobium in lakeside resettlement communities at the Oyan Reservoir in Ogun State, south-western Nigeria. *Annals of tropical medicine and parasitology*, 91(2), 187–197. https://doi.org/10.1080/00034983.1997.11813129

Ofoezie, I. E., Imevbore, A. M., Balogun, M. O., Ogunkoya, O. O., & Asaolu, S. O. (1991). A study of an outbreak of schistosomiasis in two resettlement villages near Abeokuta, Ogun State, Nigeria. *Journal of helminthology*, 65(2), 95–102. https://doi.org/10.1017/s0022149x00010531

Ogefere, H.O. & Osuolale, I.O. (2017). Risk Factors Associated with Urinary Schistosomiasis Among School-Age Children in Owo Local Government Area of Ondo State, Nigeria. *Sokoto journal of medical laboratory science (SJMLS)*, 12, 2017.

Ojo, J. A., Adedokun, S. A., Akindele, A. A., Olorunfemi, A. B., Otutu, O. A., Ojurongbe, T. A., Thomas, B. N., Velavan, T. P., & Ojurongbe, O. (2021). Prevalence of urogenital and intestinal schistosomiasis among school children in South-west Nigeria. *PLoS neglected tropical diseases*, 15(7), e0009628. https://doi.org/10.1371/journal.pntd.0009628

Oladejo, S. O. & Morenikeji, O. A. (2019). Modeling schistosomiasis infection using Kriging interpolation method in Osun State, South west, Nigeria. *Journal of Health and Environmental Sciences*, 6(1), 1-9

Oladejo, S. O. & Ofoezie, I. E. (2006). Unabated schistosomiasis transmission in Erinle River Dam, Osun State, Nigeria: Evidence of neglect of environmental effects of development projects.

Tropical Medicine & International Health, 11(6), 843-850. https://doi.org/10.1111/j.1365-3156.2006.01628.x

Oladele, V. S., Awobode, H. O., & Anumudu, C. I. (2014). Subtle morbidities associated with malaria co-infection with schistosomiasis among children in South-West Nigeria. *African journal of medicine and medical sciences*, 43 Suppl, 125–135. https://pubmed.ncbi.nlm.nih.gov/26949790/

Olaseha, I. O. & Sridhar, M. K. C. (2004). Participatory Action Research: Community Diagnosis and Intervention in Controlling Urinary Schistosomiasis in An Urban Community in Ibadan, Nigeria. *International Quarterly of Community Health Education*, 24(2), 153–160. https://doi.org/10.2190/CBYM-94N2-E7DH-QRAL

Ologunde, C. A. (2009). Endemicity of Urinary Schistosomiaisis in Ogbese-Ekiti Community of Ise-Orun Local Government Area of Ekiti State, Nigeria: Endemicity of Urinary Schistosomiaisis. *Pakistan Journal of Scientific and Industrial Research*, 52(1):28-31.

Ologunde, C. (2020). Schistosomiasis in Ogbese-Ekiti, re-infection after successful treatment with praziquantel. *International Journal of Infectious Disease*, 101:338. https://doi.org/10.1016/j.ijid.2020.09.889

Olorunlana, A., Jegede, A. S., Morenikeji, O., Hassan, A. A., Nwuba, R. I., Anumudu, C. I., Salawu, O. T., & Odaibo, A. B. (2016). Persistent Transmission of Schistosomiasis in Southwest Nigeria: Contexts of Culture and Contact with Infected River Water. World health & population, 16(3), 31–38. https://doi.org/10.12927/whp.2016.24518

Olukoya, O. 80% Ogun Residents May Suffer Neglected Tropical Disease —Health Commissioner. Nigerian Tribune. https://tribuneonlineng.com/80-ogun-residents-may-suffer-neglected-tropical-disease-health-commissioner/ (2021, February 24). Accessed 5 Jan 2023.

Oluwole, A. S., Adeniran, A. A., Mogaji, H. O., Olabinke, D. B., Abe, E. M., Bankole, S. O., Sam-Wobo, S. O., & Ekpo, U. F. (2018). Prevalence, intensity and spatial co-distribution of schistosomiasis and soil transmitted helminths infections in Ogun state, Nigeria. *Parasitology Open*, 10.1017/pao.2018.4

Omonijo, A., Asaolu, S., & Ofoezie, I. (2013). Schistosomiaisis transmission and water contact pattern in River Ureje in Ado-ekiti local government area, Ekiti state. *Research Journal of Parasitology*, 8:26-36

Onasanya, A., Bengtson, M., Oladepo, O., Van Engelen, J., & Diehl, J. C. (2021). Rethinking the Top-Down Approach to Schistosomiasis Control and Elimination in Sub-Saharan Africa. *Frontiers in public health*, 9, 622809. https://doi.org/10.3389/fpubh.2021.622809

Onayade, A. A., Abayomi, I. O. & Fabiyi, A. K. (1996). Urinary schistosomiasis: Options for control within endemic rural communities: A case study in south-west Nigeria. *Public Health*, 110(4), 221-227 https://doi.org/10.1016/S0033-3506(96)80107-7

Onifade, E.O. & 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. Available at: https://journalsajp.com/index.php/SAJP/article/view/1299

Onile, O. S., Awobode, H. O., Oladele, V. S., Agunloye, A. M., & Anumudu, C. I. (2016). Detection of Urinary Tract Pathology in Some *Schistosoma haematobium* Infected Nigerian Adults. *Journal of tropical medicine*, 2016, 5405207. https://doi.org/10.1155/2016/5405207

Oniya, M. O., Ishola, M. A. & Jayeoba, O. (2013). Schistosomiasis in Ipogun: Update Assessment on Endemicity and Efficacy of Praziquantel in Chemotherapy. *International journal of tropical disease & health*, 3(1), 37-44. doi: 10.9734/IJTDH/2013/2606

Onyeneho, N. G., Yinkore, P., Egwuage, J., & Emukah, E. (2010). Perceptions, attitudes and practices on schistosomiasis in Delta State, Nigeria. *Tanzania journal of health research*, 12(4), 287–298. https://doi.org/10.4314/thrb.v12i4.60123

Oso, O. G., & Odaibo, A. B. (2020). Human water contact patterns in active schistosomiasis endemic areas. *Journal of water and health*, 18(6), 946–955. https://doi.org/10.2166/wh.2020.147

Otuneme, O. G., Akinkuade, F. O., Obebe, O. O., Usiobeigbe, O. S., Faloye, T. G., Olasebikan, A. S., Akinleye, W. A., & Koku, O. D. (2014). A study on the prevalence of Schistosoma Haematobium and Schistosoma Intercalatum in a rural community of Ogun State, Nigeria. *South East Asia Journal of Public Health*, 4(1), 67-71. https://www.readcube.com/articles/10.3329%2Fseajph.v4i1.21845

Otuneme, O. G., Obebe, O. O., Sajobi, T. T., Akinleye, W. A., & Faloye, T. G. (2019). Prevalence of Schistosomiasis in a neglected community, South western Nigeria at two points in time, spaced three years apart. *African health sciences*, 19(1), 1338–1345. https://doi.org/10.4314/ahs.v19i1.5

Oyetunde, O., Damilola, O., Chibundu, E., Gbenga, O., & Alexander, O. (2018). The impact of chemotherapy, education and community water supply on schistosomiasis control in a Southwestern Nigerian village. *Infection, Disease & Health*, 23(2), 121-123. https://doi.org/10.1016/j.idh.2018.01.004.

Oyeyemi, O. T. (2020). Schistosomiasis Control in Nigeria: Moving Round the Circle? *Annals of global health*, 86(1), 74. https://doi.org/10.5334/aogh.2930

Oyeyemi, O. T., & Odaibo, A. B. (2017). Maternal urogenital schistosomiasis; monitoring disease morbidity by simple reagent strips. *PLoS ONE*, 12(11), e0187433. https://doi.org/10.1371/journal.pone.0187433

Oyeyemi, O. T., de Jesus Jeremias, W., & Grenfell, R. (2020). Schistosomiasis in Nigeria: Gleaning from the past to improve current efforts towards control. *One health (Amsterdam, Netherlands)*, 11, 100183. https://doi.org/10.1016/j.onehlt.2020.100183

Peletu B.J., Ofoezie I.E., & Ikwuka A.O. (2020). Urogenital schistosomiasis transmission and human water contact patterns in Aponmu-Iona River Basin, Idanre, Ondo state, Nigeria. *Donnish journal of medicine and medical sciences*, 6(1), 1–8. https://doi.org/10.5281/zenodo.3996571

Peletu, B. J., Ofoezie, I. E. & Olaniyan, R. F. (2018). Transmission of Urinary Schistosomiasis among School Aged Children in Owena, Kajola and Baiken Communities Bordering Owena Reservoir/Dam, Ondo East Local Area, Ondo State, Southwest, Nigeria. *Hydrology Current Research*, 9, 289. doi: 10.4172/2157-7587.1000289

Peterson, J. K., Bakuza, J., & Standley, C. J. (2021). One Health and Neglected Tropical Diseases—Multisectoral Solutions to Endemic Challenges. *Tropical Medicine and Infectious Disease*. 6(1), 4. https://doi.org/10.3390/tropicalmed6010004

Salawu O. T., & Odaibo A. B. (2014). The bionomics and diversity of freshwater snails species in Yewa North, Ogun State, Southwestern Nigeria. *Helminthologia* 51 (4), 337-344. DOI: https://doi.org/10.2478/s11687-014-0250-7

Salawu, O. T., & Odaibo, A. B. (2013). Schistosomiasis among pregnant women in rural communities in Nigeria. *International journal of gynaecology and obstetrics: the official organ of the International Federation of Gynaecology and Obstetrics*, 122(1), 1–4. https://doi.org/10.1016/j.ijgo.2013.01.024

Salawu, O. T., & Odaibo, A. B. (2016). Schistosomiasis transmission; socio-demographic, knowledge and practices as transmission risk factors in pregnant women. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology*, 40(1), 93–99. https://doi.org/10.1007/s12639-014-0454-2

Salawu, O.T., & Odaibo, A.B. (2012). Preliminary study on ecology of *Bulinus jousseaumei* in *Schistosoma haematobium* endemic rural community of Nigeria. *African journal of ecology*, 51 (3), 441-446. https://doi.org/10.1111/aje.12054

Sam-Wobo S. O., Garba A., Ekpo U. F., Adekunle N. O., Egbeobauwaye E., Surakat O. A., Oloyede-Ajayi F., Ajuokwu C., Ajayi R., & Kafil-Emiola M. (2017). Assessment of efficacy and safety of praziquantel in the treatment of Schistosoma haematobium in school-aged children, Ogun State, Nigeria. *Nigerian Journal of Parasitology*, 38(2), 159-164. **DOI:** 10.4314/njpar.v38i2.5

Sam-Wobo, S. O., Akintola, O., Atungwu, J., Ekpo, U. F., Adeleke, M. A., & Mafiana, C. F. (2013). Prevalence and effect of schistosome and soil-transmitted helminth infection on labour input in rice-growing communities of ogun state, Nigeria. *Epidemiology Biostatistics and Public Health*, 10 (2), 9-13. DOI: 10.2427/8841

Segun, A. O., Alebiosu, C. O., Agboola, A. O., & Banjo, A. A. (2006). Schistosomiasis--An unusual cause of abdominal pseudotumor. *Journal of the National Medical Association*, 98(8), 1365–1368. PMID: 16916140.

Sparg, S. G., van Staden, J., & Jäger, A. K. (2000). Efficiency of traditionally used South African plants against schistosomiasis. *Journal of ethnopharmacology*, 73(1-2), 209–214. https://doi.org/10.1016/s0378-8741(00)00310-x

Sun, L. P., Wang, W., Hong, Q. B., Li, S. Z., Liang, Y. S., Yang, H. T., & Zhou, X. N. (2017). Approaches being used in the national schistosomiasis elimination programme in China: a review. *Infectious diseases of poverty*, 6(1), 55. https://doi.org/10.1186/s40249-017-0271-9

Takougang, I., Meli, J., Fotso, S., Angwafo, F., 3rd, Kamajeu, R., & Ndumbe, P. M. (2004). Some social determinants of urinary schistosomiasis in Northern Cameroon: implications for schistosomiasis control. *African journal of health sciences*, 11(3-4), 111–120. https://doi.org/10.4314/ajhs.v11i3.30788

Uchendu, O., Oladoyin, V., Idowu, M., Adeyera, O., Olabisi, O., Oluwatosin, O., & Leigh, G. (2017). Urinary schistosomiasis among vulnerable children in a rehabilitation home in Ibadan, Oyo state, Nigeria. *BMC infectious diseases*, 17(1), 487. https://doi.org/10.1186/s12879-017-2591-6

Ugbomoiko, U. S., Dalumo, V., Ariza, L., Bezerra, F. S., & Heukelbach, J. (2009). A simple approach improving the performance of urine reagent strips for rapid diagnosis of urinary schistosomiasis in Nigerian schoolchildren. *Memorias do Instituto Oswaldo Cruz*, 104(3), 456–461. https://doi.org/10.1590/s0074-02762009000300010

Ugbomoiko, U. S., Dalumo, V., Danladi, Y. K., Heukelbach, J. & Ofoezie, I. E. (2012). Concurrent urinary and intestinal schistosomiasis and intestinal helminthic infections in schoolchildren in Ilobu, South-western Nigeria. *Acta Tropica* 123(1), 16-21. https://doi.org/10.1016/j.actatropica.2012.03.002

Ugbomoiko, U. S., Obiezue, R. N., Ogunniyi, T. A., & Ofoezie, I. E. (2009). Diagnostic accuracy of different urine dipsticks to detect urinary schistosomiasis: a comparative study in five endemic communities in Osun and Ogun States, Nigeria. *Journal of helminthology*, 83(3), 203–209. https://doi.org/10.1017/S0022149X08133570

Ugbomoiko, U. S., Obiezue, R. N., Ogunniyi, T. A., & Ofoezie, I. E. (2009). Diagnostic accuracy of different urine dipsticks to detect urinary schistosomiasis: a comparative study in five endemic communities in Osun and Ogun States, Nigeria. *Journal of helminthology*, 83(3), 203–209. https://doi.org/10.1017/S0022149X08133570

Ugbomoiko, U. S., Ofoezie, I. E., Okoye, I. C., & Heukelbach, J. (2010). Factors associated with urinary schistosomiasis in two peri-urban communities in south-western Nigeria. *Annals of tropical medicine and parasitology*, 104(5), 409–419. https://doi.org/10.1179/136485910X12743554760469

VAN Dorssen, C. F., Gordon, C. A., Li, Y., Williams, G. M., Wang, Y., Luo, Z., Gobert, G. N., You, H., McManus, D. P., & Gray, D. J. (2017). Rodents, goats and dogs - their potential roles in the transmission of schistosomiasis in China. *Parasitology*, 144(12), 1633–1642. https://doi.org/10.1017/S0031182017000907

Van, G. Y., Onasanya, A., van Engelen, J., Oladepo, O. & Diehl, J. C. (2020). Improving Access to Diagnostics for Schistosomiasis Case Management in Oyo State, Nigeria: Barriers and Opportunities. *Diagnostics (Basel)*, 10(5): 328. https://doi:10.3390/diagnostics10050328

Victor, A. & Joshua, A. (2018). Socioeconomic and Prevalence of Urinary Schistosomiasis Infection in Riverine Areas of Ondo State, Nigeria. *International journal of tropical disease & health*, 33(1), 1-7. doi: 10.9734/IJTDH/2018/43962

Xu, B., Gordon, C. A., Hu, W., McManus, D. P., Chen, H. G., Gray, D. J., Ju, C., Zeng, X. J., Gobert, G. N., Ge, J., Lan, W. M., Xie, S. Y., Jiang, W. S., Ross, A. G., Acosta, L. P., Olveda, R., & Feng, Z. (2012). A novel procedure for precise quantification of Schistosoma japonicum eggs in bovine faeces. *PLoS neglected tropical diseases*, 6(11), e1885. https://doi.org/10.1371/journal.pntd.0001885

Yousif, F., Wassel, G., Boulos, L., Labib, T., Mahmoud, K., El-Hallouty, S., El Bardicy, S., Mahmoud, S., Ramzy, F., Gohar, L., El-Manawaty, M., El Gendy, M. A., Fayad, W., & El-Menshawi, B. (2012). Contribution to in vitro screening of Egyptian plants for schistosomicidal activity. *Pharmaceutical biology*, 50(6), 732–739. https://doi.org/10.3109/13880209.2011.625952

APPENDIX

All appendix documents can be accessed via this link

Appendix 1 - Ethical approval for each state

Appendix 2 - Literature review protocol

Appendix 3 - Data collection tools

Appendix 4 - Consent form

HDI

One Health & Development Initiative

www.onehealthdev.org

info@onehealthdev.org

One Health and Development Initiative

@onehealthdev

@onehealthdev

@onehealthdev