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SCHOOL OF PUBLIC HEALTH

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UNIVERSITY OF GHANA

PREVALENCE OF SCHISTOSOMIASIS IN CHILDREN UNDER SIX YEARS IN TWO ENDEMIC COMMUNITIES ALONG THE WEIJA LAKE

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULLFILLMENT OF REQUIREMENTS FOR THE AWARD OF A MASTER OF PUBLIC HEALTH DEGREE.

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DECLARATION

I, Ivy Ewurakua Lengoi Bentil declare that, except for references made to other people's work, which I have duly acknowledged, this dissertation is a product of my own research. This dissertation titled "Prevalence of Schistosomiasis in Children under Six Years in Two Endemic Communities along the Weija Lake" presented today has neither wholly nor partially been presented for the award of any degree in any Tertiary Institution.

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DEDICATION

This work is dedicated to my God, Almighty for His infinite and sufficient grace and love, to the Bentil family, the people of Tomefa and Manheam and to my nation Ghana.

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ABSTRACT

Introduction: Schistosomiasis, a neglected tropical disease, often endemic in areas with poor sanitation, is known to cause physical and mental defects in children and adults alike. Consequently, a number of strategies with much emphasis on drug administration for morbidity control have been put in place to combat schistosomiasis in Ghana and the world at large. Unfortunately, children under six years have been excluded from chemotherapy for several years and it is in recent times that the WHO has begun putting measures in place to correct this lapse.

Objective: The aim of this study was to determine the prevalence of schistosomiasis among children under six years in two communities along the Weija Lake, and identify risk factors that predispose them to *Schistosoma* infections.

Methodology: A cross-sectional study involving the collection of stool and urine samples from 186 children below age six, in two communities along the Weija Lake was done using convenient sampling. Urine chemistry and parasitological methods, involving Kato Katz and 10ml urine filtration were used to analyse samples for parasite eggs. Microscopic examination of parasite eggs was done to detect infection state and determine the prevalence of *Schistosoma* infections in these children respectively. Questions were developed to help detect risk factors that expose these children to the disease.

Results: The average prevalence of schistosomiasis in the two communities studied was 7.9%. Average prevalence of *S. mansoni* was 9.2% in the communities; 10.5% in Tomefa and 7.5% in Manheam. Tomefa recorded only 1 (1.43%) *S. haematobium* and 6 (10.53%) *S. mansoni* infections, where as Manheam had 3 (7.50%) *S. mansoni* infections with no record of *S. haematobium* infection. Risk factors or determinants of infection included zone of community lived in and nearness to the waterbody.

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Conclusion: *Schistosoma* infections were established in children under six years in Manheam and Tomefa. *Schistosoma mansoni* infection was more prevalent compared to *S. haematobium.*

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TABLE OF CONTENTS

DECLARATION i
DEDICATION ii
ACKNOWLEDGEMENT iii
ABSTRACT iv
LIST OF TABLES ix
LIST OF FIGURES x
DEFINITION OF TERMS xi
LIST OF ABBREVIATIONS xii
CHAPTER ONE 1
INTRODUCTION 1
1.1 Background 1
1.2 Problem Statement 4
1.3 Conceptual Framework 6
1.4 Justification 10
1.5. Objectives of Study 11
1.5.1. Main Objective 11
1.5.2. Specific objectives 11
CHAPTER TWO 12
LITERATURE REVIEW 12
2.1 Schistosomiasis 12
2.2 Epidemiology of the Disease 13
2.3 Biology of the Schistosome 13
2.4. Lifecycle of the Schistosome 14
2.5. Risk factors associated with *Schistosoma* infection 15
2.6. Forms of Schistosomes and Pathogenesis 16
2.7 Treatment of Schistosomiasis 18
2.8 Schistosomiasis in Children under Age Six 19

University of Ghana http://ugspace.ug.edu.gh

CHAPTER THREE 22
METHODS 22
3.1 Study Design 22
3.2 Study Sites..22
3.3 Study Population 23
3.3.1. Inclusion criteria 23
3.3.2. Exclusion criteria 23
3.4 Sample Size Determination 24
3.5 Data Collection Procedure and Tools..24
3.6 Quality Control..25
3.7 Variables..25
3.7.1 Dependent variable or Outcome variable: 25
3.8 Data Collection tools 26
3.8.1. Questionnaire 26
3.8.2. Parasitological and urine chemistry methods 27
3.8.3.0. Data Management 29
3.8.4 Statistical Analyses 30
3.8.5. Ethical Considerations 30
CHAPTER FOUR..32
RESULTS 32
4.1. General characteristics of study participants..32
4.1.1 Knowledge about schistosomiasis 39
4.2. Prevalence of schistosome infections in children under six..41
4.2.1 Other findings 41
4.3. Hygiene and Sanitation Practices at Study Sites 44
4.4. Determinants of Schistosomiasis 45
4.5.0. Strip test urinalysis 50
CHAPTER FIVE 52
DISCUSSION 52

University of Ghana http://ugspace.ug.edu.gh

5.1.0. Study limitation 57
CHAPTER SIX 58
CONCLUSION AND RECOMMENDATION 58
6.1. CONCLUSION 58
6.2 RECOMMENDATIONS 58
REFERENCES 61
APPENDICES 70
APPENDIX I: Ethical Clearance Letter 70
APPENDIX II: Ga South Municipal Area- Acceptance Letter 71
APPENDIX III: Consent Form 72
APPENDIX IV: Volunteer Agreement Form 74
APPENDIX V: Questionnaire 75
APPENDIX VI: Tables Demonstrating Distribution Of Baseline Characteristics 80
APPENDIX VII: Tables Demonstrating Distribution Of Urinalysis Parameters 90

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LIST OF TABLES

Table 4. 1: Baseline characteristics relating to the different zones in the two study sites. 34

Table 4. 2: Baseline characteristics relating to the different zones in the two study sites. 35

Table 4. 2: Baseline characteristics relating to the different zones in the two study sites. 36

Table 4. 3: Baseline characteristics relating to the different zones in the two study sites. 37

Table 4. 4: Baseline behavioural characteristics relating to the different zones in the two study sites. 38

Table 4. 5. Knowledge about schistosomiasis 39

Table 4. 6 Parents' knowledge about symptoms of schistosomiasis 40

Table 4. 7 Parents' knowledge in methods for preventing schistosomiasis. 40

Table 4. 8 Parents' knowledge on ways of preventing schistosomiasis. 40

Table 4. 9 Distribution of *Schistosoma* parasites from urine and stool samples in specific zones in the two communities using various parasitological techniques 42

Table 4. 10: Estimated intensity of *Taenia* eggs in stool samples 43

Table 4. 11: Distribution of *Taenia* sp. in specific zones in community sites. 43

Table 4. 12: Univariate analysis of demographic factors associated with *Schistosoma* infection.....46

Table 4. 13: Univariate analysis of socioeconomic factors associated with *Schistosoma* infection..47

Table 4. 14: Univariate analysis of clinical history as factors associated with *Schistosoma* infection 48

Table 4. 15: Univariate analysis of behavioural factors associated with *Schistosoma* infection.......49

Table 4. 16 : Multivariate analysis of the factors associated with schistosome infections in children under six. 50

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LIST OF FIGURES

Fig. 1.1 Conceptual Framework: Determinants of *Schistosoma* infection in children under six. 9

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DEFINITION OF TERMS

Dysuria – Painful, discomforting or burning sensation felt when urinating

Haematuria- visible blood seen when passing urine.

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LIST OF ABBREVIATIONS

MDA- Mass Drug Administration

CI- confidence interval

OR- Odds Ratio

ml- Millilitres

g- Grams

WHO- World Health Organization

EPG- Eggs Per Gram

PZQ- Praziquantel

ELISA- Enzyme – Linked Immunosorbent Assay

N – Number of respondents (Frequency)

% - Percentage

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CHAPTER ONE

INTRODUCTION

1.1 Background

Schistosomiasis is a major disease of public health concern. It ranks second to malaria as the most important and devastating parasitic disease (Waknine-Grinberg *et al*., 2010), with high morbidity and mortality. It is responsible for approximately 280,000 deaths in sub-Saharan Africa (Nyati-Jokomo & Chimbari, 2017). Of the 800 million people at risk of schistosomiasis globally, more than 200 million have contracted the disease in 76 countries (Nyati-Jokomo & Chimbari, 2017). Africa alone houses up to 85% of the infected population (Mose, Kutima, Waihenya, & Yole, 2013), if not more (Sady *et al*., 2013; World Health Organization, 2018; Yirenya-Tawiah, Ackumey, & Bosompem, 2016). Studies have shown that in the year 2009, about 112 million people contracted active urogenital schistosomiasis while about 54 million people had intestinal schistosomiasis (Senghor *et al*., 2014). Schistosomiasis is detected mainly in rural and peri-urban deprived areas with dams and irrigation systems, which also have fishing and agriculture as their major occupation. Poor housing units without toilet facilities and lack of potable water, indicating poor sanitation usually characterize these areas (Njenga *et al.*, 2014).

Schistosomiasis is caused by the Schistosoma trematode found in fresh water bodies inhabited by water snails, usually *Bulinus*, *Biomphalaria and Oncomelania* sp.. These snails serve as intermediate hosts to the *Schistosome* parasite. The types of human schistosomes are *S. mansoni, S. mekongi, S. guineensis, S. haematobium, S. japonicum and S. intercalatum* (Gryseels, Polman, Clerinx, & Kestens, 2006; Colley, Bustinduy, Secor, & King, 2014). The *Bulinus* sp. hosts mainly

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the *S. haematobium* and *S. intercalatum and S. guineensis, Biomphalaria* sp. hosts *S. mansoni Oncomelania* sp. hosts *S. japonicum and Neotricula aperta* for *S. mekongi* sp. (Gryseels *et al.*, 2006; Kali, 2015; Leshem, Meltzer, Marva, & Schwartz, 2009). The three main species endemic in sub-Saharan Africa however are the *S. mansoni, S. haematobium* and *S. intercalatum* (Njenga *et al*., 2014). Schistosomiasis is endemic in Ghana (Yirenya-Tawiah *et al.*, 2011), and the main species of Schistosoma are *S. haematobium* and *S. mansoni* (Bosompem *et al.*, 2004; Shiff, Naples, Isharwal, Bosompem, & Veltri, 2010), which cause urogenital and intestinal schistosomiasis respectively. The disease symptomatically presents itself with haematuria for urogenital schistosomiasis, and diarrhoea and abdominal pain, with intestinal schistosomiasis (Sady *et al.*, 2013). Infected persons may also present other general symptoms such as anaemia, fever, headache, general body pains, poor growth, gastrointestinal irregularities and liver tenderness and enlargement (Aagaard-hansen, Bruun, & Watts, 2008; Colley et al., 2014; Leshem et al., 2009; Mduluza & Mutapi, 2017). However, there have been many cases of the disease with asymptomatic tendencies (Aagaard-hansen *et al.*, 2008; Bosompem *et al.*, 2004; Leshem *et al*., 2009; Lodh, Naples, Bosompem, Quartey, & Shiff, 2014).

The *Schistosoma* parasite undergoes a lifecycle involving an egg stage, a miracidial stage, a cercarial stage, a schistosomula stage and an adult worm stage. The adult schistosome worm lays eggs that hatch into the miracidia. The miracidium is a larval stage of the worm that dwells in its appropriate snail host (intermediate host). The cercaria plays a major role in transmission as it is the stage that infects humans. The schistosomula also known as the somula, is the young adult worm, which later develops into the full adult worm. The adult worm lays the eggs, which are found in the urine or faecal matter of its host (Colley, Bustinduy, Secor, & King, 2014). The eggs

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are known to be the main source of the disease morbidity in the schistosome lifecycle, as their spines are responsible for the characteristic haematuria and blood in faeces. The eggs are thence required during disease diagnoses (Colley *et al*., 2014; Gryseels *et al.,* 2006). However, pathogenesis could also be due to release of secretory antigens into the body of the human host which elicit a strong immune response, thus contributing to pathological changes including fibrosis (Colley *et al*., 2014; Gryseels *et al*., 2006).

Schistosomiasis is diagnosed using various methods such as the urine dipstick methods for heme (a quick diagnostic tool, usually for on field detection), parasitological, serological and molecular methods. The parasitological method mainly Kato-Katz and/or flotation methods (for intestinal schistosomiasis) and filtration method (for urinary schistosomiasis) together with microscopy is widely used. ELISA is a typical serological method (Bosompem *et al.*, 1996) while PCR is the main molecular method used for parasite detection (Lodh *et al*., 2014; Mensah-Bonsu, 2016; Shiff *et al*., 2010).

Schistosomiasis is treated using Praziquantel (PZQ), the effective drug of choice (Osakunor, Woolhouse, & Mutapi, 2018). Alternatively, Oxamniquine is used; however, this is only effective against *S. mansoni* and its infections (Aagaard-hansen *et al.*, 2008; Mensah-Bonsu, 2016). Other anti-helminthic drugs such as Albendazole or Mebendazole could be used in combination with other drugs to control the disease (King, Dickman, & Tisch, 2005; Mutapi, 2015). Praziquantel however, is by far the most efficacious against schistosomes (Mutapi, 2015; Stothard, Bustinduy, & Montresor, 2014).

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Understanding the determinants of transmission of schistosomiasis in infected communities is essential for control and prevention programmes to be successful (Nyati-Jokomo & Chimbari, 2017). Age, sex, educational level, occupation and income earned, water contact practices, history of past infection and general knowledge on Schistosomiasis may pose as risk factors affecting infection. Other such factors may include sanitary conditions, presence of dams and irrigational projects, climatic conditions, biota found in the waterbody and use of water among others. These determinants tend to influence transmission of the disease and might differ depending on the location for infections (Atalabi, Lawal & Ipinlaye, 2016; Nyati-Jokomo & Chimbari, 2017; Osakunor *et al*., 2018).

1.2 Problem Statement

Children and young adults between six and twenty-three years are generally more prone to schistosomiasis in endemic areas, and have higher infection incidence and disease burden due to their active water contact behaviour. About 60% of the population of African children carry *Schistosoma* parasites in them (Mutapi, 2015) with about 40% of these infected children being under six (Osakunor *et al*., 2018). In attempt by public health researchers and WHO advocates to reduce and treat schistosomiasis in endemic communities, children under six, who tend to be most vulnerable are often neglected (Dabo, Badawi, Bary, & OK, 2011; Mutapi, 2015).The adults find their way into the clinics and health centres to treat the disease leaving those under six. Children below age six, not being able to recognize and understand the repercussion of having blood in urine or in their stool, could lead to cases being under-reported.

None of the 28 countries in Africa enrolled children below six years in the implementation of chemotherapeutic schistosomiasis control programmes from 1995- 2013, although few such as

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Nigeria and Zimbabwe have indicated significant schistosome levels in children of this age bracket in their countries (Mutapi, 2015). Ambiguity in levels of exposure of children under six years and their levels of infection and morbidity could have led to the exclusion of this age group from the treatment. Other contributing factors were their immune responses to the choice drug of treatment, Praziquantel (PZQ) due to the immaturity of their system and its ability to act synergistically with PZQ. Another uncertainty was the safety and efficacy of PZQ to these young children (Bustinduy, Stothard, & Friedman, 2017; Mutapi, 2015).

Some studies conducted in Africa recorded up to 79% of children within the ages of 4 months to 6 years as exposed to schistosome infection. In these cases, some infection intensities were as high as in the adults and caregivers, who were later treated. In addition to this, research work done in Kenya has put the doubts concerning the treatment of children under six with PZQ to rest (Mduluza & Mutapi, 2017; Mutapi, 2015).

Cases of diarrhoea, fever and headaches, which are also symptoms of schistosomiasis (Mduluza & Mutapi, 2017) could often be misdiagnosed in children as malaria, or some other common disease that affect children (Osakunor, Woolhouse, & Mutapi, 2018). The disease if not detected and treated early, can end up advancing to chronic effects, affecting the growth, mental and general development of the child, not forgetting his/ her reproductive health in future (Mduluza & Mutapi, 2017; Osakunor *et al.*, 2018). It could also lead to bladder cancer, liver damage, as well as increased susceptibility to HIV in adulthood (Mutapi, 2015).

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1.3 Conceptual Framework

Infections tend to be more or less rampant depending on the determining or risk factors associated with the disease. *Schistosoma* infections are no different in this scenario. This is because these factors such as the demographic, behavioural, environmental, biological and socioeconomic factors tend to affect the prevalence of the disease both independently and when integrated (Aagaard-hansen *et al.*, 2008). This conceptual framework throws light on some linkages and relationship among the dependent variables as well as between the dependent and independent variables.

Demographic factors such as age and sex of children could play a role in the transmission of the disease (Kosinski *et al*., 2012). The tribe, religion, housing and proximity to waterbody could also influence *Schistosoma* infections. One's tribe/ religion could pre-dispose him into being infected. People from the coastal belts, accustomed to fishing or farming would be more likely to pursue fishing as an occupation. Proximity with water body could increase water contact, which in effect could increase infection, as will influence recreation and washing among others (Kosinski *et al*., 2012).

The biological factors as well contribute to its prevalence. A child still breastfeeding could acquire immunity from mother (Kosinski *et al*., 2012). Probability of babies or children suckling getting the infections is minimal, especially when mothers have ever been infected. They may pass antibodies unto the children, which might prevent infection.

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Damming the water source prevents the water from rapid movements, which goes a long way in providing suitable conditions for breeding the intermediate snail hosts. This tends to facilitate *Schistosoma* infections in the environment, as the parasite requires the presence of standing or slow flowing water (Bosompem et al., 2004; Zakhary, 1997). Availability and accessibility of toilet facilities in homes and vantage points in the community reduce the risk of open defecation (Sady *et al*., 2013). This in turn reduces re-infection of water bodies when treated. Other environmental conditions such a climate could influence transmission as more sunlight induces cercarial shedding and thereby increase prevalence (Coffie, 2015). Again, warm weather might increase the urge to take a dip in the water (Coffie, 2015). Proximity to water bodies could influence family or children's decision to fetch water, play and even bath in the water source. Parents' economic status could affect transmission, as the occupation of the parent could be a predisposing factor (Yirenya-Tawiah *et al*., 2011). Children whose parent(s) are fisher folk would be more likely to train their children to fish (Coffie, 2015). Alternatively, children would be kept supervised and out of harm's way while in the sight of parents. Income of the parents would determine if treatment of water or alternative source of water could be sought. Meanwhile, availability of source of potable water, could reduce transmission (Coffie, 2015). One's level of education or knowledge on Schistosomiasis could affect the decision to allow children to play in the water body again the level of education could affect his/ her decision to egest or bath into the water bodies, which could highly affect the prevalence or incidence of the disease(Aagaard-hansen et al., 2008; Coffie, 2015).

Children under six may be affected actively as observed in the other age groups. Such active pre-exposures happen when guardians take them along to the water body. This water body might serve either as their source of recreation or occupation. Likewise these elderly ones may go there to do

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their domestic chores such as washing or fetching water. In event of this, the children may be left to play and infect themselves with the water containing schistosomes (Coffie, 2015; Kosinski *et al*., 2012).

Passive transmission could occur when these guardians fetch the water home and use it in bathing these children. Even on site, while guardians, mainly the fisher-folk or farmers are working, children could be infected when some water is fetched to clean them when they defecate. Children, being carried at guardians back can also be infected when some of the water fetched accidently trickles down on them.

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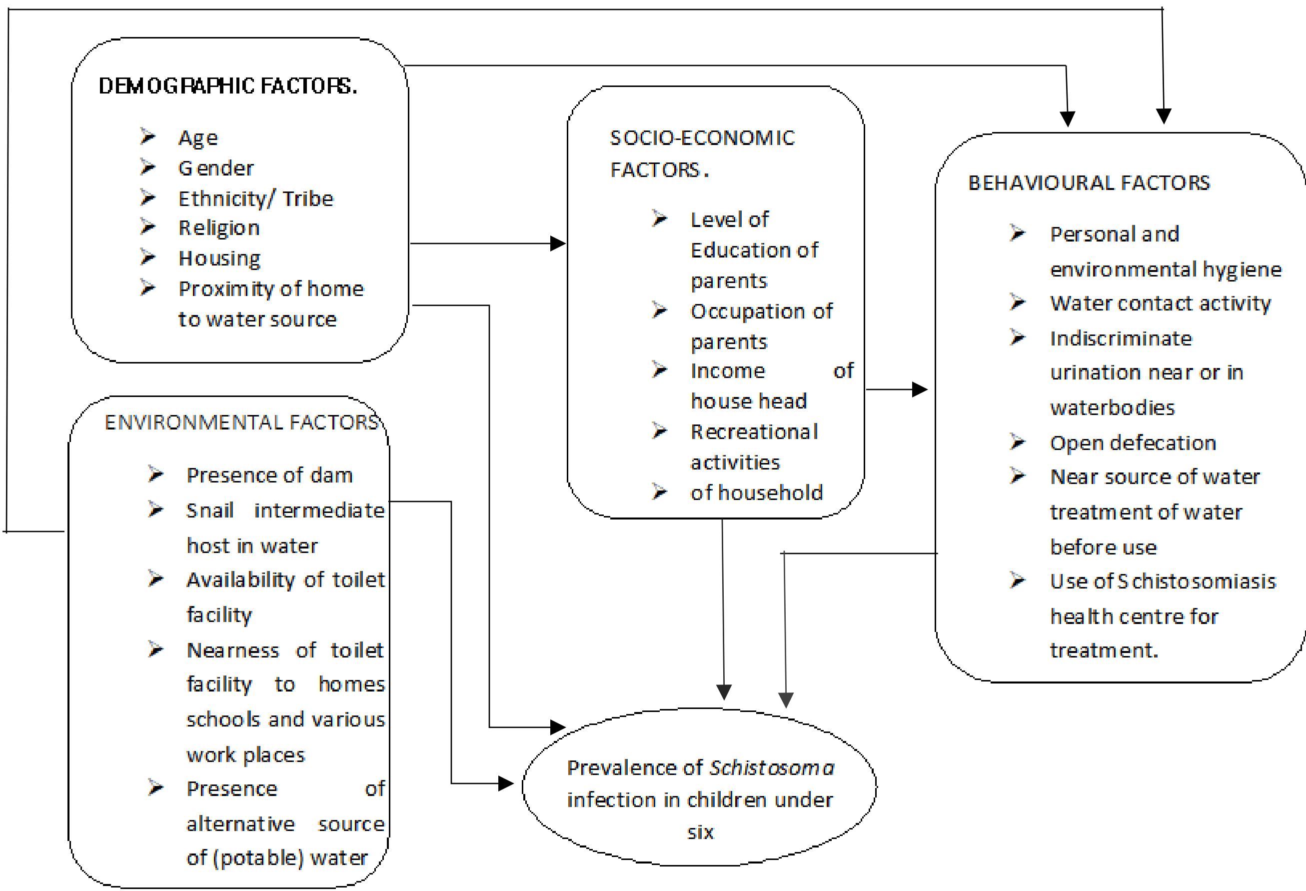

Fig. 1.1 Conceptual Framework: Determinants of *Schistosoma* infection in children under six.

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1.4 Justification

Schistosomiasis is a highly morbid neglected tropical disease of public health concern. Schistosomiasis prevalence is relatively high in Ghana (Rollinson *et al*., 2013; Yirenya-Tawiah *et al*., 2016), it is still endemic countrywide (Sokolow, 2015). In spite of the various interventions put in place to control the disease, it still is of public health significance. Control will be greatly enhanced if gaps in the current treatment practices, especially infections among children under six years are identified and treated.

The concept of paediatric schistosomiasis in children below six is understudied compared to that of school-aged children (Bosompem *et al*., 2004; Mutapi, 2015; Osakunor *et al*., 2018). If controlled, this could in a long run, reduce child mortality in Ghana and in addition help reduce number of infected school-aged children.

In less developed areas with schistosomiasis, where the freshwater bodies tend to be their main source of water, guardians bath these children with water from the rivers or lakes and in the process might be infecting them. Children under six years are naturally curious and in wandering about may be exposed to open sources of contaminated water in the home (Bosompem *et al*., 2004). In our settings, mothers often carry their babies at their backs to give them ease while engaging in other activities. In a situation where the mother has to carry water, which has been collected from an infected water source, there is a possibility of infecting the child as water drips onto the child. Most of the inhabitants of schistosomiasis endemic areas are fisher folk and sometimes take their children to the waterbody. The water, serving as an occupational hazard, could get into contact with skin of children, thereby increasing risk of infection among children. All these water- contact activities, though mostly passive and unintentional, directly expose children to the risk of

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contracting the disease (Bosompem *et al*., 2004; Mduluza & Mutapi, 2017; Osakunor *et al*., 2018; Osakunor *et al*., 2018).

There is therefore the need to obtain prevalence of schistosomiasis in children under six years who could eventually grow up with higher complications such hepatosplenomegaly, liver fibrosis, renal cancers and intestinal complications among others in order to treat them (Mduluza & Mutapi, 2017; Osakunor, Mduluza, *et al*., 2018; Osakunor, Woolhouse, *et al.*, 2018). There is also the need to know the risk factors associated with prevalence of schistosomiasis in children below six years. The knowledge and understanding of these risk factors particular to the under six age bracket is important in enlightening us on measures to put in place in controlling and preventing the disease in their cases.

1.5. Objectives of Study

1.5.1. Main Objective

To determine the prevalence of schistosomiasis in children under six years in communities along the Weija Lake.

1.5.2. Specific objectives

1. To determine the prevalence of *Schistosoma haematobium* infection in children under six years.
2. To estimate the prevalence of *Schistosoma mansoni* infection in children under six years.
3. To determine whether there are mixed infections of *Schistosoma* parasites in the children.
4. To assess the determinants or risk factors associated with *Schistosoma* infections in children.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Schistosomiasis

Schistosomiasis is one of the 17 neglected tropical diseases (NTDs) identified by the World Health Organisation (WHO) to be of global and public health concern (Njenga *et al.*, 2014). The disease was formerly known as bilharziasis or snail fever (Mutapi, 2015), and runs up only to malaria as important parasitic disease (Atalabi *et al*., 2016). It is primarily found in Africa, Asia and Latin America (Colley *et al.*, 2014) where it is widespread among peri-urban and rural settings characterized with poverty and poor sanitary conditions (Hotez *et al*., 2007) in areas along fresh waterbodies. As any NTD, schistosomiasis has prolonged and disfiguring conditions and has high disease burden with significantly high clinical and socio-economic effects (Hotez *et al*., 2007; Olamiju, Olamiju, Adeniran, Mba, & Ukwunna, 2014). The Platyhelminthes are known to parasitize vertebrates, typically birds and mammals, serving as their definite host while they complete another part of their lifecycle in aquatic or amphibious snails as their intermediate host. Its causative parasite of genus *Schistosoma* is of the family Schistosomatidae, which belongs to the order Digenea. The genus contains about 19 species of which six (6) are of primary public health importance to man (Colley *et al*., 2014; Gryseels *et al.*, 2006). The human schistosome parasites include *Schistosoma haematobium* (*S. haematobium*), *S. mansoni*, *S. japonicum*, *S. mekongi*, *S. intercalatum*, and *S. guineensis* (Gryseels *et al*., 2006), differing in pathology, final site in host, number, shape and size of eggs produced, among others (IARC, 1993, 2012). Aside the *S. haematobium*, which settles in the venous plexus of the bladder, thereby causing urogenital schistosomiasis, the rest cause intestinal schistosomiasis, as they reside in the mesenteric vesicles (Kali, 2015; Tuffour *et al*., 2017). In Africa however, are three main human *Schistosoma* species,

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which are prevalent. These include *S. haematobium, S. mansoni and S. intercalatum* (Njenga *et al*., 2014) among which, *S. haematobium* and *S. mansoni* are most prevalent in Ghana (Bosompem *et al.*, 2004).

2.2 Epidemiology of the Disease

About 800 million people in the world are at risk of contracting schistosomiasis with greater than 200 million people already having the disease (Nyati-Jokomo & Chimbari, 2017). Out of these, Africa happens to house approximately 85% (Mose *et al*., 2013) and over (Yirenya-Tawiah *et al*., 2016) of the infected populace. Among the various types of *Schistosoma* that affect humans, it has been observed that *S. mansoni* and *S. haematobium* are most prevalent in Ghana (Bosompem *et al*., 2004). According to statistics, about 17.1 million people in Ghana were identified to be at risk of being infected while 12.4 million people infected as at 2000 (Chitsulo, Engels, Montresor, & Savioli, 2000). Most of these people were found around the southern and central Ghana. As of 2010, national prevalence was at 70.9% (Rollinson *et al.*, 2013) with *S. haematobium* endemic in all regions while *S. mansoni* was higher in the two upper regions (Sokolow, 2015; Zhang, Harvim, & Georgescu, 2017). Global distribution maps however, indicate an overlap of these prevalent species of *Schistosoma* inferring that there is co-endemicity in these areas (Ismail, Kamal, & Salem, 2016).

2.3 Biology of the Schistosome

Schistosome worms, unlike other trematodes, tend to be dioecious or bisexual; contrasting the other forms which most often than not are hermaphroditic (IARC, 2012; Loker & Brant, 2006; Southgate, Rollinson, Ross, & Knowles, 1982; Webster, Diaw, Seye, Webster, & Rollinson, 2013).

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They also exhibit dimorphism (Abonie, 2013). Schistosomes again, contrasting other trematodes, have two hosts in order to complete their lifecycle; while the others tend to have a three- host lifecycle (Abonie, 2013; Loker & Brant, 2006). The female, which has an observably longer and thinner body compared to that of the male, is held in the groove also known as the gynaecophoric channel, located on the male's ventral side (Abonie, 2013). The Schistosome adult couple live within the perivesical (S. *haematobium*) or mesenteric (other species) venous plexus permanently together as attached in the groove of the male, where they mate. Through the process of anaerobic glycolysis, the schistosome worms are able to feed on blood particles in the definite host (IARC, 2012).

2.4. Lifecycle of the Schistosome

Disease transmission occurs when an infected host urinates or egests faeces containing schistosome eggs into freshwater bodies, contaminating them (Colley *et al*., 2014; Gryseels *et al*., 2006). These eggs hatch upon contact with water, releasing miracidia. The miracidia are inclined to actively swim and can be active for about 8- 12 hours until they locate a suitable intermediate host, guided by stimuli and light. The miracidal stage is the first (1st) larval stage of the schistosome parasite. The miracidia, upon reaching their suitable snail intermediate host species penetrate them, and then transformed into mother sporocysts. In approximately 16 days, multiple multicellular sporocysts are produced through asexual reproduction. They are then transformed into cercarial larvae, and released into the freshwater environment. Cercarial shedding is triggered by illumination (by either sunlight or artificial light) and mainly occurs during the day, being most efficient around the hours of 10 am to 12 pm. It takes the cercaria about 4-6 weeks to be shed from the snail, post infection, and a maximum 72 hours to remain active and spin in their natural

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environment in search of its appropriate definite host (Akuetteh, 2016; Gryseels *et al*., 2006). The cercaria is the infective stage of the schistosome parasites, which possess embryonic suckers. This is accompanied by bifurcated tails for active and intermittent locomotion in their environment, for effective host encounter. Presence of fatty acids as well as proteases secreted influence cercaria in successful host penetration. The cercariae, on finding a host, penetrate the skin moving into a venule with tail breaking off. After penetration, cercarial head develops into schistosomula, which involves remodelling of the surface membrane to make it double layered and water intolerant. It takes 4-7 days post cercarial infection for the somula to move into the lungs where it resides for about two days before moving into the liver. By the 10th - 11th day, worms, although not sexually mature, become morphologically distinguishable by their sexes. They therefore pair up (male and female) and move to either the mesenteric or the perivesicular vein (depending on the species), on which they attach and live (Colley *et al*., 2014; Gryseels *et al*., 2006). When sexually mature they mate and can produce up to 600 billion eggs, which is highly dependent on species and location, an adult worm can live an average of 5 years however there have been instances where they lived up to thirty years. The disease is however mainly caused by the trapping of the eggs released, which has its spine causing inflammations to the vessels (Gryseels *et al*., 2006).

2.5. Risk factors associated with *Schistosoma* infection

Schistosomiasis transmission occurs in areas found to generally have dams and irrigation sites associated with the waterbody. In addition to this, transmission tends to be location-specific and may include age, occupation, water contact practices, nearness to water, socioeconomic status, and distance to safe and unsafe water sources (Kosinski *et al*., 2012). However, among these risk factors, age and sex tend to be most common. Children, especially schoolchildren between ages

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of 10 to 15 are known to be at highest risks due to their high rates of water activity. These children are more prone to swimming, fetching water and being involved in various house chores that require the use of water (Agnew-Blais *et al*., 2010). In the study by Agnew-Blais *et al*., male gender and both pre-adolescence and adolescence were socio- demographic factors, that affect schistosomiasis (Agnew-Blais *et al*., 2010). Age and sex risk factors could account for higher morbidity is higher in children as they have more contact with water (Primarily through recreational water contact such as swimming and fetching of water among other household chores, which adults hardly do) (Kosinski *et al*., 2012). In addition, though males may have higher chances of infection, it is likely to be most affected by behavioural differences (Kosinski *et al*., 2012; M'Bra *et al*., 2018). However, infections in children under six, most especially infants are less likely to be associated with sex compared to the older siblings as may have equal risk of being taken to water sites with their caregivers. Hence the risk may be centred on their "being taken" to the water sites (Coulibaly, Gbesso, Guessan, & Winkler, 2013; Dabo *et al*., 2011). A caregiver's record of schistosomiasis might also expose children under six, if they tend to go to the water site with them (Sady *et al*., 2013). Their source of water such as drinking water could also increase or decrease likelihood for infection in children under six (Sady *et al*., 2013). The likelihood of infection was higher for children who had father's occupation as a fisher (Geleta, Alemu, Getie, Mekonnen, & Erko, 2015), as well as children below ages of six whose parents allowed them play around and in water bodies (Ekpo *et al.*, 2012).

2.6. Forms of Schistosomes and Pathogenesis

The type of schistosomiasis, being either intestinal or urogenital schistosomiasis is based on the disease or pathological condition presented by schistosome parasites. It also factors in, the position

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and presence of eggs, as well as the tissues these eggs are found in (Abonie, 2013; CDC, 2019). *Schistosoma haematobium* is the parasite responsible for transmitting urogenital schistosomiasis and is identified by its characteristic symptom haematuria. The presence of blood in urine is often due to the presence of spined eggs clogging the perivesical venous plexus, causing the veins to burst, and allowing entry of blood into the urinary bladder. Haematuria is usually accompanied by other localized inflammatory conditions in host that result in extreme tissue damage in and beyond the urinary tract. Such inflammations could lead to dysuria, lesions on cervix and vagina, bleeding and nodules in the vagina, disease affecting seminal vesicles, prostate and even lead to infertility in both sexes (Abonie, 2013; Colley *et al*., 2014; Gryseels *et al*., 2006). Intestinal schistosomiasis is evident when blood is observed in stool because of egg-clogged mesenteric veins burst in the intestinal / abdominal region of the host's body. In addition to the aforementioned, stool is usually loose and accompanied by abdominal pains. All other human schistosomes with the exception of *S. haematobium* are responsible for the disease condition. Intestinal schistosomiasis in its prolonged state could lead to hepatosplenomegaly among others (Abonie, 2013).

Chronic schistosomiasis in general could result in complications in both adults and children alike. Among such complications found for adults, include prostrate, cervical, bladder and other forms of death- causing cancer, hydronephrosis, liver cirrhosis, renal and reproductive disorders, suppression of immune system to accommodate diseases such as HIV (Human Immunodeficiency) and AIDS (Acquired Immune Deficiency Syndrome)(Ndhlovu *et al.*, 2007). It could also result in conditions such as malnutrition, poor and stunted growth, low mental development, iron deficiency anaemia and reduced school performance are evident in schistosomiasis-infected children.

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2.7 Treatment of Schistosomiasis

Praziquantel (PZQ), formerly known as Biltricide, is the choice drug for the treatment of the disease schistosomiasis. PZQ is deemed an important drug, as it finds itself on the WHO List of Essential Medicines and was the first de-wormer to be used in Mass Drug Administrations to combat not only schistosomiasis, but also other parasitic infections (WHO, 2002). Praziquantel is a pyrazino-isoquinoline taken as a single dose and is derivative, which kills all known *Schistosoma* parasites with definite host as man. Studies done reveals that its mode of action is against the tegument of the adult worm, in that, upon reaction, drug tends to destroy adult worm tegument. This tegument when destroyed minimizes the worm's immune system, making it weak. The host's immune system working synergistically with the worm is able to damage the muscles thereby contracting it, which is also possible by the influx of calcium into the worm. Not only does PZQ kill the adult worm, but also reverses the pathological process associated with the disease. This also speeds up the acquisition of a stronger immune system against schistosome worms, reducing the probability of re-infection (King, Muchiri, Ouma, & Koech, 1991; Mutapi, 2015).

The dosage for administering the drug is 40mg/kg (Ross *et al*., 2017) after being measured using the PZQ dose pole (Olliaro, Vaillant, Hayes, Montresor, & Chitsulo, 2013). The drug's side effects includes making its consumers feel nausea, vomit and have high temperature, and mainly based on drug's bitter taste and infection intensity. Praziquantel is however known to be affordable, about $0.10 (Stothard *et al*., 2014), which is equivalent to about 40 pesewas or less in Ghana, effective and in high prevalence areas is quite accessible. Despite these, it is less accessible is in some areas and not available to certain populations in dire need of the drug (Ross *et al*., 2017). Although PZQ is believed not lead to disease elimination in schistosomiasis despite the high global expectation

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of the availability of the drug (Ross *et al*., 2017), it will help reduce the incidence of the disease, most especially if children under six years are included in the treatment.

2.8 Schistosomiasis in Children under Age Six

There have been various efforts put in place to reduce the burden of schistosomiasis globally. Africa has been a beneficiary of these programmes among which the mass drug administration (MDA) programme is a part. This programme as recommended by the World Health Organization, has targeted school-aged children in the treatment of the disease (Ndhlovu *et al*., 2007). A switch has therefore been suggested from disease control to complete disease eradication, as revised by the Sustainable Development Goal 3. Preventive chemotherapy, the main control strategy for the elimination has not yielded complete results as far as schistosomiasis eradication is concerned. One particular lapse that has been realised in the treatment of the disease aside the treatment of animal sources and snail (intermediate host eradication) is the neglecting of out-of-school children, and predominantly, pre-school children below six years (Mduluza & Mutapi, 2017). In Ghana for instance, little work has been done on this age bracket, in comparison to that of school-aged children. An example of such is the work done by Bosompem *et al*., on infant schistosomiasis in Ghana (Bosompem *et al*., 2004). This delays early detection and prevents whole population coverage mainly in endemic areas. One core cause for the neglect being the lack of enough evidence pointing to the need for the treatment of *Schistosoma* parasites in children below six years of age (Mduluza & Mutapi, 2017). The lack of assurance for age-specific safety and efficacy also plays an important role in the neglect of these children. Contrary to the belief that these children have, if any, a very low risk of contracting the disease, due to their non-participation in expository activities, passive and unintentional events expose them to *Schistosoma* infections (Bosompem *et*

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al., 2004; Mduluza & Mutapi, 2017). A child at one in high prevalence areas, by his first year completed, would have already been infected with schistosomiasis (Woolhouse, Mutapi, Ndhlovu , Chandiwana & Hagan, 2000; Osakunor, Woolhouse, & Mutapi, 2018) and would have infection intensity increasing as he also increases in years (Wami *et al.,* 2014; Osakunor *et al.*, 2018). Such passive activities involve being bathed with contaminated water fetched home by parents and older sibling or playing with water while adult is working or water accidentally spilling on children while being carried by an adult. Therefore, although exposure becomes less passive and apparent as children grow older, the risk of contracting the disease is present throughout the ages. There is also evidence to prove the existence of these infections with research done over the years in some African countries. These countries include as Mali, Kenya , Uganda Cote D'Ivoire, Nigeria and Zimbabwe (Mduluza & Mutapi, 2017). Per WHO's recommendation for treatment of these children through preventive chemotherapy which has been deemed safe and effective, there is the need to gradually integrate treatment of children below six years into the Mass Drug Administration programme worldwide. Despite the challenges involved in administering the drug to these young children due to its difficulty in breaking for correct dosage and its difficulty to dissolve, not to mention its bitter taste, it is a necessary evil as administering the drug will help treat the disease and prevent further complications in disease morbidity (Mduluza & Mutapi, 2017). Research done in epidemiology infers that *Schistosoma* infections, which mostly occurs in the early years (Bosompem *et al*., 2004), have implications later in life if left untreated (Osakunor *et al*., 2018). Most of these early schistosomiasis induced complications in these children begin with common symptoms such as fever, body irritations and swellings, headaches, abdominal pains, loss of appetite and reduced food intake. (Osakunor *et al*., 2018). However if not treated these

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could result in anaemia, poor academic performance, poor growth physically and mentally and could even lead to death (Osakunor *et al*., 2018)

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CHAPTER THREE

METHODS

3.1 Study Design

This study was a quantitative analytic cross-sectional study aimed at determining the prevalence of *Schistosoma mansoni* and *Schistosoma haematobium* in children below six years in Tomefa and Manheam. This involved the use of a structured questionnaire to collect data on demographic characteristics and other risk factors. The study procedure included laboratory analysis of stool and urine samples obtained from study participants as well. This study was carried out between June 2019 and July 2019.

3.2 Study Sites

The study was carried out in the Ga South Municipality, specifically in Tomefa and Manheam, both located along the Weija Lake in Greater Accra. Tomefa is a suburb in the Domeabra-Obom constituency situated in the 17 km west of Accra in the Greater Accra region, with GPS coordinates N 05.57379˚ and W 000.37714˚ while Manheam however is situated in the Ngleshie Amanfro-Bortianor Constituency with GPS coordinates, 5º32’31.2’’N 0º23’52.4’’W, and both in the Ga South Municipal Assembly.

Both communities in the coastal savannah zones are known to be endemic areas for schistosomiasis (Aryeetey *et al.*, 2000; Lodh *et al.*, 2017, 2014; Tuffour *et al.*, 2017). The Weija Lake being a dammed lake provides favourable conditions for the transmission of schistosomiasis and characterized by aquatic plants such as *Ceratophyllum demersum, Pistia stratiotes* and *Nymphaea odorata*. In addition, the lake houses *Bulinus* sp. and *Biomphalaria* sp. snails that serves as vectors for the disease.

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These communities are mainly characterized by mud and cement houses roofed with aluminium sheets without internal toilet facilities. The occupants of this community are generally fisher folk, petty traders and of migrant fishers from other parts of the country. The water body serves as source of water for domestic, recreational and occupational purposes. It therefore acts as a *Schistosoma* infection site.

Tomefa and Manheam are known to have high prevalence and intensity of schistosome infection in school-aged children. These communities have been part of the Mass Drug Administrations (MDAs) for school children of ages 6 years and above (Lodh *et al*., 2014), and therefore were selected for the study.

My study participants thence involved children between six months and six years.

3.3 Study Population

The study population included children under six in Tomefa and Manheam. These children were those whose parent gave consent and children, their cooperation.

3.3.1. Inclusion criteria

Any child between 6 months of age and six years found in Tomefa and Manheam, whose parent gave consent and allows the collection of the samples from ward.

3.3.2. Exclusion criteria

Any child below the age of six months, and those aged six years and above. Children below six years whose parent refused to give consent even after explanation.

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3.4 Sample Size Determination

To determine the prevalence of schistosomiasis in children aged below 6years in Ga South Municipality, the sample size was estimated using a predetermined prevalence of 11.2% (Bosompem *et al.*, 2004), a 95% confidence level and $\pm$ 5% allowable margin of error. Assuming a non–response rate of 10%, a minimum sample size of 165 was estimated using the Cochran's formula below (Ahmad & Halim, 2017):

$$n=\frac{(Z^2)P(1-P)}{e^2} \qquad n=\frac{(1.96^2)0.11(1-0.11)}{0.05^2}$$

n= 150+ 10% (150)

n= 165

However, 186 was used since 165 was the minimum size required to power the study and nothing above due to resource constraints.

Where n = sample size, e= allowable margin of error, Z= Z- statistics for the level of confidence and P = expected prevalence.

3.5 Data Collection Procedure and Tools

A pre-tested questionnaire and direct observation were used to determine the factors influencing schistosomiasis transmission.

Parasitological protocol was also pre-tested in General Parasitology Laboratory in Noguchi Memorial Institute for Medical Research before use.

3.5.1 Sampling design

Stratified sampling was used in the two communities, Tomefa and Manheam. Both communities were divided into two strata, as they were both peri-urban communities found around the Weija

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Lake and with people from relatively distant and proximal places using the water body. A distant community and a lakeside community was thence derived from each. In each stratum however, convenient sampling was used. This was because of the difficulty in obtaining children under six due to parent's resistance based on previous researches and MDAs as well as younger ages and limited time involved for this research.

3.6 Quality Control

To ensure uniformity and collection of data with accuracy and of good quality, a standardized protocol was followed. Questionnaires were numbered and completeness ensured before they were administered.

Research assistants were trained on all data collection methods. For additional quality control, 10% of the Kato-Katz thick smears and urine slides were re-examined by a senior technician in the Parasitology Department, NMIMR. Checklists were used for consistency and correctness by the Principal Investigator, and crosschecked in the Parasitology Department of NMIMR. Data were managed, validated, and double cross checked to detect inconsistencies in Microsoft Excel and exported to Stata for analysis.

3.7 Variables

3.7.1 Dependent variable or Outcome variable:

Prevalence of schistosomiasis and Schistosoma infection characterized by presence or absence of schistosomal eggs in samples

3.7.2 Independent variables or Explanatory variables

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Demographic, socioeconomic, environmental and behavioural factors contributing to the prevalence of the disease

- Demographic factors such as age at last birthday, sex were included in the study.
- Socioeconomic factors were identified and included the level of education, occupation of household head and recreational activities.
- Environmental factors were measured by using presence of the intermediate hosts in their water bodies, availability of toilet facility in the home and around the home, presence of potable water, cleanliness of environment.
- Behavioural factors included personal hygiene, practice of indiscriminate urination near or in water bodies, open defecation near source of water, swimming in the water body, boiling water before use, use of health centre for schistosomiasis treatment.

3.8 Data Collection tools

Two quantitative methods were used

3.8.1. Questionnaire

A pre-tested structured questionnaire was designed to collect data on the demographic, socio-economic, environmental and behavioural factors, including clinical signs and symptoms of urinary or intestinal schistosomiasis and history of receiving anti-schistosomal treatment. Data collected included age, gender, date of birth, use of toilets, frequenting water body with children under six years, among others. Information was collected from the recruited children's parents or adult guardians using the questionnaire. This was done after the objective of the study had been explained to them and they had signed the of consent form.

In addition to this, the community was directly observed in order to record more details about their personal hygiene and sanitation as well as water contact behaviours.

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3.8.2. Parasitological and urine chemistry methods

Stool and urine samples were collected from the children in dry, water- tight, sanitary plastic sealable containers (Lodh *et al.*, 2014; Sady *et al*., 2013). These containers were labelled with their age, sex, date, time and a unique identification code for each participant.

About 20 ml of urine and parent's thumb size of stool from the children were taken with the help of parents or caregivers at home. Samples were then kept in a cool box/ ice chest at 4°C for transportation to the laboratory (lab) for microscopic examination (Bowie, Purcell, Shaba, Makaula, & Perez, 2004). This maintained the integrity of eggs before arriving at the lab.

Urine filtration and dipstick method were used for examining urine while Kato-Katz were used for the stool.

Remaining samples was stored in favourable conditions (-20°C and below) for about five years. Permission would however be sought from a reputable ethics committee before using samples or any related information in the future. Positive (+) or negative (-) was recorded for presence and absence of schistosomes in the samples.

3.8.2.1. Stool examination

Kato-Katz Technique

Prior to examination, pre-cut cellophane tape, which are hydrophilic, were soaked into 10% glycerol - malachite green solution and microscope glass slides were labelled with IDs, ages and date of collection.

For each sample, a gram of stool was transferred to a non-leaking (pergamyn) paper using a wooden depressor. The stool was then sieved through a nylon screen (fine mesh) to give a finer concentrate. This concentrate was then used in filling up the hole in the template with a microscope slide placed beneath. The concentrated stool was levelled to remove excesses. The template was

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then removed carefully vertically and a pre-soaked cellophane piece placed on sieved stool. This was inverted, and then compressed, to spread the filtered stool evenly (Barbosa, Gomes, Marcelino, Cavalcante, & Nascimento, 2017; Katz, Chaves, & Pellegrino, 1972; World Health Organisation, 2019a). The microscope slide was put on the rack after the preparation process. This methodology for stool was applied to all the stool samples after which it was observed under the compound microscope for examination.

3.8.2.2. Urine examination

The urine analysis was done using the filtration technique and the urine test strip (dipstick).

Urinalysis reagent test strip (Dipstick) method

Reagent strip was first dipped into each urine sample (one dipstick to one sample collected), for about two seconds. It was then removed and placed on a clean flat surface, after which it was read. The strip was compared to reference printed on the box or container it came in. Important information such as presence of glucose in urine, urine acidity (pH levels), urine concentration (specific gravity), haematuria (blood in the urine), bilirubin (possible liver disease or red blood cell breakdown) and urobilinogen (possible liver disease or etodolac medication) were obtained from this reading. Readings began after 30 seconds and were completed by the 2nd minute. Positive samples were scored and deduced according to strip colours and parameters (Memişoğulları, Yüksel, Yıldırım, & Yavuz, 2010; World Health Organisation, 2019b).

Filtration technique

About 10 ml of each urine sample was drawn into a syringe after homogenization. The syringe was then attached to a Swinnex filtering chamber and filtered through a 12µm pore 25mm diameter Millipore membrane to trap schistosome eggs. Using a pair of forceps, the membrane was then cautiously detached from the chamber and positioned on a microscope slide. The side on which

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eggs was trapped was place such that it was in contact with the slide surface for microscopic examination (Senghor *et al*., 2014).

3.8.2.3 Microscopic examination

For the microscopic examinations, each microscope slide was examined in a systematic zigzag pattern and recorded in a lab datashe*et al*ong with viewed characteristics and sample number for statistical analysis.

3.8.3.0. Data Management

Presence or absence of the eggs was coded as 1 or 0 and these were recorded for both Kato- Katz and urine analyses. Data was entered and summarized in Microsoft Excel Spreadsheet and SPSS.

3.8.3.1 Prevalence

Prevalence of infection based upon samples examined was calculated using the formula below.

$$Prevalence = \frac{Presence\ of\ schistosome\ eggs}{(Presence + Absence)\ of\ schistosome\ eggs} \times 100\ \ in\ samples\ received.$$

3.8.3.1 Intensity

Faecal eggs counts is a measure of the number of eggs found in the stool of the individual. It gives an estimation of the intensity of the disease in the host. Intensity of disease in this study was defined as the number of faecal egg counts in the stool multiplied by 24 per gram and its units as EPG (Eggs per gram). This is given in the formula below.

$$Intensity = \ number\ of\ faecal\ eggs\ counted\ \times\ 24\ per\ gram.$$

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3.8.4 Statistical Analyses

Stata version IC 15.1 was used as the statistical tool to analyse data. Data was summarized using frequencies and cross-tabulations of descriptive statistics. Chi square test was used to examine the significance of the associations and differences in frequency distribution of variables while multiple logistic regression (multivariate) analysis were used to identify the factors significantly associated with schistosomiasis. Invalid and missing data was not used in analysis. All analyses were two-tailed and set at 5% level of significance.

3.8.5. Ethical Considerations

Ethical approval was sought from the Noguchi Memorial Institute for Medical Research-Institutional Review Committee. Before the study began, a community entry was undertaken, to introduce the research team, to thank the community for allowing us entry and to seek their support. During this entry, the team's purpose was explained for clarity. After this, guardians and caregivers were made fully conversant of the objective of the study. Subsequently, the guardians and caregivers were given an informed consent form to sign for their children, after its content has been translated to them in local dialect. Only preschool children whose guardians and caregivers signed (or fingerprinted) the consent sheet were allowed participation in the study. The study objective was thereafter explained to older preschool children in order to make them understand and enhance their cooperation.

There were minimum risks associated. The information of participants was however kept confidential and participants remained anonymous. The information was kept under lock and key with access limited to the principal researcher only. In addition, computed data will be protected by password. Volunteers were admitted and allowed to drop out without any threat. There was no

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compensation or incentives whatsoever given to participant instead, the study inform policy to reduce, if not help completely eradicate paediatric schistosomiasis.

The principal researcher has no conflict of interest regarding this study.

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CHAPTER FOUR

RESULTS

4.1. General characteristics of study participants

A total of 186 children (107 from Tomefa and 79 from Manheam) comprising 45.2% females and 54.8% males with ages ranging from six months to five years (mean age of 2.83 ± 1.37 years) were recruited in the study. However, in the course of the study, one participant did not complete the questionnaire given. This resulted in the some discrepancies in the data.

Out of 127 samples (68.3%) obtained from the two communities, 61.4% of the samples were from children in Tomefa and 38.6% from Manheam. Almost half (48.1%) of the children who presented samples in Tomefa had parents who either lived or worked near the lakeside in the community. However, only 13 (26%) of these parents worked or lived along the lake in Manheam.

Again all 3 (100%) unemployed fathers was from Tomefa (Table 4.2).

Tomefa lakeside community engaged more in the various activities such as fishing, swimming, fetching of water and washing compared to the other sites. Meanwhile, Manheam lakeside had the least engagements (Table 4.2).

The lakeside communities used more of the water from the lake than any other source. The use of pipe water was generally higher in Manheam when compared to Tomefa. Generally, however, those closer to the lake lacked pipe borne water (Table 4.3).

Most of those whose sibling had schistosomiasis were from the lakeside communities. However, more mothers from Manheam had history of *Schistosoma* infection while more fathers from Tomefa had history of *Schistosoma* infection (Table 4.4).

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Among behavioural characteristics, Tomefa lakeside, though had the most number of participants with toilets at home (Table 4.3), defecated and urinated in the bush (Table 4.5). The largest percentage of those who urinated or defecated in the bush were from Manheam lakeside. Majority of the participants neither boiled nor decanted their water, with 90% of those from Manheam Lakeside being the highest.

Table 4.1-4.5 describes the socio-demographics and behavioural characteristics of the whole study population showing their distribution in Manheam and Tomefa and their distribution compared between their lakeside and mainland.

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Table 4. 1: Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics (Variables)	Tomefa		Manheam		P-value
	Lakeside community	Mainland community	Lakeside community	Mainland community	
Demographic characteristics	Number (%)	Number (%)	Number (%)	Number (%)	
Age					
≤2	17 (32.08)	21 (38.89)	9 (47.37)	30 (50.00)	0.246
>2	36 (67.92)	33 (61.11)	10 (52.63)	30 (50.00)	
Sex					
Male	34 (64.15)	29 (53.70)	15 (78.95)	24 (40.00)	0.009*
Female	19 (35.85)	25 (46.30)	4 (21.05)	36 (60.00)	
Nearness of home to water					
Near	13 (24.53)	45 (84.91)	7 (36.84)	33 (55.00)	<0.001*
Far	40 (75.47)	8 (15.09)	12 (63.16)	27 (45.00)	
Knowledge of disease in area					
No idea	17 (32.08)	28 (52.83)	9 (47.37)	30 (50.00)	
Heard	21 (39.21)	18 (33.96)	10 (52.63)	27 (45.00)	0.004*
Know	15 (28.30)	7 (13.21)	0 (0.00)	3 (5.00)	

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Table 4. 2: Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics (Variables)	**Tomefa**		**Manheam**		**P-value**
Socioeconomic	**Lakeside community**	**Mainland community**	**Lakeside community**	**Mainland community**	
Occupation of father					
Farmer	1 (1.89)	0 (0.00)	0 (0.00)	2 (3.33)	
Fisher	39 (73.58)	1 (1.89)	5 (26.32)	9 (15.00)	
Trader	0 (0.00)	6 (11.32)	4 (21.05)	11 (18.33)	<0.001*
Unemployed	0 (0.00)	3 (5.66)	0 (0.00)	0 (0.00)	
Other	13 (24.53)	43 (81.13)	10 (52.63)	38 (63.33)	
Fetching					
Yes	48 (90.57)	12 (22.64)	2 (10.53)	15 (25.00)	<0.001*
No	5 (9.43)	41 (77.36)	17 (89.47)	45 (75.00)	
Washing					
Yes	41 (77.36)	7 (13.21)	12 (63.16)	10 (16.67)	<0.001*
No	12 (22.64)	46 (86.79)	7 (36.84)	50 (83.33)	
Swimming					
Yes	15 (28.30)	0 (0.00)	3 (15.79)	1 (1.67)	<0.001*
No	38 (71.70)	53 (100.00)	16 (84.21)	59 (98.67)	
Fishing					<0.001*
Yes	27 (50.94)	1 (1.89)	0 (0.00)	8 (13.33)	
No	26 (49.06)	52 (98.11)	19 (100.00)	52 (86.67)	
Farming					
Yes	0 (0.00)	4 (7.55)	0 (0.00)	3 (5.00)	0.162
No	53 (100.00)	49 (93.81)	19 (100.00)	57 (98.00)	
Easing one's self					
Yes	2 (3.77)	0 (00.00)	0 (0.00)	1 (1.67)	0.436
No	51 (96.23)	53 (100.00)	19 (100.00)	59 (98.33)	

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Table 4. 2: Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics (Variables)	**Tomefa**		**Manheam**		**P-value**
Socioeconomic	**Lakeside community**	**Mainland community**	**Lakeside community**	**Mainland community**	
Others					
Yes	4(7.55)	3 (5.66)	5 (26.32)	14 (23.33)	0.009*
No	49 (92.45	50 (94.34)	14 (73.68)	46 (76.67)	
General water activity					
Yes	51 (96.23)	14 (26.42)	12 (63.84)	16 (26.67)	<0.001*
No	2 (3.77)	39 (73.58)	7 (36.84)	44 (73.33)	
Use of lake as primary water source					
Yes	36 (67.92)	13 (24.53)	9 (47.37)	13 (21.67)	<0.001*
No	17 (32.08)	40 (76.99)	10 (52.63)	47 (78.33)	
Use of pipe borne water as primary source					
Yes	4 (7.55)	11 (20.75)	4 (21.05)	27 (45.00)	<0.001*
No	49 (92.45)	42 (79.25)	49 (78.95)	33 (55.00)	
Toilet in house					
Yes	15 (28.30)	31 (58.49)	9 (47.37)	15 (25.00)	0.001*
No	38 (71.70)	22 (41.51)	10 (52.63)	45 (75.00)	

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Table 4. 3: Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics	**Tomefa**		**Manheam**		**P-value**
	Lakeside community	**Mainland community**	**Lakeside community**	**Mainland community**	
History					
Mother had schistosomiasis					
Yes	9 (16.98)	7 (13.21)	6 (31.58)	12 (20.00)	0.344
No	44 (83.02)	46 (86.79)	13 (68.42)	48 (80.00)	
Father had schistosomiasis					
Yes	6 (11.32)	6 (11.32)	3 (15.79)	3 (5.00)	0.453
No	47 (88.68)	47 (88.68)	16 (84.21)	57 (95.00)	
Siblings had schistosomiasis					
Yes	12 (22.64)	2 (3.77)	4 (21.05)	7 (11.67)	0.027*
No	41 (77.36)	51 (96.23)	15 (78.95)	53 (88.33)	

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Table 4. 4: Baseline behavioural characteristics relating to the different zones in the two study sites.

Baseline characteristics	**Tomefa**		**Manheam**		**P-value**
Behavioural	**Lakeside community**	**Mainland community**	**Lakeside community**	**Mainland community**	
Urinate or Defecate in bush					
Yes	27 (50.94)	16 (30.19)	3 (15.79)	6 (10.00)	<0.001*
No	26 (49.06)	37 (69.81)	16 (84.21)	54 (90.00)	
Boil water					
Yes	4 (7.55)	11 (20.75)	7 (36.84)	6 (10.00)	0.008*
No	49 (92.45)	42 (79.25)	12 (63.16)	54 (90.00)	
Decant water					
Yes	23 (43.40)	8 (15.09)	5 (26.32)	6 (10.00)	<0.001*
No	30 (56.60)	45 (84.91)	14 (73.68)	54 (90.00)	
Use immediately					
Yes	23 (43.40)	26 (49.06)	5 (26.32)	39 (65.00)	0.003*
No	30 (56.60)	27 (50.94)	14 (73.68)	21 (35.00)	
Take child along to waterbody					
Yes	30 (56.60)	13 (24.53)	11 (57.89)	15 (25.00)	<0.001*
No	23 (43.40)	40 (75.47)	8 (42.11)	45 (75.00)	
Allow child to play in or around waterbody					
Yes	3 (5.66)	30 (56.60)	8 (42.11)	8 (13.33)	<0.001*
No	50 (94.34)	23 (43.40)	11 (57.89)	52 (86.67)	
Bath child in waterbody					
Yes	16 (30.19)	3 (5.66)	7 (36.84)	4 (6.67)	<0.001*
No	37 (69.81)	50 (94.34)	12 (63.16)	56 (93.33)	
Urinate or Defecate in water					
Yes	12 (22.64)	1 (1.89)	6 (31.58)	6 (10.00)	0.022*
No	41(77.36)	52 (98.11)	13 (68.42)	54 (90.00)	

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4.1.1 Knowledge about schistosomiasis

The study assessed knowledge about schistosomiasis among inhabitants of these communities by asking questions relating to symptoms, mode of transmission, vector, and indicators visible by the naked eye in the environment, prevention, treatment, and effects. Parents' overall knowledge was scored. Every right answer scored as one (1). Wrong answers were subtracted from the score to give an overall score of maximum 17. These were then categorised as shown into low, moderate and high knowledge (Table 2.0). Only 6 parents (3.2%) of the participants demonstrated "high knowledge" of the disease. These were all from Tomefa. Meanwhile, 33% of the parents had "moderate knowledge" of schistosomiasis with 54.10% from Tomefa and the remaining 45.9% from Manheam. The study detected "low knowledge" in 118 (63.8%) of the parent population with 67 from Tomefa and 51 (43.2%), Manheam (Table 2.1.).

Upon assessment of the knowledge on symptoms of the disease, the highest number of parents (76.2%) selected blood in urine or stool was while a minimum of 7 (3.8%) chose skin lesions in both sites (Table 2.0).

While approximately 15.1% of the parents knew no way of preventing the disease, 10.8% expressed knowledge in only one method of prevention. About 74.2% of parents knew more than one way of preventing the disease as shown in Table 3.2 and 3.3. Meanwhile, an average of 35.1% of 185 parents knew about visible indicators of schistosomiasis in the environment. The difference between graded knowledge and sites was not statistically significant (p = 4.74; p = 0.093) (Appendix; Table 1.1). Knowledge of disease in the area and the graded knowledge, however, had a significant association. (x^2= 12.4; p = 0.015).

Table 4. 5. Knowledge about schistosomiasis

Categorization for grade	Grade given	Frequency (N)	Percentage (%)
0-9	Low	6	3.24
10-14	Moderate	61	32.98
15-17	High	118	63.78

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Table 4. 6 Parents' knowledge about symptoms of schistosomiasis

Symptom (n=185)	Frequency (N)	Percentage (%)
Dysuria	66	35.68
Skin irritation/ lesion	7	3.78
Haematuria and blood in urine	141	76.22
Diarrhoea and abdominal pain	27	14.59
Frequent head ache	15	8.16
Skin lesions	7	3.78

Table 4. 7 Parents' knowledge in methods for preventing schistosomiasis.

Number of prevention	Frequency (N)	Percentage (%)
0	28	15.14
1	20	25.95
2	34	18.38
3	37	20.00
4	42	22.70
5	24	12.97

Table 4. 8 Parents' knowledge on ways of preventing schistosomiasis.

Method of Prevention	Frequency (N)	Percentage%
Bathing with treated water	66	35.68
Stop urinating defecating into water bodies	36	19.46
Boiling water before use	138	74.59
Reducing contact with contaminated water	91	49.19
Dressing appropriately covering exposed body part with water resistant clothing	36	19.46

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4.2. Prevalence of schistosome infections in children under six.

A total of 10 children out of the 127 children were positive for schistosome infections when screened by urine filtration for *S. haematobium* and Kato Katz for *S. mansoni*. These yielded a prevalence of 7.9% in both study sites. In total, there was no mixed infection present in the samples received.

The total prevalence for S. *haematobium* was less than one percent (that is, 0.9%) for 109 urine samples received from both sites. This sample was collected in Tomefa and yielded a 1.4% prevalence from 70 samples (Table 4.10). Manheam, on the other hand, had no positives samples for urine for both dipstick and microscope from all 39 urine samples presented (Table 4.10). The dipstick method yielded a 0% prevalence for both sites (Table 4.10).

There was no significant association found between *S. haematobium* and the study sites ($p = 0.453$) as well as different zones in these sites, that is the lakeside community and the mainland ($p = 0.240$).

S. mansoni recorded a total of 9.2% for the 97 stool samples as the prevalence for both sites. The Kato Katz technique yielded 10.5% prevalence of *S. mansoni* out of 57 samples received from Tomefa, while the 40 stool samples collected in Manheam yielded a 7.5% prevalence. The difference between prevalence found in the two sites was not statistically significant ($p= 0.613$).

The 20% prevalence obtained from the 50 samples collected from both sites, Tomefa and Manheam, yielded an average of 7.7% ($p <0.001$). All the 10 positive samples realised in the study came from the lakeside community.

Although 80% of the infected children were above two years of age, there was no statistical difference between the prevalence of the infection and their age ranges ($p = 0.209$).

4.2.1 Other findings

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Besides Schistosome species, this study recorded 8 *Taenia* positive samples. These had a minimum of a faecal egg count (1) which makes 24 EPG and a maximum of about 228 eggs per gram (EPG), which is equivalent to 10 faecal egg counts of *Taenia* eggs in the stool samples (Table 4.11). The ratio of males to females with *Taenia* eggs was 3:1, with the least age of 2 years while the oldest was 4. In terms of distribution, Tomefa, specifically the lakeside community had the most numerous number of children infected while their mainland had the least (Table 4.12).

Table 4. 9 Distribution of *Schistosoma* parasites from urine and stool samples in specific zones in the two communities using various parasitological techniques

Parasitological technique	Total Frequency (Percentage)	Tomefa		Manheam	
		Mainland	Lakeside	Mainland	Lakeside
	N (%)	N (%)	N (%)	N (%)	N (%)
Urine filtration technique					
Presence	1 (0.92)	0 (0.00)	1 (3.03)	0 (0.00)	0 (0.00)
Absence	108 (99.08)	37 (100.00)	32 (96.97)	26 (100.00)	13 (100.00)
Urine Strip Analysis (Dipstick)					
Presence	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Absence	109 (100.00)	37 (100.00)	33 (100.00)	26 (100.00)	13 (100.00)
Kato-Katz technique					
Presence	9 (9.28)	0 (0.00)	6 (27.27)	0 (92.86)	9 (75.00)
Absence	88 (90.72)	35 (100.00)	16 (72.73)	28 (7.14)	3 (25.00)

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Table 4. 10: Estimated intensity of *Taenia* eggs in stool samples

Average Number *Taenia sp.* egg counts	**Frequency N**	**Percentage (%)**	**Eggs per gram (EPG)**
1	2	2.06	24
2	2	2.06	48
3	1	1.03	72
4	1	1.03	96
4.5	1	1.03	108
9.5	1	1.03	228

Table 4. 11: Distribution of *Taenia* sp. in specific zones in community sites.

Taenia sp.	**Total Frequency (Percentage) N (%)**	**Tomefa Mainland N (%)**	**Tomefa Lakeside N (%)**	**Manheam Mainland N (%)**	**Manheam Lakeside N (%)**
Presence	8 (8.25)	0 (0.00)	5 (22.73)	2 (7.14)	1 (8.33)
Absence	89 (91.75)	35 (100.00)	17 (73.68)	26 (92.86)	11 (91.67)

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4.3. Hygiene and Sanitation Practices at Study Sites

Observation of both study sites revealed poor hygiene and sanitation practices. There was no proper disposal of rubbish and drainage system, as well as low access to safe water. Besides, there were few infected snails found at the lakeside.

Both communities lacked proper drainage systems. Their gutters were choked with rubbish and filth, resulting in the stagnant water found in them. Often, inhabitants poured children's excreta and other waste materials into the drains. As such, rains carried waste into the water bodies during heavy downpours. The water bodies in both communities contained plastic waste and overgrown plants. This provided a suitable environment for the intermediate hosts, Bulinus and Biomphalaria snails to attach. In Manheam, rubbish bins were filled to the brim and spilled over, as authorised institutions failed to collect waste on time. Fishmongers and fishermen also poured back the waste generated from their activities into the water body.

Most people in both communities used shared latrines, mostly without flush-systems. In Tomefa, lack of commissioned public toilets enhanced open defecation comparatively.

Access to safe water was relatively low. Most individuals utilized the lake as their primary source of water. Only a few people had access to pipe-borne water, borehole in the area.

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4.4. Determinants of Schistosomiasis

Univariate analysis in Table 4.14. revealed that the fathers who worked as fishers and traders had a higher likelihood of having their children infected; the likelihood being about eight (8) times higher for fathers who were fishers (95% CI= 1.66-43.12; p = 0.010) compared to the other occupations. Similarly, parents who swam washed or fished in the two study sites had children with higher likelihood of infection compared to those who only fetched water, farmed or had any other activity by the water body.

Children below years six whose siblings had been previously diagnosed with the disease showed strong association with the prevalence of the disease, as they were eight times more likely to have an infection compared to those whose sibling had no history (95%CI=2.04-31.39; p=0.003) (Table 4.15).

Among the behavioural characteristics, parents or guardians who take children along to waterbody, allow them to play or bathe them in waterbody were likely to have their children host the parasites. There was therefore strong association between the prevalence and these risk factors (Table 4.16).

Aside the different zones and the nearness of home or work place to the water body, none of the demographic characteristics showed any association with the prevalence of the *Schistosoma* infections. However, the odds of infection were zero (0). This depicts a strong negative association with an infinite likelihood (Table 4.13).

About 7.78% of parent who lived near restricted their ward from playing in or around the waterbody in contrast to the 57.45% in further areas of the lakeside (x^2=21.71; $p < 0.001$). Children who lived farther were five times more likely to play in or around water bodies when compared to those who lived nearer (95%CI = 2.53, 11.10; $p \leq 0.001$). There was also a three times likelihood of parents

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living far from the water body, taking their children along in comparison to those who live near (95% CI= 1.61, 5.55; p = 0.001) (Table 4.16).

Table 4. 12: Univariate analysis of demographic factors associated with *Schistosoma* infection

Baseline characteristics (Variables)	***Schistosoma* infections**		**Crude 0R (95%CI)**	
Demographic	**Prevalence N (%)**	**P-value**		**P-value**
Different zones of community in site				
Lakeside community	10 (100.00)	<0.001*	0	<0.001*
Mainland community	0 (0.00)			
Sex of child				
Male	5 (50.00)	0.735		
Female	5 (50.00)			
Site				
Tomefa community	7 (70.00)	0.561		
Manheam community	3 (30.00)			
Nearness of home to water				
Near	0 (0.00)	<0.001*	0	<0.001*
Far	10 (100.00)			
Knowledge of disease in area				
No idea	5 (50.00)	0.946		
Heard	4 (40.00)			
Know	1 (10.00)			

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Table 4. 13: Univariate analysis of socioeconomic factors associated with *Schistosoma* infection

Baseline characteristics (Variables) Socioeconomic	**Prevalence N (%)**	**P-value**	**Crude 0R (95%CI)**	**P-value**
Occupation of father			8.44 (1.66, 43.12)	0.010*
Fisher	7 (70.00)	0.047*		
Trader	1 (10.00)		2.69 (0.22, 31.90)	0.432
Unemployed	0 (0.00)		1	
Other	2 (20.00)		1	
Fetching				
Yes	6 (60.00)	0.202		
No	4 (40.00)			
Washing				
Yes	8 (80.00)	0.004*	7.70 (1.56, 37.98)	0.012*
No	2 (20.00)		1	
Swimming				
Yes	4 (40.00)	0.001*	9.08 (2.12, 38.90)	0.003*
No	6 (60.00)		1	
Fishing				
Yes	5 (50.00)	0.016*	4.57 (1.21, 17.22)	0.025*
No	5 (50.00)		1	
Farming				
Yes	0 (0.00)	0.552		
No	10 (100.00)			
Others		0.693		
Yes	1 (10.00)			
No	9 (90.00)			
General water activity				
Yes	8 (80.00)	0.051		
No	2 (20.00)			
Use of lake as primary water source				
Yes	6 (60.00)	0.079		
No	4 (10.00)			
Use of pipe borne water as primary source		0.335		
Yes	2 (20.00)			
No	8 (80.00)			

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Table 4. 14: Univariate analysis of clinical history as factors associated with *Schistosoma* infection

Baseline characteristics (Variables) **History**	**Prevalence** **N (%)**	**P-value**	**Crude 0R (95%CI)**	**P-value**
Siblings had schistosomiasis				
Yes	5 (50%)	0.001*	8 (2.04-31.39)	0.003*
No	5 (50%)		1	

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Table 4. 55: Univariate analysis of behavioural factors associated with *Schistosoma* infection

Baseline characteristics (Variables)	Prevalence		Crude 0R (95%CI)	
Behavioural characteristerics	**N (%)**	**P-value**		**P-value**
Urinate or Defecate in bush				
Yes	5 (50.00)	0.071		
No	5 (50.00)			
Use water without treatment				
Yes	1 (10.00)	0.009*	0.10 (0.01, 0.80)	0.030*
No	9 (90.00)		1	
Take child along to waterbody				
Yes	8 (80.00)	0.005*	7.41 (1.50, 36.55)	0.014*
No	2 (20.00)		1	
Allow child to play in or around waterbody				
Yes	6 (60.00)	0.013*	4.77 (1.26, 18.11)	0.022*
No	4 (40.00)		1	
Bath child in waterbody				
Yes	4 (40.00)	0.015*	4.90 (1.23, 19.55)	0.024*
No	6 (60)		1	
Decant water				
Yes	6 (60.00)	0.013*	4.77 (1.25, 18.11)	0.022*
No	4 (40.00)		1	

p-values with * = statistically significant using Pearson's chi square test

*OR= Odds Ratio

CI= Confidence Interval

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Table 4.17 below shows the multivariate analysis of the factors associated with schistosome infections in children under six. None of the factors, except the different zones of community sites and nearness of home to water was retained after the multivariate logistic regression analysis of the remaining variables from the univariate analysis, as their p-values were all not significantly associated. However, likelihood of prevalence in the different zones of community sites and nearness of home to water was zero; thereby depicting a strong negative association with an infinite odds. When the two factors, different zones in study sites and nearness to water were removed from the model however, children with siblings with record of schistosomiasis was the only strongly associated risk factor (95% CI=1.60, 129.85; p =0.017).

Table 4. 66 : Multivariate analysis of the factors associated with schistosome infections in children under six.

Characteristics	Odds Ratio (OR)	(95%CI)	P-value
Occupation of father			
Fisher	0.78	0.35, 21.73	0.396
Washing	5.14	0.41, 64.38	0.458
Swimming	0.069	0.20, 21.71	0.138
Fishing	3.96	0.34, 46.35	0.273
Decant water	3.53	0.48, 25.85	0.214
Use water immediately without treatment	3.79	0.01, 4.05	0.264
Take child along to waterbody	3.86	0.32, 47.00	0.289
Allow child to play in or around waterbody	0.18	0.02, 1.99	0.163
Bath child in waterbody	6.25	0.11, 10.54	0.105
Siblings had schistosomiasis	4.08	0.11, 23.03	0.111

CI= Confidence Interval

4.5.0. Strip test urinalysis

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From the strip test analysis, there was no micro-haematuria positive in all urine samples. Despite this, 53 urine samples (48.6%) had traces as well as positives of proteinuria. When proteinuria was compared in the sites (p= 0.540) and with the child's age (p = 0.587) and sex (p = 0.678), the differences were not statistically significant. Although few samples, 26 (23.9%) had amber colouration, none of these was macro-haematuria sample. There was, therefore, no positive for haematuria. Nitrite and leukocytes had positives, with "moderate leukocytes" (leukocytes with 3+) being on the increase in the children (45.9%). Though the difference between the high number of children with positive nitrite values and their site (65 out of 109) were not significant, levels of leukocytes showed significant association within the sites (p = 0.04). Below are the parameters compared across the different sites and their zones (Appendix VII; Table 3.0).

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CHAPTER FIVE

DISCUSSION

Schistosomiasis is still a neglected tropical disease causing high morbidities and despite the many interventions to control the disease (Hotez, Biritwum, & Fenwick, 2019), priority is only given to school-aged children and adults (Ekpo, Oluwole, Abe, & Etta, 2012; Mduluza & Mutapi, 2017; Mutapi, 2015). Studies show about 70 million schistosomiasis-infected people have developed dysuria with this complication. It also records 18 million people with bladder-wall infection, 10 million with severe hydronephrosis, sometimes cases of non- functional kidneys 8.5 million people with hepatomegaly and about 150,000 dying per year (Ekpo *et al*., 2012). Haematemesis, pulmonary hypertension and urethral fibrosis, sandy patches in the bladder mucosa and bladder cancer are also likely to occur in later stages of the disease (Sady *et al*., 2013). This does not rule out the incidence of malnutrition, retardation in both mental and physical development, cerebral cancers, Female Genital Schistosomiasis, haematospermia, orchitis, prostatitis, dyspareunia, and oligospermia and increased susceptibility to HIV when chronic (Colley *et al*., 2014; World Health Organisation, 2019c; World Health Organization, 2018). In Ghana, schistosomiasis control policies often do not include children aged under six years, who actually live with siblings and relatives above six years of age (Osakunor *et al.,* 2018). Determination of prevalence and determinants of schistosomiasis in children under the age of six, especially in endemic communities is critical to establish their vulnerability to infections. Furthermore, Ghana is considered a high schistosomiasis endemic region (Abonie, 2013; Aryeetey *et al*., 2000; Ismail, Kamal, & Salem, 2016; Sokolow, 2015).

There was a response rate of 68.3% from parents who consented to enrol their children in the study. Here, despite the fact that 186 parents enrolled in the study and filled questionnaires, only 127 brought samples and sample containers back. This was because parents took their children with them to the

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market and/or workplaces very early, and returned too late which made it impossible for them to provide stool and urine of their children. Also during the time for the collection of samples, some children refused to defecate hence the withdrawal. For very small children especially those between 7- 36 months, they urinated before their parents realised. In addition to this, the refusal of spouses and children's fear of medication and vaccinations led to the decision to drop out. Some parents also refused to enrol their children under six in the study for the following reasons; that previous researchers failed to communicate findings of screening among children to their parents and guardians, and several parents complained about the side effects of the drug, that is, Praziquantel administration, in their children. Parents and community members complained of high rates of vomiting, dizziness, and children becoming very sick and unwell after the intake of drugs during MDAs, particularly Praziquantel. This could have led to participation bias, which could affect the prevalence obtained in this study.

The overall prevalence of 7.9% was lower than a previous study in Ghana, which reported prevalence of 11.2% by microscopy (Bosompem *et al*., 2004; Osakunor *et al*., 2018). In Ghana, one important intervention policy is the Mass Drug Administration (Praziquantel/ deworming) to school-going children and adults as well, some improvement in sanitation and provision of potable water (Nyarko et al., 2018), thereby consequently reducing transmission and suitability of water for survival of the primary hosts of the *Schistosoma* sp., *Bulinus* sp. *and Biomphalaria* sp.. There is also improvement in education and sensitization about the disease in endemic communities. Microscopy or the strip test analysis could fail to detect infection with low levels of egg infection (Coulibaly *et al*., 2013). The detection of positives using the strip test analysis was lower as it could not detect the one sample positive by microscopy after filtration. This could be because the filtration technique afforded a more

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concentrated surface while the strip could not pick up any blood. Also, 31.7% of the participants dropped out of the study, it is possible that the urine of such people could have been picked up by the strip to increase prevalence by micro-haematuria. Another factor that could have resulted in the low prevalence rate was the reduction or scarcity of snail intermediate host along the banks of dam as water levels rise.

Questionnaire survey on determinants of *Schistosoma* infections revealed that, despite the 60% difference in the prevalence of diseases among children two years of age below and above ages of two, there was no association with the factors. However, the difference in prevalence could have been due to the more active nature of children above two accompanied by lower supervision. Age categorization was chosen on the basis that children began independent walking around age two (Kaymaz *et al*., 2015).

Children whose parent lived or work nearer in the river community had a higher prevalence compared to those away in the mainland. Among the inhabitants of the river community however, those nearer to the waterbody had comparatively low prevalence. This could be due to longer exposure hours in those living farther away. Mothers' or older siblings for want to finish chores requiring the use of water might stay near the water bodies for a longer time affording children a longer playtime and hence longer exposure time playing with or in the water (Ekpo *et al.*, 2012). In addition to this, parents further away from waterbody might not want to, to large extent be concerned about restrict their children from going to the water body to play as sensitization might be made to people in the parts of the community closer to the waterbody. This is evident as in the results, while only 12 parents allowed reported that their kids played at either at the bank or in the river, about 42% could not restrict them ($x2=21.71$; $p < 0.001$). A five time's likelihood of a child playing at the waterbody site was realise in children living in the further part of the main community. Hence, a higher likelihood of

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infection (Coulibaly *et al*., 2013; Ekpo *et al.*, 2012). This can be related as twice as many parents who live away from the water also take their children along when going to the water body to those who live near.

For those who lived in the mainland, the prevalence was relatively low, as distance did not permit them. However, a few still went to wash their clothes (15.1%) as well as buy fish (15.0%) from the lakeside. Again, those in the mainland mostly found other sources such as pipe-borne water (60.8%), which was only available to those who lived in the mainland in Manheam, which could minimize the prevalence. Those in Tomefa were still exposed as tankers (34.0%) sometimes fetched water from the Weija Lake (19.8%) and occasionally pipe-borne (14.2%) for their use. This indicates the lack or scarcity of safe water for their use, which could promote diseases like trachoma, scabies and some intestinal tract diseases.

Fathers' occupation was found to have a significant association with the prevalence of the disease. Fishing among all the occupations had the highest prevalence of infection compared to the rest of the occupations. Parent's activities including washing, fishing, bathing, and swimming in the water body also increased their wards' likelihood to infection hence having a strong association with the disease (Woldegerima, Bayih, Tegegne, Aemero, & Zeleke, 2019).

From the results of this study, parent's behaviour generally increased the odds of a child being infected with the schistosomal parasites. Behavioural characteristics of parents such as the use of water without treatment, mainly not decanting it, taking the children to the waterbody and allowing

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them to play in the water body and bathing them in the waterbody also increased their odds of being infected as seen in Table 4.16.

Based on the results of the study, while in the multinomial logistic regression model, only different zones in community and nearness to the water body were retained. When removed, however, none other showed an association with the prevalence.

The odds of zero, for both different zones and nearness, suggests a strong negative association between prevalence and living farther to the water body as well as prevalence and living in the lakeside community. Living or working at the further part of the lakeside community consequently predisposes children to infection.

Environmental factors such as poor hygiene and sanitation promote the spread of the disease. This not only enhances the proliferation of the snail host but also continues the cycle of transmission by the re-introduction of Schistosome eggs when faeces are washed into the water body by rains. The examinations also resulted in the diagnosis of *Taenia* eggs in some *Schistosoma*-negative children found along the lakeside. Not only does the presence of *Taenia* confirm the availability of faecal matter, but also, the presence of other pathogens in the water. These could have several health implications on the inhabitants upon consumption.

Although knowledge of disease is area as well as grade has no effect on the prevalence of disease, it could help inform the people and affect their health seeking behaviour to help reduce the prevalence of the disease.

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5.1.0. Study limitation

The duration for the study was limited; this prevented the total collection of samples for the work, as parents were busy. In addition due to time constraints, samples could not be obtained from all persons from 10 am to 2 pm though egg output are highest during that time of the day. This was due to their busy schedule of going to work and older kids around ages of four and five going to school around seven. In addition, some children who did not defecate during the study period were exempted. Some of the children were been treated, by a similar running project, as well as during post-natal care (weighing) by use of other anti-helminthic drugs.

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CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1. CONCLUSION

This study reveals that children under the ages of six are prone to *Schistosoma mansoni* and *S. haematobium* infections. These, if undetected in early ages could eventually lead to more severe forms of schistosomiasis. These children may tend to be a source of transmission in the communities if left untreated.

Though the prevalence of both *S. mansoni* and *S. haematobium* were determined, no mixed infections was detected in the children involved in this study.

Nearness to water and different zones of the community were the main determinants in Schistosomiasis in children under six in Tomefa and Manheam. Factors such as siblings' medical history, swimming, bathing, and fishing are only associated with the prevalence of schistosomiasis.

Schistosoma infections in children under six in Tomefa and Manheam are important and hence proper measures must be taken to further reduce the prevalence in these communities.

6.2 RECOMMENDATIONS

Based on the findings of this study,

- It is recommended that children under six years of age are included in Mass Drug Administration in the country. This will consequently reduce disease prevalence and transmission. In addition, a child suitable formulation of PZQ should be prepared for these children under six years to enhance their participation in the MDA.
- Further work could also be done by using more sensitive methods such as serology and molecular methods such as PCR to detect the schistosome DNA in the stool or urine samples.

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- A comparative study could also be done to compare the prevalence of the children under five with those above and measure the effectiveness after drug administrations.
- Safe water should be introduced Manheam and Tomefa to reduce disease incidence and transmission. As schistosomiasis are considered a water-based disease, provision of safe water such as borehole, public standpipe and protected spring water will breach complete their lifecycle and consequently reduce disease transmission in these areas.
- Fisher folk should be encouraged to wear protective clothing such as wellington booths to protect themselves during contact with water. Disease symptoms should be reported to the clinics to reduce high morbidities associated with schistosomiasis.
- Children should be kept under the scrutiny of an older person to reduce transmission in them.
- Community-owned or participatory projects and communal clean-up exercises should be organised sanitation and personal hygiene. The government can also use law enforces such as tax forces to instil fear in the people as well as other forms of appeals to curb the situation.
- Improved toilet facilities should be built to reduce disease transmission in these areas. Programmes like “One toilet per home", "No toilet, no wife" or Reduced sales or "Pay half the price to own a toilet", usually organised by NGOs should be introduced.
- Education and advocacy, using either grass-root advocacy or media should be used to sensitize the inhabitant on the various ways of preventing, treating and avoiding the spread of schistosomiasis in the communities.
- Drains should be properly constructed and desilted occasionally in these two communities. This will not only reduce the rate of spread of schistosomiasis but other helminths and pathogens transmitted oro-faecally.

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APPENDICES

APPENDIX I: Ethical Clearance Letter

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL

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8th May, 2019

ETHICAL CLEARANCE

FEDERALWIDE ASSURANCE FWA 00001824 **IRB 00001276**

NMIMR-IRB CPN 065/18-19 **IORG 0000908**

On 8th May, 2019, the Noguchi Memorial Institute for Medical Research (NMIMR) Institutional Review Board (IRB) at a full board meeting reviewed and approved your protocol titled:

TITLE OF PROTOCOL : **Determinants and Prevalence of *Schistosoma* Infections in Children Under Six Years in Two Endemic Communities along the Weija lake**

PRINCIPAL INVESTIGATOR : **Ivy Ewurakua Lengoi Bentil, MPH Cand.**

Please note that a final review report must be submitted to the Board at the completion of the study. Your research records may be audited at any time during or after the implementation.

Any modification of this research project must be submitted to the IRB for review and approval prior to implementation.

Please report all serious adverse events related to this study to NMIMR-IRB within seven days verbally ar fourteen days in writing.

This certificate is valid till 7th May, 2020. You are to submit annual reports for continuing review.

Signature of Chair: ....
Mrs. Chris Dadzie
(NMIMR – IRB, Chair)

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APPENDIX II: Ga South Municipal Area- Acceptance Letter

GA SOUTH MUNICIPAL ASSEMBLY

NGLESHIE AMANFRO

In case of any reply, the number and date of the letter should be quoted

P. O. Box WJ 305, Ngleshie Amanfro
Ghana Post GPS Code: GS0163-6020
Tel: 0302908466 / 0302908467
Email: info@gsma.gov.gh
Website: www.gsma.gov.gh
Dunkonaa Avenue, Opp. Ayigbe Town Junction

My Ref: GSMA/EHS/7/33/12

Your Ref: ....

21ST March 2019

ACCEPTANCE LETTER TO CONDUCT A RESEARCH WITHIN THE GA SOUTH MUNICIPAL ASSEMBLY

We refer to the letter dated 1st March, 2019 requesting a research to be done within the Ga South Municipal Assembly on "**Determinants and Prevalence if Schistosoma Infections in Children under Six Years in Two Endemic Communities along the Weija Lake**".

The Ga South Municipal Assembly invites **Ivy Ewurakua Lengoi Bentil (10463890)** from the Department of Biological, Environmental and Occupational Health from the University of Ghana, Legon to conduct her research on the above subject.

Counting on your cooperation and understanding.

EMMANUEL BAISIE
MUNICIPAL CO-ORDINATING DIRECTOR
FOR: MUNICIPAL CHIEF EXECUTIVE

PROF. JULIUS FOBIL
HEAD OF DEPARTMENT
DEPT. OF BIOLOGICAL, ENVIRONMENTAL AND OCCUPATIONAL HEALTH
UNIVERSITY OF GHANA

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APPENDIX III: Consent Form

NMIMR-IRB PARENTAL CONSENT FORM

Title: **Determinants and Prevalence of *Schistosoma* Infection in Children under Six Years in Two Endemic Communities along the Weija Lake.**

Principal Investigator: Ivy Ewurakua Lengoi Bentil

Address: Department of Biological, Environmental and Occupational Health Sciences
School Of Public Health
P.O. Box LG 13
University Of Ghana
Legon

General Information about Research

This study aims to estimate the number of children below the ages of six who will test positive for schistosomiasis. We would also want to know the actual situations that causes the disease and how the children are infected with the disease in this community. The research work is expected to be conducted between May and July 2019, all things being equal. It would require a maximum of a week of your time.

Upon agreeing to participate, you agree to give us the faecal samples and urine of your ward/ children, faecal samples (about a parent's thumb size) and urine (about 5-10 tablespoonful/ as marked on the containers) of your ward. You (the parent / guardian) would also be agreeing to fill a questionnaire. This could be collected between 10am and 2pm and will be examined under the microscope for results.

Possible Risks and Discomforts

This is a minimum risk study. You are free to provide us with the stool/ faeces and urine of your wards. There will therefore be no harm to you and your ward.

Possible Benefits

You will not benefit directly from this study. However, you will be advised seek to medical care if results are positive. In addition, recommendations will be made to the Ghana Health Service to include children under six in the Mass Drug Administration

Confidentiality

We will protect your information as much as we can. Your ward's information will be kept confidential and child will not be named in any reports. No one, apart from those included in the

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research, will be able to know how you responded to the questions and your information will be anonymous.

Compensation
You will not be compensated for participation in this study.

Voluntary Participation and Right to Leave the Research
Participation in this study is voluntary and you can withdraw at anytime.
Storage and Usage
I would like to store and re-use your samples for future studies.
Do you agree? Yes / No.
If agreed upon, samples left and questionnaires after this study will be stored in favourable conditions and archived under lock and key respectively, for a maximum of five years after which they will be properly disposed of.
Ethical clearance, however, will be sought from an ethics committee before using your information and ward's samples in the future.

Contacts for Additional Information
You may ask us any questions about this study. You can call us at any time on mobile telephone numbers
Ivy Bentil 0267024585/ Dr. William Anyan 0268012634 or talk to us the next time you see us for answers to pertinent questions about the research.

Your Child's Rights as a Participant
This research has been reviewed and approved by the Noguchi Memorial Institute for Medical Research Institutional Review Board (NMIMR-IRB). If you have any questions about your child's rights as a research participant you can contact the IRB Office between the hours of 8am-5pm through the landline 0302916438 or email addresses: nirb@noguchi.ug.edu.gh

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APPENDIX IV: Volunteer Agreement Form

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title ***(Determinants and prevalence of Schistosoma infection in children under six years in two endemic communities along the Weija Lake)*** has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree that my child should participate as a volunteer.

________________________ ____

Date Name and signature or mark of parent or guardian

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the child's parent or guardian. All questions were answered and the child's parent has agreed that his or her child should take part in the research.

________________________ ____

Date Name and signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

________________________ ____

Date Name Signature of Person Who Obtained Consent

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APPENDIX V: Questionnaire

Questionnaire

Greetings. My name is …………………………………. I am a member of a team from the School of Public Health in the University of Ghana. We are currently conducting a study on *Schistosoma* infections in children under six in Tomefa and Manheam in the Ga South Municipality of Greater Accra Region of Ghana.

Upon agreeing to take part in this research work, you will be given a questionnaire to fill correctly. In addition to this, you are agreeing to give urine and faecal samples of your ward under six years of age to us.

All your supplied information will be kept confidential. This information will be kept anonymous and no one will know which answer you provided except members of this team.

Please note: **NO ANSWER IS WRONG.**

Your participation in the study is voluntary and you are free to end the interview or measurement process at any time. However, I will be happy if you participate in the study to contribute in discovering the prevalence of schistosomiasis in children under five and risk factors that led to infection.

Questionnaire number: …………………………………………………………….…...

Name of interviewer: ………………………………………………………….….…...

Name of interviewee: ……………………………………………………………….

Date: ………………………………………………………...…...........................

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Questionnaire

SOCIO-DEMOGRAPHIC CHARACTERISTICS

(Please fill in the blank space & tick one option where suitable)

1. Child Code ………………………………………………………………
2. Date of administering questionnaire ……………………………………………………
3. Age of parent / guardian ……………………………………………………………..
4. Age of child ………………………………………………………………
5. Date of birth of child - ……………………………………………………………..
6. Sex of child [1] Male [2] Female
7. Tribe ………………………………………………………………
8. Religion ………………………………………………………………
9. Mother, level of education:

   [1] No formal education [2] Primary [3] Secondary/technical [4] Tertiary

   [5] Other: specify …………………………………………..

10. Father, level of education

    [1] No formal education [2] Primary [3] Secondary/technical [4] Tertiary

    [5] Other: specify …………………………………………..

11. Occupation of father

    [1] Student [2] Farmer [3] Fisher [4] Trader [5] Unemployed [6] Other

12. Occupation of mother

    [1]Student [2] Farmer [3] Fishmonger [4] Trader [5] Unemployed [6] Other

13. Length of stay in the community:

    [1] <1 [2] 1-2 [3] 2-5 [4] 5-10 [5] >10

14. Nearness to water body

    [1] Very far (>1km) [2] Far (750m-1km) [3] Not too far (500m-750m)

    [4]Near (200m-500m) [5] Very near (100m-200m)

15. Knowledge of disease in the area;

    [1] No idea [2] Heard [3] Know

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HISTORY (Please one (1) option with Yes and No answers)

16. Has mother ever had schistosomiasis/ bilharzia?

    [1] Yes [2] No

17. Has father ever had schistosomiasis/ bilharzia?

    [1] Yes [2] No

18. Has siblings had schistosomiasis / bilharzia before/ now

    [1] Yes [2] No

19. Has mother had treatment of Schistosomiasis/ bilharzia?

    [1]Yes [2] No

20. Is child still breastfeeding?

    [1]Yes [2] No

BEHAVIOURAL CHARACTERISTICS (Please tick more than one option where suitable)

21. Water Contact activity: how do you get into contact with water.

    [1] Fetching water [2] Washing [3] Swimming [4] Fishing

    [5] Farming [6] Easing one's self [7] Other ……………………………………………

    [0] No contact

22. Do you take ward along when going to waterbody

    [1]Yes [2] No

23. Do you bath your ward in the water body

    [1]Yes [2] No

24. Do you allow your ward(s) to play with or in the water.

    [1]Yes [2] No

25. Source of water for household chores

    [1] Waterbody [2] Well [3] Bore-hole [4] Pipe borne

26. Do you boil the water from the lake before use

    [1] Yes [2] No

27. How do you treat your water?

    [1] Filter [2] Boil [3] leaving to settle and pouring out [4] Using immediately

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28. Do you have a toilet in your house

    [1]Yes [2] No

29. Do you have a toilet at workplace

    [1] Yes [2] No

30. Do you have a toilet in the community

    [1] Yes [2] No

31. Do you use it?

    [1] Yes [2] No

32. Do you defecate in the nearby bush

    [1] Yes [2] No

33. Do you defecate or urinate into the waterbody?

    [1] Yes [2] No

34. If yes how often

    [1] Once [2] Every time [3] Often [4] Sometimes [5] Rarely

GENERAL KNOWLEDGE ABOUT SCHISTOSOMIASIS (BILHARZIA)

(Please tick more than one option where suitable)

35. Symptoms; What sign do you think are related to bilharzia/ schistosomiasis?

    [1] Severe heartburn and constipation [2] Painful urination [3] Nausea

    [4] Hair loss and broken limbs [5] Lesions on skin [6] Blood in urine or stool

    [7] Pimples [8] Diarrhoea and abdominal pain; [9] Frequent headache and fever

    [10] Frequent urination

36. Mode of transmission: how do you get schistosomiasis/ bilharzia

    [1] Insect bite [2] Upon contact with infected water [3] Oro-faecal

    [4] By contact with infected person

37. Vector : what do you thinks transmits / spread the disease?

    [1] Plants in water [2] Snail intermediate host in water [3] Insect host [4] Fish

38. Indicators visible by naked eye in environment

    [1] Water lilies [2] Snail host [3] Miracidia [4] Adult worm [5] Cercaria

39. Prevention: What can be done to stop spreading the disease (bilharzia)?

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[1] Bathing with contaminated water [2] Bathing with treated water

[3] Stop urinating defecating into water bodies [4] Boiling water before use

[5] Reducing contact with contaminated water

[6] Dressing appropriately covering exposed body part with water resistant clothing

40. Treatment: What can cure bilharzia?

[1] Taking painkiller [2] Visiting the clinic [3] Staying at home

[4] Going to a faith healer/ Praying

41. Effects : What does the disease result in?

[1] Shows you are a man/ woman [2] Children become dull at school

[3] Makes children malnourished as they cannot eat properly

[4] Could lead to cancer (especially prostate and cervical cancer)

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APPENDIX VI: Tables Demonstrating Distribution Of Baseline Characteristics

Table 1.1.: Distribution of Baseline characteristics relating to Tomefa and Manheam *communities.*

Baseline characteristics (Variables) **Demographic characteristics**	Tomefa community Number (%)	Manheam community Number (%)	P-value
Age			
≤2	38 (35.51)	39 (49.37)	0.058
>2	69 (64.49)	40 (50.63)	
Sex			
Male	63 (58.88)	39 (49.37)	0.198
Female	44 (41.12)	40 (50.63)	
Different zones of community in site			
Lakeside community	53 (49.53)	19 (24.05)	<0.001
Distant community	54 (50.47)	60 (575.95)	
Nearness of home to water			
Near	58 (54.72)	40 (50.63)	0.582
Far	48 (45.28)	39 (49.37)	
Knowledge of disease in area			
No idea	45 (42.45)	39 (49.37)	0.004
Heard	39 (36.76)	37 (46.84)	
Know	22 (20.75)	3 (3.80)	

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Table 1.2.: Distribution of socioeconomic characteristics in Tomefa and Manheam communities.

Socioeconomic characteristics	Tomefa Number (%)	Manheam Number (%)	P-value
Occupation of father			
Farmer	1 (0.94)	2 (2.53)	
Fisher	40 (37.74)	14 (17.72)	
Trader	6 (5.66)	15 (18.99)	0.002
Unemployed	3 (2.83)	0 (0.00)	
Other	56 (52.83)	48 (60.76)	
Fetching			
Yes	60 (56.60)	17 (21.52)	<0.001
No	46 (43.40)	62 (78.48)	
Washing			
Yes	48 (45.28)	22 (27.85)	0.016
No	58 (54.72)	57 (72.15)	
Swimming			
Yes	15 (14.15)	4 (5.06)	0.044
No	91 (85.85)	75 (94.94)	
Fishing			
Yes	28 (26.42)	8 (10.13)	0.006
No	78 (73.58)	71 (89.87)	
Farming			
Yes	4 (3.77)	3 (3.80)	0.993
No	102 (96.23)	76 (96.20)	
Easing one's self			
Yes	2 (1.89)	1 (1.27)	0.741
No	104 (98.11)	78 (98.73)	
Others			
Yes	7 (6.60)	19 (24.05)	0.001
No	99 (93.40)	60 (75.95)	

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Table 1.2.: Distribution of socioeconomic characteristics in Tomefa and Manheam communities.

Socioeconomic characteristics	Tomefa Number (%)	Manheam Number (%)	P-value
General water activity			
Yes	65 (61.32)	28 (35.44)	<0.001
No	41 (38.68)	51 (64.56)	
Use of lake as primary water source			
Yes	49 (46.23)	22 (27.85)	0.011
No	57 (53.77)	55 (72.15)	
Use of pipe borne water as primary source			
Yes	15 (14.15)	48 (60.76)	<0.001
No	91 (85.85)	31 (39.24)	
Toilet in house			
Yes	46 (43.40)	24(30.38)	0.071
No	60 (56.60)	55 (69.62)	

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Table 1.3: Distribution of clinical schistosomiasis history relating to Tomefa and Manheam communities.

Baseline characteristics (Variables)	Tomefa community Number (%)	Manheam community Number (%)	P-value
History			
Mother had schistosomiasis			
Yes	16 (15.09)	18 (22.78)	0.41
No	90 (84.91)	61 (77.22)	
Father had schistosomiasis			
Yes	12 (11.32)	6 (7.59)	0.398
No	94 (88.68)	73 (92.41)	
Siblings had schistosomiasis			
Yes	14 (13.21)	11(13.92)	0.888
No	92 (86.79)	68 (86.08)	

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Table 1.4.: Distribution of Baseline characteristics relating to Tomefa and Manheam communities.

Baseline characteristics (Variables) Behavioural characteristics	Tomefa community Number (%)	Manheam community Number (%)	P-value
Urinate or Defecate in bush			
Yes	43 (40.57)	9 (11.39)	<0.001
No	63 (59.43)	70 (88.61)	
Boil water			
Yes	15 (14.15)	13 (16.46)	0.665
No	91 (85.85)	66 (83.54)	
Decant water			
Yes	31 (29.25)	11 (13.92)	0.014
No	75 (70.75)	68 (13.92)	
Use immediately			
Yes	49 (46.23)	44 (55.70)	0.213
No	57 (53.77)	35 (44.30)	
Take child along to waterbody			
Yes	43 (40.57)	26 (32.91)	0.287
No	63 (59.43)	53 (67.09)	
Allow child to play in or around waterbody			
Yes	33 (68.87)	16 (20.25)	0.097
No	73 (31.13)	63 (79.75)	
Bath child in waterbody			
Yes	19 (17.92)	11 (13.92)	0.465
No	87 (82.08)	68 (86.08)	

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Table 2.1.: Distribution of Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics (Variables)	***Lakeside community***	**Mainland community**	**P-value**
Demographic characteristics	**Number (%)**	**Number (%)**	
Age			
≤2	46 (63.89)	51 (44.74)	0.245
>2	26 (36.11)	63 (55.26)	
Sex			
Male	49 (68.06)	53 (46.49)	0.004
Female	23 (31.94)	61 (53.51)	
Site			
Tomefa community	53 (73.61)	54 (47.37)	<0.001
Manheam community	19 (26.39)	60(52.63)	
Nearness of home to water			
Near	20 (27.78)	78 (69.03)	<0.001
Far	52 (72.78)	35 (30.97)	
Knowledge of disease in area			
No idea	26 (36.11)	58 (51.33)	
Heard	31 (43.06)	45 (39.82)	0.030
Know	15 (20.83)	10 (8.85)	

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Table 2.2.: Distribution of Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics (Variables)	*Lakeside community*	Mainland community	P-value
Socioeconomic	**N (%)**	**N (%)**	
Occupation of father			
Farmer	1 (1.39)	2 (1.77)	
Fisher	44 (61.11)	18 (8.85)	
Trader	4 (5.56)	17 (80.95)	<0.001
Unemployed	0 (0.00)	3 (15.001)	
Other	23 (31.94)	81 (71.68)	
Fetching			
Yes	50 (69.44)	27 (23.89)	<0.001
No	22 (30.56)	86 (76.11)	
Washing			
Yes	53 (73.61)	17 (24.29)	<0.001
No	19 (26.39)	96 (84.96)	
Swimming			
Yes	18 (25.00)	1 (0.88)	<0.001
No	54 (75.00)	112 (99.12)	
Fishing			
Yes	27 (62.50)	9 (25.00)	<0.001
No	45 (37.50)	104 (92.04)	
Farming			
Yes	0 (0.00)	7 (6.19)	0.031
No	72 (100.00)	106 (93.81)	
Easing one's self			
Yes	2 (2.78)	1(0.88)	0.320
No	70 (97.22)	112 (99.12)	

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Baseline characteristics (Variables) Socioeconomic	Lakeside community N (%)	Mainland community N (%)	P-value
Others			
Yes	9 (34.62)	17 (65.38)	0.627
No	63 (39.62)	96 (60.38)	
General water activity			
Yes	63 (87.50)	30 (26.55)	<0.001
No	9 (12.50)	83 (73.45)	
Use of lake as primary water source			
Yes	45 (62.50)	26 (23.01)	<0.001
No	27 (37.50)	87 (76.99)	
Use of pipe borne water as primary source			
Yes	19 (26.39)	44 (38.94)	0.079
No	53 (73.61)	69 (61.06)	
Toilet in house			
Yes	24 (33.33)	46 (40.71)	0.313
No	48 (66.67)	67 (59.29)	

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Table 2.3...: Distribution of Baseline characteristics relating to the different zones in the two study sites.

Baseline characteristics	**Lakeside community**	**Mainland community**	**P-value**
History	**N (%)**	**N (%)**	
Mother had schistosomiasis			
Yes	15 (20.83)	19 (16.01)	0.491
No	57 (79.17)	94 (83.19)	
Father had schistosomiasis			
Yes	9 (12.50)	9 (7.96)	0.310
No	63 (87.50)	104 (92.04)	
Siblings had schistosomiasis			
Yes	16(22.22)	9 (7.96)	0.006
No	56 (35.00)	104 (65.00)	

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Table 2.4.: Distribution of Baseline behavioural characteristics relating to the different zones in the two study sites.

Baseline characteristics	Lakeside community	Mainland community	P-value
Behavioural	**N (%)**	**N (%)**	
Urinate or Defecate in bush			
Yes	42 (58.33)	22 (80.53)	0.001
No	30 (41.67)	91 (19.47)	
Boil water			
Yes	15 (14.15)	13 (16.46)	0.966
No	91 (85.85)	66 (83.54)	
Decant water			
Yes	28 (66.67)	14 (33.33)	<0.001
No	44 (30.77)	99 (69.23)	
Use immediately			
Yes	28 (38.89)	65 (57.52)	0.013
No	44 (61.11)	48 (42.48)	
Take child along to waterbody			
Yes	41 (56.94)	28 (24.70)	<0.001
No	31 (43.06)	85 (75.22)	
Allow child to play in or around waterbody			
Yes	38 (52.78)	11 (9.73)	<0.001
No	34 (47.22)	102 (90.27)	
Bath child in waterbody	23 (31.94)	7 (6.19)	<0.001
Yes			
No	49 (68.06)	106(93.81)	

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APPENDIX VII: Tables Demonstrating Distribution Of Urinalysis Parameters

Table 3.0. Comparison of Strip Test Urinalysis Parameters among the Various Zones and Communities

Strip Test Urinalysis Parameters		Tomefa Mainland N (%)	Tomefa Lakeside N (%)	Manheam Mainland N (%)	Manheam Lakeside N (%)	Total N (%)
Protein	Negative	19 (50.00)	10 (34.48)	22 (73.33)	5 (41.67)	46 (51.38)
	Trace	17 (44.74)	15 (51.72)	7 (23.33)	7 (58.33)	56 (42.20)
	+	2 (5.26)	4 (13.79)	1 (3.33)	0 (0.00)	7 (6.20)
Leukocytes						
	Trace	3 (7.89)	4 (14.81)	0 (0.00)	0 (0.00)	7 (6.42)
	Small (+)	0 (0.00)	7 (25.93)	1 (3.45)	1 (10.00)	9 (8.26)
	Moderate (++)	20 (52.63)	8 (29.63)	13 (44.83)	7 (70.00)	50 (45.87)
	Negative	15 (52.63)	8 (29.63)	15 (51.72)	2 (20.00)	43 (39.45)
pH	6.0	10 (26.32)	3 (10.34)	15 (50.00)	7 (58.33)	35 (32.11)
	6.5	22 (57.89)	23 (79.321)	9 (30.00)	4 (33.33)	58 (53.21)
	7.0	5 (13.16)	3 (10.34)	5 (16.67)	1 (8.33)	14 (12.84)
	7.5	1 (2.63)	0 (0.00)	1 (3.33)	0 (0.00)	2 (1.83)
Specific Gravity	1.000	0 (0.00)	1 (3.45)	0 (0.00)	1 (8.33)	2(1.83)
	1.005	18.42	6 (20.69)	8 (26.27)	4 (3.33)	25 (22.94)
	1.010	10 (26.32)	4 (13.79)	5 (16.67)	2 (16.67)	21 (19.27)
	1.015	7 (18.42)	2 (6.90)	3 (10.00)	1 (8.33)	13 (11.93)
	1.020	7 (18.42)	9 (31.03)	8 (26.67)	1 (8.33)	25 (22.94)
	1.025	7 (18.42)	6 (20.69)	6 (20.00)	3 (25.00)	22 (20.19)
	1.030	0 (0.00)	1 (3.45)	0 (0.00)	0 (0.00)	1 (0.92)

Table 3.1. Comparison of Strip Test Urinalysis Parameters among the Various Zones and Communities

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Strip Test (Dipstick) Urinalysis Parameters		Tomefa Mainland N (%)	Tomefa Lakeside N (%)	Manheam Mainland N (%)	Manheam Lakeside N (%)	Total N (%)
Appearance	Clear	33 (82.50)	21 (75.00)	19 (65.52)	8 (66.67)	81 (74.31)
	Hazy	2 (5.00)	5 (17.86)	3 (10.34)	2 (16.67)	12 (11.01)
	Cloudy	4 (10.00)	2 (7.14)	7 (24.14)	2 (16.67)	15 (13.76)
	Turbid	1 (2.50)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.29)
Colour	Colourless	0 (0.00)	1 (3.45)	0 (0.00)	1 (8.33)	2 (1.83)
	Straw	29 (76.32)	16 (55.17)	26 (90.00)	9 (75.00)	81 (76.15)
	Amber	9 (23.00)	12 (41.38)	3 (10.00)	2 (16.67)	26 (23.85)
Glucose	Negative (-)	38 (100.00)	29 (100.00)	30 (100.00)	12 (100)	109 (100.00)
Bilirubin	Negative	33 (76.32)	29 (100.00)	29 (96.67)	19 (100.00)	99 (90.83)
	Small	1 (2.63)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.92)
	Moderate	8 (21.05)	0 (0.00)	1 (3.33)	0 (0.00)	9 (8.26)
Ketone	Negative	31 (81.58)	27 (93.10)	29 (96.67)	12 (100.00)	99 (90.83)
	Small	7 (18.42)	0 (0.00)	1 (3.33)	0 (0.00)	8 (7.34)
	Moderate	0 (0.00)	2 (6.90)	0 (0.00)	0 (0.00)	2 (1.83)
Haematuria (Blood in urine)	Negative	38 (100)	29 (100)	30 (100)	12 (100)	109 (100.00)
Urobilirubin	Normal	37 (97.37)	29 (100.00)	30 (100.00)	12 (100.00)	108 (99.08)
	1	1 (2.63)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.92)
Nitrite	Positive(+/++)	23 (57.50)	19 (67.86)	16 (53.33)	7 (58.33)	65 (59.63)
	Negative (-)	17 (42.50)	9 (32.14)	14 (46.67)	5 (41.67)	44 (40.37)