ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 11, pp.42402-42411, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

AGE DISTRIBUTION OF SCHISTOSOMIASIS AND OTHER GASTROINTESTINAL RELATED PARASITIC INFECTIONS AMONGST CHILDREN AGED 0-15 YEARS IN OGUTA IMO STATE, NIGERIA; A RETROSPECTIVE STUDY OF PREVALENCE RATES (2012-2015)

[1]Michael Ihiechukwu Onwukwe, [2]Prof Timothy Paget, [3,*]Dr Catherine Hayes and [4]Dr John Fulton

[1]MSc Nursing Graduate, Faculty of Health Sciences and Wellbeing, University of Sunderland, UK
[2]Professor of Medical Microbiology, Faculty of Health Sciences and Wellbeing, University of Sunderland, UK
[3]Reader in Pedagogic Practice, Faculty of Health Sciences and Wellbeing, University of Sunderland, UK
[4]Reader in Research Based Practice, Faculty of Health Sciences and Wellbeing, University of Sunderland, UK

ARTICLE INFO

Article History:
Received 16th August, 2016
Received in revised form
30th September, 2016
Accepted 15th October, 2016
Published online 30th November, 2016

Key words:

Trichuris trichura,
Ascaris lumbricoidies,

ABSTRACT

Background: Despite major redevelopments and changes to existing health care delivery infrastructure a range of pathologies and associated health problems prevail that impact on society as a whole. Many of these diseases and health problems are directly attributable to lifestyle choices and environmental factors. One of these diseases is Schistosomiasis (also known as bilharzias), a condition still prevalent in countries such as Nigeria, with school age children most commonly affected. This study analysed the specific age distribution of Schistosomiasis and other gastrointestinal (GI) related parasitic infections among children (0-15 years) in Holy Ghost Hospital, Imo State Nigeria from 2012 – 2015.

Methodology: Using a retrospective survey design, to provide a quantitatively measurable and statistical description of the subject under study the demographic profiles of 323 children with a clinical diagnosis of Schistosomiasis were collected. Details collated included year of clinical diagnosis, age, gender, diagnosis, parent occupation and other related GI parasitic infections.

Result: The demographic profiles of 353 children (between the ages of 0-15 years) were anonymised. Of the 353 children clinically diagnosed of Schistosomiasis from 2012-2015, 263(75%), were male while 90(25%) were female. The age distribution of the population sample was 11-15years (62%); 6 -10years (31%) and 0-5 years (7%) respectively. Frequency of the Schistosomiasis amongst the 353 children was; age range 11-15years 219, 6-10years 110 and 0-5years 24**.** Results also demonstrated that children whose parents are fishermen and traders had highest prevalence rates of GI infection, followed by those whose parents were businessmen and civil servants. The majority of the children had an additional clinical diagnosis of *Ascaris lumbricoidies*, which represent 91% of this group, followed by *Trichuris trichura* 8%, with only 1% of the population not having a formal diagnosis of GI related infection.

Conclusion: High prevalence rates of Schistosomiasis in Oguta are of great significance in paediatric caseloads; this study indicates a need for urgent intervention in controlling the exponential increase of these pathologies. Findings from the survey indicate the need to implement treatment in remote geographical areas not previously targeted by mass drug administration programmes.

Citation: Michael Ihiechukwu Onwukwe, Prof Timothy Paget, Dr Catherine Hayes and Dr John Fulton. 2016. "Age distribution of schistosomiasis and other gastrointestinal related parasitic infections amongst children aged 0-15 years in oguta imo state, Nigeria; a retrospective study of prevalence rates (2012-2015)", *International Journal of Current Research*, 8, (11), 42402-42411.

INTRODUCTION

Schistosomiasis or bilharzia is one of the most predominant Neglected Tropical Diseases (NTDs) in many developing countries in the tropics and subtropics (Dawaki *et al.,* 2015). Nigeria has the highest amount of cases of Schistosomiasis globally, with about 29 million infested cases and around 101 million individuals at risk of infection (Adenowo, 2015).

**** Corresponding author: Dr Catherine Hayes,***
Reader in Pedagogic Practice, Faculty of Health Sciences and Wellbeing, University of Sunderland, UK.

Schistosomiasis is a blood fluke infection, the aetiology of which stems from trematodes infection. Of the three type of this worm called schistosoma causing the infection, two are found consistently in Nigeria. The most common worms are *S. haematobium* which causes urinary schistosoma and *S. mansoni* that in turn causes intestinal Schistosomiasis. Across Nigeria, Schistosomiasis is an infection of substantial and increasing importance due to the insufficiency of drinkable water and critical incidents linked to water irrigation, fishing and farming (Noreen, 2015). Intestinal Schistosomiasis is largely attributed to infection by *S. mansoni*. Largely, the infection majorly affects poor rural and the susceptible age group, school children are the victims of the disease.

Schistosomiasis is also associated to illnesses such as carcinoma of the bladder, anaemia and liver dysfunction. The incidence and prevalence of Schistosomiasis are highest in children and adolescents (Dawaki *et al.,* 2015). Thus, the negative impact on routine and the debilitation caused by untreated contaminations negatively impacts on both social and economic development in Nigeria. It is estimated that around 70 million disability-adjusted life years (DALYs) are accrued annually due to Schistosomiasis (Oppong, 2014). Despite these statistics, there is a scarcity of clinical or epidemiological research on Schistosomiasis. Schistosomiasis is a particularly prevalent condition in the Oguta health district. Such evidence is essential to recognise and make instrumental operative control procedures. A key aim of any health care provision scheme nowadays is to standby and make the most of human capital by contribution health protective and social performs that effect the prevention of disease through provision of diagnosis, treatment and reintegration facilities for prevailing infections (Rogers and Pilgrim, 2014). Schistosomiasis is an infection initiated by a parasitic worm or fluke, a trematode, which executes its life cycle partially in humans and partially in snails (Ahmed, 2015). The pathophysiological consequences include necrosis of human tissue and the fibrotic scarring of the bladder, urethra, ureter and/or the descending colon, depending on the type of organism contracted (Njoku, 2014).

Epidemiology

Nigeria has the highest prevalence rate of Schistosomiasis in the African continent, with about 20 million at an annual risk of contracting the condition. To address this, the National Schistosomiasis Control Program was formed in 1988 with the specific aim of delivering prophylactic anti-helminth treatment to paediatric populations identified as being most at risk of infection in rural areas of the country. This specific intervention program was based on formal guidelines of the World Health Organisation (Nikolay *et al.,* 2015).

Nigeria's disease control strategies consist of:

- Disease control processes (using Chemotherapy-Pranziquantel, directed to children of school age and other at risk populations).
- Health training and campaigning.
- Partnership with suitable investors for the establishment of satisfactory hygiene and portable water in conjunction with;
- Snail control
- In Nigeria, there are scarce few statistics on the numbers of people affected or at risk of contracting Schistosomiasis and Soil Transmitted Helminthic infection (STHs infections). Scarce funding of clinical interventions hinders effective control programme interventions.

Aim of the Study

The aim of the study was to establish the prevalence rates of of Schistosomiasis and other GI related parasitic infections amongst children aged 0-15 years in Holy Ghost Hospital, Imo State Nigeria from 2012 – 2015**.**

Objectives

- To investigate the distribution of Schistosomiasis cases among children of different age groups (0-15years).
- To establish any gender variation in the prevalence rates of Schistosomiasis
- To investigate the distribution of Schistosomiasis cases amongst children with parents of differing occupations.
- To establish if there are other GI related diseases that affects this age group.

Operational Definitions for the Study

- **Schistosomiasis** also known as bilharzias or snail fever, is a disease caused by a parasitic flatworm or fluke called Schistosoma, a trematode, which completes its life cycle partly in humans and partly in snails. It is a neglected tropical disease found in Parts of Asia, Africa and South America (WHO, 2015).
- **Trichuris trichuria**; is a roundworm commonly known as whipworm which causes trichuriasis, it is a type of helminthiasis that affects more of human intestine.
- **Ascaris lumbricoidis**; is an intestinal roundworm that predominates in areas of poor sanitation, also associated with malnutrition, iron deficiency anaemia and impairment of growth and cognition.
- **Prevalence**, Prevalence in epidemiology is the proportion of a population found to have a condition (Aschengrau, 2013). In this study, prevalence was use vis-a-vis age distribution of Schistosomiasis
- **Children** For this purposes of this study, children will are categorised as being aged from 0-15 years.

Background Literature Review

According to Adenowo *et al.,* (2015), Schistosomiasis is the second most prominent NTD in Sub-Saharan Africa (SSA) after hookworm, predominantly diagnosed in children and adolescents. SSA accounts for approximately 95% (189 million) of the globally approximated 209 million cases of Schistosomiasis. The five highest occurrences of the condition across Africa are seen in Nigeria (30 million), followed by Tanzania (20 million), Ghana, and Democratic Republic of Congo (18 million). These figures represent an underestimation of the factual occurrence of Schistosomiasis with the estimate of a total of 800 million global cases of Schistosomiasis-related diseases (King, 2010).

Neglected Tropical Diseases (NTDs)

Schistosomiasis which is one of the NTD is still an important community health delinquent globally with an estimated 207 million cases reported each year. Of the cases reported, 93 % (192 million) occur in SSA and over 200,000 deaths are directly linked to chronic infection with *Schistosoma haematobium* in this geographical region (McPhee, 2012). About 80% of the human population in SSA inhabits areas close to rivers, lagoons, and other water bodies, which are polluted with snail transitional hosts (Adenowo *et al.,* 2015). Those living near reservoirs are at particular risk of infection (Steinmann *et al.,* 2006), and Africa has seen numerous instances where the infection has developed or there has been a dramatic rise in the incidence of Schistosomiasis because of water scheme construction. Change in climate and worldwide heating can be influences in the increase of reported cases (Stensgaard *et al.,* 2016). In endemic regions in SSA, infection with Schistosomiasis usually occurs in childhood (Navaratnam *et al.,* 2012).

Key contributing factors to this include poor sanitation and increased exposure to mud and water as children play. Children who live in these regions are also most at risk since they swim and shower regularly in water containing *cercariae* (larva) that are infectious. The infection is routinely introduced to new areas through migration of refugees to urban areas. It has also been estimated that 5% to 10% of an endemic group might be contaminated, and the rest acquire cases of a mild-to-moderate severity.

Like many other helminth infections, Schistosomiasis is generally a chronic disease that does not cause death, although it can debilitate and weaken those infected severely (Murray *et al.*, 2010). Infection with the disease is usually asymptomatic, particularly intestinal Schistosomiasis, which can remain undetected for a long period of time (Meltzer and Schwartz, 2013). This evident lack of early and acute symptomology in those who are infected leads to levels of complacency both on an individual and community level. Hence, until recently, Schistosomiasis was not considered a threat to public health in most endemic countries. This condition and other neglected tropical diseases do not receive such a significant degree of financial support, treatment and control compared to Malaria, Tuberculosis and HIV/AIDS, three major causes of mortality across Africa (Hotez et al, 2009). Politically it has also been posited that Schistosomiasis and other NTDs are not prioritised because they are easily treated clinical infections affecting the poor, whose low incomes do not offer a high profit margin for drug companies (Oprea *et al*., 2009).

Public attitude towards Schistosomiasis is changing and improving. As more people are infected and scientific understanding of the disease is improved, the magnitude of the disease has become more apparent. It is now widely recognised that the physical disabilities caused by Schistosomiasis are effectively halting economic development in low-income countries. This can be attributed to few resources being available in these countries, with few resources available for diversion to the care and treatment of those infected with Schistosomiasis (Oprea *et al*., 2009). It is well established that infection with Schistosomiasis account for billions of dollars of lost productivity as those infected become too weak to work (Conteh *et al*., 2010). This loss is purely estimation as numbers of years of potential production lost due to premature death or as a direct result of inability to work caused to Schistosomiasis infection also referred to as DALYS (Disability Adjusted Life Years). The disease is now considered the second most prevalent and important parasitic infection after malaria in the tropics, eliciting a devastating impact on the socio-economic wellbeing of humankind. In recognition of this, a number of pharmaceutical companies have actively committed donations of drugs required for the treatment of Schistosomiasis.

Geographical Context of Schistosomiasis Infection

Two types of Schistosomiasis are common in most region of SSA. About two-thirds of the Schistosomiasis cases are due to infection caused by *Schistosoma haematobium (S.haematobium)*, which signifies a significant source of simple urinary tract disease (Murray *et al.*, 2011). In 2000, an estimated 32-70 million persons out of 700 million people in SSA had experienced haematuria and dysuria, respectively because of *S. haematobium* (Murray *et al.,* 2011). Similarly, *S. haematobium* produces bladder wall pathology in approximately 20 million people in SSA, and 12 million people agonize from hydronephrosis. Renal failure result into a large percentage of the estimated 150,000 deaths from urinary tract Schistosomiasis in SSA, and there is a significant association between major bladder wall pathology and squamous cell carcinoma (Parkin, 2008). A significant percentage of women and men with urinary Schistosomiasis acquire genital ulcers and other lesions (King and Dangerfield-Cha, 2008). In the former, urogenital Schistosomiasis is a noteworthy cause of poor reproductive health, including sexual dysfunction and infertility (Swai *et al.,* 2015). Genital Schistosomiasis also encourages the horizontal transmission of HIV/AIDS across SSA (Kjetland *et al*.,2006). Intestinal Schistosomiasis from *S. mansoni* causes most of the remaining cases in SSA. An estimated 5 million persons with *S. mansoni* have bloody diarrhoea and bowel ulceration, and 9 million develop hepatomegaly and accompanying periportal liver fibrosis, portal hypertension, and haematemesis from *S. mansoni* infection, with approximately 130,000 deaths (King & Dangerfield-Cha, 2008). *S. intercalatum* causes a second form of intestinal Schistosomiasis, but with a restricted distribution in West and Central Africa (Tchuenté *et al.,* 2013).

In addition to the organ-specific pathology described for both *S. haematobium* and *S. mansoni* infections, there is evidence to suggest the existence of more generalised morbidity as a direct result of the chronic inflammation of these long-standing infections (King & Dangerfield-Cha, 2008). Of the greatest significance in these co-morbidities are anaemia due to chronic inflammation and iron deficiency anaemia, stunted growth, malnutrition, fatigue, diminished physical fitness, and impaired cognitive development (King & Dangerfield-Cha, 2008). The impact of Schistosomiasis ranges between 2 and 5 million DALYs lost annually (2 and 4.2 million DALYs in SSA) but these present approximations do not take into consideration the over-all diseases outlined above. It has also been suggested that the impact of Schistosomiasis may be several times higher than previously estimated (King & Dangerfield-Cha, 2008), subsequently making this infection the most important NTD in SSA. A relationship is also hypothesised to exist between Schistosomiasis and Malaria (Colley *et al.,* 2014).

Schistosomiasis in Nigeria

Nigeria has the highest population in Africa, with a population of over 183 million. It is distributed across five diverse provincial states; the North, South, East and West as well as the capital region. The country's topographical demography is massively characteristic and in addition provides a context for various cultures. Principal ethnic groups are Yoruba, Hausa/Fulani and Igbo, which accounts for about 68% of the total population. About 27% of the population is comprised of Ijaw, Kanuri, Tiv, Nupe, Edo, and the Ebiras, and the remaining 5% is constructed of other minority groups. The rural area is home to about 68% of the population, and the urban area has about 32%. The population density of Nigeria is about 150 people per square kilometre, there are about 374 identifiable ethnic groups in Nigeria with varying languages, customs, and cultures constituting a nation with rich ethnic diversity. In Nigeria, Schistosomiasis due to *S. haematobium* is spreading extensively and as a consequence is creating a community health problem particularly in relation to children's health and wellbeing (Atalabi, 2011). The distribution of the disease is crucial to its ability to spread, combined and typically connected to water resources and development schemes such as fishing projects, fish/rice farming and dams.

It occurs in all the states of the federation, with a high infection rate between schoolchildren (Hassan *et al.,* 2010). There are remarkable generality and distribution of Schistosomiasis in Nigeria owing to differences in geographical and socio-demographic characteristics of the different localities in the population. In order to identify the endemic area and communities at higher risk and to lay down priorities towards the formulation of intervention strategies, various comparative parasitological and epidemiological studies on the prevalence of parasitic infection have been undertaken in different geographical contexts of Nigeria. In these studies it has been observed that the highest prevalence rates of infection are found in children. It is reported that in endemic, untreated populations, the prevalence and intensity of schistomiasis is higher in children than in adults, giving rise to a typically convex age infection profile (Sousa-Figueiredo *et al.,* 2009).

In Nigeria, previous research confirmed that both *S. mansoni* and *S. haematobium* are endemic, with the latter being more widespread (Atalabi, Lawal and Ipinlaye, 2016). Historically, in a systematic review conducted between 1990 and 2010 on the environmental spreading of Schistosomiasis and its control in Nigeria, by Ekpo *et al.,* (2011) in which 326 relevant articles were accessed showed that Schistosomiasis is endemic in 34 of the 36 states in Nigeria. Infection was reported from 632 locations, mainly in school children aged 5-14 years living in rural and semi urban areas. *S. heamatobium* infection was reported in 493(78%) locations in 35 (95%) states (Shetty *et al.,* 2011). *S. intercalatum* has been reported in 17(3%) locations in 1 (3%) state. Eighteen states reported both *S. masoni* and *S. haematobium* infection. Ogbonna *et al.*, (2010) stated that urinary Schistosomiasis is endemic in most Eastern parts of Nigeria namely; Enugu State, Imo and Anambra. The morbidity and mortality due to Schistosomiasis among children of school age are higher among this group compared to other groups (Ekpo *et al.,* 2010). In addition, these children also have reduced cognitive ability, poor physical fitness and do not attend school regularly (Ekpo *et al.,* 2010; Opkara *et al.,* 2007).

Lifestyle Factors

The lifestyle habits of populations play a pivotal role in the transmission of urinary Schistosomiasis. Infected individuals contaminate water supplies with their urine due to poor knowledge about disease transmission, poor living standards or the pre-requisite need for attention to hygiene in relation to the minimisation of the spread of infection. Furthermore, people in developing countries such as Nigeria are subject to poor healthcare infrastructure, which magnifies the impact of the disease. In such communities, self-medications with anthelminthic drugs are common but they are often misused. One of the consequences of such self-medication and anthelminthic drug misuse includes suppression of the egg laying capacity of schistosomes and other worms (Rollinson, 2009). The total effect could result in erroneous diagnoses of cases with commonly employed diagnostic tools such as microscopic examination of urine samples and reagent strip test for haematuria. In such circumstances, there is usually a correspondingly high rate of subclinical, chronic and a few instances of acute infection. Schistosomiasis originated in the Northern part of Nigeria and was introduced by Fulani settlers from the upper Nile Valley ensuring that *S. haematobium* became widespread in Nigeria (Ekpo *et al.,* 2010). Prevalence rates are high in those children involved in cattle rearing, which could be attributed to stagnant water pits and slow flowing rivers especially during the dry season. Similarly, a study by Mfuh *et al.,* (2011) investigated the incidence and prevalence rates of Schistosomiasis in Methodist primary school in Otukpo, Benue state North-western Nigeria. The author found that majority of pupils who suffered the greatest physical pain from the condition were between the ages of six and ten years, this was followed by 35% of those newly infected with Schistosomiasis being diagnosed between the ages of eleven and fifteen years old. Children in this age bracket have a tendency to be exposed to infected areas and are generally free in terms of their ability to move around since their parents usually have younger siblings to care for. Interestingly, prevalence in the age group below five years of age was zero, which consolidates the assumption that at this age, children are confined mainly to their mothers or the immediate environment of their mothers. Male pupils suffered more from the diseases 44% compared to the females 32% and mostly from class four and five. This is understandable since boys rather than girls engage more in activities outside of the home environment and as a result are more exposed to infection.

A cross sectional study was conducted between January 2014 and June 2014 to determine Schistosomiasis level and risk factors that exposed school-aged children to infection. In addition mapping of the condition in relation to altitude and rainfall in Taraba state North-eastern Nigeria was undertaken. Urine and faecal samples were collected from 1080 school-aged children and processed using filtration and formol-ether concentration techniques. The results demonstrated that Schistosomiasis remains a serious public health public problem amongst school-aged children as evidenced by overall prevalence rates. In the study, proximity to water and fishing were identified as predisposing risk factors in the increased prevalence of both urinary and intestinal Schistosomiases. Several other studies have also reported high risk of infection amongst children living close to bodies of water and especially in those involved in water contact activities such as fishing and swimming (Woodhall *et al.,* 2013). The lack of portable water and a health infrastructure not fit for purpose in some areas in Nigeria have contributed greatly to this hyper-endemity. Urinary Schistosomiasis in rural area of Nigeria ranges from 76% in Ekiti, 72% in Kastina, 83% in Odau community in Niger Delta and 65% in Edo (Olugunde, 2012). Similarly, the age related prevalence showed that children 6-10 years and 11-15 years had the highest prevalence rates.

Control measures in Combating Schistosomiasis

Control of infection usually requires control of transmission, elimination of vectors and elimination of reservoirs for the infective pathogens. For Schistosomiasis, as you can see from the previous life cycle, the snail is an important element of the life cycle, thus it is an obvious target for control. Breeding sites for snail will typically include water sources such as rivers, dams, streams and other water sources that have being contaminated with faecal and urinary discharge Several Studies have shown that patterns of infection are most prevalent in communities with stagnant or slow moving water. In terms of occurrence fresh water in the tropics, natural and artificial water reservoirs are potential homes for snails (Steinmann *et al.,* 2010).

Anosike *et al.,* (2003) stated that species of snail infecting humans with Schistosoma *Cercariae* were found in stagnant

pools, waters from flooding and impoundments like dams. Singh, Muddasiru and Singh (2016) also reported that "large waters associated with dams like the Kainji Dam in Nigeria are major transmission foci and are endemic areas for the fluke worms that cause Schistosomiasis". Schistosomiasis can also be transmitted through water sources contaminated with urine and faecal matter (Grimes et al, 2016).

Educating Individuals on Behavioural changes

It is very important to educate people, both early and old on the consequence of emptying urinary and faecal waste into rivers. This social change could potentially contribute much to the reduction of contaminated of water sources, which will subsequently lead to and thus lead to a potential reduction in the rate of transmission of Schistosomiasis and other water-transmitted diseases. Intensified efforts to educating people on the risk of Schistosomal infection and transmission is necessary to assist in achieving positive behavioral changes regarding waste elimination and personal exposure to open water sources (Hotez et al., 2009). Inhabitants of endemic areas need to be encouraged to reduce water contact as much as possible in a bid to reduce Schistosomiasis transmission (Stothard et al., 2009**).** In addition, educating people on how to respond to earlier symptoms is also important.

Research Design and Methodology

Using a retrospective survey research design, to provide a quantitative, measurable and statistical description of the subject under study, the aim of the study was to use the resultant data analysis to make inferences about the prevalence rates of Schistosomiasis amongst children aged 0-15 years. A technique that is often used to obtain information on social and behavioural variables and the relationship between these variables is a survey research, in which the researcher selects a sample or subgroup of people and either ask those questions or get record about an issue related to the research. The answers to these questions are then regarded as description identifying the opinions and the attitudes of the whole population from which the sample was taken (Creswell, 2013). Surveys are conducted for the general purpose of obtaining information about practices, opinion, attitudes, prevalence and other characteristics of people. According to Polit and Beck, (2013), the most basic function of a survey is description and interpretation of why a particular issue is common among a population, or why people behave as they do, comparison and prediction of responses concerning the variables of interest may be additional objectives.

Target Population

The data for this study was obtained from the medical record of Holy Ghost Hospital of clinically diagnosed children aged 0-15years with Schistosomiasis from 2012-2015. The decision to study this population is underpinned by three evidence:

- Imo state is one of the riverine areas with the highest prevalence of Neglected Tropical Disease (NTD) based on the recent findings (Balla and Jabbo, 2015).
- The incidence of Schistosomiasis in children is still on the rise despite the various intervention (Amuta and Houmsou, 2014; Ekpo, 2010).
- Contrary to the global view that Schistosomiasis is generally reducing in the world, the prevalence of the infection in Nigeria is a public health issue (Biu, Kolo and Agbadu, 2009).

Sampling method

Data was collated retrospectively from extant medical records at Holy Ghost Hospital, which provided information on children 0-15 year (male and female) who had received a clinical diagnosis of Schistosomiasis between the calendar years 2012-2015.

Instrument of Data collection

Data collected for the study was undertaken by extracting data previously collected in schedule sheets (DCSS) which recorded specific incidences of Schistosomiasis cases among children in Holy Ghost Hospital between 2012 – 2015. Patients that reported to the hospital based on their age, gender, the occupation of parents and whether there was any other identifiable gastrointestinal infection present.

Data analysis

The data collected was analysed using Statistical Package for Social Sciences (SPSS). Only descriptive statistics were compiled because the main variable was constant (all the children had Schistosomiasis).It ought to be noted that although in the secondary data, the ages of the children were collected as a continuous variable where the individual age was written, during analysis, this was converted into a categorical or discrete variable.

Data Analysis and Research Findings

All factors under scrutiny in the study were confirmed from retrospective medical records as having normal distribution and variables. The following variables were included in the analysis of this study: Prevalence of Schistosomiasis, ages of children from 0-15, gender, occupation of parent and other related diagnoses that are clinically associated to Schistosomiasis. Statistical analysis of data to ascertain the relationship between variables was undertaken using Statistical Package for the Social Science (SPSS). Descriptive statistics were then used to illuminate the findings from the study with tables being incorporated to give the overall sample size, sample sizes in important subgroups, and demographic or clinical characteristics such as the average age, the proportion of subjects of each gender, occupation and other variables.

Prevalence of Schistosomiasis amongst Children aged 0 – 15 years

353 children's medical records, whose identities were anonymised to ensure confidentiality, of were used in this research study. The inclusion criteria incorporated those children clinically diagnosed with Schistosomiasis from Holy Ghost Hospital Imo State, Southern part of Nigeria between 2012 – 2015. 75% of the children were male and 25 % are female. The age distribution of Schistosomiasis showed that it had a 62% prevalence rate amongst the age range 11 – 15 years; a 31% prevalence rate in the age range 6 – 10 years and 7% in the age range 0 – 5 years respectively. These results in a frequency of Schistosomiasis among children of 219 in ages 11-15 years, 110 in 6-10 years and 24 in ages 0-5 years.

Table 1. Frequency distribution showing the age distribution of Schistosomiasis among children in Holy Ghost hospital based on their different age

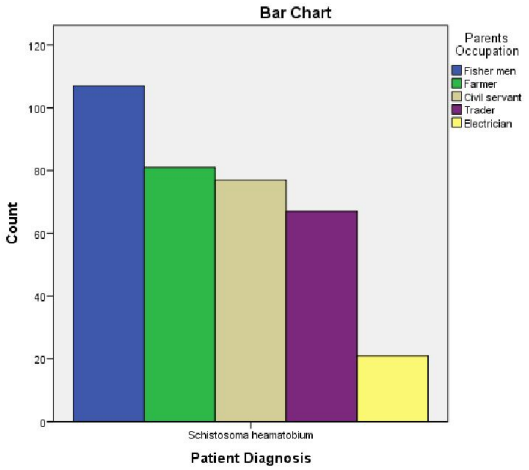
Variables	Frequencies	Percentage (%)
Age range in years		
11-15years	219	62
6-10years	110	31
0-5years	24	7
Total number of cases	353	100

Among the 353 children that were diagnosed of Schistosomiasis from 2012-2015, 263 were male which made up of 75% of the population while 90 were female, making up 25% of the general population.

Table 2. Frequency distribution of prevalence of Schistosomiasis among children in Holy Ghost hospital based on their gender

			Gender		
			Male	Female	Total
Patient Diagnosis	Schistosoma heamatobium	Count	263	90	353
		% within Patient Diagnosis	75%	25%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	75%	25%	100.0%
		Adjusted Residual			

From the analysis, it can be deduced that 30% of the parents are fishermen, 23% farmers, 22% civil servants, 19% traders and 6% electricians, all represented on the bar chart below.



Note; the percentage difference represents the total number of increase and reduction of the disease occurrence over the years.

Fig 5. Frequency distribution showing the age distribution of Schistosomiasis among children in Holy Ghost hospital based on their parent's occupation (Fig 3)

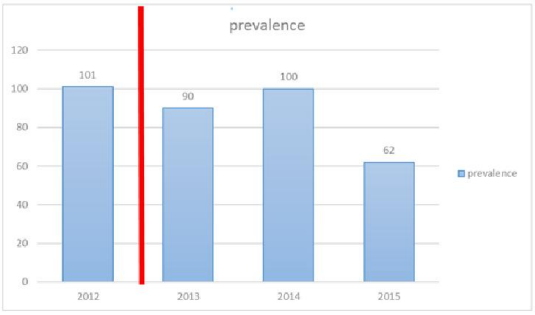
Overall, it was found out that majority of the children were diagnosed of *Ascaris lumbricoid* that represent 90.9% of the general population, followed by *Trichuris trichura* 7.9% and lastly 1.1% of the population were not having any gastrointestinal related infection.

Table 3. Frequency distribution of prevalence of Schistosomiasis among children in Holy Ghost hospital based on other gastrointestinal related parasitic infection

Other GIT related parasitic infection		Frequency	Percent
Valid	Ascaris lumbricoides	321	90.9
	Trichuris trichura	28	7.9
	None	4	1.1
	Total	353	100.0

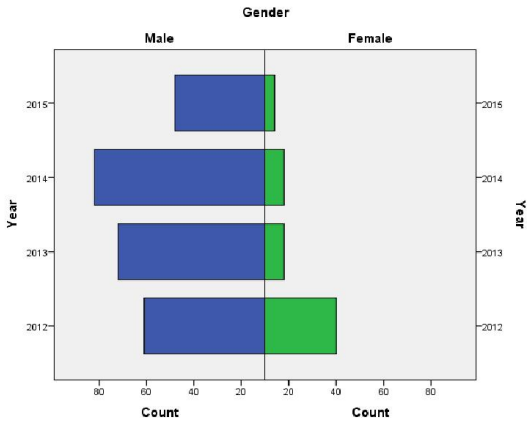
Frequency Distribution of Schistosomiasis Cases over the Study Years

From the information in the table below, the total cases of Schistosomiasis in 2012 were 101 which represents 29% of the general population, 2013 was 90 cases (26%), 2014 100 (28%) and 2015 62(18%).



Note; the red line on the graph indicates when the government intervention was launched in 2013.

Fig 6. Age Distribution of Schistosomiasis (2012 – 2015)



Note: the red vertical line indicates the launch of governmental policy

Fig 7. Gender Profile of Patient Records

Table 4. Occupation of Parents between 2012 and 2015

Parents occupation	Year 2012	Year 2013	Year 2014	Year 2015
Fisher men	30 (29.7%)	27 (30.0%)	39 (39.0%)	11 (17.7%)
Farmer	19 (18.8%)	27 (30.0%)	14 (14.0%)	22 (35.5%)
Civil servant	24 (23.8%)	16 (17.8%)	20 (20.0%)	15 (24.2%)
Trader	22 (21.8%)	14 (15.6%)	21 (21.0%)	10 (16.1%)
Electricians	6 (5.9%)	6 (6.7%)	6 (6.0%)	4 (6.5%)
Total	100%	100%	100%	100%

DISCUSSION

This study investigated the prevalence of Schistosomiasis among children between the ages of 0 – 15 years in Holy Ghost Hospital in Imo State Nigeria between 2012 – 2015, the findings showed that the prevalence of Schistosomiasis from 2012-2015 was 353 cases. The highest prevalence of Schistosomiasis cases was in 2012 with 101 (29 %) cases, followed by 2014 100 (28 %) cases, then 2013 was 90 (26 %) cases and 2015 62 (18%) cases. Secondly, the research investigated the distribution of Schistosomiasis cases amongst children of different age groups (0-15years) in Holy Ghost Hospital in Imo State Nigeria from 2012-2015. The findings of age distribution of Schistosomiasis showed a prevalence rate of 62% amongst the age range 11 – 15years, 31% prevalence in the age range 6 – 10years and 7% in the age range 0 – 5 years respectively.

This translate that the frequency of Schistosomiasis among children is revealed to be 219 between the age range 11-15 years, 110 between the age of 6-10 years and 24 between the age of 0-5 years. It can be deduced that children between the ages of 11-15 years had the highest prevalence rate with 219 cases, followed by children between the ages of 6-10 year with 110 cases. Children between the ages of 0-5 years had the lowest prevalence of 24. However, research carried out by Mfuh et al, (2011), revealed that 65% of the children who suffered from Schistosomiasis were aged between the age of 6-10 years followed by 35% of children between the ages of 11-15 years. These findings were rationalised in the study by illuminating the fact that children within this age group are more physically active with minimal restriction and care from their parents, who may be caring for younger siblings. The study also revealed that the prevalence in the age group below 5 years was very low because children at this age were confined to their parent's care and hence less exposed to risks of infection. In contrast, a study carried out by Satayathum over the years in Kenya stated that the prevalence of Schistosomiasis was minimal in older children. This study suggests that children who reside close to water sources and whose parents are fishermen and anglers were more susceptible to the development of Schistosomiasis infection. One of the research questions in the study sought to ascertain if there are gender variations in the prevalence of Schistosomiasis among children between the ages of 0-15 years in the Holy Ghost Hospital in Imo State Nigeria. The findings showed that, amongst the 353 children that were diagnosed of Schistosomiasis from 2012-2015, Male children had the highest prevalence of Schistosomiasis of 263 which constituted 75% of the population whilst 90 were female, making up 25% of the affected population. In a similar study conducted by Mfuh, *et al* (2011) in the Northern part of Nigeria, which used 512 cases,it was reported that male children (284) suffered from the infection compared to the females (228) he attributed it again to the fact that boys engage more in activities outside the house with little or no restrictions compared to girl in the same age groups. In line with this study, Satayathum *et al,* 2006 reported in his study of the Kenya prevalence rates of Schistosomiasis that the prevalence rate is higher in boys in these specific age groups and this can be attributed to their natural curiosity about the world around them, in particular their engagement in water based activities which could predispose them to the risk of Schistomiasis infection.

The distribution of Schistosomiasis cases amongst children whose parents had differing occupational backgrounds. From the study findings, it can be inferred that the prevalence of Schistosomiasis was higher amongst children whose parents are fishermen which covered 30% of the general population, followed by 23% of the parents who were farmers, 22% of the parents were civil servants, whilst 19% were traders; however children whose parents are electricians had the lowest prevalence rate of the condition at 6%. Mfuh et al, (2011) posited that the occupation of a child's parents could affect their relative risk of exposure to Schistosomiasis; he revealed that children whose parents were farmers were at higher risk, followed by civil servants, traders and other occupations. This was attributed to the fact farmers are exposed to water sources, which could potentially be contaminated whereas civil servants do not have adequate time available to them to be able to take proper care of their children's hygiene. One the other hand a study conducted by Woodhall *et al,* (2013) highlighted again the high risk of infection amongst children living close to water bodies and those involved in water contact activities such as fishing and swimming. A further area of investigation in the study was undertaken to establish whether other related GI infections affects this age group. It was evident that the majority of the children were diagnosed with *Ascaris lumbricoidis*, which represent 91% of the general population, followed by Trichuris trichura 8%, and lastly 1% of the populations were not having any Gl related infection. The report from Holy Ghost Hospital stated that majority of the children had *Ascaris lumbricoidis* because it has same route of transmission with Schistosomiasis. Some children without a clinical diagnosis of Schistosomiasis had a positive diagnosis of *Ascaris lumbricoid*. Methods of diagnosis and treatment of Schistosomiasis at the hospital under study were also confirmed, namely:

- Criteria for diagnosis of Schistosomiasis is confirmed to be through gross haematuria and evidence of *Schistosoma haematobium* in urine microscopy.
- Treatment of Schistosomiasis and other related worms example *Ascaris lumbricoid* and *Trichuris tricuria* was confirmed to be with:

Tabs Pranziquantel 20mg/kg t.d.s, 3 doses. Tabs mebendazole 100 mg 2wice daily for 3 days.

Government Strategy and Clinical Interventions in NTDs

Via the National Programme, Schistosomiasis received large-scale regulator determinations in Nigeria. Prevention to date has been exceptionally limited and is restricted to specific geographical areas. The Carter Center (TCC) is the only Non-Governmental Development Organization (NGDO) applying integrated control of Schistosomiasis and other NTDs in three states, this translates into only a 6% coverage of the total population of Nigerians at potential risk of the development Schistosomiasis across Nigeria. Combined Plotting was piloted in 19 States, namely: Plateau (17 LGAs)/Nassarawa (13 LGAs), supported by TCC, Taraba (11 LGAs) and Lagos state (7 LGAS) supported by Mission to save the Helpless, Ekiti (16 LGAs) supported by Ekiti State Ministry of Health (SMOH). Ondo state 18 LGAs was supported by SMOH, Federal Capital Territory (six LGAs) supported by the Federal Capital Territory Development Authority, Sokoto (23 LGAs) supported by Sightsavers, Niger (3LGAs), Benue (eight LGAs), Anambra (13 LGAs). Similarly, Ogun and Zamfara, Enugu (six LGAs), Ebonyi (five LGAs), Cross River (nine LGAs) and Gombe (11) states supported by FMOH, Jigawa (fifteen LGAS) supported by SMOH and Kwara (fifteen LGAs) supported by Sight savers.

Zamfara Ekiti, Kwara, Sokoto, Federal Capital Territory, Ondo, Ogun, Enugu (18 LGAs) and Gombe (11LGAs) are the only states where Schistosomiasis has been completely mapped to date. In 2009, the National Programme received the first donation of 4 million tablets of Praziquantel for two states via the World Health Organisation. Subsequently, there have been donations of tablets of Praziquantel in 2010 and 2011 treatment years. Bulk administration of Praziquantel tablets is currently being undertaken in 13 separate states. An estimated 9 million people out of the 27 million people targeted from these states have been now been treated. Outcomes of this study indicate a need for a holistic approach to the prevention and treatment of Schistosomiasis throughout Nigeria.

A significant finding of the study outlines the need to develop an epidemiological model, which will help in understanding how health promotion can be effectively channelled to at risk populations. Such a model would actively enable health professionals to acquire an ecological or system perspective for numerous different health problems. Such a lens would enable the identification of potential courses of action, which could potentially moderate or eliminate health risk. The general strategy in the employment of the traditional epidemiological model as regards to this study is threefold:

- To facilitate the resistance of hosts (children) to Schistosomiasis infection
- To decrease the virulence of the spreading agents of Schistosomiasis
- To create barrier to environments where Schistosomiasis thrives, which subsequently will prevent infectious agent reaching the hosts (children)

The Social Determinants of Health Model (Dahlgren and Whitehead, 1991) outlines that the overall socioeconomic, education, status, religion and environmental conditions in which people live and work can help weaken or improve their health rapidly. Likewise, these social determinants lead to health disparities within and between countries and it is obvious, as this study has also identified that the prevalence of Schistosomiasis is associated with the occupation, and subsequent socio-economic status of parents (Arigbede, 2012). Parent such as fishermen, anglers, farmers or communities with exceptionally high prevalence rates, should also have access to regular treatment for Schistosomiasis, and appropriate prophylactic prevention measures promoted within their respective working environments. Integrated control activities with other sectors such as agriculture and water resource development programmes, including small-scale irrigation schemes, should therefore be planned from the beginning (Dent *et al.,* 2013). In some instances, the use of snail control may also be indicated (Cioli *et al.,* 2014). Suitable treatment and re-treatment schedules in any given endemic setting will be predisposed by a variety of influences, including duration and intensity of exposure. The time intervals when re-treatment becomes necessary depend ultimately on the transmission pattern in a specified prevalent location (Berk *et al.,* 2016). Despite this study being carried out in a riverine area of high transmission of Schistosomiasis, treatment of children at the standard dose of Praziquantel at annual intervals may be appropriate to prevent or substantially reduce urinary tract pathology and reduce levels of current morbidity. Schistosomiasis can be characterised as a disease of poverty (Weerakoon, 2015). Nevertheless, evidence connecting social resources, economic status, and infection at community and household levels still needs to be directly correlated (Drummond *et al.,* 2015). These relationships can be described through quantitative as well as qualitative analysis of changes taking place over time, taking into account the nature of transmission lifestyle of family members (McNabb, 2015). Suitable sites for research on social and economic determinants would be locations where new water resources development projects are taking place and where control programmes are being actively implemented.

Conclusion

This study has raised policy, research and practical issues which when applied will reduce the prevalence of Schistosomiasis among children. The findings provide insight and understanding into the incidence of Schistosomiasis in Oguta community and with this the government, professional organisations and hospitals can develop and implement policies, guidelines and protocols to eliminate the inhibiting factors and promote as well as improve the health and wellbeing of population at risk of Schistosomiasis infection. The study highlights the need for a comprehensive health promotion through mass media campaign and awareness raising to re-emphasise and remind the public of their role in assisting in this goal of preventing the spread of infection and in advocating effectively used processes of sanitation. Although the socioeconomic status and occupation of parents are sensitive issues that are inherently difficult to change, it is possible that with continued campaigns and health education on the potential prevention of Schistosomiasis that they will influence long term outcomes.

REFERENCES

Adenowo, A.F., Oyinloye, B.E., Ogunyinka, B.I. and Kappo, A.P. 2015. Impact of human Schistosomiasis in sub-Saharan Africa. *Brazilian Journal of Infectious Diseases*, *19*(2), pp.196-205.

Ahmed, A.R. 2015. *The Prevalence Of Schistosomiasis Among Basic School Children At Asslaya Campus* (Doctoral dissertation, UOFK).

Amuta, E. U., Houmsou, R. S. 2014. Prevalence, intensity of infection and risk factors of urinary schistosomiasis in pre-school and school aged children in Guma Local Government Area, Nigeria. Asian Pacific journal of tropical medicine, 7(1), 34-39.

Anosike, J. C., Okere, A. N., Nwoke, B. E., Chukwu, J. U., Nwosu, D. C., Njoku-Tony, R. F. & Ogbusu, F. I. 2003. Endemicity of vesical schistosomiasis in the Ebonyi Benue river valley, south eastern Nigeria. *International journal of hygiene and environmental health*, *206*(3), 205-210.

Arigbede, Y.A. 2012. *Childhood Disease Mapping in Kaduna State Using Geographic Information Systems* (Doctoral Dissertation, Ahmadu Bello University, Zaria).

Atalabi, T. E., Lawal, U., & Ipinlaye, S. J. 2016. Prevalence and intensity of genito-urinary schistosomiasis and associated risk factors among junior high school students in two local government areas around Zobe Dam in Katsina State, Nigeria. *Parasites & Vectors*, *9*(1), 388.

Balla, H. J., & Jabbo, A. A. 2013. Survey of Urinary Schistosomiasis among School-aged Children in the Rural Communities of Mayo–Belwa Local Government Area, Adamawa State, Nigeria. Journal of Natural Science Research, 3(4), 73-77.

Berk, D.M., Stone, J., Amin-Hanjani, S. and Charbel, F., 2016. Oral Presentations 2016 AANS Annual Scientific Meeting. *J Neurosurg*, *124*, p.A1146.

Biu, A. A., Kolo, H. B., & Agbadu, E. T. 2009. Prevalence of Schistosoma haematobium infection in school aged children of Konduga Local Government Area, Northeastern Nigeria. *Int. J. Biomed. & Hlth. Sci. Vol*, *5*(4).

Cioli, D., Pica-Mattoccia, L., Basso, A. and Guidi, A., 2014. Schistosomiasis control: praziquantel forever?. *Molecular and biochemical parasitology*, *195*(1), pp.23-29.

Colley, D. G., Bustinduy, A. L., Secor, W. E., & King, C. H. (2014). Human schistosomiasis. The Lancet, 383(9936), 2253-2264.

Conteh, L., Engels, T., & Molyneux, D. H. 2010. Socioeconomic aspects of neglected tropical diseases. *The Lancet*, *375*(9710), 239-247.

Creswell, J.W., 2013. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Dahlgren, G., & Whitehead, M. 1991. Policies and strategies to promote social equity in health. *Stockholm: Institute for future studies*.

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. and Nasr, N.A., 2016. Prevalence and risk factors of Schistosomiasis among Hausa communities in Kano state, Nigeria. *Revista do Instituto de Medicina Tropical de São Paulo*, *58*.

Dent, D., Dubois, O. and Dalal-Clayton, B., 2013. *Rural planning in developing countries: supporting natural resource management and sustainable livelihoods*. Routledge.

Drummond, M.F., Sculpher, M.J., Claxton, K., Stoddart, G.L. and Torrance, G.W., 2015. *Methods for the economic evaluation of health care programmes*. Oxford university press.

Ekpo, U., Vounatsou, P., Huerlimann, E., Utzinger, J., Mafiana, C., Mafe, M., Oluwole, A., Abe, M., Nebe, O. and Kadiri, M., 2011. SP5-9 Geographical distribution of Schistosomiasis and its control in Nigeria. *Journal of Epidemiology and Community Health*, *65*(Suppl 1), pp.A447-A447.

Grimes, J. E., Tadesse, G., Mekete, K., Wuletaw, Y., Gebretsadik, A., French, M. D. & Templeton, M. R. (2016). School Water, Sanitation, and Hygiene, Soil-Transmitted Helminths, and Schistosomes: National Mapping in Ethiopia. *PLoS Negl Trop Dis*, *10*(3), e0004515.

Hassan, A. O., Amoo, A. O. J., Akinwale, O. P., Adeleke, M. A., & Gyang, P. V. 2016. Molecular Characterization and Detection of Infection in Vector Snails of Urinary Schistosomiasis around Erinle and Eko Ende Dams in South West Nigeria. *British Microbiology Research Journal*, *14*(1).

Hotez, P. J., Fenwick, A., Savioli, L., & Molyneux, D. H. 2009. Rescuing the bottom billion through control of neglected tropical diseases. *The Lancet*, *373*(9674), 1570-1575.

King, C. H. 2010. Parasites and poverty: the case of schistosomiasis. *Acta tropica*, *113*(2), 95-104.

King, C. H., & Dangerfield-Cha, M. 2008. The unacknowledged impact of chronic schistosomiasis. Chronic illness, 4(1), 65-79.

Kjetland, E. F., Ndhlovu, P. D., Gomo, E., Mduluza, T., Midzi, N., Gwanzura, L. & Gundersen, S. G. 2006. Association between genital schistosomiasis and HIV in rural Zimbabwean women. Aids, 20(4), 593-600.

Mc Phee, K.E., Inglis, D.A., Gundersen, B. and Coyne, C.J., 2012. Mapping QTL for Fusarium wilt Race 2 partial resistance in pea (Pisum sativum). *Plant breeding*, *131*(2), pp.300-306.

McNabb, D.E., 2015. *Research methods for political science: Quantitative and qualitative methods*. Routledge.

Meltzer, E., and Schwartz, E. 2013. Schistosomiasis: current epidemiology and management in travelers. *Current infectious disease reports*, *15*(3), 211-215.

Mfuh, A. Y., Lukong, C. S., & Ogbu, D. 2011. Determinants and Prevalence of Schistosomiasis in a Primary School in Benue State, Nigeria. *West African Journal of Nursing*, *22*(1).

Murray, C. J., Vos, T., Lozano, R., Naghavi, M., Flaxman, A. D., Michaud, C. & Aboyans, V. 2013. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The lancet*, *380*(9859), 2197-2223.

Navaratnam, A. M. D., Sousa-Figueiredo, J. C., Stothard, J. R., Kabatereine, N. B., Fenwick, A., & Mutumba-Nakalembe, M. J. 2012. Efficacy of praziquantel syrup versus crushed praziquantel tablets in the treatment of intestinal schistosomiasis in Ugandan preschool children, with observation on compliance and safety. Transactions of the Royal Society of Tropical Medicine and Hygiene, 106(7), 400-407.

Nikolay, B., Mwandawiro, C.S., Kihara, J.H., Okoyo, C., Cano, J., Mwanje, M.T., Sultani, H., Alusala, D., Turner, H.C., Teti, C. and Garn, J., 2015. Understanding heterogeneity in the impact of National Neglected Tropical Disease Control Programmes: evidence from school-based deworming in Kenya. *PLoS Negl Trop Dis*, *9*(9), p.e0004108.

Njoku, J.C., 2014. Epidemiological study of urogenital schistosomiasis in apparently healthy and hiv-infected females in jos, plateau state, nigeria (doctoral dissertation, university of jos).

Noreen, M., 2015. *Prevalence of Schistosomiasis Among the Schoolchildren at Kejarra Basic School 2009* (Doctoral dissertation, u).

Ogbonna, C. C., Dori, G. U., Nweze, E. I., Muoneke, G., Nwankwo, I. E. & Akputa, N. 2012. Comparative analysis of urinary schistosomiasis among primary school children and rural farmers in Obollo–Eke, Enugu State, Nigeria: Implications for control. *Asian Pacific journal of tropical medicine*, *5*(10), 796-802.

Ologunde, C. A., Olaoye, A. B., Olaifa, O. A. & Olowu, O. Y. 2012. Schistosomiasis in Ogbese-Ekiti, re-infection after successful treatment with Praziquantel. *Global Journal of Medical Research*, *12*(3).

Oppong, O. 2014. *Insecticide Treated Bed Net Usage Pattern in Ashaiman Municipality Accra* (Doctoral dissertation, University of Ghana).

Oprea, L., Braunack-Mayer, A., & Gericke, C. A. 2009. Ethical issues in funding research and development of drugs for neglected tropical diseases. *Journal of Medical Ethics*, *35*(5), 310-314.

Parkin, D. M. 2008. The global burden of urinary bladder cancer. Scandinavian Journal of Urology and Nephrology, 42(sup218), 12-20.

Polit, D.F. and Beck, C.T., 2013. *Essentials of nursing research: Appraising evidence for nursing practice*. Lippincott Williams & Wilkins.

Rogers, A. and Pilgrim, D., 2014. *A sociology of mental health and illness*. McGraw-Hill Education (UK).

Rollinson, D. 2009. A wake up call for urinary schistosomiasis: reconciling research effort with public health importance. *Parasitology*, *136*(12), 1593-1610.

Satayathum, S. A., Muchiri, E. M., Ouma, J. H., Whalen, C. C., & King, C. H. 2006. Factors affecting infection or reinfection with Schistosoma haematobium in coastal Kenya: survival analysis during a nine-year, school-based treatment program. *The American journal of tropical medicine and hygiene*, *75*(1), 83-92.

Shetty, P., Sejao, A. and Kowli, S., 2011. SP5-6 It's time to focus on the nutritional status of boys. *Journal of Epidemiology and Community Health*, *65*(Suppl 1), pp.A447-A447.

Singh, K., Muddasiru, D., & Singh, J. 2016. Current status of schistosomiasis in Sokoto, Nigeria. *Parasite Epidemiology and Control*, 1(3), 239-244.

Sousa-Figueiredo, J. C., Basáñez, M. G., Khamis, I. S., Garba, A., Rollinson, D., & Stothard, J. R. 2009. Measuring morbidity associated with urinary schistosomiasis: assessing levels of excreted urine albumin and urinary tract pathologies. PLoS Negl Trop Dis, 3(10), e526.

Steinmann, P., Keiser, J., Bos, R., Tanner, M., & Utzinger, J. 2006. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. *The Lancet infectious diseases*, 6(7), 411-425.

Stensgaard, A. S., Booth, M., Nikulin, G., & McCreesh, N. 2016. Combining process-based and correlative models improves predictions of climate change effects on Schistosoma mansoni transmission in eastern Africa. Geospatial health, 11(1s).

Stothard, J. R., Chitsulo, L., Kristensen, T. K., & Utzinger, J. 2009. Control of schistosomiasis in sub-Saharan Africa: progress made, new opportunities and remaining challenges. *Parasitology*, 136(13), 1665-1675.

Swai, B., Poggensee, G., Mtweve, S., & Krantz, I. 2006. Female genital schistosomiasis as an evidence of a neglected cause for reproductive ill-health: a retrospective histopathological study from Tanzania. BMC infectious diseases, 6(1), 1.

Tchuenté, L. A. T., Momo, S. C., Stothard, J. R., & Rollinson, D. 2013. Efficacy of praziquantel and reinfection patterns in single and mixed infection foci for intestinal and urogenital schistosomiasis in Cameroon. Acta tropica, 128(2), 275-283.

Weerakoon, K.G., Gobert, G.N., Cai, P. and McManus, D.P., 2015. Advances in the diagnosis of human Schistosomiasis. *Clinical microbiology reviews*, *28*(4), pp.939-967.

Woodhall, D. M., Wiegand, R. E., Wellman, M., Matey, E., Abudho, B., Karanja, D. M., & Secor, W. E. 2013. Use of geospatial modeling to predict Schistosoma mansoni prevalence in Nyanza Province, Kenya. *PloS one*, 8(8), e71635.

****