AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT (AAMUSTED)

THE EPIDEMIOLOGICAL TREND OF SCHISTOSOMIASIS IN THE OFORIKROM MUNICIPALITY OF THE ASHANTI REGION OF GHANA

BY

OSEI THOMPSON

MARCH, 2025

AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

THE EPIDEMIOLOGICAL TREND OF SCHISTOSOMIASIS IN THE OFORIKROM MUNICIPALITY OF THE ASHANTI REGION OF GHANA

BY

OSEI THOMPSON

(8222030001)

A THESIS SUBMITTED TO THE DEPARTMENT OF PUBLIC HEALTH EDUCATION, FACULTY OF ENVIRONMENT AND HEALTH EDUCATION, AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY IN PUBLIC HEALTH

OCTOBER, 2025

DECLARATION

Student's Declaration

I hereby declare that, except for references to other people's work, which have been duly acknowledged, this thesis work is the result of my work and has neither in whole nor partially been presented elsewhere.

Candidate's Name: **OSEI THOMPSON**

Signature: ……. **Date: …….**

Supervisor's Declaration

We hereby declare that the preparation and presentation of this thesis were supervised following the guidelines on supervision of the thesis laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

Principal Supervisor's Name: **DR. NANA YAA AWUA-BOATENG**

Signature: …… **Date: …….**

Co-Supervisor's Name: **DR. DENIS DEKUGMEN YAR**

Signature: ……..…….. **Date: …….**

ACKNOWLEDGEMENT

To God be the glory and great things He has done, for without Him, nothing is possible, I am grateful for His guidance and protection throughout my life throughout my study at this university.

I am also very thankful to my supervisors, Dr. Nana Yaa Awua-Boateng and Dr. Denis Dekugmen Yar, for their exceptional supervision and for always being available to advise, provide ideas, and support me in finishing this thesis.

I am also grateful to the heads and staff of all the health facilities in the study sites for their tremendous assistance. I acknowledge Enoch Owusu Yeboah for his assistance in data analysis and peer review of this thesis.

To all my friends and loved ones who supported and helped me overcome setbacks in the course of this work, as well as my entire graduate study, I say, a big thank you to you all.

DEDICATION

It is with genuine gratitude and warm regards that I dedicate this work to God Almighty and my parents for their support towards my education.

TABLE OF CONTENTS

CHAPTER TWO

CHAPTER FIVE

CHAPTER SIX

LIST OF TABLES

TABLE OF FIGURES

Figures **Pages**

LIST OF ABBREVIATION

AAMUSTED	-	Akenten Appiah Menka University of Skills Training and Entrepreneurial Development
CCA	-	Circulating Cathodic Antigen
DALYs	-	Disability-adjusted life years
DNA	-	Deoxyribose Nucleic Acid
ERR	-	Egg reduction rates
FGS	-	Female Genital Schistosomiasis
GHS	-	Ghana Health Service
HIV	-	Human Immunodeficiency Virus
KNUST	-	Kwame Nkrumah University of Science and Technology
LBW	-	Low Birth Weight
MDA	-	Mass Drug Administration
NTDs	-	neglected tropical diseases
PCR	-	Polymerase Chain Reaction
PZQ	-	Praziquantel
RNA	-	Ribonucleic Acid
SCI	-	Schistosomiasis Control Initiatives
SPSS	-	Statistical Product and Service Solutions
WASH	-	Water, Sanitation, and Hygiene
WHO	-	World Health Organization

ABSTRACT

Schistosomiasis, a debilitating parasitic disease, poses significant public health concerns worldwide, particularly in Sub-Saharan Africa. Ghana, one of the endemic countries, continues to report recurring outbreaks. This study investigated the trends and prevalence of schistosomiasis to inform targeted interventions in the Oforikrom Municipality of the Ashanti Region of Ghana. A retrospective design was adopted, focusing on trend analysis to examine the prevalence and patterns of schistosomiasis. Stratified random sampling and purposive sampling were employed to select participants. The study targeted male and female individuals of all ages diagnosed with schistosomiasis who sought treatment between 2014 and 2023 at selected hospitals within Oforikrom Municipality. Data were analysed using Statistical Package for the Social Sciences (SPSS) version 20. A total of 620 confirmed cases were recorded, representing a prevalence of 15.82%, Kwame Nkrumah University of Science and Technology Hospital (18.08%) and Aninwa Hospital (17.37%) reported higher prevalence rates than Graceland Hospital (11.62%). A significant difference was observed among the three hospitals ($p = 0.006$, 95% CI: 6.89–24.49). The results also showed a slight female predominance (51.13%) compared with males (48.87%). Cases were distributed across facilities as follows: University Hospital, KNUST (35.00%), Aninwa Medical Centre (42.42%), and Graceland Hospital (22.58%). The highest number of cases occurred among individuals aged 21–30 years (189 cases, 30%), while the lowest was among those aged 61–70 years (15 cases, 3.1%). University Hospital recorded the most cases in the 11–20 years age group, while Aninwa and Graceland Hospitals reported the highest cases in the 21–30 years age group. The study recommends that public health authorities implement targeted health education initiatives, particularly for older individuals, focusing on specific risk factors such as occupational exposure to contaminated water sources.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Schistosomiasis remains a significant public health concern in the Oforikrom Municipality, with fluctuating prevalence trends over the past decade influenced by environmental, demographic, and intervention-related factors in the Ashanti Region (Owusu *et al.*, 2025). It remains a significant public health concern, particularly in tropical and subtropical regions with limited access to safe drinking water and adequate sanitation. It is predominantly transmitted through contact with contaminated freshwater harbouring specific species of freshwater snails carrying infective larvae (cercariae) of Schistosoma parasites (Essien-Baidoo *et al.*, 2023).

This chronic disease affects millions worldwide, primarily in tropical and subtropical regions, including Ghana (Nortey, 2024). The World Health Organisation (WHO) reports that at least 90% of individuals requiring treatment for schistosomiasis reside in Africa (WHO, 2022). Globally, schistosomiasis affects over 200 million people, with more than 700 million at risk in endemic areas (Zhang *et al*., 2024). The disease manifests in two primary forms: intestinal and urogenital. Intestinal schistosomiasis, caused by species such as *Schistosoma mansoni*, leads to symptoms like abdominal pain, diarrhea, and blood in the stool (Ofori *et al*., 2024, Kokaliaris *et al.*, 2022, Nelwan *et al*., 2020). Urogenital schistosomiasis, primarily due to *Schistosoma haematobium*, is characterised by hematuria (blood in urine) and can result in long-term complications such as bladder cancer and infertility (Santos *et al*., 2021).

In the African context, schistosomiasis is endemic in numerous countries, with the highest prevalence observed in sub-Saharan Africa (Aula *et al.,* 2021). The region accounts for approximately 85% of the global population at risk (Sadigov, 2022). Factors contributing to this high burden include limited access to clean water, inadequate sanitation, and certain occupational and domestic activities that increase exposure to infested water bodies (Wolf *et al.*, 2023) .

Schistosomiasis is prevalent in various regions in Ghana, especially in communities near freshwater bodies like rivers, lakes, and ponds (Essien-Baidoo *et al*., 2023). The disease primarily affects populations with limited access to clean water and sanitation facilities (Okesanya *et al*., 2024). Children are particularly vulnerable due to frequent water contact during play and chores, leading to high infection rates and subsequent health complications that can impair their growth and educational outcomes (Rhue *et al*., 2023). Remaining a pressing health issue, the country experiences both intestinal and urogenital forms of the disease, with *Schistosoma haematobium* being the most prevalent species (Mawa *et al*., 2021). A study assessing diagnostic techniques and water-related risk factors in Ghana highlighted the significant health burden posed by schistosomiasis, especially among school-aged children (Ayabina *et al.,* 2023).

Moreover, it is reported that the prevalence of Female Genital Schistosomiasis (FGS) ranges from 10% to 50% among women, leading to severe reproductive health issues, including infertility (Orish *et al*., 2025). Recent environmental events have exacerbated the situation. For instance, following the Akosombo Dam spillage, there was a notable spike in FGS cases within communities along the Volta Basin (Dumevi *et al*., 2024). The flooding facilitated the spread of aquatic weeds harbouring snails that serve as

intermediate hosts for the schistosome parasites, thereby increasing transmission rates (Habib *et al*., 2021).

Tracking a world free of schistosomiasis, the WHO sets goals to control the disease incidence by 2030, eliminate it as a public health challenge by 2035, and disrupt transmission in member states and some African countries by 2040 (Fenster, 2025). With Ghana as a strong partner in this agenda, such ambitious goals require an in-depth understanding of the disease context, the current trend and trajectory, and the contribution of all populations to ongoing transmission in endemic zones (Adams *et al*., 2024)

1.2 Problem Statement

Schistosomiasis (bilharzia) remains a major neglected tropical disease in Ghana, particularly in communities with frequent contact with fresh water and limited sanitation infrastructure (Cunningham *et al.,* 2020). National control efforts including mass drug administration (MDA) with praziquantel since 2008, combined with health education, snail control, and water-sanitation interventions have contributed to a general downward trend in prevalence across the country. However, Ghana still registers prevalence rates often exceeding 10–20 % in endemic locales, with school-aged children and high-risk subgroups bearing a major burden (Owusu *et al.*, 2025). Despite national mapping and district-level assessments, there is little granular, longitudinal data focused on specific municipalities such as Oforikrom in the Ashanti Region. It is therefore unclear whether schistosomiasis prevalence in Oforikrom followed the national pattern from 2014 to 2023.

Moreover, there is also a knowledge gap regarding how schistosomiasis prevalence in Oforikrom varies by gender and age. Past studies in other parts of Ghana have consistently shown higher prevalence among males and older children, however the specific demographic breakdown for Oforikrom has not been well quantified, limiting the ability to tailor age- or gender-sensitive prevention campaigns.

Finally, while Ghana's national MDA campaigns and health education efforts are well documented, the effectiveness of control and preventive measures implemented in Oforikrom Municipality over the 2014–2023 period has not been systematically evaluated. It is unknown whether MDA coverage reached the WHO target of 75–100 %, whether complementary strategies such as WASH interventions, water recreation areas, snail control, community engagement were applied locally, or whether reductions in prevalence were sustained at sub-district and municipal levels, among young adults in those engaging in water-contact activities such as fishing or swimming.

1.3 Research Questions

1. What are the trends and the prevalence of schistosomiasis in the Oforikrom Municipality from 2014 to 2023?
2. How does schistosomiasis prevalence vary by gender and age in the Oforikrom Municipality?
3. How effective have the control and preventive measures of schistosomiasis in the Oforikrom Municipality been over the period?

1.4 Main Objective

The main objective of this study was to assess the trends and prevalence of schistosomiasis in the Oforikrom Municipality of the Ashanti Region of Ghana over the last decade.

1.4.1 Specific Objectives

1. To describe the association of the demographical characteristics with the prevalence of schistosomiasis in the Oforikrom Municipality from 2014 to 2023
2. To assess the trends and prevalence of schistosomiasis in the Oforikrom Municipality from 2014 to 2023.
3. To evaluate the control and preventive measures of the schistosomiasis in the Oforikrom Municipality from 2014 to 2023.

1.5 Significance of the Study

The study's significance lies in its potential to provide detailed insights into the trends and prevalence of schistosomiasis in Oforikrom Municipality, which would facilitate evidence-based health interventions and policy formulation. Identifying trends in the spread of schistosomiasis would enable the Ghana Health Service and other stakeholders to refine existing strategies, address implementation gaps, and allocate resources more efficiently to high-risk areas within the Municipality (Tetteh *et al*., 2025).

This study would also be significant because it addresses the socio-economic and environmental factors contributing to schistosomiasis persistence in Oforikrom. It would also inform targeted education campaigns to promote preventive practices, ultimately reducing the disease burden over time (Mbata *et al.*, 2024). The significance of this study further extends to the national and international efforts to eliminate neglected tropical

diseases (NTDs), including schistosomiasis. The findings from this study would provide localized data to support Ghana's commitment to achieving the World Health Organization's (WHO) 2030 NTD eradication goals. The insights gained would be a valuable reference for researchers and practitioners addressing similar public health challenges in other urban areas.

In the long term, the study would contribute to designing sustainable health interventions, improved environmental resilience, and enhanced public health outcomes in Oforikrom Municipality and beyond (WIAFE, 2024).

1.6 Organization of the Study

This study was organized into six chapters. Chapter One discussed the introduction, which included the background of the study, a statement of the problem, objectives, and the significance of the study. Chapter Two reviewed literature that dealt with concepts, past studies, and information relevant to the study. Chapter Three outlined the research methodology, including a description of the study area, sampling techniques, data collection methods, and data analysis tools. Chapter Four presented the results of the study while Chapter Five discussed the findings of the study. Finally, conclusions and recommendations were presented in Chapter Six.

CHAPTER TWO

LITERATURE REVIEW

2.1 Background of S*chistosomiasis*

Schistosomiasis, also known as bilharzia, is transmitted by the freshwater snail by an intravascular route (Onyekwere, 2022). The World Health Organisation classifies the disease as a neglected tropical disease, with an estimated 732 million people worldwide at risk of infection (WHO, 2023). More than 200 million individuals are already infected, primarily in Africa, Asia, and South America.(Mosegui *et al*., 2022). Also, it is estimated that schistosome infections and geohelminths account for over 40 % of the world's tropical disease burden, excluding malaria (Nkemngo *et al.*, 2023).

According to (Gonzalez, 2021), the disease was first described in ancient Egyptian medical texts dating back to 1550 BC and was referred to as “Aaa” disease. Evidence of schistosomiasis has also been found in the mummies of ancient Egyptians, indicating that the disease was prevalent in the Nile Valley long before modern times (Mitchell, 2024). The presence of hematuria (blood in urine), a symptom of urinary schistosomiasis, was noted by early physicians and linked to the infection caused by Schistosoma haematobium (Tamarozzi *et al.*, 2021).

2.2 Disease Morphology, Vector and Transmission

Schistosomiasis is a parasitic disease caused by blood flukes of Schistosoma, affecting over 250 million people worldwide (Buonfrate *et al*., 2025). The disease's morphology, vector, and transmission vary across its complex life cycle, which involves both human and freshwater snail hosts (Pathak *et al.*, 2024). Schistosoma species is vital for effective control and prevention of schistosomiasis. Detailed knowledge of the parasite’s structure, its intermediate snail hosts, and the environmental conditions that support transmission

helps guide surveillance, treatment, and public health interventions. This comprehensive perspective supports targeted measures, such as snail control, improved sanitation, and health education, ensuring that strategies are evidence-based and adaptable to local ecological and epidemiological contexts, thereby promoting lasting disease reduction (Almeida *et al*., 2025).

2.2.1 Disease Morphology

Schistosoma species exhibit distinct morphological forms at different life stages. The eggs, which are excreted in human urine or faeces, hatch in freshwater, releasing ciliated miracidia (Yeroshenko *et al.*, 2022). These miracidia infect specific freshwater snails, where they develop into sporocysts. Within the snail, the parasite undergoes asexual reproduction, producing cercariae—free-swimming larvae with a forked tail (Weinstock & Leung, 2022). Cercariae penetrate human skin after being released into freshwater, transform into schistosomula, and travel through the bloodstream to develop into adult worms. Adult schistosomes display clear sexual dimorphism: males have a distinctive gynecophoral canal that encloses the longer, more slender females during copulation, ensuring close contact for reproduction. This adaptation allows the paired worms to remain together as they migrate to their preferred venous sites, where they mature and begin producing eggs that drive the disease process in human hosts. (LoVerde, 2024). The adult worms reside in specific blood vessels, depending on the species; for example, *S. haematobium* typically inhabits the venous plexus of the bladder (Weinstock & Leung, 2022).

2.2.2 Disease Vectors

Freshwater snails serve as intermediate hosts for *Schistosoma* species. The specific snail species involved vary by parasite species and geographic region (Gaye *et al*., 2024). Biomphalaria snails serve as intermediate hosts for Schistosoma mansoni, while Bulinus snails transmit S. haematobium. These freshwater snails are critical to the parasite's life cycle, supporting the asexual reproductive stage that allows the organisms to multiply and mature. Within the snail, the parasite develops into cercariae, the infectious form capable of penetrating human skin. Once released into surrounding water, these free-swimming cercariae spread readily in rivers, ponds, and irrigation systems where people bathe, swim, or collect water. Without these snail hosts, the parasites could not complete their development, making snail control an essential strategy for interrupting schistosomiasis transmission and protecting public health. (Dokmak *et al., 2024).*

2.2.3 Life Cycle *Schistosoma*

The life cycle of *Schistosoma* involves two hosts: humans and freshwater snails. Roques *et al.* (2018) reported that the life cycle begins when Schistosoma eggs are excreted from an infected human host through the urine for *Schistosoma haematobium* or faeces for *Schistosoma mansoni* and *Schistosoma japonicum*. If these eggs reach fresh water, they hatch into free-swimming larvae called miracidia. The miracidia are covered with tiny hair-like structures called cilia, which allow them to swim and penetrate a suitable freshwater snail host within a few hours to continue their development (Roquis *et al*., 2018).

Different species of Schistosoma infect various snail species, and within the snail, the miracidia transform into sporocysts, which undergo asexual reproduction to produce

numerous cercariae (Adekiya *et al*., 2020). This stage involves developing and multiplying the parasite within the snail over several weeks. The cercariae are the free-swimming larval form that emerges from the snail into the water, and they have a distinctive forked tail that propels them through the water (Mulero *et al*., 2019). According to Mulero *et al*. (2019), the Cercariae must find a human host within 48 hours to survive. When they come into contact with human skin, they penetrate it using enzymes and mechanical action. Once inside the human host, the cercariae shed their tails and transform into *schistosomulae*.

These immature worms migrate through the bloodstream to the liver, where they mature into adult schistosomes over several weeks; mature schistosomes are long, slender worms that pair up (male or female) and migrate to the blood vessels of either the intestines or the bladder and lay eggs, which pass through the walls of blood vessels into the lumen of the intestines or bladder (Rawlinson *et al*., 2021). The parasite matures within 4 to 6 weeks in the veins, copulate, and move to their destination, either the perivascular or mesenteric venous plexus, to start the cycle again (Fig. 2.1).

According to Luka and Mbaya (2015), an infected snail has the ability to shed thousands of eggs every day for many months. An adult parasitic fluke called the schistosome has an average lifespan of between 3 and 5 years, but can also live for 30 years (Lamberton *et al*., 2017). A single schistosome pair (male and female) has a plausible reproduction ability of up to 600 billion schistosomes. The intermediate host (freshwater snail) occupies slowly moving freshwater rivers, ponds, streams or lakes (Lamberton *et al*., 2017). The infection rate in humans rises with the number of times spent in a contaminated water, and diagnostically the eggs can easily be seen under a microscope

due to their unique shape and size, and the possession of a lateral or terminal spine (Wilson & Jones, 2021).

When individuals come into contact with infested water during activities like swimming, bathing, or domestic chores, the larvae penetrate the skin, infecting the human host (Leger & Webster, 2020). Once inside the body, the parasites mature and lay eggs, leading to various health complications. According to Oleaga *et al*. (2019), schistosomiasis manifests in two primary forms, intestinal and urogenital, caused by different species of Schistosoma. Chronic infection may lead to a spectrum of health issues, including abdominal pain, diarrhea, blood in urine or stool, anaemia, organ damage (such as liver, spleen, or bladder), stunted growth in children, and impaired cognitive development (Oleaga *et al*., 2019). These health consequences significantly impact the quality of life, productivity, and socioeconomic well-being of affected individuals and communities. The life cycle of schistosome is shown in Figure 2.1

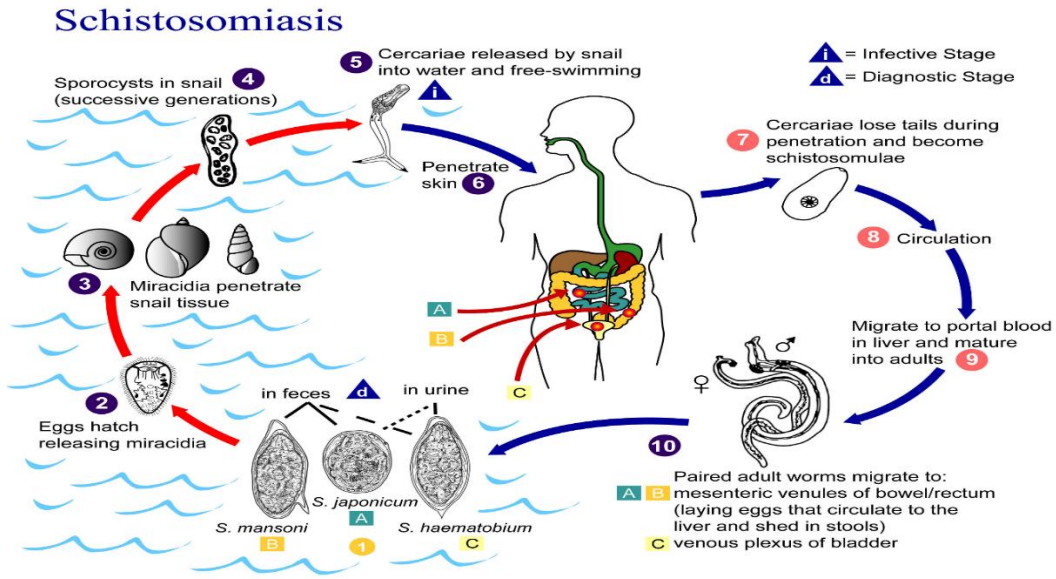


Figure 2.1. The life cycle of Schistosoma (Lamberton *et al*., 2017).

2.2.4 Disease Transmission

Schistosomiasis transmission occurs when humans engage in activities that expose them to contaminated freshwater, such as swimming, bathing, fishing, or agricultural work (Leger & Webster, 2020). Specifically, freshwater snails in these water bodies are crucial for the parasite's life cycle, as they release the infective cercariae. Environmental factors, including water resource development projects and seasonal changes, can influence transmission dynamics by affecting snail habitats and human water contact patterns (Leger & Webster, 2020).

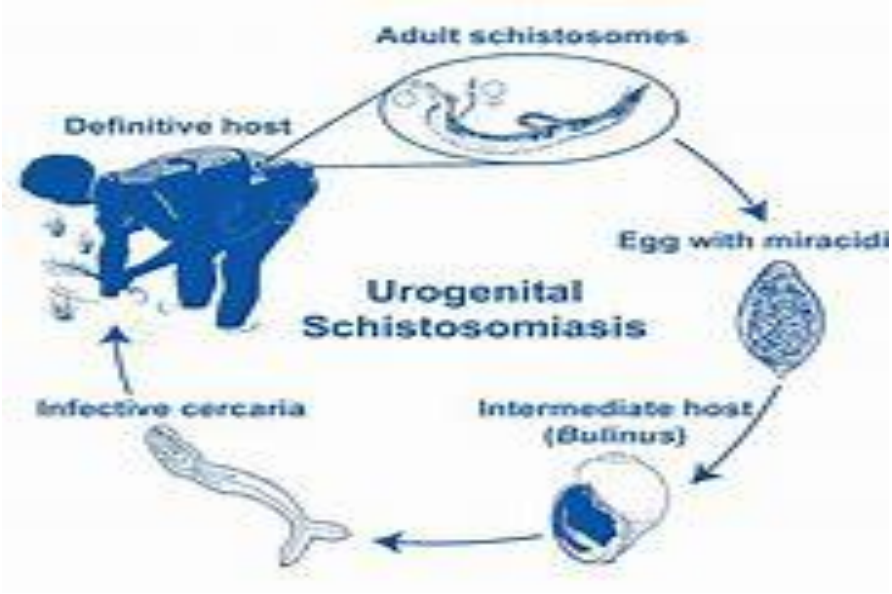


Figure 2.2. The disease transmission of Schistosoma
(Leger & Webster, 2020)

2.2.5 The Role of the Schistosoma Parasite in Morbidity

Morbidity levels of schistosomiasis have been linked with infection intensity. Recently, the expansion of mass drug administration (MDA) programs has led to the significant drops in the disease prevalence, and ensuing human host infections (Sokolow *et al*., 2016). Nonetheless, it remains to be certain on exactly how much MDA, together with other human activities, may impact parasite fitness and strategies, nor how this, on the other hand, may affect their genetic diversity, transmission dynamics, clinical outcome

and drug resistance development across vulnerable populations, most especially in Africa (Abe *et al*., 2018). Field-based studies in which large number of intervention trials are carried out for optimal treatment in different zones of Africa have demonstrated a strong variability of response to annual MDA (Akpata *et al*., 2015; Adekiya *et al*., 2020). In some cases, after multiple rounds of MDA in the transmission hotspots, egg reduction rates (ERR) were found to have decreased below the WHO recommendation of 90 % in contrast to that observed amongst school children but with a lower past MDA pressure history (Adekiya *et al*., 2020).

With praziquantel (PZQ) as part of the MDA, assessing its therapeutic efficacy against schistosomes and the changes in parasites' susceptibility is important. As drug resistance is associated with life-history costs, the potential for drug resistance and associated trade-offs may be important factors in the maintenance of high infection intensities and morbidity levels across Africa. The success, or not, of control strategies in several endemic areas is likely to be affected by host-parasite-drug interactions, and these associations have raised concerns that there may be reduced drug efficacy, especially in communities with a more intensive history of PZQ treatment (Akpata *et al*., 2015).

Some studies suggest reduced drug effectiveness, but more research is needed. This will help us understand how drug resistance develops in the field. Resistance may come from host responses or reinfection, which could explain low cure rates (Abe *et al*., 2018). There are other factors to consider. These include how parasites reproduce and affect the host. One of these is density-dependent fecundity compensation. This happens when parasite reproduction adjusts based on the number of parasites. It may also vary by location (Alqahtani *et al*., 2017).

Studies on Schistosoma worms show mixed results. Some show density-dependent fecundity inhibition, while others do not. For example, Schistosoma mansoni shows a linear relationship between egg count and worm burden. However, this is not the case for Schistosoma haematobium (Alqahtani *et al*., 2017). These findings raise important questions. They suggest that parasites may continue to thrive after treatment. This could explain the persistence of infection and high morbidity (Anyan *et al*., 2019).

Parasites that survive treatment may reproduce faster. This could spread drug resistance and other harmful traits (Bianchi *et al*., 2015). Disease control programs focus on schistosome-specific effects. However, parasites often interact with other species. These interactions may affect host morbidity in different ways (Bizimana *et al.,* 2019).

2.3 Disease Ecological Factors

Schistosomiasis transmission and prevalence are shaped by ecological conditions that affect the parasite, its snail hosts, and human contact with infested water. Key influences include water resource development, climate, vegetation, and human activity, all of which determine where snails thrive and how often people are exposed to infectious cercariae. These interacting factors create a dynamic environment that sustains transmission and complicates control efforts. Effective prevention, therefore, requires more than medical treatment. Integrated water management can limit snail habitats, while improved sanitation reduces contamination of freshwater sources. Targeted snail control, combined with health education and safe water access, further lowers infection risk. Addressing these ecological and behavioural drivers together is essential for lasting reductions in disease burden. A coordinated approach that links environmental

management, public health interventions, and community participation offers the strongest path to breaking the cycle of schistosomiasis and protecting at-risk populations.

2.3.1 Water Resource Development

The schistosome parasite requires an avenue wherein there is direct contact between the molluscan intermediate snail and the final human host for transmission of schistosomiasis to take place (Rogers *et al*., 2021). The construction of dams, irrigation schemes, and other water resource development projects creates habitats conducive to the proliferation of snail intermediate hosts. Slow-moving or stagnant water with aquatic vegetation provides an ideal snail breeding and cercarial release environment. For instance, the Aswan High Dam in Egypt significantly increased the prevalence of schistosomiasis by expanding snail habitats (Steinmann *et al*., 2016). An estimated 76 % of the sub-Saharan population lives close to various open water bodies, which are infested with the intermediate snail host necessary for transmitting the disease (Chibwana *et al*., 2020). Multiple studies have established a direct association between the intensity of the disease and the proximity of infected individuals to natural water sources such as lakes, rivers, and ponds. A study by Kagabo *et al*. (2023), showed that children whose schools were closer to open water bodies had an increased risk of infection, a finding in consonance with that reported by Abe *et al*. (2018).

2.3.2 Climate Factors

There is an established link between climate change and the transmission of infectious diseases. Schistosomiasis is a typical example of a disease whose local infection and geographical expansion are influenced by climate change and global warming. Temperature, rainfall, and humidity affect the lifecycle of Schistosoma and its intermediate hosts. Snails thrive in warm, tropical climates with stable freshwater

sources, where water temperatures between 25 and 30°C are optimal for cercarial survival and infectivity. Changes in rainfall patterns can either expand or reduce suitable habitats, impacting transmission dynamics (Colley *et al*., 2019). Alzaylaee *et al*., (2020) demonstrated that a rise in ambient temperature from 20 °C to 30 °C could lead to an over tenfold increase in the mean burden of S. mansoni infection in endemic areas. Nonetheless, at temperatures above 30 °C, a decrease in the disease burden was observed, likely due to the higher death rate of the intermediate snail host. Alzaylaee *et al*. (2020) further noted that while an increase in disease burden leads to heightened morbidity and mortality, there might be a negligible increase in disease prevalence.

Rainfall patterns also affect the transmission of schistosomiasis; in Sub-Saharan Africa, the snail species *Biomphalaria pfeifferi* is responsible for *S. mansoni* transmission during the rainy season, while during the dry season, *S. haematobium* infection is transmitted by *Bilunus globosus* (Deng *et al*., 2019).

2.3.3 Vegetation and Water Quality

Aquatic vegetation creates ideal habitats for freshwater snails by supplying both food and shelter. Dense plant growth provides surfaces for egg laying and refuge from predators, while decaying plant material enriches the water with nutrients. Algal blooms and decomposing organic matter serve as additional food sources, boosting snail survival and reproduction. When water quality declines, often from agricultural runoff or other forms of pollution, the resulting increase in organic debris and nutrients can further promote snail population growth. Elevated nutrient levels stimulate algae and plant overgrowth, creating a feedback loop that sustains high snail densities. These conditions are particularly significant in areas where snails act as intermediate hosts for parasites, as their proliferation raises the risk of disease transmission. Understanding the link

between aquatic vegetation, nutrient enrichment, and snail ecology is therefore critical for managing freshwater ecosystems and controlling snail-borne diseases such as schistosomiasis. (Rollinson *et al*., 2013).

2.3.4 Human Activities and Land Use

Human activities like farming, fishing, and domestic chores like washing and bathing increase exposure to infested water sources. Ecological changes due to the man-made construction of irrigation schemes, reservoirs and dams for agricultural purposes, and electricity generation are also responsible for the continued transmission of schistosomiasis in some sub-Saharan African countries (Jones *et al*., 2018). Land use changes, such as deforestation and agricultural expansion, often modify water flow, creating snail habitats and promoting schistosomiasis transmission (Hotez *et al*., 2008). These man-made changes alter aquatic ecosystems, creating favourable environments for Schistosome larvae to develop and multiply. Construction of dams led to a remarkable increase in cases of urinary schistosomiasis, as experienced in some sub-Saharan African countries such as Senegal, Cote d'Ivoire, Ghana, Mali, Namibia, and Cameroun. Steinmann *et al*. (2016) estimated that 13.6 % (106 million) of people vulnerable to schistosomiasis reside near irrigation schemes and large dam reservoirs.

Dams create large reservoirs that provide breeding sites for Schistosome vectors, such as Snails. Changes in temperature and precipitation patterns alter snail populations and schistosome development, facilitating transmission (Murray *et al*., 2019). Inadequate water treatment and sanitation infrastructure contribute to the persistence of schistosomiasis (WHO, 2020). Poor hygiene practices, such as bathing or washing clothes in contaminated water, increase the risk of infection (King *et al*., 2017).

2.3.5 Urbanisation and Population Growth

Rapid urbanisation, especially in resource-limited settings, often outpaces the development of sanitation and water management systems. As cities expand without adequate infrastructure, untreated wastewater and poor drainage contaminate rivers, lakes, and other water bodies with Schistosoma eggs, creating ideal conditions for transmission. Population growth intensifies this challenge by increasing the number of people who rely on the same limited water sources for bathing, washing, and recreation. Greater human–water contact raises the likelihood of exposure to infected snails that serve as intermediate hosts, sustaining the parasite's life cycle. Informal settlements and overcrowded neighbourhoods further strain sanitation services, while limited public health resources hinder regular monitoring and control measures. Together, these factors create a cycle in which rapid urban growth, inadequate infrastructure, and rising demand for water reinforce each other, driving persistent schistosomiasis transmission and making effective prevention and long-term disease control far more difficult. (Ekpo *et al*., 2012).

2.3.6 Socio-Economic Factors

In sub-Saharan Africa, socio-economic factors contribute to the spread of schistosomiasis. These factors include poverty, work activities, poor sanitation, and lack of clean water (Verjee, 2019). A World Bank study found that most people in this region live on $1.25–2 per day. Musisi and Kinyanda (2020) suggested that poverty and schistosomiasis create a harmful cycle. They explained that poverty forces people to use dirty water for daily needs, leading to infection. When they get sick, they can't work and make money, which keeps them in poverty. Hutton and Chase (2016) also found a

connection between schistosomiasis and poverty in a study of two peri-urban communities. Their study showed a worrying 62% prevalence among 1,023 people.

2.4 Disease Burden and Diagnosis

Schistosomiasis remains a major public health challenge, especially in resource-limited regions where access to preventive care and treatment is constrained. The disease places a heavy burden on affected communities, contributing to both acute illness and long-term disability. Symptoms may begin with allergic reactions such as rash or fever, but can progress to chronic complications involving the liver, intestines, bladder, or other organs, often leading to reduced quality of life and socioeconomic hardship. Early and accurate diagnosis is essential to break this cycle. Parasitological tests remain the standard for detecting active infection, while immunological and molecular techniques provide greater sensitivity and help identify low-intensity infections that might otherwise be missed. Timely diagnosis enables prompt treatment, limits transmission, and supports broader control programs. Strengthening surveillance systems, improving diagnostic capacity, and ensuring access to effective therapies are therefore central to reducing the disease burden and protecting vulnerable populations.

2.4.1 Disease Burden:

Schistosomiasis remains a significant public health issue, particularly in low- and middle-income countries, where it affects over 250 million people globally, with 93% of cases concentrated in sub-Saharan Africa (WHO, 2022). Schistosomiasis causes significant illness rather than high mortality, but its impact on health and productivity is considerable. The disease leads to chronic complications that diminish quality of life, including persistent anaemia, stunted growth in children, and impaired cognitive

development. These effects are especially pronounced in endemic areas, where repeated infections compound long-term harm. Beyond the physical burden, schistosomiasis carries serious social and economic consequences. Reduced school performance and lifelong developmental challenges affect children, while adults often experience fatigue and weakness that limit their ability to work. This loss of productivity, combined with the cost of ongoing medical care, places a heavy strain on families, communities, and national health systems. Agricultural communities are particularly affected, as illness reduces labour capacity during critical farming seasons, further deepening poverty cycles. The World Health Organisation estimates that the disability-adjusted life years (DALYs) lost to schistosomiasis reach about 3.5 million each year, reflecting years of healthy life compromised by disability or premature death. These figures highlight the need for sustained prevention and control efforts, including access to clean water, improved sanitation, and regular mass drug administration. Addressing these factors is essential to reducing the disease's long-term health consequences and its wider economic and social impact. (Vos *et al*., 2020).

2.4.2 Impact of Schistosomiasis on Public Health and Agriculture

Schistosomiasis has significant public health implications, causing chronic illness that can lead to severe health complications, including liver and kidney damage, bladder cancer, and growth and cognitive delays in children (Colley *et al*., 2017). In livestock, the disease can result in reduced productivity, weight loss, and even death, adversely affecting the agricultural economy. The burden of schistosomiasis thus extends beyond health, impacting socio-economic development and food security in endemic regions (Adenowo *et al*., 2015). Schistosomiasis has a profound impact on public health and agriculture, particularly in endemic regions such as Ghana. On the public health front,

the disease contributes significantly to morbidity and mortality. Chronic infection can lead to severe health issues, including liver and kidney damage, bladder cancer, and developmental problems in children (Crimmins *et al*., 2019).

The symptoms, such as abdominal pain, diarrhoea, blood in urine or stool, and general fatigue, can severely affect the quality of life and productivity of individuals. In children, schistosomiasis can cause malnutrition, stunted growth, and cognitive impairments, limiting educational attainment and future economic opportunities. The economic burden of schistosomiasis on healthcare systems is substantial. Endemic regions face high healthcare costs due to the need for ongoing medical treatment, diagnostic services, and public health interventions (Crimmins *et al*., 2019). Mass drug administration (MDA) programs, while effective, require significant resources and infrastructure. Moreover, repeated infections necessitate regular treatment, straining already limited healthcare resources. The disease's impact extends to families and communities, with affected individuals often unable to work or attend school, leading to lost income and reduced economic productivity (Rosiek *et al*., 2015). Agriculture, a primary livelihood in many schistosomiasis-endemic areas, also suffers due to the disease. Livestock, such as cattle and goats, can be infected with Schistosoma species, leading to decreased animal health, lower productivity, and increased veterinary costs. Infected livestock may exhibit symptoms such as weight loss, reduced milk production, and reproductive issues (Rosiek *et al*., 2015).

2.4.3 Disease Symptoms

The clinical presentation of schistosomiasis depends on the stage of infection, the infecting Schistosoma species, and the intensity of the parasite load. During the initial

phase, some individuals experience a mild, itchy rash at the site of cercarial penetration, often called swimmer's itch. Within weeks, the acute stage, also known as Katayama fever, may develop, marked by fever, chills, muscle aches, cough, and abdominal discomfort as the body reacts to migrating larvae. Chronic disease emerges when adult worms settle in the mesenteric or pelvic veins and begin producing eggs. These eggs can become trapped in tissues, provoking inflammation and organ damage. Intestinal schistosomiasis typically causes abdominal pain, diarrhoea, and blood in the stool, while urinary schistosomiasis presents with hematuria and, over time, bladder fibrosis or cancer risk. Severe infections may lead to liver fibrosis, portal hypertension, or pulmonary hypertension. Symptoms often reflect both the species involved and the cumulative egg burden in affected organs. (Akpata *et al*., 2015):

Acute Phase (Cercarial Dermatitis or Katayama Fever)

According to Alqahtani *et al*. (2017), this phase occurs within days of infection as cercariae penetrate the skin. Schistosomiasis symptoms may develop well after the initial infection. The first sign is often an itchy rash or localized dermatitis at the point where the parasite entered the skin. As the immature worms, known as schistosomula, migrate through the body, the immune system reacts, triggering a range of systemic symptoms. These can appear two to eight weeks after exposure and may include fever, fatigue, muscle aches, cough, and in some cases shortness of breath. The severity of these symptoms varies with the parasite load and the host's immune response. Some individuals experience only mild discomfort, while others develop a more intense inflammatory reaction that resembles an acute febrile illness. Recognizing this delayed presentation is important for timely diagnosis, especially in endemic regions or after travel to areas with freshwater exposure. Early medical evaluation and appropriate

treatment can prevent progression to the chronic stage, which carries the risk of serious organ damage.

Chronic Phase

Chronic symptoms are caused by the immune response to eggs trapped in tissues and vary by the affected organs, leading to inflammation and fibrosis (Alqahtani *et al*., 2017), and this can cause severe complications such as hepatosplenomegaly (enlargement of the liver and spleen), intestinal polyps, and bladder cancer:

Intestinal Schistosomiasis (e.g., *S. mansoni*, *S. japonicum*): Abdominal pain, diarrhea, bloody stools, and hepatosplenomegaly are common. Long-term infection may lead to liver fibrosis and portal hypertension.

Urogenital Schistosomiasis (e.g., *S. haematobium*): Symptoms include hematuria (blood in urine), frequent urination, and bladder inflammation. Chronic infection can cause bladder fibrosis, kidney damage, and an increased risk of bladder cancer. In women, it can lead to genital schistosomiasis, resulting in infertility or complications during pregnancy.

Complications: Severe cases can result in liver cirrhosis, ascites, and esophageal varices. Neurological schistosomiasis can occur if eggs lodge in the brain or spinal cord, leading to seizures or paralysis.

2.4.4 Disease Diagnosis

Diagnosis of schistosomiasis draws on a combination of clinical evaluation, parasitological examination, immunological testing, and molecular techniques. The primary method remains the microscopic detection of parasite eggs in stool or urine, which directly confirms active infection. When egg counts are low or intermittent,

serological assays that detect antibodies or antigens provide supportive evidence, although they cannot always distinguish past from current infection. Molecular methods, such as polymerase chain reaction (PCR), offer high sensitivity and specificity for identifying Schistosoma DNA, making them valuable in low-transmission settings and for monitoring control programs. Imaging modalities, including ultrasound and, when indicated, CT or MRI, help reveal complications such as liver fibrosis, portal hypertension, or urinary tract damage, guiding clinical management. Together, these complementary approaches ensure accurate diagnosis, assess disease burden, and inform treatment decisions, which is critical for reducing long-term morbidity and supporting public health efforts to control and eliminate schistosomiasis. (Oliveira *et al*. 2018).

Parasitological Diagnosis

The definitive diagnosis of schistosomiasis relies on detecting Schistosoma eggs through microscopic examination of stool or urine. This remains the gold standard because it directly identifies the parasite, confirming active infection. For intestinal schistosomiasis, the Kato-Katz thick smear technique is most widely used. In this method, a measured amount of stool is processed on a slide and examined under a microscope, allowing for both detection and estimation of egg counts, which helps assess infection intensity. For urogenital schistosomiasis, urine filtration is the preferred approach. A specific volume of urine is passed through a fine filter that traps the eggs, which are then visualized microscopically. These methods are valued for their specificity and relatively low cost, making them suitable for field surveys and routine clinical settings in endemic regions. However, their sensitivity can be limited, especially in low-intensity infections or when egg output fluctuates throughout the day. Multiple samples collected over consecutive days often improve detection rates. Despite advances in molecular and serological

diagnostics, such as polymerase chain reaction (PCR) and antibody tests, microscopic identification of eggs remains the reference standard for confirming infection, guiding treatment decisions, and monitoring the effectiveness of control programs in both individual and community settings. (Afifi *et al*., 2016). These methods are sensitive to high-intensity infections but may miss low-intensity cases.

Serological and Immunological Tests

Tests that detect antibodies or circulating Schistosoma antigens, such as the circulating cathodic antigen (CCA) in blood or urine- are valuable tools for identifying active infections, including those with low parasite loads. They offer an important advantage over traditional stool or urine microscopy, which may miss light infections. Antigen detection reflects the presence of live worms and can signal ongoing transmission in a community, making these tests useful for surveillance and program monitoring. However, their interpretation requires caution. Antibody assays cannot reliably distinguish between a current infection and one that has been successfully treated, because antibodies may persist long after parasites are cleared. Even antigen-based tests, while more specific for active infection, may show reduced sensitivity when parasite levels are very low or after partial treatment. For accurate diagnosis and effective control strategies, these tests are best used alongside clinical assessment, epidemiological data, and, when possible, confirmatory parasitological methods. (Afifi *et al*., 2016).

Molecular Diagnosis

Polymerase Chain Reaction (PCR) is a powerful molecular technique for detecting Schistosoma DNA in stool, urine, or blood samples. Its high sensitivity allows it to identify even very small amounts of parasite genetic material, which makes it particularly

valuable in areas where infection levels are low or transmission has been reduced through control efforts. Unlike traditional parasitological methods, which rely on finding eggs under a microscope, PCR can detect infections that produce few or no eggs, helping to reveal hidden cases that might otherwise be missed.

This level of precision is important for both diagnosis and surveillance. In endemic communities, PCR supports early detection and treatment, reducing the risk of ongoing transmission and long-term complications such as liver fibrosis or urinary tract damage. For national and regional control programs, it provides reliable data for assessing the impact of interventions like mass drug administration and environmental management. PCR testing can be applied to a range of sample types, stool for intestinal schistosomiasis, urine for Schistosoma haematobium, and blood for systemic detection, offering flexibility in field and laboratory settings. Although it requires specialised equipment and trained personnel, its ability to uncover low-intensity or subclinical infections makes PCR a critical tool in the global effort to monitor and ultimately eliminate schistosomiasis. (Guegan *et al*., 2019).

Imaging and Clinical Assessment

Ultrasound is a key tool for detecting organ damage, particularly changes in the liver and bladder. It helps identify structural abnormalities such as fibrosis, thickening of the bladder wall, and other early signs of chronic disease. A detailed clinical history complements imaging by revealing past exposures, symptoms, and risk factors, while a thorough physical examination provides additional evidence of complications that may not yet be visible on imaging. Together, these approaches improve diagnostic accuracy, especially in regions where the disease is endemic and chronic complications are

common. Combining ultrasound findings with clinical evaluation allows for timely recognition of progressive organ damage, guiding appropriate treatment and monitoring. This integrated approach is essential for preventing severe outcomes, as it captures both current pathology and the patient's disease trajectory. In endemic settings, where repeated infections and long-term organ involvement are frequent, this method provides a practical, non-invasive way to detect and manage chronic complications effectively. (Guegan *et al*., 2019., Afifi *et al*., 2016).

2.5 Disease Prevention and Treatment

Control and prevention of schistosomiasis in Ghana remain difficult due to limited resources, weak healthcare infrastructure, and the challenge of sustaining interventions over time. National and local programs focus on several key strategies. Mass drug administration (MDA) of praziquantel is the mainstay, aiming to reduce infection levels across at-risk populations. Health education campaigns complement treatment by encouraging safer water contact practices and promoting regular screening. Investments in clean water supplies and improved sanitation are critical to break the cycle of transmission, though coverage is uneven in rural areas. Snail control, targeting the freshwater snails that host the parasite, has shown promise but requires ongoing funding and environmental management. Community-based initiatives, including training local volunteers and integrating control measures into existing health services, help maintain participation and address reinfection risks. Sustained political commitment, adequate financing, and cross-sector collaboration are essential to strengthen these efforts and achieve lasting reductions in disease burden. (Opare *et al*., 2025).

2.5.1 Prevention and control of schistosomiasis

Schistosomiasis control relies on several strategies. These include large-scale treatment for at-risk groups, access to safe water, better sanitation, hygiene education, behaviour change, and snail control (Grimes *et al*., 2015). The World Health Assembly's new road map for neglected tropical diseases (2021–2030) aims to eliminate schistosomiasis in all endemic countries. The goal is to stop its spread and remove infections in some countries (WHO, 2022).

The WHO strategy focuses on reducing disease by giving regular treatments with praziquantel. This large-scale treatment targets affected populations (Zhang et al., 2017). WHO recommends treating infected preschool children based on diagnosis and clinical judgment. They should be included in treatment using the pediatric version of praziquantel (WHO, 2023).

Treatment frequency depends on the infection rate in school-age children. In high-risk areas, treatment may need to be given every year for several years. Monitoring is crucial to see how well control efforts are working. The goal is to reduce disease and transmission to eliminate it as a public health issue (Danso-Appiah *et al*., 2022).

Periodic treatment helps cure mild symptoms and prevents severe chronic disease (Roucher *et al*., 2021). Praziquantel is the recommended drug for all types of schistosomiasis. It is effective, safe, and inexpensive. While reinfection can happen after treatment, it reduces the risk of severe disease, especially when treatment is given repeatedly in childhood (Bianchi *et al*., 2019).

2.6 Trends and Prevalence of Schistosomiasis

Schistosomiasis remains a major public health challenge worldwide, particularly in tropical and subtropical regions where access to clean water and adequate sanitation is limited. The disease is driven by a complex interplay of ecological, behavioural, and demographic factors. Freshwater habitats that support the snail hosts, coupled with human activities such as fishing, farming, and domestic water use, create conditions for ongoing transmission. Demographic variables, including age and gender, further shape patterns of exposure and infection. Children are often at higher risk because of frequent contact with infested water during play or household chores, while occupational exposure places adults, especially men involved in agriculture or fishing, at increased risk. These dynamics highlight the need for interventions that reflect the realities of specific communities rather than relying solely on broad, one-size-fits-all programs. Effective control requires a combination of strategies: regular mass drug administration, health education to reduce risky water contact, improved sanitation, and snail control where feasible. Addressing gender roles and cultural practices is equally important to ensure that prevention efforts reach all affected groups. Sustained public health commitment, supported by local engagement and international collaboration, is essential to reduce the burden of schistosomiasis and move toward its eventual elimination.

2.6.1 The Global Trend of Schistosomiasis

The burden of Schistosomiasis persists in many parts of the world, particularly in sub-Saharan Africa. Understanding its global incidence, prevalence, and demographic distribution is crucial for effective control and prevention strategies.

Despite global efforts to reduce the burden of schistosomiasis, it remains a pervasive health issue, particularly in Africa. Understanding the disease's incidence, prevalence,

and demographic patterns is essential for tailoring interventions. Targeted strategies, including MDA, improved sanitation, health education, and integration of FGS treatment into reproductive health services, are vital to address the specific needs of affected populations and move towards the elimination of schistosomiasis (Oliveira *et al*. 2018).

Global Prevalence

Schistosomiasis affects over 200 million individuals worldwide, with more than 600 million people at risk of infection. The disease is endemic in 74 to 76 developing countries, with approximately 85% of cases occurring in Africa. The prevalence rate is approximately 268 per 100,000 individuals globally (Guegan *et al*., 2019).

There has been a concerted effort to control schistosomiasis through mass drug administration (MDA) programs, improved sanitation, and health education. These interventions have led to a decline in prevalence in some regions (Ogongo *et al.,* 2022). However, challenges such as limited access to clean water, inadequate healthcare infrastructure, and environmental changes continue to impede progress. Notably, migration and population movements have introduced the disease to new areas, complicating control efforts (Afifi *et al*., 2016).

The disease's prevalence varies geographically, influenced by factors such as environmental conditions, water resource development, and public health interventions. In regions like the shores of Lake Victoria and certain irrigation schemes, prevalence rates can range from 40% to 100% (Ozretich *et al.,* 2022).

Global efforts, including mass drug administration (MDA) programs using praziquantel, have aimed to reduce the disease burden. While these interventions have led to declines

in prevalence in some areas, challenges such as reinfection, drug accessibility, and emerging transmission in previously non-endemic regions persist (Lamberton *et al.*, 2017). Notably, climate change has facilitated the survival of freshwater snails, the parasite's intermediate hosts, in parts of Southern Europe, leading to new cases in countries like Spain, Italy, and Greece.

2.6.2 Trend of Schistosomiasis in Africa

Helminthic infections, including schistosomiasis, are a major issue in many developing countries. However, their impact on morbidity and mortality has often been underestimated (Adenowo *et al*., 2015). School-aged children, teenagers, women, and young adults are most affected by schistosomiasis (Ogongo *et al.,* 2022). Infected children can suffer from growth delays, fatigue, weakness, memory problems, and anaemia. These issues can lead to poor academic performance and limit their potential (Medley *et al.,* 2016). This also adds to society's economic burden.

Although schistosomiasis is rarely fatal, it causes long-term problems like anaemia. This is due to bleeding from the urinary and intestinal tracts when worms invade. Nutritional issues, like malabsorption and digestive problems, can also lead to iron deficiency (Ansha *et al.,* 2020). Clinical studies and autopsies show that schistosomiasis can cause kidney damage, especially in elderly patients, leading to death (Qokoyi *et al.,* 2021). Urogenital schistosomiasis is a major factor in the spread of HIV. It makes it easier for HIV to spread between women and their male partners and also speeds up disease progression in people already infected with HIV (Qokoyi *et al.,* 2021). A study in Zimbabwe showed that women with S. haematobium infection had three times the risk of having HIV (Pillay *et al.,* 2020).

Schistosomiasis also affects pregnancy. S. haematobium infection can cause placental inflammation, leading to poor birth outcomes (Patel *et al*., 2021). Heavy S. mansoni infection increases the risk of anaemia in pregnant women. This can cause maternal mortality or low birth weight babies. The anaemia may be caused by iron loss from urine and feces. Schistosomiasis-related inflammation can cause loss of appetite in pregnant women, leading to poor weight gain and low birth weight babies (Gitau *et al.*, 2017).

Combating Schistosomiasis in Sub-Saharan Africa

Preventive treatment with praziquantel is the main strategy to control schistosomiasis. This has reduced morbidity but has not stopped the disease from recurring (Onasanya *et al.*, 2021). The WHO reported that, by 2010, 34.8 million people in 30 countries received praziquantel, with 250 million tablets donated annually (WHO, 2022). The WHO aims to control schistosomiasis-related illness by 2030 and eliminate the disease in all endemic countries (WHO, 2022).

Even though sub-Saharan Africa faces the highest burden of schistosomiasis, efforts to control the disease were limited until the Schistosomiasis Control Initiatives (SCI) began in 2002 (Bizimana *et al.,* 2019). These initiatives helped launch national programs in countries like Zambia, Mali, Tanzania, Burkina Faso, Niger, and Uganda. However, the programs struggled because mass drug distribution was incomplete. Infants and preschool children were often not treated, and fewer than 50% of the high-risk population received the drug (Bizimana *et al.,* 2019). Additionally, the focus on treating everyone without identifying individual cases led to poor results (Oyeyemi *et al.,* 2020). As a result, morbidity reduction and transmission control were limited.

Before 2013, over US$ 150 million had been spent on schistosomiasis and other neglected tropical diseases (NTDs) in sub-Saharan Africa. In 2013, new funding from the United States increased efforts to combat these diseases (Oyeyemi *et al.,* 2020). However, most sub-Saharan African countries cannot afford the 1.2 billion praziquantel tablets needed to treat 400 million people every year (Mazigo *et al.,* 2019). Therefore, control efforts rely heavily on foreign aid.

While efforts so far have focused on reducing morbidity, there is a clear need for strategies aimed at eliminating the disease (Colley *et al.,* 2020). Vaccines are key to controlling and eradicating diseases, as shown by the 1978 eradication of smallpox. Researchers agree that the introduction of anti-schistosomal vaccines could help control transmission and long-term disease effects (Colley *et al.,* 2020).

2.6.3 Ghana in Focus

Schistosomiasis has a long history in Ghana, with its presence documented as far back as ancient times. Early records indicate that the disease was prevalent in regions surrounding the Volta River (Cunningham *et al*., 2020). The construction of the Akosombo Dam in the 1960s significantly altered the epidemiology of schistosomiasis in Ghana (Adedze-Kpodo *et al*., 2023). The creation of the Volta Lake provided an extensive habitat for freshwater snails, the intermediate hosts for Schistosoma parasites (Zhang *et al*., 2017). This environmental change led to a surge in infection rates among communities living near the lake. Studies from the 1970s and 1980s reported high prevalence rates of *Schistosoma haematobium* and *Schistosoma mansoni*, particularly among school-aged children, who are often in contact with infested waters (Zhang *et al*.,

2017). These findings highlighted the public health impact of schistosomiasis and underscored the need for comprehensive control measures.

In the decades following the construction of the Akosombo Dam, various control efforts were implemented, but the disease remained a significant public health issue (Zhang *et al*., 2017). The 1990s and early 2000s saw continued high prevalence rates in endemic areas, with significant morbidity associated with chronic schistosomiasis (Sokolow *et al*., 2016). Recent epidemiological data indicate a mixed trend, with some regions experiencing a decline in prevalence due to these interventions while others continue to struggle with high infection rates. This uneven progress reflects the ongoing challenges in controlling schistosomiasis in Ghana, including logistical difficulties in reaching remote communities and ensuring compliance with MDA programs (Khieu *et al*., 2019).

Recent Epidemiological Trends of schistosomiasis in Ghana

Ghana's schistosomiasis landscape shows a mixed picture, with notable progress in some areas and persistent challenges in others. Nationwide surveys and localized studies indicate that schistosomiasis remains prevalent, particularly in rural and peri-urban areas with poor sanitation and access to clean water (Anyan *et al*., 2017). A national survey conducted in 2010 found that approximately 23 % of school-aged children were infected with schistosomiasis, with significant regional variations (Aryeetey *et al*., 2013). While some regions have reported a decline in prevalence due to intensified control measures, including mass drug administration (MDA) of praziquantel and snail control programs, other areas continue to exhibit high infection rates. This highlights the need for sustained and targeted interventions to address the persistent transmission hotspots.

More recent studies, such as those by Tetteh-Quarcoo *et al*. (2020), indicate that continuous MDA efforts have led to significant reductions in schistosomiasis prevalence among school children in certain endemic areas. These findings underscore the effectiveness of regular drug administration in reducing the disease burden. However, the epidemiological landscape of schistosomiasis in Ghana remains dynamic, influenced by factors such as population movements, changing environmental conditions, and variability in program implementation. Challenges such as drug resistance, logistical issues in reaching remote populations, and variable compliance with MDA programs persist (Tetteh-Quarcoo *et al*., 2020). Addressing these challenges requires a comprehensive approach that includes improved water, sanitation, and hygiene (WASH) infrastructure, enhanced health education, and robust monitoring and evaluation frameworks to ensure the sustainability of control efforts. The prevalence and transmission dynamics of schistosomiasis in Ghana are heavily influenced by socio-economic and environmental factors (Adenowo *et al*., 2015). Poor sanitation and lack of access to clean water are significant contributors to the persistence of the disease. Many rural and peri-urban communities rely on freshwater sources such as rivers, lakes, and irrigation canals for bathing, washing, and other domestic activities, which increases their exposure to Schistosoma-infested waters (Adekiya *et al*., 2020). The construction of large-scale water projects, such as dams and irrigation systems, has historically created favourable environments for the intermediate snail hosts, thereby facilitating the transmission of schistosomiasis (Aboagye & Edoh, 2021).

Additionally, limited health infrastructure and inadequate health education hinder effective disease management and prevention efforts. Socio-economic factors also play a crucial role in the transmission and control of schistosomiasis. Poverty exacerbates the

risk of infection, as impoverished communities often lack the resources to implement and maintain adequate sanitation facilities. Furthermore, low literacy rates and insufficient health education contribute to poor awareness about the disease and its transmission, reducing the effectiveness of prevention measures. Agricultural practices, such as rice farming, which involve prolonged contact with water, also increase the risk of infection among farmers. The economic burden of schistosomiasis is significant, as it can lead to reduced productivity and educational attainment due to illness, perpetuating the cycle of poverty and disease (Adekiya *et al*., 2020).

2.7 Demographical Associations of Schistomiasis

Schistosomiasis is common in tropical and subtropical areas, especially in poor communities without access to clean drinking water and proper sanitation (Phillips *et al.*, 2022). About 90% of people who need treatment for schistosomiasis live in Africa.

Schistosomiasis mostly affects poor and rural communities, especially those who work in agriculture and fishing. Women who do domestic chores, like washing clothes in contaminated water, are also at risk and may develop female genital schistosomiasis (Adenowo *et al.,* 2015). Children are especially vulnerable because poor hygiene and contact with infected water increase their risk of infection.

Migration to cities and movement of people are spreading the disease to new areas. As populations grow, the need for water and power often leads to changes in the environment that make transmission easier (Ozretich *et al.*, 2022). The rise in eco-tourism and travel to remote areas is also increasing the number of tourists getting schistosomiasis. Some tourists experience severe infections, including unusual problems like paralysis. Urogenital schistosomiasis is also linked to an increased risk of HIV infection, especially

in women (Masong *et al.,* 2021). The geographical distribution of schistosomiasis is presented in Table 2.1

Table 2. 1: Parasite species and geographical distribution of schistosomiasis

	Species	Geographical distribution
Intestinal schistosomiasis	*Schistosoma mansoni*	Africa, the Middle East, the Caribbean, Brazil, Venezuela and Suriname
	Schistosoma japonicum	China, Indonesia, the Philippines
	Schistosoma mekongi	Several districts of Cambodia and the Lao People's Democratic Republic
	Schistosoma guineensis and related *S. intercalated*	Rainforest areas of Central Africa
Urogenital schistosomiasis	*Schistosoma haematobium*	Africa, the Middle East, Corsica (France)

Source: Mawa *et al*., (2021). Schistosomiasis morbidity hotspots: roles of the human host, the parasite and their interface in the development of severe morbidity

Schistosomiasis in Ghana

Schistosomiasis occurs across Ghana, but its distribution varies with local conditions. Environmental factors such as the presence of freshwater bodies, patterns of water use, and sanitation practices strongly influence where the disease thrives. Communities that rely on rivers, lakes, or irrigation systems for daily activities like bathing, fishing, or farming face a higher risk of infection. Socio-economic conditions also play a role, as limited access to clean water and inadequate health services increase vulnerability. Although schistosomiasis has been reported in every region of the country, the burden is greatest in the Northern, Upper East, and Upper West regions. These areas combine extensive freshwater exposure with lower levels of sanitation infrastructure, creating favorable conditions for transmission. Understanding these geographic and social

patterns is essential for targeted control efforts, allowing health programs to prioritize surveillance, education, and preventive measures where they are most needed to reduce infection rates nationwide. (Abass *et al.,* 2020). These areas have limited access to clean water and sanitation, many water bodies, and agricultural practices that increase contact with water. The Volta River Basin, including areas around Lake Volta, is a major hotspot. This area has good conditions for the snails that spread the disease and high levels of human contact with the water (Kulinkina *et al.,* 2017).

Impact of Schistosomiasis in Ghana

Schistosomiasis remains a major public health and economic challenge in Ghana. The World Health Organisation estimates that millions of Ghanaians are at risk of infection, with school-aged children bearing the greatest burden (WHO, 2022). In some endemic communities, more than 70 per cent of children test positive, reflecting the persistent transmission and the limited reach of control programs (Chaparro & Suchdev, 2019). The disease is caused by parasitic worms transmitted through freshwater snails, making communities that rely on rivers and lakes for daily activities especially vulnerable. Repeated exposure during routine tasks such as bathing, swimming, or collecting water sustains infection cycles and increases the risk of chronic illness.

The health consequences are severe and often long-term. Infected children commonly experience anaemia, stunted growth, and cognitive impairment, all of which undermine school performance and future productivity. Adults may suffer progressive damage to vital organs, including the liver, intestines, and urinary tract, which can lead to debilitating complications and reduced economic capacity (Dheda et al., 2017). Addressing this burden requires sustained mass drug administration, improved

sanitation, and community education to reduce contact with contaminated water. Without intensified efforts, schistosomiasis will continue to erode health outcomes and hinder socio-economic development in affected regions of Ghana.

2.7.1 Gender and Schistosomiasis

The distribution of schistosomiasis exhibits distinct patterns concerning age and gender, primarily due to varying water contact behaviours and occupational exposures. Gender-related differences in schistosomiasis prevalence are closely linked to cultural roles and daily activities (Ayabina *et al.,* 2021). In some communities, males exhibit higher infection rates, often due to occupations like fishing or farming that involve prolonged water contact (Ngajilo *et al.,* 2019). Conversely, females may have higher prevalence rates in other settings, especially if they are responsible for household chores such as laundry and water collection from infested sources (Sevilimedu *et al.,* 2016). For example, research in Zambia found higher prevalence among male school children, attributed to activities like swimming and fishing, whereas other studies have reported higher rates in females due to domestic water-related tasks (Sandema *et al.,* 2023).

Additionally, female genital schistosomiasis (FGS) is a significant but often overlooked condition affecting an estimated 56 million women and girls, primarily in sub-Saharan Africa (Jacobson *et al.,* 2022). Symptoms mimic those of sexually transmitted infections, leading to frequent misdiagnoses. FGS can lead to severe reproductive health issues, including pain, organ damage, and infertility, underscoring the need for increased awareness and integration of FGS screening into sexual and reproductive health programs (Wangari *et al.,* 2023). Recent campaigns aim to incorporate FGS treatment into sexual and reproductive health programs, with targets for increased screenings in

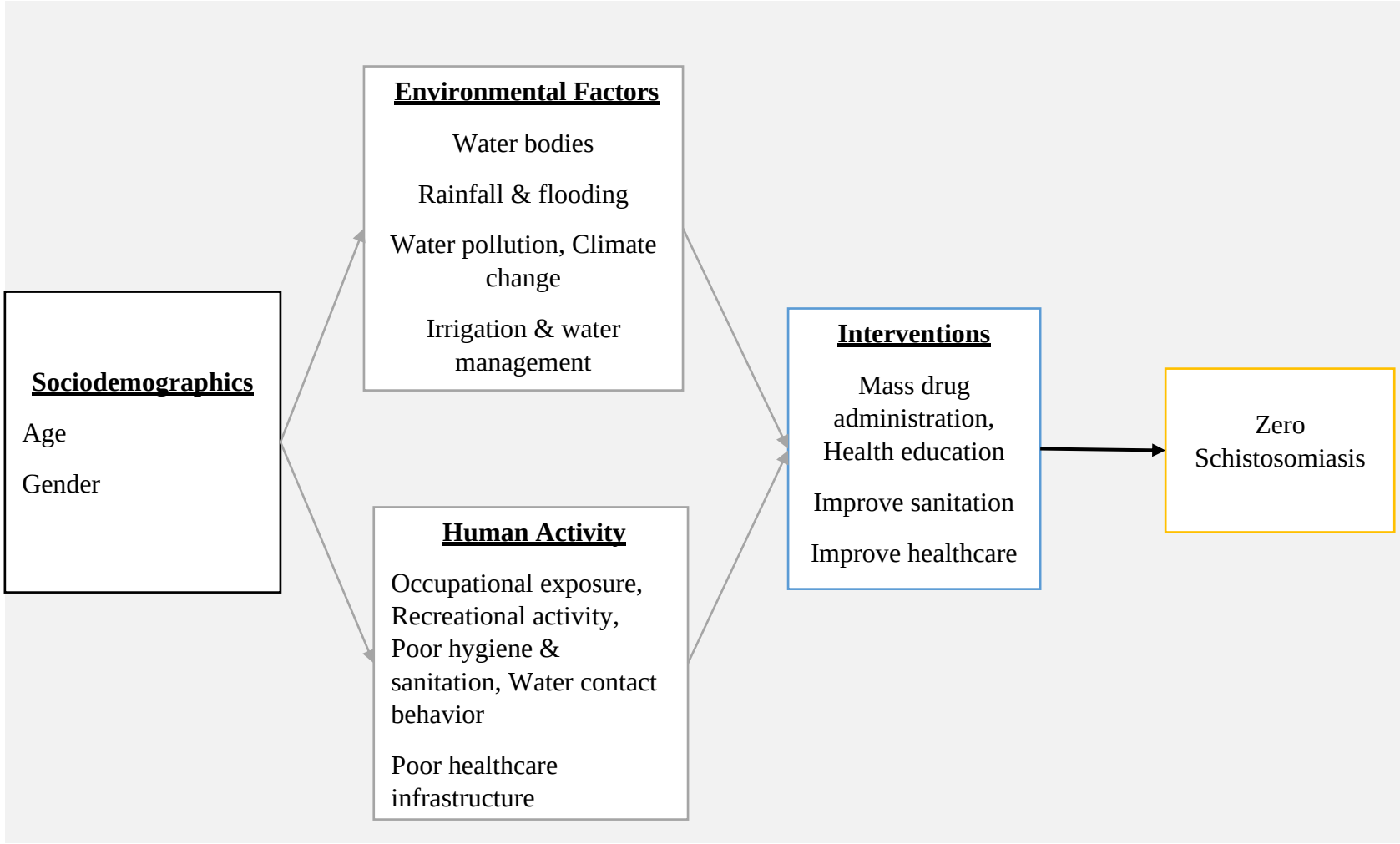
endemic areas. In men, occupational activities such as fishing or farming in contaminated waters can increase exposure risk. Urogenital schistosomiasis in men may lead to pathology of the seminal vesicles, prostate, and other organs, potentially resulting in infertility (Vlassoff *et al.,* 2022).

2.7.2 Age and Schistosomiaisis

In age, schistosomiasis affects all age groups, but school-aged children and adolescents in endemic areas exhibit the highest infection intensities. This heightened vulnerability is attributed to frequent contact with contaminated water during activities like swimming, bathing, and fetching water. In children, the disease can cause anemia, stunting, and reduced learning ability, though these effects are usually reversible with treatment (Pillay *et al.*, 2020).

In many endemic regions, prevalence and infection intensity peak among school-aged children (10–19 years). This trend is attributed to children's frequent engagement in activities such as swimming and playing in infested waters. For instance, studies in Tanzania have reported higher infection rates in individuals under 30 years, with a notable decrease in prevalence among older age groups, possibly due to the development of partial immunity over time (Lamberti *et al.,* 2021).

2.8 Conceptual Framework



CHAPTER THREE

METHODOLOGY

3.1 Research Design

The study employed a retrospective cross-sectional design to assess the trends of schistosomiasis in the Oforikrom Municipality from 2014 to 2023. Secondary data were collected and analyzed from the University Hospital, KNUST, Aninwa Medical Centre, and Graceland Hospital. It sought to investigate the trends in schistosomiasis prevalence and variations in infection rates across demographic groups and identify which segments of the population were most at risk.

3.2 Study Area

The study was conducted in the Oforikrom Municipality of the Ashanti Region of Ghana. Geographically, the municipality lies between latitude 6.35°N and 6.40°S and longitude 1.30°W and 1.35°E, with an elevation ranging between 250 to 300 meters above sea level. This strategic location places Oforikrom within the Kumasi Metropolitan Area, making it an important administrative and economic hub.

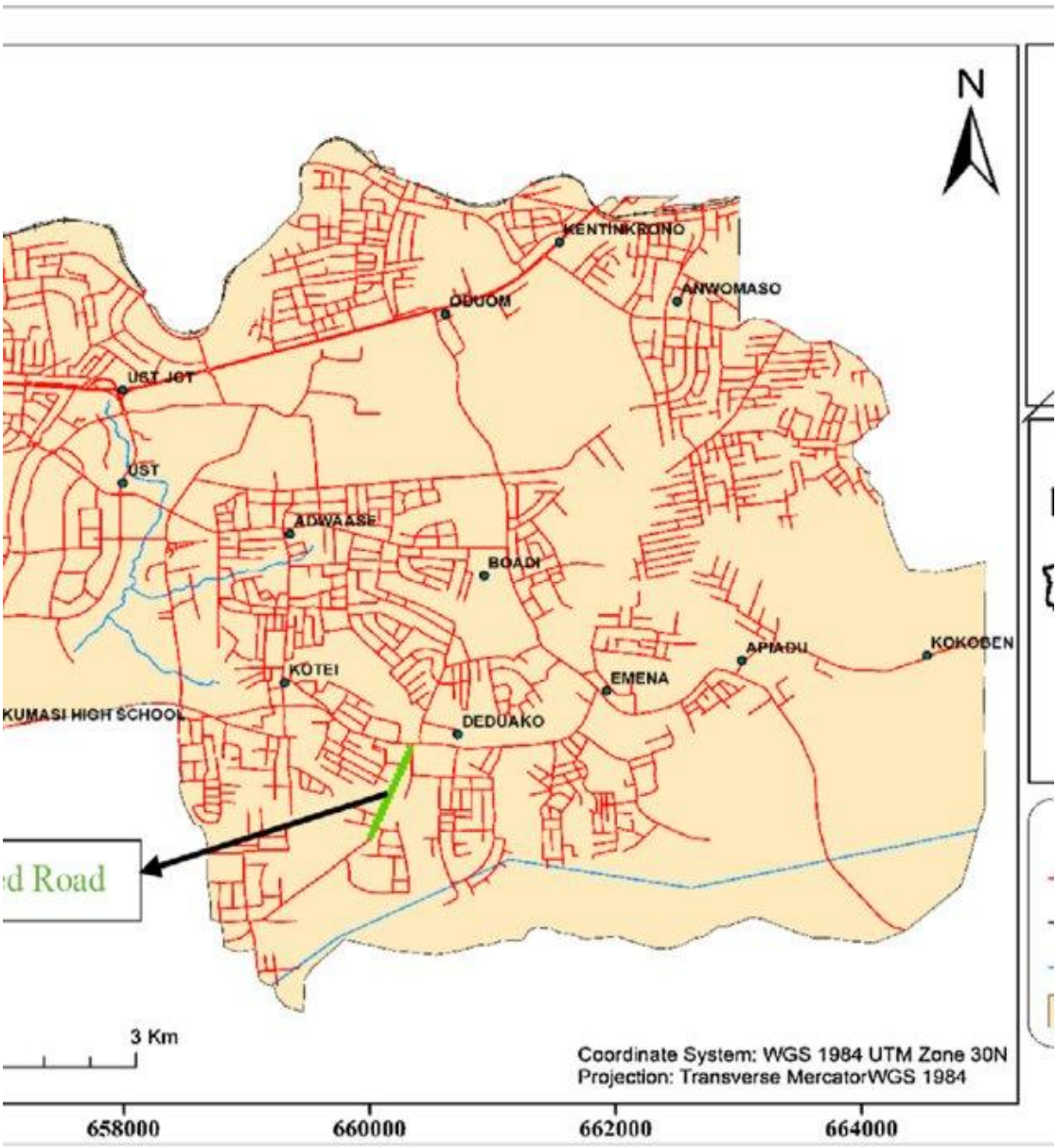


Figure 3. 1: Map of Oforikrom Municipal
(Source: Ghana Statistical Service, 2018)

3.2.1 Land Use and Environmental Factors

The Municipality's topography and environmental features significantly influence human activities and health outcomes. The area experiences a tropical climate characterized by alternating rainy and dry seasons. Rainfall is moderate to heavy between April and October, while the dry season, which extends from November to March, is often marked by dusty conditions and higher temperatures. The combination of urban development and agricultural practices creates both economic opportunities and environmental challenges.

Streams and small rivers, such as the Subin River, flow through the area, increasing the risk of waterborne diseases like schistosomiasis (Darko *et al*., 2022). Seasonal flooding in parts of the Municipality exacerbates the spread of diseases, as it provides breeding grounds for snails that act as intermediate hosts for the Schistosoma parasites responsible for schistosomiasis transmission (Stothard *et al*., 2020).

3.2.2 Economic Activities

Despite rapid urbanisation, subsistence agriculture remains a significant economic activity in Oforikrom, particularly in peri-urban communities. The residents primarily cultivate vegetables such as carrots, cabbage, lettuce, green peppers, and spring onions. Livestock rearing, including chickens, goats, sheep, cattle, pigs, and small-scale fish farming, is also practised to supplement household incomes. However, the agricultural sector faces challenges due to increasing urbanisation, which pressures land availability and water resources. Farmers depend heavily on streams and other open water sources for irrigation, increasing the potential exposure to contaminated water and raising public health concerns (Adubofour *et al*., 2019).

3.2.3 Health Facilities

The Municipality's health infrastructure includes public and private healthcare facilities, such as Aninwa Medical Centre, which plays a pivotal role in managing diseases, including schistosomiasis. The Ghana Health Service has identified the need for mass drug administration programs and public health education campaigns to reduce the incidence of waterborne diseases within the municipality (World Health Organization, 2022) due to increased risk. The mix of urban infrastructure, agricultural activities, and environmental vulnerabilities makes Oforikrom Municipality a significant area of study

for assessing the dynamics of schistosomiasis transmission and the effectiveness of control measures.

3.3 Data Source and Sampling Strategy

The study adopted a purposive sampling technique to select hospitals in Oforikrom Municipality. Three hospitals out of eight namely University Hospital- KNUST, Aninwa Medical Centre, and Graceland Hospital which have data on schistosomiasis from 2014 to 2023 were purposively selected for the study. These hospitals were selected based on their accessibility and their role as key healthcare providers in the Municipality.

3.4 Inclusion and Exclusion Criteria

This study focused on University Hospital-KNUST, Aninwa Medical Centre, and Graceland Hospital, facilities with laboratories that have data on schistosomiasis from 2014 to 2023. Eligible participants included individuals of all ages who sought treatment for schistosomiasis at the selected facilities. However, hospitals or clinics without laboratories or schistosomiasis data from 2014 to 2023 were not included in this research.

3.5 Data Collection

The study collected secondary data on schistosomiasis prevalence from the records of three healthcare facilities: University Hospital, KNUST, Aninwa Medical Centre, and Graceland Hospital. Data were obtained from the hospitals' patient databases, specifically on individuals diagnosed with schistosomiasis between 2014 and 2023.

3.6 Target Population

The target population for this study comprised individuals diagnosed with schistosomiasis who sought treatment at University Hospital, KNUST, Aninwa Medical Centre, and Graceland Hospital between 2014 and 2023. This population included male and female patients across various age groups, specifically children, adolescents, and adults, who were recorded in the hospital databases for schistosomiasis-related consultations, diagnoses, or treatments.

3.7 Statistical Analysis

The data analysis for this study involved a quantitative approach to evaluate the prevalence of schistosomiasis in Oforikrom Municipality based on secondary data obtained from the University Hospital, KNUST, Aninwa Medical Centre, and Graceland Hospital.

3.7.1 Objective One

Descriptive statistics was employed to summarise the demographic characteristics of individuals diagnosed with schistosomiasis, such as gender, age, and geographical location, and the relative risk with these characteristics. To investigate the relationship between age, gender, and schistosomiasis prevalence in the Oforikrom Municipality, contingency tables were constructed to display the frequency distribution of these variables.

3.7.2 Objective Two

With the reported prevalence of the study period, a trend analysis was applied to capture the overall pattern of the disease, allowing for the identification of seasonal patterns and fluctuations in the disease prevalence.

3.7.3 Objective Three

With the plotted trends and prevalence of the study period and trend analyses, the yearly percentage change in prevalence was calculated to evaluate the control and preventive measures of schistosomiasis in the Oforikrom Municipality over the period.

3.8 Ethical Approval

This study was approved by the Ethics Committee of KNUST (Reference number: CHRPE/AP/497/24) after submitting an ethical application. Permission was obtained to use secondary data from the facilities. To ensure data protection and confidentiality, the research adhered to strict protocols including, anonymizing facility and participant data, securing data storage and access, and complying with relevant data protection regulations.

CHAPTER FOUR

RESULTS

4.1 Introduction

This Chapter presents the findings of the study in a comprehensive analysis of the epidemiological trend of schistosomiasis in the Oforikrom Municipality of the Ashanti region of Ghana. This study assessed the trends and prevalence of schistosomiasis, examined the association between demographic characteristics and the prevalence of schistosomiasis, and evaluated the control and preventive measures for schistosomiasis in the Oforikrom Municipality over the study period. The findings are presented through rigorous quantitative data analysis, supported by relevant up-to-date publications. The chapter concludes by synthesizing key findings, thereby laying the groundwork for the ensuing discussion and evidence-based recommendations that follow.

4.2 The demographic characteristics associated with the prevalence of schistosomiasis in the Oforikrom Municipality.

Descriptive statistics was employed to summarise the demographic characteristics of individuals diagnosed with schistosomiasis, such as gender, age, and geographical location, and the relative risk with these characteristics. Contingency tables were used to examine the relationship between age, gender, and schistosomiasis prevalence in the Oforikrom Municipality by creating contingency tables displaying these variables' frequency distribution.

4.2.1 Sex Distribution of Schistosomiasis Cases in Oforikrom Municipality (2014-2023)

Schistosomiasis cases in Oforikrom Municipality from 2014 to 2018 displayed fluctuating gender distribution. Females slightly outnumbered males in 2014, and this gap widened in 2015, with females making up 62.9% of cases. The trend reversed in 2016 and 2018, with males accounting for 51.61% and 57.35%, respectively. A slight female majority reappeared in 2017. See table 4.1

Table 4.1. Sex distribution of schistosomiasis cases in Oforikrom Municipality.

Year	Male (n)	Percentage (%)	Female (n)	Percentage (%)
2014	29	48.33	31	51.67
2015	23	37.10	39	62.90
2016	32	51.61	30	48.39
2017	30	46.15	35	53.85
2018	39	57.35	29	42.65
2019	31	50.82	30	49.18
2020	29	48.33	31	51.67
2021	34	50.00	34	50.00
2022	32	50.79	31	49.21
2023	24	47.06	27	52.94
Total	**303**	**48.87**	**317**	**51.13**

Source: (Existing Hospital data, 2024)

4.2.2 Sex Distribution of Schistosomiasis cases across the selected facilities in Oforikrom Municipality (2014-2023)

The sex distribution of schistosomiasis cases in Oforikrom Municipality from 2014 to 2023. Among the selected facilities, females accounted for a slight majority of schistosomiasis cases (317) over males (303). Aninwa Medical Centre reported the highest number of cases (263), followed by University Hospital-KNUST (217), and

Graceland Hospital (140). Each facility displayed a relatively balanced gender distribution. See table 4.2

Table 4.2: Sex Distribution of Schistosomiasis Cases across the selected facilities in Oforikrom Municipality (2014-2023).

Facility	Male Cases	Female Cases	Total Cases	Percentage
University Hospital, KNUST	104	113	217	**35.00**
Aninwa Medical Centre	132	131	263	**42.42**
Graceland Hospital	67	73	140	**22.58**
Overall Total	**303**	**317**	**620**	**100**

Source: (Existing Hospital data, 2024)

4.2.3 Age Distribution of Schistosomiasis Cases Across Selected Facilities in Oforikrom Municipality (2014-2023)

The schistosomiasis cases recorded across three hospitals, categorised by age group. The highest number of cases was among individuals aged 21–30 years (189 cases, 30%), followed by those aged 11–20 years (148 cases, 23.9%) and over 10 years (83 cases, 13.4%). The fewest cases were in the 61–70 years group (15 cases, 3.1%). University Hospital recorded the most cases in the 11–20 years group, Aninwa Hospital in the 21–30 years group, and Graceland Hospital also in the 21–30 years group. Overall, 620 cases were reported, with cases mainly occurring in younger age groups across all hospitals. See table 4.3

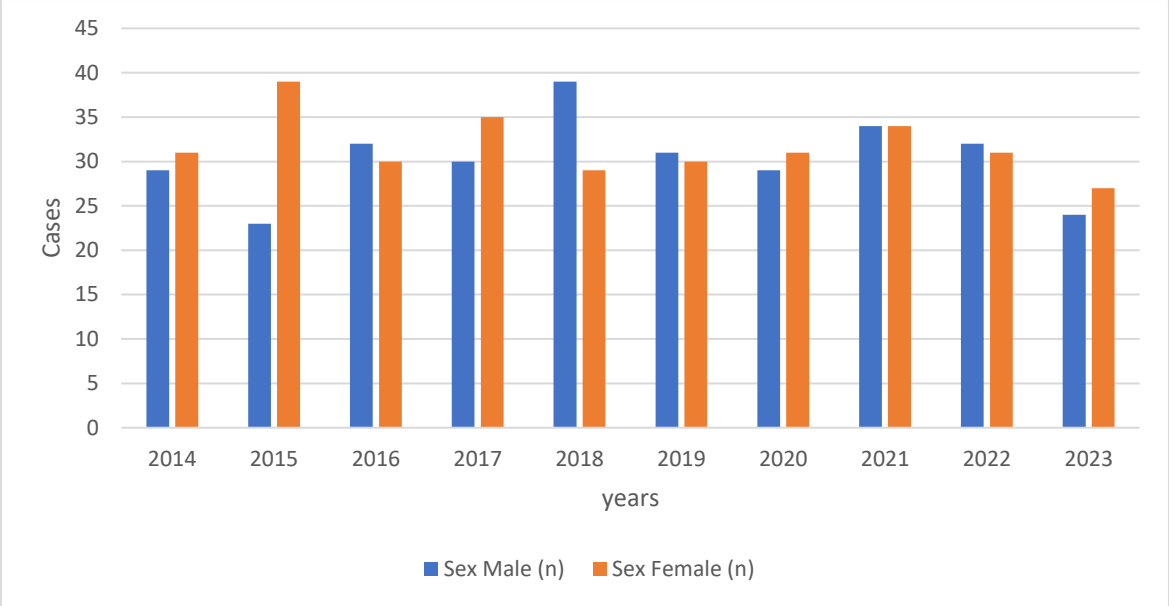
Table 4.3 Age Distribution of Schistosomiasis Cases Across Selected Facilities in Oforikrom Municipality (2014-2023)

Age Group	Uni. Hosp.	Aninwa Hosp.	Graceland Hosp.	Total	Percentage
≤ 10 years	46	29	8	83	13.4
11- 20 years	55	58	35	148	23.9
21- 30 years	34	86	69	189	30.0
31- 40 years	28	42	12	82	13.0
41- 50 years	26	25	9	60	9.7
51- 60 years	23	15	5	43	6.9
61- 70years	5	8	2	15	3.1
Total	**217**	**263**	**140**	**620**	**100**

Source: (Existing Hospital data, 2024)

4.2.4 Total Schistosomiasis cases across age and sex groups in all hospitals

The gender distribution of schistosomiasis cases across age groups in the Oforikrom Municipality. The highest percentage was recorded in the 21–30 years group (30.0%), followed by 11–20 years (23.9%). The lowest was 61–70 years (3.1%). University Hospital reported 217 cases, Aninwa 263, and Graceland 140, making a total of 620 cases. Most cases are found in individuals aged 11–40 years, indicating a higher prevalence among young and middle-aged adults. See figure 4.1



Source: (Existing Hospital data, 2024)

Figure 4.1: Total Schistosomiasis Cases across Age and sex Groups in All Hospitals (2014–2023*)*

4.3 Prevalence of Schistosomiasis Infection among the Selected Facilities.

The study recorded 620 confirmed cases, with a prevalence of 15.82%. University Hospital (18.08%) and Aninwa Hospital (17.37%) reported higher prevalence rates than Graceland Hospital (11.62%). A significant difference was observed among the three hospitals (p = 0.006, 95% CI: 6.89–24.49). See Table 4.4

Table 4.4: Prevalence of Schistosomiasis among the Selected Facilities.

Facilities	Confirmed Cases	Number of Patients	Prevalence (%)	ANOVA (95%CI) P-Value
University Hosp. (KNUST)	217	1200	18.08	
Aninwa Hosp.	263	1514	17.37	25.10 (6.89-24.49) 0.006
Graceland Hosp.	140	1204	11.62	
Total	**620**	**3918**	**15.82**	

Source: Existing Hospital data (2024)

4.3.1 Overall trends and prevalence of Schistosomiasis for the study period in all selected facilities

The overall trend and prevalence of schistosomiasis in Oforikrom Municipality from 2014 to 2023. Prevalence peaked in 2014 at 20.07% but sharply declined to 14.09% in 2015. It rose again, reaching a secondary peak of 18.38% in 2018, then fluctuated slightly before climbing to 18.00% in 2022. A significant drop occurred in 2023, with prevalence falling to 11.83%, the lowest within the past ten years, suggesting possible improvements in control measures. See figure 4.2

4.3.2 Trends and prevalence of Schistosomiasis for the study period in all selected facilities (2014-2023)

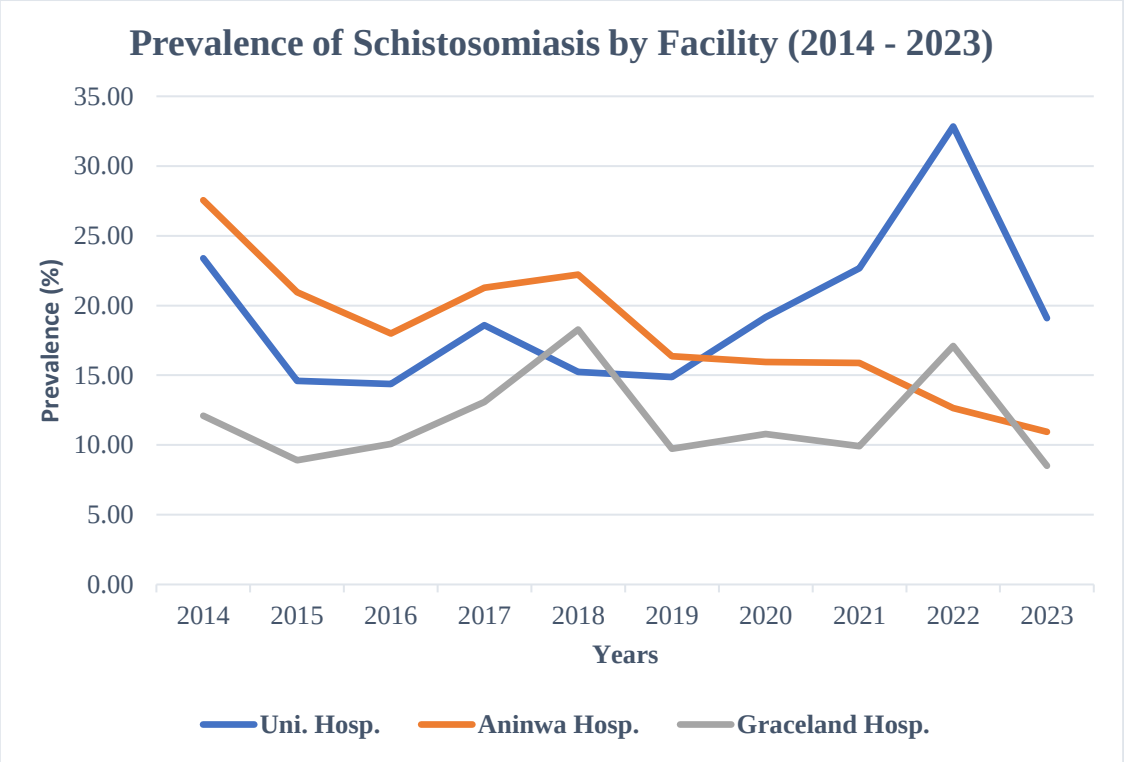
Figure 4.2 Annual Schistosomiasis Cases across all Selected Facilities (2014-2023)

(Source: Existing Hospital data, 2024)

4.3.3 Overall trend of Schistosomiasis prevalence across the selected facilities (2014-2023)

The prevalence of schistosomiasis by facility in Oforikrom Municipality from 2014 to 2023. Aninwa Hospital started with the highest prevalence 27% in 2014 but showed a steady decline over the years. University Hospital-KNUST saw fluctuations, peaking sharply 32% in 2022 before dropping in 2023. Graceland Hospital recorded the lowest 20% and most stable prevalence overall, with minor fluctuations and a slight decline towards 2023 across all three facilities. See figure 4.3.

4.3.4 Overall trend of *Schistosomiasis* across all the selected facilities in the Municipality (2014-2023).



(Source: Existing Hospital data, 2024)

Figure 4.3: Overall trend of Schistosomiasis prevalence across the selected facilities (2014-2023)

4.3.5 Geographical Distribution of Schistosomiasis Cases

The distribution of schistosomiasis cases across health facilities in Oforikrom Municipality from 2014 to 2023 revealed notable variations in intensity and spread. Facilities F and E recorded the highest number of cases, indicated by larger red triangles. Facility F, located in the southeastern part of the Municipality, consistently reported high case rates throughout the years. Facility E, situated in the northeast, began registering increased cases from 2016 onward. In contrast, Facilities C, D, and A reported fewer cases, illustrated by smaller grey triangles, with minimal growth over time. Overall, the years 2015, 2016, 2018, and 2023 saw a marked rise in cases, particularly in Facilities F and E, which emerged as disease hotspots. See figure 4.4a&4.4b

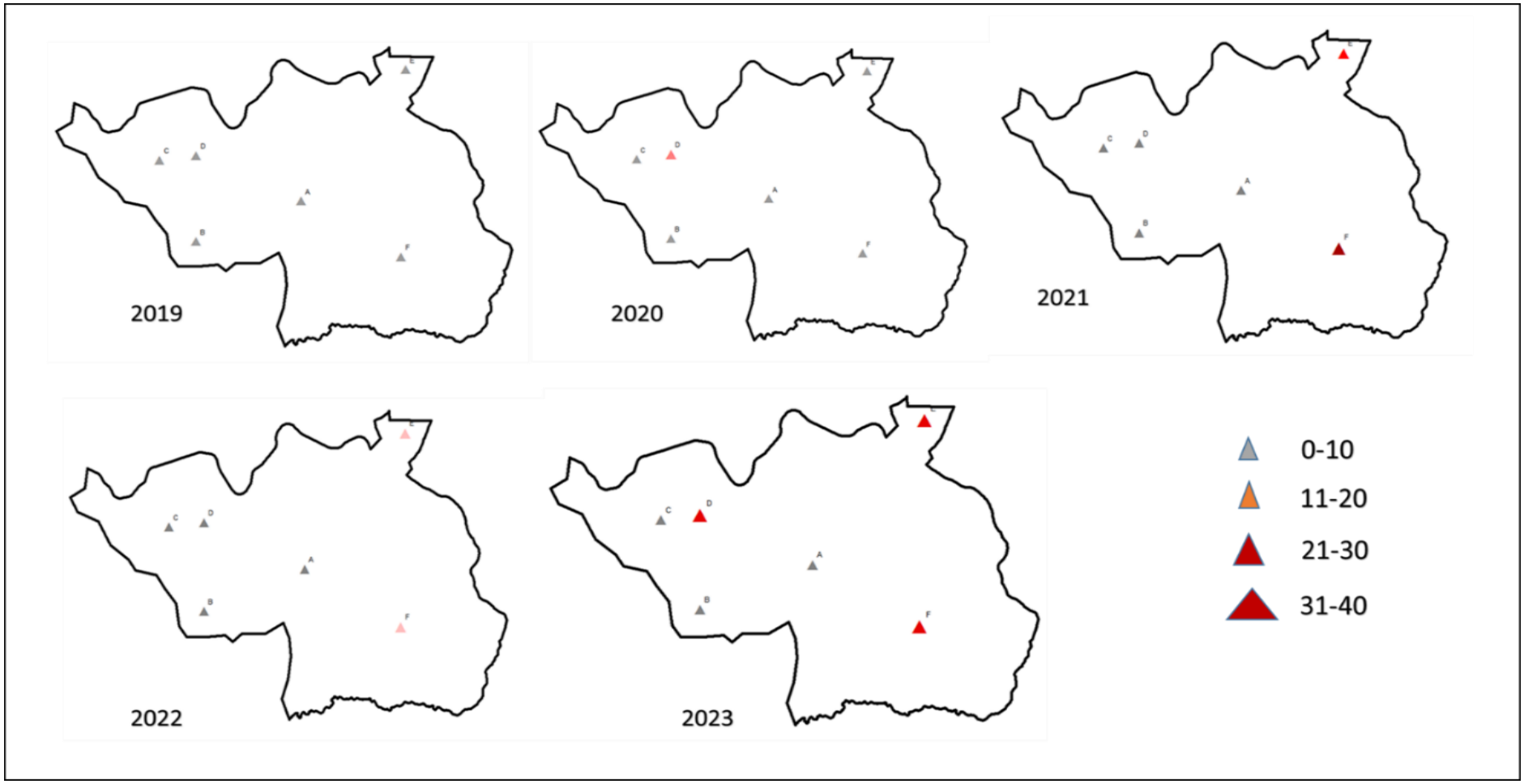


Figure 4.4a: Distribution of Schistosomiasis Cases in Health Facilities from 2014-2023. D - KNUST Hospital, E- Aninwa Medical Centre, F- Graceland Hospital.

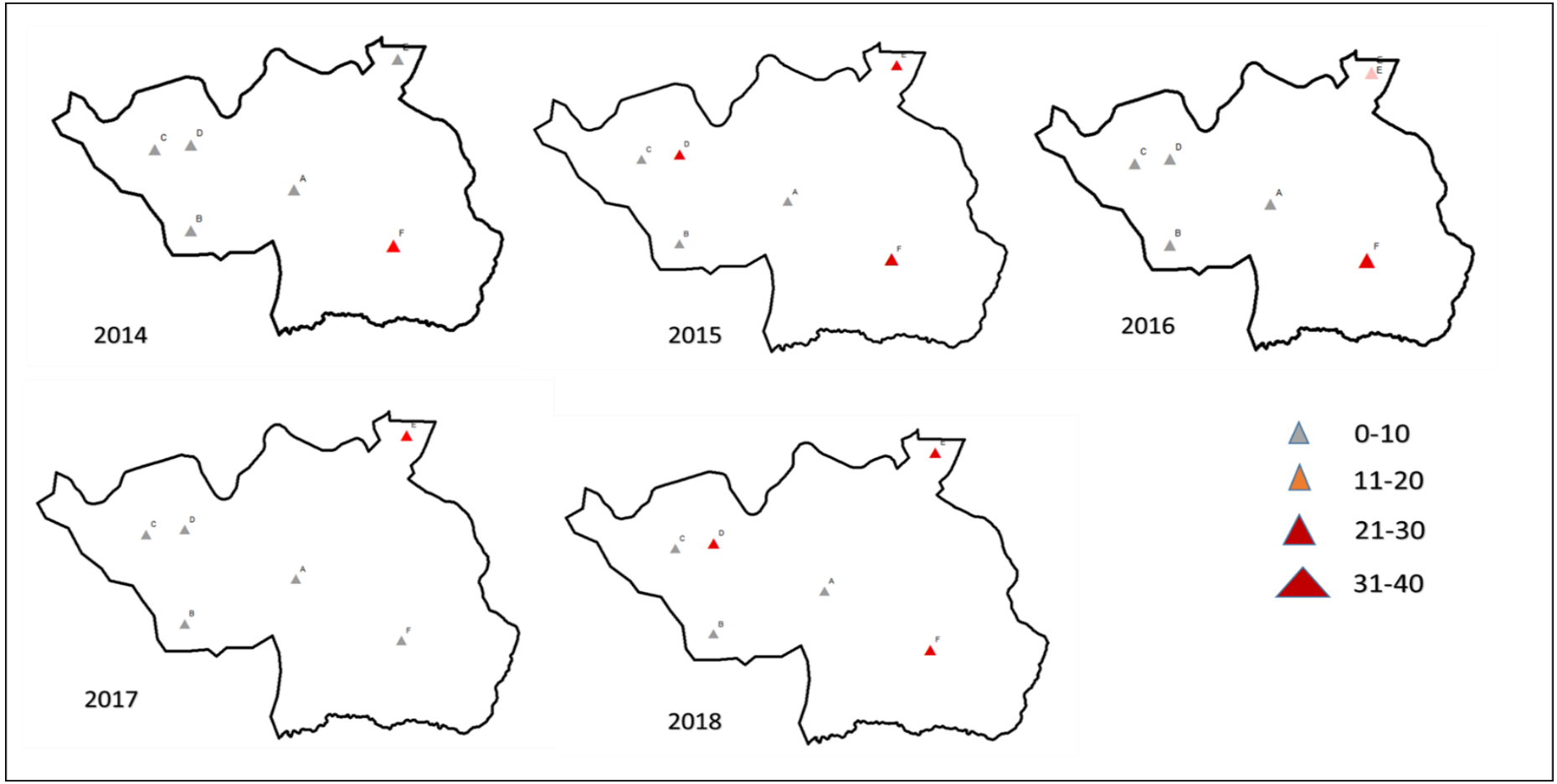
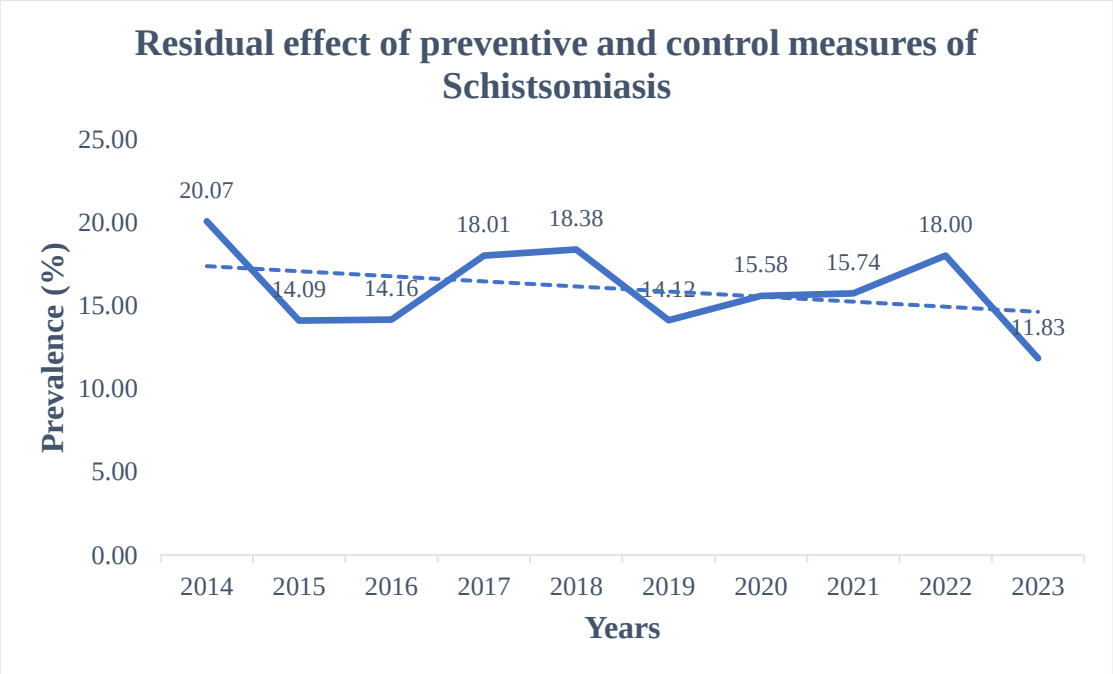


Figure 4.4b: Distribution of Schistosomiasis Cases in Health Facilities from 2014-2023, D- KNUST Hospital,E- Aninwaa Medical Centre, F- Graceland Hospital

4.4 The control and preventive measures of Schistosomiasis in the Oforikrom Municipality

The residual effects of schistosomiasis prevention and control measures from 2014 to 2023. Prevalence began at 20.07% in 2014, declined sharply to 14.09% in 2015, and fluctuated over the following years, peaking at 18.38% in 2018 and 18.00% in 2022. A significant decrease occurred in 2023, reaching 11.83%. The linear trendline reveals a gradual overall decline, indicating the sustained impact of intervention efforts. See figure 4.5.

4.4.1 Residual effect of the preventive and control measures implemented in fighting the rise in the incidence and prevalence of *Schistosomiasis* in the Oforikrom Municipality 2014 – 2023.



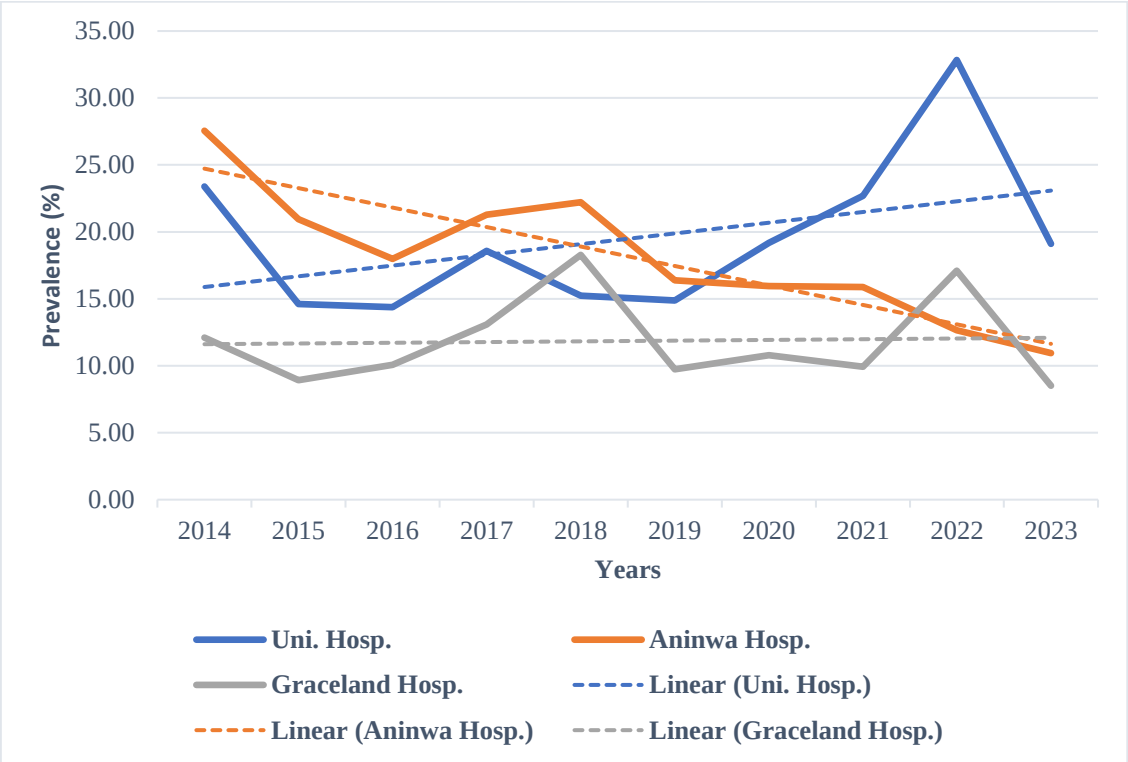
(Source: Existing Hospital data, 2024)

Figure 4.5 Residual effect of preventive and control measures of schistosomiasis across all selected facilities (2014-2023)

4.4.2 Residual effect of preventive and control measures of *Schistosomiasis* across the selected facilities (2014 - 2023).

The residual effects of schistosomiasis prevention and control measures across three facilities between 2014 and 2023. Aninwa Hospital exhibits a consistent downward trend, reflecting a steady decline in prevalence. Graceland Hospital remains relatively stable, with a modest reduction. In contrast, University Hospital displays an upward trajectory amid fluctuations, suggesting a limited long-term impact. See figure 4.6

4.4.3 Residual effect of preventive and control measures of *Schistosomiasis* across the selected facilities (2014 - 2023).



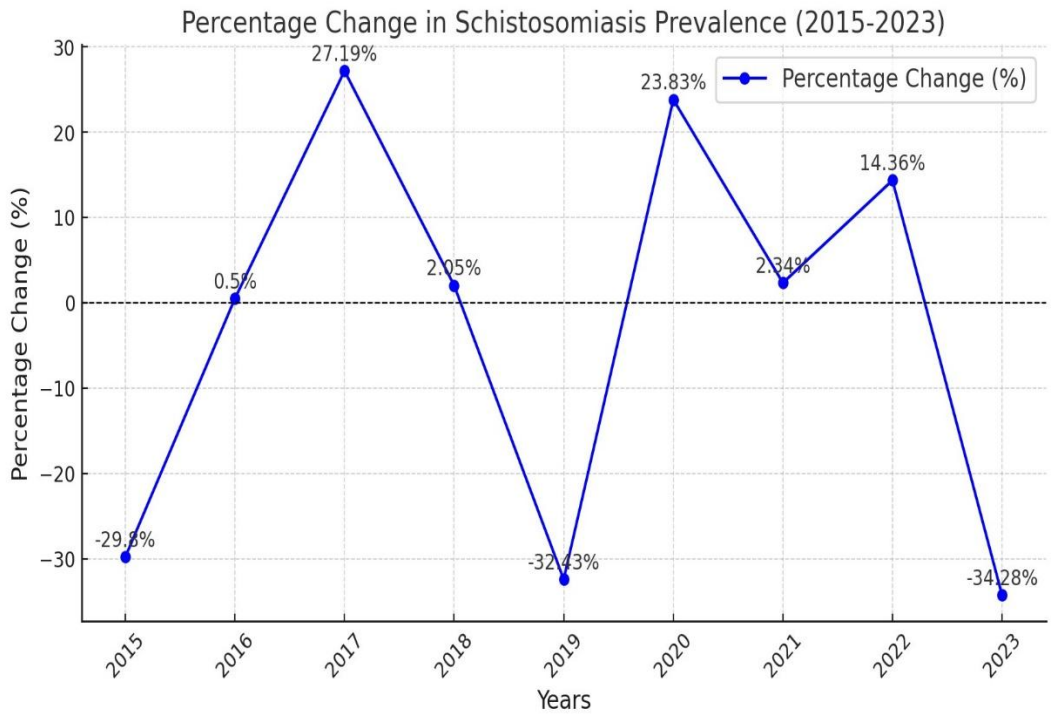
(Source: Existing Hospital data, 2024)

Figure 4.6: Overall trend lines of Schistosomiasis prevalence across the selected health facilities (2014-2023)

4.4.4 Percentage change in disease prevalence across all the selected facilities in the Oforikrom Municipality (2014 - 2023).

The percentage change in schistosomiasis prevalence from 2014 to 2023 showed a fluctuating pattern. A modest decline of 2.34% occurred in 2021, while more substantial drops were recorded in 2019 and 2023, with reductions of 32.43% and 34.28% respectively, indicating marked variability in disease trends over time. See figure 4.7

4.4.5 Percentage change in disease prevalence across all the selected facilities in the Oforikrom Municipality (2014 - 2023).



(Source: Existing Hospital data, 2024)

Figure 4.7: Percentage change in Schistosomiasis prevalence across the selected health facilities (2014-2023)

CHAPTER FIVE

DISCUSSION

5.1 The demographic characteristics associated with the prevalence of schistosomiasis in the Oforikrom Municipality.

The findings from this study illustrated the demographic patterns of schistosomiasis in the target population, revealing significant insights into the age and gender dynamics associated with the disease. The analysis of the disease prevalence by gender and age reveals significant variations as part of its demographics that underscore the necessity for targeted public health interventions.

5.1.1 Gender Distribution of *Schistosomiasis* Cases in Oforikrom Municipality (2014-2023)

The gender distribution of schistosomiasis cases in Oforikrom Municipality between 2014 and 2018, as presented in Table 4.1, demonstrates a fluctuating trend with no consistent gender dominance. Females constituted the majority in 2014 and particularly in 2015. However, this pattern reversed in 2016 and 2018, with males representing a larger proportion of cases. In 2017, the distribution shifted again, showing a slight female majority. These irregularities indicate that gender alone may not be a reliable predictor of schistosomiasis prevalence, highlighting the need to consider additional factors such as occupational exposure, access to water sources, and health-seeking behaviour.

The current study supports the research conducted by Danso-Appiah *et al*. (2016) in southern Ghana, who reported higher schistosomiasis prevalence among males, attributing this to their frequent contact with contaminated water through occupational and recreational activities. Similarly, Ekpo *et al*. (2018) also found that males generally

exhibit higher schistosomiasis prevalence than females, with pooled male-to-female infection ratios of 1.20 for S. haematobium and 1.15 for S. mansoni. These findings differ from the Oforikrom data in 2014 and 2015, where females accounted for the majority of cases. This contrast may reflect localised practices in Oforikrom, where women and girls often handle domestic tasks involving water contact, such as laundry and bathing children in rivers or streams, thereby increasing their exposure to infection.

The findings, therefore, highlight the importance of prioritising sex-disaggregated data collection to better understand gender-specific risk factors and guide targeted interventions. Additionally, community education programmes that address both male and female exposure risks, emphasising safe water practices and the importance of early treatment, should be implemented.

5.1.2 Age Distribution of Schistosomiasis Cases Across Selected Facilities in Oforikrom Municipality (2014-2023).

The gender distribution of schistosomiasis cases recorded across selected health facilities in Oforikrom Municipality from 2014 to 2023 shows a slight female predominance, with 317 cases compared to 303 among males. This near parity contrasts with common trends in schistosomiasis literature, which usually report higher male prevalence due to gendered occupational exposure, particularly in endemic regions.

Multiple studies across sub-Saharan Africa have consistently demonstrated that males are disproportionately affected by schistosomiasis, mainly because of increased contact with contaminated water during agricultural, fishing, and recreational activities. For example, Karanja *et al*. (2021) reported a male-to-female infection ratio of approximately

2:1 among school-aged children in Kenya. Likewise, Ezeamama *et al*. (2020) observed higher male prevalence in Nigeria, attributing this to behavioural and socio-cultural roles that expose boys and men to greater risk.

In contrast, the slight female majority seen in the Oforikrom dataset may reflect localised contextual factors. Women in peri-urban and informal settlements within the municipality are often exposed to infected water sources through domestic activities such as laundry, bathing children, and fetching water. This aligns with findings by Ampomah and Owusu (2019), who recorded increased female vulnerability in urbanising Ghanaian communities with inadequate water infrastructure and heavy reliance on surface water.
The relatively balanced gender distribution across Aninwa Medical Centre, University Hospital-KNUST, and Graceland Hospital highlights changing risk patterns in urban health settings. Aninwa Medical Centre, which recorded the highest number of cases, may serve communities with higher exposure risks due to poor sanitation and limited access to clean water. University Hospital-KNUST's substantial case count likely reflects its role as a tertiary referral centre serving a diverse population. Graceland Hospital, with the lowest number of cases, may benefit from a smaller catchment area or more effective community-level interventions.

These findings highlight the need for a nuanced approach to schistosomiasis control, one that recognises both occupational and domestic exposure pathways. Intervention strategies should go beyond male-centric programmes to actively include women and girls in community awareness, routine screening, and targeted prevention efforts.

5.2 The trends and prevalence of schistosomiasis across all the selected facilities in the Oforikrom Municipality (2014-2023).

The trend in schistosomiasis prevalence in Oforikrom Municipality from 2014 to 2023 reflects both progress and challenges in disease control. The data show a peak in 2014 at 20.07%, followed by a sharp drop to 14.09% in 2015, which may indicate the immediate impact of intensified control measures such as mass drug administration (MDA), improved sanitation, or health education campaigns. However, the subsequent rise to 18.38% in 2018 suggests these interventions may not have been sustained or fully effective. The prevalence remained moderately high through 2022, with another peak at 18.00%, before dropping markedly to 11.83% in 2023, the lowest in the observed period. Compared to other recent studies, these results are mixed. A study by Danso-Appiah *et al*. (2020) examining schistosomiasis in southern Ghana found similarly high prevalence rates in communities with limited access to clean water and health infrastructure, but also highlighted significant gains in areas with regular MDA and health promotion. Another study in Northern region of Ghana by Olivera *et al*. (2022) observed a more consistent downward trend in prevalence over a decade, largely attributed to integrated control strategies combining MDA, water infrastructure improvements, and school-based health education.

The disparity between Oforikrom and other areas showing more consistent declines could stem from several factors. First, the fluctuation in Oforikrom may point to lapses in program continuity, such as interruptions in drug supply, limited coverage of treatment programs, or poor follow-up. Secondly, environmental conditions and population movement, especially in peri-urban and rapidly growing communities like Oforikrom, can complicate control efforts by introducing or sustaining transmission hotspots. In

contrast, smaller or more rural communities with stable populations may achieve better long-term results with targeted interventions.

The significant drop in prevalence to 11.83% in 2023 is encouraging and may reflect recent improvements, possibly including expanded community outreach, better coordination among health facilities, or investments in sanitation and hygiene. However, sustaining this decline requires consistent efforts. Suggestions for further improvement include: ensuring regular and comprehensive MDA coverage, particularly among school-aged children; strengthening community-based surveillance systems; promoting the use of protective measures among high-risk groups; and addressing environmental risk factors such as stagnant water bodies that support snail vectors.

5.2.1 Geographical Distribution of Schistosomiasis Cases in Health Facilities

The spatial and temporal distribution of schistosomiasis cases in Oforikrom Municipality from 2014 to 2023 highlights important patterns in disease intensity and location-specific burden. Facilities F and E stood out with significantly higher reported cases, indicating potential localised transmission hotspots. Facility F maintained consistently high levels across the decade, suggesting persistent environmental or behavioural risk factors that have not been adequately addressed. Facility E, on the other hand, saw a sharp increase in cases from 2016 onwards, which may point to emerging risk dynamics or improved case detection in that area. Conversely, Facilities C, D, and A consistently recorded fewer cases with minimal increases over time, suggesting either lower endemicity, better control measures, or underreporting.

Several studies across sub-Saharan Africa have documented similar geographic clustering of schistosomiasis. For instance, research from northern Ghana by Anto *et al*. (2021) observed that disease distribution often corresponds to proximity to freshwater bodies, poor sanitation, and occupational exposure such as farming or fishing. In a recent study in Tanzania, Mwakitalu *et al*. (2023) also found that certain health districts repeatedly reported high incidence rates due to stagnant water bodies and limited access to health education. These findings align with the observed persistence of high cases in Facility F in Oforikrom, likely linked to unaddressed environmental conditions or insufficient community interventions. However, the emergence of Facility E as a newer hotspot after 2016 shows a divergence from the trend of static transmission zones, suggesting either expanding disease ecology or changing human behaviours such as increased migration or settlement patterns.

The disparity in case numbers among the facilities also raises questions about surveillance quality, diagnostic capacity, and health-seeking behaviour. It is possible that Facilities C, D, and A have less robust reporting systems, or that populations served by those centres have reduced exposure risks. The current study highlights the need for targeted interventions that are urgently needed in Facilities F and E, particularly environmental management, snail control, health education, and increased treatment coverage. Moreover, the study's result also calls for a review of surveillance practices across the municipality to ensure accurate case reporting. Finally, the findings reinforce the importance of localised data in guiding schistosomiasis control programs and stress the need for continuous monitoring to detect emerging hotspots and guide effective resource allocation.

5.3 The control and preventive measures of schistosomiasis in the Oforikrom Municipality

The results from the study revealed a generally declining trend in the prevalence of schistosomiasis in the study area between 2014 and 2023, with a decrease from 20. 20.07% to 11. 83%. Although interrupted by occasional spikes in 2018 and 2022, this pattern suggests that efforts towards schistosomiasis control and prevention are having a measurable impact. The overall downward trend aligns with findings from several other studies across sub-Saharan Africa and endemic regions worldwide.

For example, Danso-Appiah *et al.* (2022), investigating mass drug administration (MDA) outcomes in Ghana, reported a steady decline in infection rates where MDA was consistently combined with health education. Similarly, the World Health Organisation (2023) global updates show that expanding preventive chemotherapy and water, sanitation, and hygiene (WASH) programs in endemic areas has contributed to lowering the overall disease burden. These findings reinforce the implication of your trendline data, that long-term investments in control strategies tend to produce positive results over time.

However, the spikes in 2018 (18. 38%) and 2022 (18. 00%) indicate periodic setbacks, which align with findings from Atalabi *et al.* (2020) in Nigeria, who observed that prevalence can bounce back without ongoing control measures, poor environmental sanitation, or when communities become non- compliant with repeated MDA cycles. These fluctuations may also reflect seasonal changes, reinfection rates, or local programme inconsistencies, as noted by Mazigo *et al.* (2021) in Tanzania.

The current study indicates that schistosomiasis control efforts over the past decade have been largely effective but not without setbacks. The significant drop from 20.07. 07% in 2014 to 11. 83% in 2023, along with a downward linear trend, supports the idea of cumulative benefits from long-term interventions. Nonetheless, the intermittent increases in prevalence highlight that these efforts remain vulnerable to disruption and that gains can be reversed without ongoing investment and vigilance.

Furthermore, the data highlights the importance of maintaining both biomedical and environmental strategies. Drug-based interventions alone may not completely halt transmission in the presence of contaminated water sources and low health literacy, as also emphasised by Colley et al. (2022).

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

This study assessed the prevalence of schistosomiasis, factors influencing its variations, and the impact of past control interventions in the Oforikrom Municipality. The analysis of schistosomiasis prevalence trends in Oforikrom Municipality, encompassing the University Hospital, KNUST, Aninwa Medical Centre, and Graceland Hospital, revealed distinct fluctuations from 2014 to 2023. The gender distribution showed no consistent dominance, with a slight female predominance overall, contrasting with broader sub-Saharan African studies that typically report higher male prevalence. This anomaly may stem from local factors, particularly women's domestic roles involving frequent contact with contaminated water. The near-equal male-to-female case ratio suggests the need for sex-disaggregated data and inclusive interventions that address both occupational and domestic exposure. Over time, efforts like improved water sanitation and health education were associated with declining cases, particularly at University Hospital, KNUST, where incidence rates reached their lowest in 2023. A gender-based analysis indicated an initial dominance of male cases attributed to occupational exposure, which later reversed as females showed higher prevalence. This shift may reflect increased health-seeking behaviour and awareness among women, supported by gender-neutral health interventions that helped balance case numbers between genders over time. Similar trends were observed at Aninwa Medical Centre, with periodic spikes in cases likely due to environmental factors, highlighting the need for continuous, adaptive public health efforts.

Further analysis showed that schistosomiasis prevalence varied by gender and age, with distinct exposure risks associated with societal roles and activities. Older age groups displayed higher prevalence rates, as they are more likely to engage in outdoor and water-related tasks that increase exposure to contaminated sources. Gender disparities emerged in adolescence and adulthood, with females demonstrating higher infection rates due to roles in water fetching and domestic chores. Among children, minimal gender differences were noted, but prevalence increased in school-aged groups due to recreational activities near water sources. These findings underscore the importance of targeted interventions, such as school-based health education programs and gender-specific awareness campaigns. Public health measures should address age-specific and gender-specific exposure risks, particularly for adolescents and adults involved in high-risk activities.

The study also highlighted that certain demographic groups, especially young children and adult women, are more vulnerable to schistosomiasis in Oforikrom Municipality. Children under ten are at risk due to indirect exposure to communal water activities, while older children and adolescents face heightened risks as they assume responsibilities that involve contaminated water. In adulthood, women, particularly in agricultural settings, exhibited higher infection rates due to prolonged contact with unsafe water sources. This demographic analysis underscores the need for nuanced interventions that cater to the specific risks faced by each group. Addressing these patterns through improved water access, sanitation, and community health education can mitigate transmission and reduce the impact of schistosomiasis in high-prevalence areas.

6.2 Conclusion

The study concluded that schistosomiasis prevalence in Oforikrom Municipality showed significant variation across demographic groups and healthcare facilities from 2014 to

2023, revealing a general decline in prevalence alongside notable fluctuations. While the gender distribution was relatively balanced, with slight female predominance in some years, variations across age, sex, and location highlight the complexity of transmission dynamics. The persistent high burden in Facilities F and E points to localised environmental and behavioural risk factors, while the overall downward trend suggests that existing interventions, particularly mass drug administration and community education, are yielding results. However, recurring spikes underscore the need for sustained, integrated control strategies. Continued investment in surveillance, public education, water and sanitation infrastructure, and targeted interventions is essential to consolidate gains and prevent resurgence.

6.3 Recommendations

The Community Health Facilities:

1. Community health facilities should intensify routine health education on schistosomiasis risk factors, with tailored messages for both men and women.
2. Facilities F and E, identified as transmission hotspots, must implement targeted environmental interventions.
3. Health facilities should improve surveillance and case reporting practices to detect early shifts in transmission patterns.
4. Regular mass drug administration (MDA) campaigns should be coordinated at the facility level, with attention to improving coverage and follow-up, particularly in high-burden communities.

The District Health Directorate:

1. The District Health Directorate should establish a district-wide framework for age- and sex-disaggregated data collection to better track schistosomiasis trends and inform interventions.
2. Integrated control strategies combining MDA, health education, water and sanitation improvements, and school-based interventions should be maintained and scaled.
3. The District Health Directorate must prioritise continued investment in surveillance, training, and community engagement to prevent resurgence.

The Academic and Scientific Community:

1. Further research should be conducted to evaluate the long-term effectiveness of public health interventions and to identify emerging risk factors associated with schistosomiasis. This can help refine strategies and ensure that they remain relevant in the face of changing environmental and social conditions.
2. Engaging community members in the design and implementation of schistosomiasis control programs can foster greater awareness and ownership of health initiatives.

REFERENCES

Adams, I., Adi-Dako, O., Boafo, E., Ofori, E. K., Amponsah, S. K. J. R. C. D. B., Management,, & Treatments. (2024). Recent Trends and Possible Future Trajectory of COVID-19. 7-19.

Almeida, M. E. A., dos Reis Silva, Y. R., Detoni, M. B., Rocha, T. L., & Damacena-Silva, L. J. C. P. (2025). The life cycle of Schistosoma mansoni and schistosomiasis disease: an educational approach. *22*(4), e13928-e13928.

Aula, O. P., McManus, D. P., Jones, M. K., Gordon, C. A. J. T. m., & disease, i. (2021). Schistosomiasis with a focus on Africa. *6*(3), 109.

Ayabina, D. V., Clark, J., Bayley, H., Lamberton, P. H., Toor, J., & Hollingsworth, T. D. J. P. n. t. d. (2021). Gender-related differences in prevalence, intensity and associated risk factors of Schistosoma infections in Africa: A systematic review and meta-analysis. *15*(11), e0009083.

Adedze-Kpodo, R. K., Ewusie, E. A., & Odonkor, S. T. (2023). Prevalence and Trend of Urinary Schistosomiasis in West Africa: A Systematic Review and Meta-Analysis. Asian Journal of Research in Infectious Diseases, 14(4), 165-191.

Adekiya, T. A., Aruleba, R. T., Oyinloye, B. E., Okosun, K. O., & Kappo, A. P. (2020). The effect of climate change and the snail-schistosome cycle in transmission and bio-control of schistosomiasis in Sub-Saharan Africa. International journal of environmental research and public health, 17(1), 181.

Adenowo, A. F., Oyinloye, B. E., Ogunyinka, B. I., & Kappo, A. P. (2015). Impact of human schistosomiasis in sub-Saharan Africa. The Brazilian journal of infectious diseases : an official publication of the Brazilian Society of Infectious Diseases, 19(2), 196–205. https://doi.org/10.1016/j.bjid.2014.11.004

Afifi, A., Ahmed, A. A. A., Sulieman, Y., Zakaria, M. A., & Pengsakul, T. (2016). Evaluation of some microscopic techniques for detecting bilharzia and intestinal parasites. International Journal of Research–Granthaalayah, 4(7), 185-195.

Akpata, R., Neumayr, A., Holtfreter, M. C., Krantz, I., Singh, D. D., Mota, R. & Richter, J. (2015). The WHO ultrasonography protocol for assessing morbidity due to Schistosoma haematobium. Acceptance and evolution over 14 years. Systematic review. Parasitology Research, 114, 1279-1289.

Alqahtani, D. O., Abbas, M., Alshahrani, A. M., & Ibrahim, M. E. (2017). Acute intestinal schistosomiasis among school-aged children presented to King Abdullah Hospital, Bisha province, Saudi Arabia: a case series.

Alzaylaee, H., Collins, R. A., Rinaldi, G., Shechonge, A., Ngatunga, B., Morgan, E. R., & Genner, M. J. (2020). Schistosoma species detection by environmental DNA assays in African freshwaters. PLoS neglected tropical diseases, 14(3), e0008129.

Ansha, M. G., Kuti, K. A., & Girma, E. (2020). Prevalence of intestinal schistosomiasis and associated factors among school children in Wondo District, Ethiopia. Journal of tropical medicine, 2020.

Anyan, W. K., Abonie, S. D., Aboagye-Antwi, F., Tettey, M. D., Nartey, L. K., Hanington, P. C., & Muench, S. B. (2019). Concurrent Schistosoma mansoni and Schistosoma haematobium infections in a peri-urban community along the Weija dam in Ghana: A wake up call for effective National Control Programme. Acta tropica, 199, 105116.

Buonfrate, D., Ferrari, T. C. A., Adegnika, A. A., Stothard, J. R., & Gobbi, F. G. J. T. L. (2025). Human schistosomiasis. *405*(10479), 658-670.

Bianchi, F., Cucunubá, Z., Guhl, F., González, N. L., Freilij, H., Nicholls, R. S., & Silva, N. (2015). Follow-up of an asymptomatic Chagas disease population of children after treatment with nifurtimox (Lampit) in a sylvatic endemic transmission area of Colombia. PLoS neglected tropical diseases, 9(2), e0003465.

Bishop, H. G., & Akoh, R. I. (2018). Risk factors, symptoms and effects of urinary schistosomiasis on anthropometric indices of school children in Zaria, Kaduna state, Nigeria. Open Access J Sci, 2(1), 61-65.

Bizimana, P., Ortu, G., Van Geertruyden, J. P., Nsabiyumva, F., Nkeshimana, A., Muhimpundu, E., & Polman, K. (2019). Integration of schistosomiasis control activities within the primary health care system: a critical review. Parasites & vectors, 12, 1-11.

Castro, A. C., Garrido, A., Brito, M. J., Pinto, S., & Bento, V. (2018). Urinary schistosomiasis: a forgotten and challenging diagnosis. Port J Nephrol Hypert, 32(4), 369-373.

Chala, B. (2023). Advances in diagnosis of schistosomiasis: focus on challenges and future approaches. International Journal of General Medicine, 983-995.

Chaparro, C. M., & Suchdev, P. S. (2019). Anemia epidemiology, pathophysiology, and etiology in low-and middle-income countries. Annals of the new York Academy of Sciences, 1450(1), 15-31.

Chibwana, F. D., Tumwebaze, I., Mahulu, A., Sands, A. F., & Albrecht, C. (2020). Assessing the diversity and distribution of potential intermediate hosts snails for urogenital schistosomiasis: Bulinus spp.(Gastropoda: Planorbidae) of Lake Victoria. Parasites & Vectors, 13, 1-18.

Colley, D. G., Andros, T. S., & Campbell, C. H. (2017). Schistosomiasis is more prevalent than previously thought: what does it mean for public health goals, policies, strategies, guidelines and intervention programs?. Infectious diseases of poverty, 6, 1-8.

Colley, D. G., Fleming, F. M., Matendechero, S. H., Knopp, S., Rollinson, D., Utzinger, J., & Binder, S. (2020). Contributions of the Schistosomiasis Consortium for Operational Research and Evaluation (SCORE) to schistosomiasis control and elimination: key findings and messages for future goals, thresholds, and operational research. The American journal of tropical medicine and hygiene, 103(1 Suppl), 125.

Crimmins, E. M., Shim, H., Zhang, Y. S., & Kim, J. K. (2019). Differences between men and women in mortality and the health dimensions of the morbidity process. Clinical chemistry, 65(1), 135-145.

Cunningham, L. J., Campbell, S. J., Armoo, S., Koukounari, A., Watson, V., Selormey, P. & Osei-Atweneboana, M. Y. (2020). Assessing expanded community wide treatment for schistosomiasis: Baseline infection status and self-reported risk factors in three communities from the Greater Accra region, Ghana. PLoS neglected tropical diseases, 14(4), e0007973.

Danso-Appiah, A., Owiredu, D., Asiamah, M., Akuffo, K., Eusebi, P., Jiangang, G., & Djirmay, A. G. (2022). Safety of praziquantel in persons with and without schistosomiasis: systematic review and meta-analysis. medRxiv, 2022-03.

Dawaki, S., Al-Mekhlafi, H. M., Ithoi, I., Ibrahim, J., Abdulsalam, A. M., Ahmed, A., & Surin, J. (2016). Prevalence and risk factors of schistosomiasis among Hausa communities in Kano State, Nigeria. Revista do Instituto de Medicina Tropical de São Paulo, 58, 54.

Deng, M. H., Zhong, L. Y., Kamolnetr, O., Limpanont, Y., & Lv, Z. Y. (2019). Detection of helminths by loop-mediated isothermal amplification assay: a review of updated technology and future outlook. Infectious diseases of poverty, 8, 1-22.

Dheda, K., Gumbo, T., Maartens, G., Dooley, K. E., McNerney, R., Murray, M., & Warren, R. M. (2017). The epidemiology, pathogenesis, transmission, diagnosis, and management of multidrug-resistant, extensively drug-resistant, and incurable tuberculosis. The lancet Respiratory medicine, 5(4), 291-360.

Dokmak, H.-A. A., Hammam, O. A., & Ibrahim, A. M. J. A. P. (2024). Impact of schistosoma sp., infection on biological, feeding, physiological, histological, and genotoxicological aspects of Biomphalaria alexandrina and Bulinus truncatus Snails. *69*(1), 648-663.

Dumevi, C. Y., Owusu-Asenso, C. M., Amoah, B. D., Asiamah, J. J., Vicar, E. K., Kretchy, J.-P.,…Health. (2024). Spillage of Akosombo and Kpong Dams in Ghana: Perspectives on Public Health Impacts on Affected Populations and Proposed Mitigation Strategies. *45*(7), 10.9734.

Ekpo, U. F., Odeyemi, O. M., Sam-Wobo, S. O., Onunkwor, O. B., Mogaji, H. O., Oluwole, A. S., & Stothard, J. R. (2017). Female genital schistosomiasis (FGS) in Ogun State, Nigeria: a pilot survey on genital symptoms and clinical findings. Parasitology Open, 3, e10.

Essien-Baidoo, S., Essuman, M. A., Adarkwa-Yiadom, B., Adarkwa, D., Owusu, A. A., & Amponsah, S. B. J. P. N. T. D. (2023). Urinogenital schistosomiasis knowledge, attitude, practices, and its clinical correlates among communities along water bodies in the Kwahu Afram Plains North District, Ghana. *17*(8), e0011513.

Fenster, G. (2025). *Evaluating the Role of Social Enterprise Funding in Malaria Treatment Development in Mozambique: Lessons for Addressing Endemic Diseases in Developing Economies*

Gitau, J., Muhoho, N. E., & Kabiru, E. (2017). Effects of Female Genital Schistosomiasis in Reproductive Tract of Women Attending Kwale Hospital in Kwale County, Kenya. International Journal of TROPICAL DISEASE & Health, 24(1), 1-9.

Grimes, J. E., Croll, D., Harrison, W. E., Utzinger, J., Freeman, M. C., & Templeton, M. R. (2015). The roles of water, sanitation and hygiene in reducing schistosomiasis: a review. Parasites & vectors, 8, 1-16.

Guegan, H., Fillaux, J., Charpentier, E., Robert-Gangneux, F., Chauvin, P., Guemas, E., & Iriart, X. (2019). Real-time PCR for diagnosis of imported schistosomiasis. PLoS Neglected Tropical Diseases, 13(9), e0007711.

Gaye, P. M., Doucouré, S., Sow, D., Sokhna, C., Ranque, S. J. T. m., & health. (2024). Freshwater snail-borne parasitic diseases in Africa. *52*(1), 61.

Gonzalez, S. R. (2021). Examining health inequity in ancient Egypt.

Habib, M. R., Lv, S., Rollinson, D., & Zhou, X.-N. J. F. i. m. (2021). Invasion and dispersal of Biomphalaria species: increased vigilance needed to prevent the introduction and spread of schistosomiasis. *8*, 614797.

Hutton, G., & Chase, C. (2016). The knowledge base for achieving the sustainable development goal targets on water supply, sanitation and hygiene. International journal of environmental research and public health, 13(6), 536.

Jones, I., Lund, A., Riveau, G., Jouanard, N., Ndione, R. A., Sokolow, S. H., & De Leo, G. A. (2018). Ecological control of schistosomiasis in Sub-Saharan Africa: restoration of predator-prey dynamics to reduce transmission. Ecology and Evolution of Infectious Disease: Pathogen Control and Public Health Management in Low-Income Countries. Oxford University Press, Oxford, United Kingdom, 236-251.

Kagabo, J., Kalinda, C., Nshimiyimana, P., Mbonigaba, J. B., Ruberanziza, E., Nyandwi, E., & Rujeni, N. (2023). Malacological survey and spatial distribution of intermediate host snails in schistosomiasis endemic districts of Rwanda. Tropical Medicine and Infectious Disease, 8(6), 295.

Kalinda, C., Mutengo, M., & Chimbari, M. (2020). A meta-analysis of changes in schistosomiasis prevalence in Zambia: implications on the 2020 elimination target. Parasitology research, 119(1), 1-10.

Kamel, B., Laidemitt, M. R., Lu, L., Babbitt, C., Weinbaum, O. L., Mkoji, G. M., & Loker, E. S. (2021). Detecting and identifying Schistosoma infections in snails and aquatic habitats: A systematic review. PLoS neglected tropical diseases, 15(3), e0009175.

Khieu, V., Sayasone, S., Muth, S., Kirinoki, M., Laymanivong, S., Ohmae, H., & Odermatt, P. (2019). Elimination of schistosomiasis mekongi from endemic areas in Cambodia and the Lao People's Democratic Republic: Current status and plans. Tropical medicine and infectious disease, 4(1), 30.

Kirk, M. D., Pires, S. M., Black, R. E., Caipo, M., Crump, J. A., Devleesschauwer, B. & Angulo, F. J. (2015). World Health Organization estimates of the global and regional disease burden of 22 foodborne bacterial, protozoal, and viral diseases, 2010: a data synthesis. PLoS medicine, 12(12), e1001921.

Kokaliaris C, Garba A, Matuska M, Bronzan RN, Colley DG, et al. Effect of preventive chemotherapy with praziquantel on schistosomiasis among school-aged children in sub-Saharan Africa: a spatiotemporal modelling study. Lancet Infect Dis. 2022 Jan;22(1):136-149. doi: 10.1016/S1473-3099(21)00090-6. Epub 2021 Dec 2. Erratum in: Lancet Infect Dis. 2022 Jan;22(1):e1.

Kulinkina, A. V., Kosinski, K. C., Plummer, J. D., Durant, J. L., Bosompem, K. M., Adjei, M. N., & Naumova, E. N. (2017). Indicators of improved water access in the context of schistosomiasis transmission in rural Eastern Region, Ghana. Science of the total environment, 579, 1745-1755.

LoVerde, P. T. J. D. T. (2024). Check for Schistosomiasis Philip T. LoVerde. *1454*, 75.

Lamberton, P. H., Faust, C. L., & Webster, J. P. (2017). Praziquantel decreases fecundity in Schistosoma mansoni adult worms that survive treatment: evidence from a laboratory life-history trade-offs selection study. Infectious diseases of poverty, 6, 1-11.

Li, S., Chen, Y., Xia, C., Lynn, H., Gao, F., Wa

Mawa, P. A., Kincaid-Smith, J., Tukahebwa, E. M., Webster, J. P., & Wilson, S. J. F. i. i. (2021). Schistosomiasis morbidity hotspots: roles of the human host, the parasite and their interface in the development of severe morbidity. *12*, 635869.

Mbata, A. O., Soyege, O. S., Nwokedi, C. N., Tomoh, B. O., Mustapha, A. Y., Balogun, O. D.,…Evaluation, G. (2024). Preventative medicine and chronic disease management: reducing healthcare costs and improving long-term public health. *5*(06), 1584-1600.

Mitchell, P. D. J. A. i. P. (2024). Parasites in ancient Egypt and Nubia: malaria, schistosomiasis and the pharaohs. *123*, 23-49.

Mosegui, G. B. G., Villar, F. A., & de Mello Vianna, C. M. J. T. J. o. I. i. D. C. (2022). Burden of disease attributed to acute respiratory infections in South America. *16*(10), 1614-1622.

Nkemngo, F. N., WG Raissa, L., Nebangwa, D. N., Nkeng, A. M., Kengne, A., Mugenzi, L. M.,…Nguiffo-Nguete, D. J. P. O. (2023). Epidemiology of malaria, schistosomiasis, and geohelminthiasis amongst children 3–15 years of age during the dry season in Northern Cameroon. *18*(7), e0288560.

Nortey, E. (2024). *Effects of Malaria on Galectin-3 And Insulin Resistance in Diabetics and Non-Diabetic Respondents within the Greater Accra Region of Ghana* University of Cape Coast].

Ofori, E. K., Forson, A. O. J. R. C. D. B., Management,, & Treatments. (2024). Schistosomiasis: recent clinical reports and management. 368-377.

Okesanya, O. J., Eshun, G., Ukoaka, B. M., Manirambona, E., Olabode, O. N., Adesola, R. O.,…health. (2024). Water, sanitation, and hygiene (WASH) practices in Africa: exploring the effects on public health and sustainable development plans. *52*(1), 68.

Onyekwere, A. (2022). *Population genetic structure and hybridization of urogenital schistosomiasis among primary school-age pupils in Nigeria* Université de Perpignan].

Orish, V. N., Kaba, G., Dah, A. K., Maalman, R. S., Amoh, M., Appiah-Kubi, A.,…Health. (2025). The burden of visually diagnosed female genital schistosomiasis among women with infertility in the Volta Region of Ghana. *53*(1), 31.

Owusu, G., Iddrisu, A.-K., Antwi-Adjei, M., Asare, T. A., Gyekyebea, P., Opoku-Kusi, R.,…Tuekpe, R. M. J. S. R. (2025). Assessment of the prevalence and praziquantel effectiveness and risk factors of urogenital schistosomiasis among school-aged children in pru east, Ghana. *15*(1), 19376.

Pathak, C. R., Luitel, H., Utaaker, K. S., & Khanal, P. J. P. r. (2024). One-health approach on the future application of snails: a focus on snail-transmitted parasitic diseases. *123*(1), 28.

Rhue, S. J., Torrico, G., Amuzie, C., Collins, S. M., Lemaitre, A., Workman, C. L.,…Wutich, A. J. W. I. R. W. (2023). The effects of household water insecurity on child health and well-being. *10*(6), e1666.

Sadigov, R. J. T. S. W. J. (2022). Rapid growth of the world population and its socioeconomic results. *2022*(1), 8110229.

Santos, L. L., Santos, J., Gouveia, M. J., Bernardo, C., Lopes, C., Rinaldi, G.,…Costa, J. M. C. d. J. J. o. C. M. (2021). Urogenital schistosomiasis—history, pathogenesis, and bladder cancer. *10*(2), 205.

Tamarozzi, F., Ursini, T., Ronzoni, N., Badona Monteiro, G., Gobbi, F. G., Angheben, A.,…Bisoffi, Z. J. J. o. t. m. (2021). Prospective cohort study using ultrasonography of Schistosoma haematobium–infected migrants. *28*(6), taab122.

Tetteh, C. D., Ginindza, T. G., Ncayiyana, J. R., & Manyeh, A. K. J. F. i. T. D. (2025). Tailoring interventions for impact: implementing evidence-based strategies for female genital schistosomiasis knowledge gaps in selected districts in Ghana. *6*, 1566451.

Verjee, M. A. (2019). Schistosomiasis: still a cause of significant morbidity and mortality. Research and reports in tropical medicine, 153-163.

Verma, H., Rai, K., Vallabhaneni, S. R., & Tripathi, R. (2017). History of aortic surgery in India. Indian Journal of Vascular and Endovascular Surgery, 2(3), 105-111.

Weinstock, J. V., & Leung, J. J. Y. s. T. o. G. (2022). Parasitic diseases: helminths. 3039-3078.

WHO. (2022). *World Health Organization guideline on control and elimination of human schistosomiasis*. World Health Organization.

WHO. (2023). *World Health Organization Global report on neglected tropical diseases 2023*. World Health Organization.

WIAFE, O. S. (2024). *LIVELIHOOD SECURITY OF URBAN FARMERS IN THE OFORIKROM MUNICIPALITY* KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI].

Wolf, J., Johnston, R. B., Ambelu, A., Arnold, B. F., Bain, R., Brauer, M.,…Colford, J. M. J. T. L. (2023). Burden of disease attributable to unsafe drinking water, sanitation, and hygiene in domestic settings: a global analysis for selected adverse health outcomes. *401*(10393), 2060-2071.

Wilson, R. A., & Jones, M. K. (2021). Fifty years of the schistosome tegument: discoveries, controversies, and outstanding questions. International Journal for Parasitology, 51(13-14), 1213-1232.

World Health Organization. (2022). WHO guideline on control and elimination of human schistosomiasis. World Health Organization.

World Health Organization. (2023). Paediatric drug optimization for neglected tropical diseases: meeting report, September 2023. World Health Organization.

Xue, Q., Deng, Y., Liu, Y., Wang, Y., Hu, W., Huang, Y., & Yang, K. (2023). A retrospective analysis of schistosomiasis related literature from 2011-2020: focusing on the next decade. Acta Tropica, 238, 106750.

Yifeng, L. I., Zongguang, L. I., Tingting, H. E., Jingzi, X. I. E., Shangbiao, L. Y. U., Min, Y. U. A. N., & Dandan, L. I. N. (2023). Analysis of epidemic trends and status of schistosomiasis in Jiangxi Province from 2002 to 2021. Shanghai Journal of Preventive Medicine, 35(7), 619-625.

Yeroshenko, G., Klepets, O., Kinash, O., Perederii, N., Vatsenko, A., Ulanovska-Tsyba, N.,…Shevchenko, K. (2022). Population-species, biogeocenotic and biosphere levels. In: Полтавський державний медичний університет.

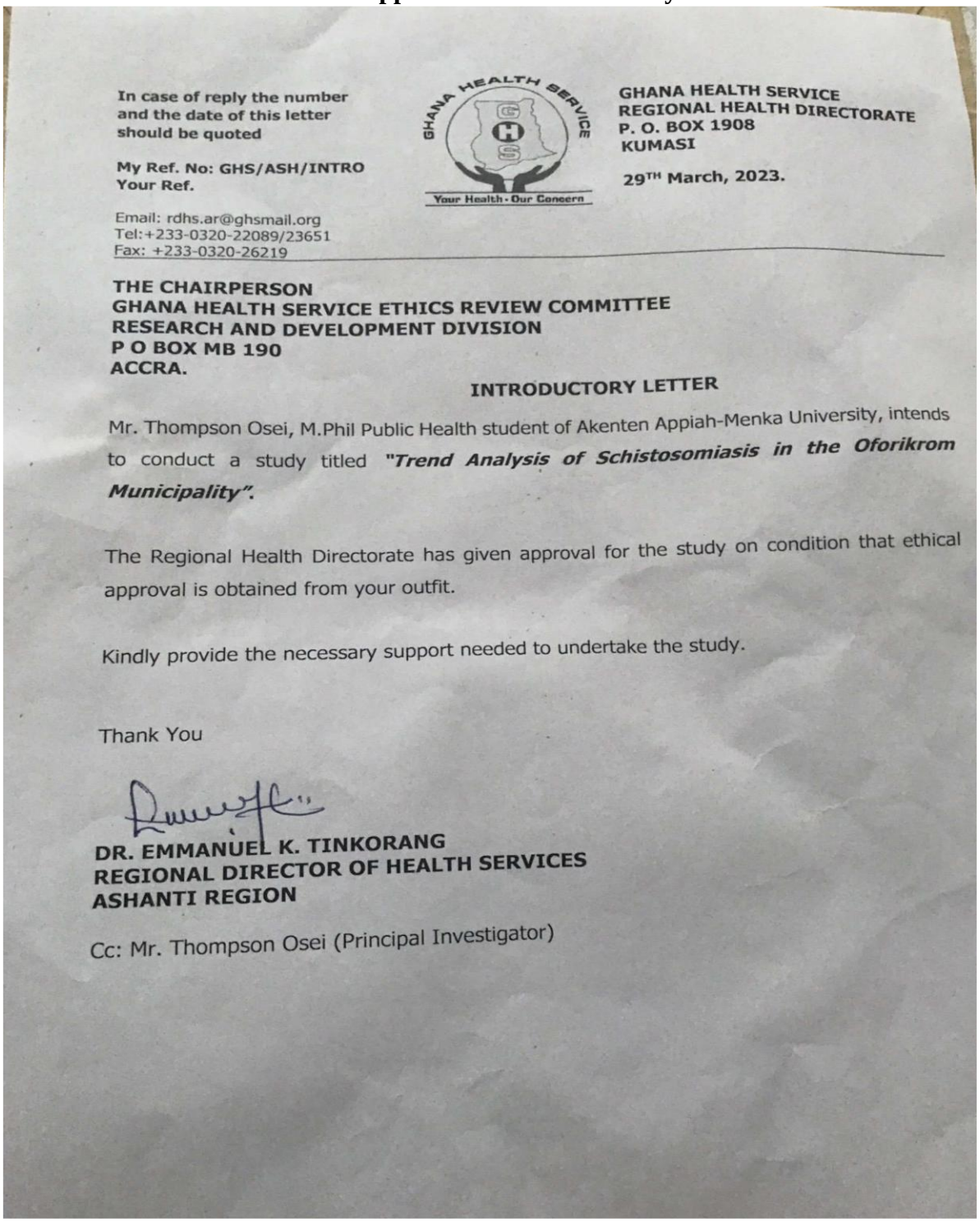
Zhang, Y., Ming, Y. J. T. M., & Disease, I. (2024). Burden of schistosomiasis in global, regional, and national 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *61*, 102751.

Zhang, H., Harvim, P., & Georgescu, P. (2017). Preventing the spread of schistosomiasis in Ghana: possible outcomes of integrated optimal control strategies. Journal of Biological Systems, 25(04), 625-655.

Zhou, Y., Zheng, M., Gong, Y., Huang, J., Wang, J., Xu, N., ... & Zhou, Y. (2024). Changing seroprevalence of schistosomiasis japonica in China from 1982 to 2020: A systematic review and spatial analysis. PLOS Neglected Tropical Diseases, 18(9), e0012466.

APPENDICES

APPENDIX I: Approval Letter from Study Area



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

My Ref. No: GHS/ASH/INTRO
Your Ref.

Email: rdhs.ar@ghsmail.org
Tel:+233-0320-22089/23651
Fax: +233-0320-26219

GHANA HEALTH SERVICE
REGIONAL HEALTH DIRECTORATE
P. O. BOX 1908
KUMASI

29TH March, 2023.

THE CHAIRPERSON
GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE
RESEARCH AND DEVELOPMENT DIVISION
P O BOX MB 190
ACCRA.

INTRODUCTORY LETTER

Mr. Thompson Osei, M.Phil Public Health student of Akenten Appiah-Menka University, intends to conduct a study titled ***"Trend Analysis of Schistosomiasis in the Oforikrom Municipality"***.

The Regional Health Directorate has given approval for the study on condition that ethical approval is obtained from your outfit.

Kindly provide the necessary support needed to undertake the study.

Thank You

DR. EMMANUEL K. TINKORANG
REGIONAL DIRECTOR OF HEALTH SERVICES
ASHANTI REGION

Cc: Mr. Thompson Osei (Principal Investigator)

APPENDIX II: Introductory Letter

AKENTEN APPIAH-MENKA UNIVERSITY
of Skills Training and Entrepreneurial Development

DEPARTMENT OF PUBLIC HEALTH EDUCATION

P.O. Box 40, Ashanti Mampong, Ghana
+233 209777318 / (0)20 204 1037
dphe@aamusted.edu.gh

16th May 2024

The Chairman
Committee on Human Research, Publication & Ethics
KNUST
Kumasi

Dear Sir,

LETTER OF RECOMMENDATION: THOMPSON OSEI

Mr. Thompson Osei (Index number: 8222030001) is an MPhil Public Health student at the Department of Public Health Education, Faculty of Environment and Health Education at the Mampong Campus of the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED). Mr. Osei, as part of his academic requirements for the award of a Master of Philosophy Degree in Public Health, is to undertake a project dissertation on "***Trend Analysis of Schistosomiasis in the Oforikrom Municipality***".

This will be a hospital-based cross-sectional study that will gather 10 years data on the prevalence and spatial distribution of Schistosomiasis cases in the Oforikrom Municipality. This study will help assess control efforts in the area. The study sites will include selected health facilities within the Oforikrom Municipality where these cases are usually reported.

The outcome of this study would provide empirical data on Schistosomiasis control efforts within this endemic zone of the region. The data collected will be used solely for academic purposes.

We would be grateful if your outfit would accord him the needed assistance for the successful execution of this proposed study. Your kind approval is required to conduct this study in fulfilment of his academic obligation.

Thank you for your kind consideration.

Yours faithfully,

Dr. Nana Yaa Awua-Boateng

(Academic Supervisor)

DEPT. OF PUBLIC HEALTH EDUCATION
FACULTY OF ENV. & HEALTH EDUCATION
COLLEGE OF AGRIC EDUCATION
AKENTEN APPIAH-MENKA
UNIVERSITY OF SKILLS TRAINING & ENTREPRENEURIAL DEPT.
MAMPONG-ASHANTI

APPENDIX III: DEPARTMENTAL LETTER

AKENTEN APPIAH-MENKA UNIVERSITY
of Skills Training and Entrepreneurial Development

FACULTY OF ENVIRONMENT & HEALTH EDU.
DEPARTMENT OF PUBLIC HEALTH EDUCATION
P.O. Box 40, Asante Mampong 0209777318

The Regional Director
Ghana Health Service
Ashanti Region
Kumasi

5th April, 2024

Dear Sir,

Permission to Conduct Research: "Trend Analysis of Schistosomiasis in the Oforikrom Municipality".

Mr. Thompson Osei (Index Number 822030001) is our M.Phil Public Health student at the Department of Public Health Education, Faculty of Environment and Health Education, AAMUSTED-Mampong Campus of the erstwhile University of Education Winneba. Mr. Osei, as part of his academic requirements for the award of a Master of Philosophy Degree in Public Health, is to conduct research titled "**Trend Analysis of Schistosomiasis in the Oforikrom Municipality**".

The will be a hospital-based cross-sectional study that will gather 10 years of data on the prevalence and spatial distribution of Schistosomiasis cases in the Oforikrom Municipality. This study will help assess control efforts in the area. The study sites will include selected health facilities within the Oforikrom Municipality where these cases are usually reported.

We seek your official consent to permit him to collect data from the proposed study sites and participants under your jurisdiction. The outcome of this study would provide empirical data on Schistosomiasis control efforts within this endemic zone of the region. Your approval letter will pave the way for him to apply for ethical clearance before the commencement of the research. The data collected will be used solely for academic purposes.

We would be grateful if your outfit would accord him the needed assistance for the successful execution of this proposed study. Your kind approval is required to conduct this study in fulfillment of his academic obligation.

Thank you for your kind consideration.

Yours faithfully,

(HEAD OF DEPARTMENT)

www.aamusted.edu.gh
Mampong Campus: 0506476198 / 0501613082
GhanaPost Code: AM0030-1697
Email: dphe@aamusted.edu.gh

APPENDIX IV: ETHICAL APPROVAL

Kwame Nkrumah
University of Science
and Technology, Kumasi

College of Health Sciences
SCHOOL OF MEDICINE AND DENTISTRY

COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS

Our Ref: CHRPE/AP/497/24

24th June 2024

Mr. Osei Thompson
Akenten Appiah Menka University of
Skill Training and Entrepreneurial Development,
Department of Public Health Education.

Dear Sir,

LETTER OF APPROVAL

Protocol Title: *"Trend Analysis of Schistosomiasis in the Oforikrom Municipality."*

Proposed Site: *Tech Hospital, Aninwa Medical Centre, Peace and Love Hospital, Graceland Hospital.*

Sponsor: *Self-Sponsored.*

Your submission to the Committee on Human Research, Publications, and Ethics on the protocol named earlier refer.

The Committee reviewed the following documents:

- A Completed CHRPE Application Form.
- Participant Information Leaflet and Consent Form.
- Research Protocol.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for one year, renewable from 24th June 2024 to 23rd June 2025. The Committee may, however, suspend or withdraw ethical approval at any time if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you for your application.

Yours faithfully,

Rev. Prof. John Appiah-Poku.
Honorary Secretary
FOR: CHAIRMAN

Room 7, Block L, School of Medicine and Dentistry, KNUST, University Post Office, Kumasi, Ghana
Tel: +233 (0) 322 063 248 Mobile:+233 (0) 205 453 785 Email: chrpe.knust.kath@gmail.com / chrpe@knust.edu.gh