SOIL-TRANSMITTED HEMINTHIASIS AND NUTRITIONAL STATUS OF SCHOOL-AGE-CHILDREN IN SELECTED PRIMARY SCHOOLS AT OBAFEMI/OWODE LOCAL GOVERNMENT AREA, OGUN STATE.

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CERTIFICATION

I hereby certify that this research project titled "**Soil-Transmitted Helminthiasis and Nutritional Status of School-Age Children in Selected Primary Schools at Obafemi/Owode Local Government Area of Ogun State**" was carried out by Adeoye, Comfort Abeni in the Department of Epidemiology and Medical Statistics, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria under my supervision.

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DEDICATION

This project is dedicated to God Almighty, He who alone is Alpha and Omega, my Father and my God, the God and Father of my Lord, Love and Savior Jesus Christ, He without Whom I can do nothing. Sweet Holy Spirit, my Guide, I love and need You.

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LIST OF ACRONMYS

BAZ	Body Mass Index-for-Age Z-score
DDS	Dietary Diversity Score
DDQ	Dietary Diversity Questionnaire
epg	Eggs per gram of feces
FFQ	Food Frequency Questionnaire
FAO	Food and Agriculture Organization
HAZ	Height-for-Age Z-score
LGA	Local Government Area
OOLG	Obafemi/Owode Local Government
PTA	Parent-Teachers Association
SAC	School-Aged Children
SD	Standard Deviation
STH	Soil-Transmitted Helminthiasis
STHs	Soil- Transmitted Helminths
TDA	Total Dietary Assessment
UNICEF	United Nations Children's Fund
WAZ	Weight-for-Age Z-score
WHO	World Health Organisation

ABSTRACT

Soil-transmitted Helminthiasis (STH) and malnutrition are major public health problems among school-age children in developing countries. Soil-transmitted helminths are a group of parasitic intestinal nematodes that cause infections in humans. These infections are endemic in developing tropical countries and are said to impact negatively on children's health states.

This study was therefore designed to assess the current prevalence of STH infections and malnutrition among school-age children, as well as determine possible associations between STH infection and nutritional status of school-age children.

An analytical cross sectional study was conducted from November 2014 to January, 2015. Multistage sampling technique was used to select 460 apparently healthy children from eleven primary schools at Obafemi/Owode Local Government Area (LGA) of Ogun state. Stool samples were collected from the children, and examined microscopically for eggs of soil transmitted helminths following preparation using Kato –Katz technique. A close ended interviewer administered questionnaire was used for collection of data on demography, socio-economics, household characteristics, hygiene habits as well as dietary intake. Dietary assessment was done using the 24 hour dietary recall method. Anthropometric measurements, height and weight were measured, and used to obtain Z-scores of the malnutrition indices height-for-age and Body-Mass-Index-for-age using WHO Anthroplus. These indices were compared with the 2007 WHO reference values to diagnose stunting (height-for-age < -2SD) and wasting (BMI-for-age < -2SD). Proportions, chi-square test of significance and regression analysis were used for statistical analysis.

The mean age of the study participants was 10.35 ± 2.39 years. Three different helminthes observed included *Ascaris lumbricoides* (28.7%), Hookworm (0.7%) and *Trichuris trichiura* (0.7%). Multiple infections were however observed in some individuals (3.0%). Of the 460 stool samples examined, 134 were infected giving a prevalence of 29.1%. Most infections were light (66.0%) to moderate (44.0%) with no heavy infections seen. *Ascaris lumbricoides* was the most encountered parasite in the study. Stunting was observed in 25% of children and it was higher among those infected with STH. Also, 19.3% of children were thin. No significant direct associations were found for Soil-transmitted Helminth infection status with HAZ and

BAZ values but a significant negative association were found between soil-transmitted helminths infections and mean height-for-age Z-score values of infected and non-infected children.

Soil-transmitted helminthiasis and malnutrition remain public health concerns in Nigerian school-age children due largely to a lack of concerted effort from stakeholders towards its eradication. The role of STH infections in undermining children's nutritional status still needs to be further investigated.

KEYWORDS: Soil transmitted Helminth Infections. Malnutrition. School-Aged Children

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TABLE OF CONTENTS

CHAPTER THREE (METHODOLOGY)

CHAPTER FOUR (RESULTS)

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background

Soil-Transmitted Helminthiasis (STH) is one of the neglected tropical diseases of public health importance, with over 1.5 billion people affected worldwide (WHO, 2014). Although STH have a worldwide distribution (WHO, 2012), their infections are more common in the Sub-Saharan Africa and South East Asia.

Intestinal nematodes are the STH disease causative agents and over 100 species of soil transmitted helminthes (STHs) have been reported from the human alimentary tract (Saka et al., 2006). Four species are most common and are collectively referred to as "soil-transmitted helminths". They are *Ascaris lumbricoides* (the roundworm), *Trichuris trichiura* (the whipworm) and *Necator americanus* or *Ancylostoma duodenale* (the hookworms) (Anderson et al., 2013).

The burden of disease from STHs is mainly attributed to their chronic and insidious impact on the health and quality of life of those infected (WHO Fact Sheet, 2014). These health impacts are more dramatic in children who also happen to be the most susceptible age group, due to poor personal and environment hygiene as well as their differential exposure to contaminated soils. (Hotez, 2008).

Infections of STH have been reported in school-age children across several populations; in both developing and developed countries such as in Ethiopia (Debalke et al., 2013). Honduras (Sanchez et al., 2013), China (Wang et al., 2012) and various parts of Nigeria (Saka et al., 2006; Opara et al., 2010; Senbanjo et al., 2011; Oguanya et al., 2012). It especially prevails however, in rural communities of developing countries of the world, where inadequate hygiene which usually accompanies poverty, predispose them to a continuing burden of STHs infections (Stephenson et al., 1993).

Unambiguous evidences have shown that parasitic infections damage children's health (Katona and Katona Apte, 2008). Mild and moderate infections of STH in children have been shown to lead to malnutrition, manifested in forms of micronutrient deficiencies, such as iron deficiency anemia (Hall et al., 2008), as well as impaired physical development (e.g. stunting) (Pullan et al., 2013). These lead to poor school performance and absenteeism in children which precipitate reduced work productivity in adulthood.

Malnutrition, a serious global issue (Fernandez et al., 2002), accounts for over half of all child deaths worldwide (Joshi et al., 2011).Similar to infections of STH, it especially persists as a major public health problem in developing countries of the world. In Nigeria, it continues to be a primary cause of ill health and mortality among children (UNICEF, 2009). Freedom from malnutrition is a basic human right and its alleviation is a fundamental prerequisite for human and national development (Sati and Dahiya, 2012). Usually referred to as silent emergency, it has devastating effects on children, society as well as future homemaking.

Infections with soil-transmitted helminths (STHs) and malnutrition co-exist as public health problems in school-age children in developing countries (Ahmed et al., 2012) and their interactions are synergistic. This means malnutrition makes a person more susceptible to infection, and infection also contributes to malnutrition, which causes a vicious cycle and unambiguous evidence have shown that parasitic infections damage children's health (Katona and Katona Apte, 2008). The school age-period is nutritionally significant because this is the prime time to build up body stores of nutrients in preparation for rapid growth of adolescence. While adequate nutrition gives stronger immune system, less illness, better health and productive community, inadequate nutritional state/malnutrition in children, leads to growth retardation, reduced work capacity and poor mental and social development (Awasthi et al., 2000).

1.2 STATEMENT OF PROBLEM

Nigeria has the largest STH disease burden in Africa (with approximately 40,384,176 million school-aged children affected in 2012), as well as the third largest burden globally (WHO, 2012). These coincide with having the highest absolute number globally, of chronically malnourished (stunted) children (WHO, 2010).

STH disease burden is believed to be mainly manifested as nutritional stress and associated with poor appetite, food indigestion and malabsorption, impaired growth and anemia (Crompton and Nesheim, 2002). Recently however, efforts have been made to fully understand the nutritional effects of soil-transmitted helminth infections. This has led to research that assess possible associations between STH and Nutrition among school children.

Studies have found significant associations between STH and nutritional deficits in children, using biochemical means of nutritional assessment (Verhagen et al., 2013) found a significant association. Others however (Ahmed et al., 2012) found no difference in the mean increments in anthropometric growth indices between helminth infected and non helminth infected groups of school-age children. Sanchez et al. (2013) who also sought to ascertain associations of STH infections with anthropometric indices of children's nutritional status (stunting, underweight and thinness) among rural school going children in Honduras found no such associations. Although it has been researched in other parts of the world, from literature search, the association between STH and nutritional status of school-age children is yet to be investigated in Nigeria.

Studying the impact of intestinal helminths on child growth and nutrition in endemic populations is not easy endeavor as it is difficult to control for other environmental or socio-economic factors or seasonal changes (Sanchez et al., 2013). Irrespective, malnutrition and parasite infections like STH so frequently co-exist that they need be considered together (Debalke et al., 2013). Increase in the available body of empirical evidence however, will help better understand the relationship between STH and Nutritional status among school-age children.

In view to the above stated problems, this present study aims to ascertain associations between STH and nutritional status in a representative sample of rural school-going children in Obafemi/Owode Local Government Area of Ogun State. Our results will globally (WHO, 2012). These coincide with having the highest absolute number globally, of chronically malnourished (stunted) children (WHO, 2010).

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In view to the above stated problems, this present study aims to ascertain associations between STH and nutritional status in a representative sample of rural school-going children in Obafemi/Owode Local Government Area of Ogun State. Our results will provide empirical evidence for policy makers in decision making on health related matters as well as serve as baseline data for future related studies.

1.3 JUSTIFICATION FOR THE STUDY

Because school aged children suffer the lowest mortality of any age group, there is a tendency to view them as essentially healthy (Partnership for health development, 1997). In recent years however, increased awareness of the need to focus attention on the health concerns of school age-children in developing countries has surfaced (Partnership for health development, 1998). This is due largely, to the burden of disease being experienced in them, found to have both immediate and long term consequences for their health, growth and education (Saka et al., 2006).

In terms of disease burden of children in school-age population, soil-transmitted helminthes infections rank first among the immediate causes of all communicable and non-communicable diseases in school-age population in developing countries (World Bank Development Report, 1993). Children bear the greatest burden of these infections and are faced with health burdens like malnutrition, stunted growth and intellectual retardation, as well as cognitive and educational deficits (Chesbrough 2006).

Nutrition is a major determinant of health, and the World Health Organization defines nutritional status as the condition of the body resulting from the intake, absorption and utilization of food (Canturk, 2009). The resolution of many nutritional issues of public health research studies have reported that even light infections may impose a threat to children's health (Stoltzfus et al., 1997), especially if living in endemic communities with poor nutritional status (Stephenson, 2000).

Reports from various parts of Nigeria have recognized STHs infections as important health problems especially among growing school age children (Asaolu et al., 2002). Amaechi et al. (2013) for example, found the prevalence of infection among school children in some rural communities of Abia State to be 75.7%.

In recognition of the global health importance of STHs infections, World Health Organization (WHO) recommends a baseline survey in school age children to determine the prevalence and intensity of infections which will be useful in the diagnosis, planning and implementation of effective control programs (Bethony et al., 2006). Understanding where at risk populations are, is fundamental for appropriate effective control strategies which need mostly be focused on the school age population (Albonico et al., 2007).

The Preventive Chemotherapy (PC) coverage for STH among school-age children in Nigeria is low, at 5% (WHO, 2012). To tackle this, in 2009, multiple health teams were charged with the duty of mapping the STH and Schistosomiasis (SCH) burden across nine Nigerian states. By the year 2013 however, Ogun state along with twenty six other states, are yet to be included in the mapping scheme (ENVISION, 2013). It is imperative that studies correlating STH infection and Nutritional Status of School-aged children, like that done in Honduras (Sanchez et al., 2013) be executed in Nigeria (GAHI, 2014).

Due to paucity of information on the prevalence and intensity of STHs among school-age-children in Nigeria relating to its effect on their nutritional status, this study in Obafemi/Owode Local Government Area of Ogun state, Nigeria is being undertaken to provide empirical evidence.

1.4 RESEARCH QUESTIONS

1. What is the prevalence of Soil-Transmitted Helminthiases among school-age children in Obafemi/Owode Local Government Area of Ogun State?
2. What are the intensities of Soil-Transmitted Helminth Infections in school-age-children at Obafemi/Owode Local Government Area of Ogun State, Nigeria?
3. What is the nutritional status of school-age children at Obafemi/Owode Local Government Area of Ogun State, Nigeria?
4. What is the association between STH Infection and the nutritional status of the school-age-children at Obafemi/Owode Local Government Area of Ogun State, Nigeria?

1.5 STUDY OBJCTIVES

1.5.1 Broad objective:

The broad objective of this investigation is to examine the effect of Soil-Transmitted Helminth infection on the nutritional status of school-aged children at Obafemi/Owode Local Government Area of Ogun state, Nigeria.

1.5.2 Specific Objectives:

Specific objectives are to:

1. determine the prevalence of Soil-Transmitted Helminthiases among the pupils,
2. assess the intensity of Soil-Transmitted Helminth Infections in the pupils,
3. assess the nutritional status of the pupils, and
4. Investigate the association between STH Infection and nutritional status of the pupils.

CHAPTER TWO

LITERATURE REVIEW

2.1 Soil-Transmitted Helminths (STHs)

Soil-transmitted helminths (STHs) are a group of intestinal nematodes. Some however are more common; these include hookworms (*Ancylostoma duodenale* and *Necator americanus*), roundworm (*Ascaris lumbricoides*), and whipworm (*Trichuris trichiura*) (WHO, 2012). Over 100 species of soil-transmitted helminths have been reported from the alimentary tract (Saka et al., 2006). *Ascaris lumbricoides (A.lumbricoides)*, Hookworm *(Ancylostoma duodenale and Necator americanus)* and *Trichuris trichiura (T.trichiura)* however have been reported among several hundred millions of people worldwide (Debalke et al., 2013).

Soil transmitted helminths (STHs) are a serious public health problem, predominantly among poor communities in the developing world (Debalke et al., 2013), mainly because of their ability to cause disease in humans (WHO, 2012).

2.2 Soil Transmitted Helminthiasis (STH)

Humans are able to host as many as 200 different types of parasites, and one worm can produce an average of 20,000 eggs per day (Katona and Katona-Apte, 2008). Soil-transmitted helminthiasis (STH) also known as Soil-transmitted Helminths (STHs) Infections refers to a group of parasitic diseases in humans caused by soil-transmitted helminths (STHs). They are the most common parasitic infection of humans worldwide. They are distributed throughout the world with high prevalence rates in tropical and sub-tropical countries mainly due to of lack of adequate sanitary facilities, inappropriate waste disposal systems, lack of safe water supply, and low socio-economic status (Debalke et al., 2013). Approximately two billion people (about a third of the world's population) are affected by STH alone, and four billion more estimated to be at risk (Bethony et al., 2006) and school age (5–14 years) children are at particular risk (WHO, 2012). The largest numbers of cases occur in impoverished rural areas of Sub-Saharan Africa, Latin America, Southeast Asia, and China (WHO, 2010).

The helminthic disease is so named because the infection is transmitted through ingestion of the nematode eggs in the soil, which is contaminated through excrements. Therefore, the disease is most prevalent in warm and moist climates where sanitation and hygiene are poor and waters are unsafe, including the temperate zones during warmer months (Amaechi et al., 2013).

The types of STH include:

Ascariasis of STH: It is caused by the large roundworm *A.lumbricoide*. It is estimated to be the most widespread STH, affecting approximately 1 billion people. The victims constitute about half of the populations in tropical and subtropical areas. Most conditions are mild and often show little or no symptoms, heavy infections however are debilitating, causing severe intestinal blockage and impair growth in children. Nutritionally impaired Children are most infected, with the most common age group being 3 to 8 year olds (i.e including SAC and Pre-SAC), and with an annual death of about 20,000. Children are more susceptible due to their frequent exposure to contaminated environment. This could be during playing of games, eating raw vegetables and fruits, or drinking wastewater (Bethony et al., 2006)

Ancylostomiasis/ hookworm infection of STH: caused by *N. americanus* and *A. duodenale*. Mild infections produce diarrhea and abdominal pain. More severe infections can create serious health problems for newborns, children, pregnant women, and malnourished adults. In fact it is the leading cause of anemia and protein deficiency in developing nations, afflicting an estimated 740 million people. *N. americanus* is the more common hookworm, while *A. duodenale* is more geographically restricted. Unlike other STHs, in which school-age children are most affected, high-intensity hookworm infections are more frequent in adults, specifically women. Roughly, 44 million pregnant women are estimated to be infected. The disease causes severe adverse effects in both the mother and infant, such as low birth weight, impaired milk production, and increased risk of mortality (Bethony et al., 2006).

Trichuriasis of ~~STH~~: Whipworm (*T. trichiura*) is the third most common STH-causing nematode in humans. According to current estimate, nearly 800 million people are infected, and majority of the victims are children. Heavy infections could lead to acute symptoms such as diarrhea and anemia, and chronic symptoms such as growth retardation and impaired cognitive development. Medical conditions are more often serious since co-infection with protozoan parasites such as *Giardia* and *Entamoeba histolytica*, and with other nematodes is common (Bethony et al., 2006). Predominantly a tropical disease of developing countries, trichuriasis is quite common in the United States (Starr and Montgomery, 2011).

2.3 Epidemiology of Soil-Transmitted Helminthiasis

Estimating the exact numbers infected with STH infection has remained an elusive goal, due in part to a dearth of reliable and accurate epidemiological data as well as the non-specificity of clinical signs due to STH. Globally an approximately estimated 438.9 million people were infected with hookworm in 2010, 819.0 million with *A. lumbricoides* and 464.6 million with *T. Trichiura, with* a vast majority (about 70%) of these infections having occurred in Asia. High proportion of individuals infected with one or more STHs reside in the People's Republic of China (18%) and India (21%), and the three most populous nations in sub-Saharan Africa (Nigeria, Ethiopia, Democratic Republic of the Congo) in total account for 8% of global STHs infections (Pullan et al., 2014).

De Silva *et al.* (2003) suggested that despite marked declines of STH in both the Americas and Asia for *Ascaris lumbricoides, Trichuris trichiura* and the hookworms (*Necator americanus* and *Ancylostoma duodenale*), little recent change had occurred in sub-Saharan Africa. A total of about 1.01 billion school-aged children live in areas where prevalence of any STH is expected to exceed 20% (16% of these in sub-Saharan Africa, 71% in Asia, 13% in Latin America and the Caribbean). On the one hand improvements in living conditions and expansion of major deworming efforts may have declined prevalence in some part and on the other hand, population growth may have increased the numbers infected within the past decade (Pullan et al., 2014).

Despite the increase in the number of children who receive preventive chemotherapy (PC) treatment against STH every year, only 200 million school-age children of the 600 million in need received treatment in 2010. A total of 166 countries are potentially endemic, including all countries in Asia (Central, east, south and south-east), Oceania, Latin America and the Caribbean, North Africa, the Middle East and sub-Saharan Africa. Prevalence rates of 15.6% (Thailand), 88.4% (Turkey), 69.9 % (Tuvalu), 53% (Guinea), 40.2% (China), 92.6% (India), and 43.5% (Ethiopia) have been reported from the different parts of the world (Debalke et al., 2013).

Of the three STHs, *A. lumbricoides* has the widest distribution with the highest rates of transmission seen in Cameroon (30.8%), Nigeria (25.4%) and the north-western countries of Central sub-Saharan Africa (ranging from 32.2% in Congo to 38.8% in Equatorial Guinea), geographically dispersed countries in Asia (including Bangladesh 38.4%, Malaysia 41.7%, Afghanistan 36.0% and the Philippines 33.6%) and the southern countries of Central Latin America (Venezuela 28.4%, Colombia 26.0% and Ecuador 35.8%). *A. lumbricoides* is also common in the Central Asian countries of Kazakhstan (22.7%) and Kyrgyzstan (23.7%), and the Middle Eastern countries of Jordan, the Syrian Arab Republic, Yemen, the State of Palestine and Morocco (ranging from 8.0% in Morocco to 19.2% in Jordan) (Pullan et al., 2014).

Hookworm infections remain common throughout much of sub-Saharan Africa (ranging from 2.3% in Eritrea to 30.5% in Central African Republic), in addition to Papua New Guinea (60.6%), Malaysia (21.0%), Nepal (30.7%) and Bangladesh (22.3%). In contrast, hookworm was not found in most of Central Asia and North Africa (excluding Egypt, where prevalence was 6.0%). Similarly, prevalence of *T. trichiura* was low in these regions. *T. trichiura* infections reach their highest prevalence in Malaysia (49.9%) and the Philippines (45.5%) as well as much of Central Africa (ranging from 11.8% in Central African Republic to 38.8% in Equatorial Guinea) and Central America (5.1% in El Salvador to 28.4% in Venezuela). Prevalence of hookworm was low for India, at

7.9%. In contrast, prevalence estimates for both hookworm and *A. lumbricoides* were high for Oceania (Pullan et al., 2014).

The largest reductions over a twenty year time period are in Asia, where regional mean prevalence of hookworm dropped from 13.8 to 7.7%, *A. lumbricoides* from 30.8 to 16.3%, and *T. trichiura* from 14.2 to 7.7%. Reductions for other world regions are more modest: in Latin America prevalence of any Soil-transmitted helminth infection fell by less than 3% from 29.2% to 27.4% and in sub-Saharan Africa by less than 5% from 36.8% to 32.2%). Trends of STHs infections between 1990 and 2010 showed that overall, prevalence of any STH across all endemic regions has dropped from 38.6% in 1990 to 25.7% in 2010, representing a reduction of 140 million infected individuals. Steep declines were seen in countries such as the People's Republic of China, Indonesia and Republic of Korea, but declines were more modest in other Asian countries and in sub-Saharan Africa and Latin America and the Caribbean (Pullan et al., 2014).

2.4 Mode of Infection with Soil-Transmitted Helminths

The transmission of Soil-transmitted helminths is by eggs that are passed in the feces of infected people into soil. There are no direct person-to-person transmissions, or infection from fresh feces, because eggs passed in feces need about three weeks to mature in the soil before they become infective. Since these worms do not multiply in the human host, reinfection occurs only as a result of contact with infective stages in the environment (WHO, 2012).

Ascaris and hookworm eggs become infective as they develop into larvae in soil. Infection occurs when vegetables and fruits, contaminated with soil infested eggs, are consumed, or when hands or fingers that have been contaminated with dirt carrying the eggs are put in the mouth. On the other hand, hookworm eggs are not directly infective. They hatch in soil, releasing mobile larvae that can penetrate the skin. Thus infection is acquired through accidental contact with contaminated soil (Bethony et al., 2006). The adult worms live in the intestine where they produce thousands of eggs each day.

2.5 Diagnosis for Soil-Transmitted Helminthiasis

In the diagnosis of STHs, specific helminths can be generally identified from the feces, and their eggs microscopically examined and enumerated using fecal egg count method. Certain limitations however exist, such as the inability to identify mixed infections (Krauth et al., 2012). A novel effective method for egg analysis is the Kato-Katz technique (WHO, 1990). It is a highly accurate and rapid method for *A. lumbricoides* and *T. trichiura*; but not so much for hookworm, due to the fast degeneration of the rather delicate hookworm eggs (Tarafder et al., 2010). Despite the intensity of infection with STHs (the number of helminths infecting an individual) can be measured either directly, by counting the number of expelled worms after anthelminthic treatment, or indirectly, by counting the number of helminth eggs excreted in feces (expressed as eggs per gram, epg), indirect methods are more commonly used because they are less intrusive and more convenient (WHO, 2012).

Three classes of intensity of infection; light, moderate and heavy are defined for each Soil-Transmitted Helminth.

2.6 Factors that Predispose to Soil-Transmitted Helminthiasis

The knowledge of possible risk factors for STHs infection is essential for the development of prevention and control strategies as well as its treatment (Debalke et al., 2013). External environmental conditions and human factors have both been shown to serve as risk factors for STH. External environmental conditions include soil type (Soriano et al., 2001), soil contamination rate of the school compounds, waste disposal system, sample collection season, climatic and topographic factors (Debalke et al., 2013), absence of sanitary facilities, unsafe waste disposal system, inadequacy and lack of safe water supply, and types of toilet used (WHO, 2002). Human factors include age, sex, socio-economic status, occupation (Mofid et al., 2011), personal hygiene, wearing habits and health information (Debalke et al., 2013). It is important that risk factors should be assessed as a whole (Soriano et al., 2001). Ogwurike et al. (2010) however found sex and school type to be the best predictors of STH among primary school children.

2.7 Prevention and Control of Soil-Transmitted Helminthiasis

The strategy for control of soil-transmitted helminth infections by the World Health Organization (WHO) is to control morbidity through the periodic treatment of at-risk people living in endemic areas. People at risk are: preschool children; school-age children; women of childbearing age (including pregnant women in the second and third trimesters and breastfeeding women); and adults in certain high-risk occupations, such as tea-pickers or miners. WHO recommends periodic drug treatment (deworming) without previous individual diagnosis to all at-risk people living in endemic areas. Treatment should be given once a year when the prevalence of soil-transmitted helminth infections in the community is over 20%, and twice a year when the prevalence of soil-transmitted helminth infections in the community is over 50%. This intervention reduces morbidity by reducing the worm burden. Anthelminthic drugs are highly effective and have minimal side-effects (Cochran Database, 2009)

Preventive chemotherapy (PC), which refers to the use of anthelminthic drugs either alone or in combination as a public health tool against helminthic infections, can be applied with the following different modalities:

Mass Drug Administration (MDA): The entire population of an area (e.g. state, region, province, district, sub-district, or village) is given anthelminthic drugs at regular intervals, irrespective of the individual infection status,

Targeted Chemotherapy: Specific risk groups in the population, defined by age, sex or other social characteristic such as occupation (e.g. school-age children, fishermen) are given anthelminthic drugs at regular intervals, irrespective of the individual infection status, and

Selective Chemotherapy: After a regular screening exercise in a population group living in an endemic area, all individuals found (or suspected) to be infected are given anthelminthic drugs.

In the control of soil-transmitted helminthiasis, preventive chemotherapy (i.e. deworming) is mainly targeted at school-age children (WHO, 2011). In addition, health and hygiene education reduces transmission and reinfection by encouraging healthy behaviors, while provision of adequate sanitation is also important but not always possible in resource-poor settings (WHO, 2014)

The aim of control activities is morbidity control: periodic treatment of at-risk populations, which will reduce the intensity of infection and protect infected individuals from morbidity. Periodic deworming can be easily integrated with child health days or supplementation programs for preschool children, or integrated with school health programs. In 2011, over 300 million preschool-aged and school-aged children were treated with anthelminthic medicines in endemic countries, corresponding to 30% of the children at risk (WHO, 2014).

Schools provide a particularly good entry point for deworming activities, as they allow easy provision of the health and hygiene education component such as the promotion of hand washing and improved sanitation (WHO, 2014).

2.8 School Health Program

School health, an important branch of public health serves as one of the most cost effective platform for health interventions. WHO described school health as "a strategic means to prevent important health risks among the youth, which if targeted is an economical and powerful means of raising community health, and more importantly in future generations". One of the objectives of school health is the prevention of diseases. Early diagnosis, treatment and follow up of defects is achieved by screening students for risk factors for various diseases. The WHO global school health initiative stated that

"Research in both developed and developing countries demonstrates that school health programs can simultaneously reduce common health problems, increase the efficiency of the educational system and advance public health education and social and economic development of a nation" (WHO, 2013).

2.9 Global Efforts to Combat Soil-Transmitted Helminthiasis (STH) among School-Age Children

Over 609 million school-aged children in 112 countries were estimated to need PC for STH in 2012. In total, 59 countries reported data in 2012 and 242.8 million school-aged children were treated (205.8 million in 2011). The number of school-aged children requiring PC in 2014 and treated was 219.5 million, corresponding to a global coverage of 36% (Weekly Epidemiologic record, 2014). Of all school-aged children that received treatment for STH, 54.4% were treated through STH control programs, while 45.6% were treated through the programs for elimination of lymphatic filariasis. The target of 75% coverage of this age group was reached by 27 countries (WHO, 2014).

In the World Health Organization (WHO) African Region, of 42 countries where PC is needed, 25 reported data in 2012. In the region, 60.9 million school-aged children in need of PC were treated in 2012, equivalent to a regional coverage of 30.1%. The target coverage of 75% was reached by 11 countries (Burkina Faso, Burundi, Cameroon, Ghana, Malawi, Mali, Niger, Rwanda, Sierra Leone, Togo and Uganda). In Burundi, Togo and Uganda 2 rounds of PC were implemented.

In the WHO Region of the Americas, in 2012 of 30 countries where PC is needed, 13 reported data. In this region, 11.9 million school-aged children in need of PC were treated in 2012, equivalent to a regional coverage of 33.6%, and 7 countries reached the 75% coverage target (Belize, Dominican Republic, El Salvador, Haiti, Guyana, Mexico and Nicaragua). In Mexico 2 rounds of PC were implemented.

In the WHO South-East Asia Region, in 2012 of 8 countries where PC is needed, 7 reported data. A total of 134.4 million school-aged children in need of PC were treated in

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2012, equivalent to a regional coverage of 51.1% (+7.5% compared with 2011). The Democratic People's Republic of Korea and Myanmar maintained 75% coverage in this age group. Bangladesh and Nepal implemented 2 rounds of PC for STH, reaching and surpassing 75% coverage target for the first time.

WHO European Region Country evaluations were conducted in the region, as a result of which the number of countries where PC is needed was reduced to 8, of which 3 countries (Azerbaijan, Tajikistan and Uzbekistan) reported treatment of 0.7 million children in need of PC in 2012, equivalent to a regional coverage of 62.3%. Tajikistan and Uzbekistan achieved 75% coverage.

For the WHO Eastern Mediterranean Region, of the 9 countries where PC is needed, only Yemen reported treatment data in 2012. Overall, 0.994 million school-aged children were treated in 2012, equivalent to a regional coverage of 1.8%.

In the WHO Western Pacific Region, of the 15 countries where PC is needed, 10 reported treatment of a total of 10.5 million school-aged children in 2012, equivalent to 20.1% regional coverage, and 3 countries reached the 75% coverage target (Cambodia, Kiribati and Tuvalu). Data reported from China were excluded as they were still being validated at the time. Cambodia, Lao People's Democratic Republic, Vanuatu and Viet Nam implemented 2 rounds of PC for STH (WHO, 2014).

2.10 School-Age-Children (SAC)

Children between the ages 5 and 14 years who may or may not be enrolled in school are usually referred to as school-age-children (SAC). The exact ages of school enrolment can vary slightly between different countries. Because peak prevalence and intensity of soil-transmitted helminth infection occur primarily in school-age children, and because this risk population is easily accessed through schools, deworming activities are implemented through the school system. In some other particular countries, the school age is different (e.g. from 6 to 15 years) (WHO, 2011).

School-aged children account for the bulk of helminth transmission and they are most likely to spread worm infections because they are less likely to use latrines and more generally have poor hygiene practices (Butterworth et al., 1991).

The school age period is nutritionally significant because this is the prime time to build up body stores of nutrients in preparation for rapid growth of adolescence. Nutrition plays a vital role, as inadequate nutrition during childhood may lead to malnutrition, growth retardation, reduced work capacity and poor mental and social development. In children, protein/calorie deficient diet results in underweight, wasting and lowered resistance to infection, stunted growth and impaired cognitive development and learning. There still remains dearth of information however, on nutritional status of school going children particularly from rural areas, as most of the research that has been conducted on nutritional status of children is limited to infants and preschool children (Sati and Dahiya, 2012).

2.11 Nutritional Status in School Age

Nutritional status is the combination of an individual's health as influenced by intake and utilization of nutrients. It can be determined from information obtained by physical (anthropometric), biochemical and dietary studies (Durning and Fidanza, 1985) and has a major impact on children's survival due to the synergistic relationships between malnutrition and disease (de Onis et al., 2012). Adequate nutrition is essential for proper growth, development and maintenance of health through all the stages of life, as nutrient depletion is associated with increased mortality and morbidity (August et al., 2002). Adequate nutrition during childhood however, helps ensure healthy growth, proper organ formation and function, a strong immune system and neurological and cognitive development (UNICEF, 2012).

2.12 Assessment of Nutritional Status

August et al (2002) defined Nutritional assessment as a comprehensive approach to defining nutritional status that uses medical, nutrition, and medication histories; physical examination; anthropometric measurements; and laboratory data. It also includes the organization and evaluation of information to declare a professional judgment.

The scientific methods of assessing nutritional status were put together after World War II when there was widespread malnutrition across Europe. They were used to detect people who were poorly nourished. Nutrition surveys were done in communities considered at risk by nutrition specialists in Britain and North America. In the 1950s, these methods were applied in the rest of the world, especially in less-developed countries where Kwashiorkor was re-discovered in 1952 (Truswell, 2007).

Nutritional assessment utilizes static measurements of body compartments and examines the alterations caused by under-nutrition. The most frequently used methods in nutritional assessments include anthropometric method, biochemical/laboratory method, clinical method and dietary method (August et al., 2002)

2.12.1 Anthropometric Assessment:

Anthropometry is the single most portable, universally applicable, inexpensive, and non-invasive method available to assess the proportions, size and composition of the human body. It reflects both health and nutrition and predicts performance, health and survival (Habicht et al, 1996). For these reasons, it is used in selecting at risk groups for health and nutrition interventions, identifying social and economic inequity and evaluating responses to interventions (Cogill, 2003). These measures are relatively fast to perform and have long been used by varied health professionals (Lai et al., 2010). However, Collins et al (2000) emphasized that an ideal index of nutritional status for any age group should meet the following requirements: it must be correlated with body fat and protein stores, health or functional outcomes and also must be simple to obtain and interpret in the field as well as being accurate (close to the true value), valid (represent what it is thought to represent) and precise (repeatable).

2.12.2 Use of Anthropometry to Assess School-Age Children: It is generally accepted that human growth indicators are suitable markers of population health and nutritional status (dos Santos et al., 2014). Age in combination with height and weight are used to calculate the following anthropometric indicators: height-for-age Z-score (HAZ) to assess stunting; weight-for-age Z-score (WAZ) to assess underweight; and body-mass-index-for-age Z-score (BAZ) to assess thinness (Sanchez et al., 2013). These anthropometric indicators are used to define malnutrition. Calculations are then done with the WHO AnthroPlus software (WHO, Geneva, Switzerland) using the WHO international reference values.

Because of its inability to differentiate between relative height and body mass, WAZ is not recommended for the assessment of growth beyond childhood (>10 years of age) (COFINSA, 2005). BAZ could therefore be used as a complement to HAZ. These indicators are recommended by the WHO as they provide an assessment of a child's nutritional status in comparison with a healthy reference population (de Onis et al., 2007) and according to the 2007 WHO growth reference for school-aged children and adolescents, stunting, underweight and thinness are defined as <−2 standard deviations (SD) HAZ, WAZ and BAZ, respectively.

Stunting as an Anthropometric Index: Stunting (linear growth retardation) is one of two main anthropometric indicators used to define malnutrition; the other being wasting/thinness (UN, 2012). Stunting defined as height-for-age z-score (HAZ) of equal to or less than minus two standard deviation (-2 SD) below the mean of a reference standard (WHO, 1995), is a well-established child-health indicator of chronic malnutrition. It reliably gives a picture of the past nutritional history and the prevailing environmental and socioeconomic circumstances (WHO, 1996). Worldwide, 178 million children aged less than five years (under-five children) are stunted with the vast majority in South-central Asia and sub-Saharan Africa (Lancet, 2008). Stunting hinders cognitive growth, thereby leading to reduced economic potential. In a study on the effects of nutritional status on primary school achievement score in Kenya, undernourished girls were more likely to score less on achievement tests (Mukudi, 2003).

Though known to be highly prevalent in environments that are characterized by a high prevalence of infectious diseases (de Onis and Blossner, 2003), stunting on the other hand impairs host immunity, thereby increasing the incidence, severity, and duration of many infectious diseases (Verhoef et al., 2002). In Nigeria, the national prevalence of stunting among under-five children between 2000 and 2006 was 38% (UNICEF, 2008).

Wasting (BAZ) as an Anthropometric Index: Wasting (low weight-for-height or low body mass index [BMI] for age) as an anthropometric indicator represents a history of nutritional insult to a child. It is acute malnutrition which is generally associated with recent illness and/or food deprivation (United Nations System Standing Committee on Nutrition, 2012).

2.13 Malnutrition among School-Age Children

Malnutrition as defined by August et al. (2002) is any disorder of nutritional status. including disorders resulting from a deficiency of nutrient intake, impaired nutrient metabolism, or over-nutrition. It manifests in different forms including micronutrients malnutrition (Smith and Haddad, 1999) and is a major underlying cause of the persistently high child mortality. It contributes to more than a third of all child deaths among children under age 5-years (Ezzati et al., 2006). Because SAC have the lowest mortality of any age group (Partnership for health development, 1997), they are usually left out of nutrition intervention programs and research even though plagued with deficiencies of critical micronutrients such as iron, folate and iodine (Perignon et al., 2014). Some of these nutrient deficiencies lead to impaired cognitive functions due to their pivotal role in brain development.

Malnutrition is a major public health problem in developing countries (Sati and Dahiya, 2012). Nigeria is not exempted and according to a UNICEF report (2009), the prevalence of stunting, wasting and underweight in Nigerian children under the age of 5 years is very high (41%, 23% and 14% respectively).

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2.14 Determinants of Child Nutritional Status

The high prevalence of parasitic diseases in developing countries contributes greatly to malnutrition there (Black and Sazawal, 2001). Similarly, malnutrition increases one's susceptibility to and severity of infections, and is thus a major component of illness and death from disease (Florentino et al., 2013). Malnutrition is consequently the most important risk factor for the burden of disease in developing countries (WHO, 2001). It is the direct cause of about 300,000 deaths per year and is indirectly responsible for about half of all deaths in young children (Cole et al., 2007). The risk of death is directly correlated with the degree of malnutrition (Cook et al., 2003).

The causes of childhood malnutrition, also known as determinants of child nutritional status, are diverse, multidimensional and interrelated (Herrador et al., 2014). A comprehensive analytical framework suggested by the United Nations Children's Fund (UNICEF, 1998) incorporates both biological and socioeconomic causes of malnutrition and categorizes the causes into (a) immediate causes, (b) underlying causes and (c) basic causes.

Immediate Causes of Malnutrition: These manifest themselves at the level of the individual human being. They are dietary intake (energy, protein, fat and micronutrients) and health status (as influenced by illnesses). These factors themselves are interdependent. A child with inadequate dietary intake is more susceptible to disease. In turn, disease depresses appetite, inhibits the absorption of nutrients in food, and competes for a child's energy. Dietary intake must be adequate in quantity and in quality, and nutrients must be consumed in appropriate combinations for the human body to be able to absorb them. These immediate determinants of child nutritional status are, in turn, influenced by three underlying causes.

Underlying Causes of Malnutrition: Also known as underlying determinants of nutritional status, they manifest themselves at the household level. These are lack of food security, inadequate care for mothers and children, and lack of a proper health environment, including inadequate access to health services and unhealthy environment. Associated with each of these is a set of resources necessary for their achievement.

Food security is achieved when a person has access to enough food to lead an active and healthy life (World Bank, 1986). The resources necessary for gaining access to food are food production, income for food purchases, or in-kind transfers of food (whether from other private citizens, national or foreign governments, or international institutions). Irrespective of how much food is available, no child grows without nurturing from other human beings. This aspect of child nutrition is captured in the concept of care for children and their mothers, who give birth to children and who are commonly their main caretakers after they are born.

Care, the second underlying determinant, is the provision by households and communities of "time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members" (ICN, 1992). Examples of caring practices are child feeding, health-seeking behaviors, support and cognitive stimulation for children, and care and support for mothers during pregnancy and lactation. The adequacy of such care is determined by the care giver's control of economic resources, autonomy in decision making, and physical and mental status. All of these resources for care are influenced by the caretaker's status relative to other household members. A final resource for care is the caretaker's knowledge and belief (IFPRI, 2000).

Health environment and services, the third underlying determinant of child nutritional status, rests on the availability of safe water, sanitation, health care, and environmental safety, including shelter.

A key factor affecting all underlying determinants is poverty. A person is considered to be in absolute poverty when he or she is unable to satisfy adequately his or her basic needs – such as food, health, water, shelter, primary education, and community participation (Frankenberg, 1996). The effects of poverty on child malnutrition are pervasive. Poor households and individuals are unable to achieve food security, have inadequate resources for care, and are not able to utilize (or contribute to the creation of) resources for health on a sustainable basis (IFPRI, 2000).

Basic causes of Malnutrition: Finally, the underlying determinants of child nutrition (and poverty) are, in turn, influenced by basic determinants. The basic determinants include the potential resources available to a country or community, which are limited by the natural environment, access to technology, and the quality of human resources. Political, economic, cultural, and social factors affect the utilization of these potential resources and how they are translated into resources for food security, care, and health environments and services (IFPRI, 2000)

Freedom from malnutrition and its alleviation is fundamental prerequisite for human and national development (Sati and Dahiya, 2012).

2.15 Effects of Soil-Transmitted Helminthiasis on Health and Nutrition

The burden of disease from STH is mainly attributed to their chronic and insidious impact on the health and quality of life of those infected rather than to the mortality they cause. Infections of heavy intensity impair physical growth and cognitive development and are a cause of micronutrient deficiencies including iron-deficiency anemia leading to poor school performance and absenteeism in children. It is regarded as one of the world's most important causes of intellectual and physical retardation (Bethony et al., 2006).
STH morbidity is related to the intensity of infection, with the most intense infections occurring in only a minority of infected individuals (Anderson and May, 1991). People with light infections usually have no symptoms. Heavier infections can cause a range of symptoms including intestinal manifestations (diarrhea, abdominal pain), general malaise and weakness, and impaired cognitive and physical development. The risk of potential morbidity however, is based on the empirical observation that there is some worm burden threshold above which morbidity is likely to occur (Pullan et al., 2013).

Blood loss and decreased supply of nutrients for erythropoiesis, resulting in iron deficiency anemia have been shown to be associated with Intestinal helminthiasis. Though iron deficiency anemia is multifactorial, hook worm infestation is a major contributor to anemia in endemic areas (Cochran Database, 2009). Also, both abdominopelvic problems and symptomatic infection are considered as disabling consequences that are assumed to occur in 100% of individuals who harbour worm burdens above the higher threshold, and persist for the duration of infection (Bundy et al., 2004). Cognitive impairment however is no longer considered a sequela for STH (Pullan et al., 2013).

According to the WHO, soil-transmitted helminths impair the nutritional status of the people they infect in multiple ways, such as:

i) The worms feed on host tissues, including blood, which leads to a loss of iron and protein,

ii) The worms increase malabsorption of nutrients. In addition, roundworm may possibly compete for vitamin A in the intestine, and

iii) Some soil-transmitted helminths also cause loss of appetite and therefore a reduction of nutritional intake and physical fitness. In particular, *T. trichiura* can cause diarrhoea and dysentery.

There were an estimated 2,824 deaths attributable to *A. lumbricoides* in 2010, with most occurring in populations from Asia and south Asia. Deaths from STH are all attributable to heavy *A. lumbricoides* infection, and are primarily due to intestinal obstruction and biliary or pancreatic disease in children under 10 years of age (Pullan et al., 2014). Although the nutritional impairment caused by soil-transmitted helminths is recognized to have a significant impact on growth and physical development (WHO, 2014), anthelminthic drugs have been highly effective and have minimal side-effects (Cochran Database, 2009)

The elimination of moderate and heavy infections is the target of PC programs (WHO, 2012) since scientific evidence has linked STH morbidity with worm burden (*i.e.*, the number of adult parasites inhabiting the intestine (Stephenson et al., 2000). In addition to worm burden, poly-parasitism -the concurrent infection with multiple parasite species- has also been associated with children's malnutrition (Hall et al., 2008). Light infections may also impose a threat to children's health (Stolzfus et al., 1997) especially if living in endemic communities with poor nutritional status (Crompton et al, 2002).

Sanchez et al. (2013) aimed to ascertain potential associations of STHs infections with children's nutritional status (stunting, underweight and thinness) but their result did not support such associations. It is recognized that studying the effects of intestinal helminths on child growth and nutrition in endemic populations is not an easy endeavor, as it is difficult to control for other environmental or socio-economic factors or seasonal changes in the food supply (Tanner et al., 2009). The overlap of poverty, malnutrition and STH endemicity in some populations may obscure the true effect of helminthiasis in childhood health (Sanchez et al., 2013)

CHAPTER THREE

STUDY METHODOLOGY

3.1 Study Area

This study was implemented at Obafemi/Owode local government area (LGA) in Ogun State, Nigeria.

Obafemi/Owode Local Government came into existence through Edict No. 9 of 1976, resulting from the 1976 Local Government reforms. Prior to this period, the administration of the area was carried out by Oba Provincial Authority, Owode District Council and Obafemi District Council. Obafemi/Owode Local Government has its headquarters at OwodeEgba.

Obafemi/Owode Local Government shares common boundaries with the following Local and State Governments: North – Odeda Local Government and Oyo State; East – Sagamu and Ikenna Local Governments; South – Ifo Local Government and Lagos State. It has an estimated population of 230,000 and is made up of 1,204 towns and villages with a land mass of 104,787.07 hectares of largely agricultural land.

This Local Government is made up of people residing in Adigbe, Oba Kobape, Obafemi, Ogunmakin, Ajebo, Owode, Ibafo, Iro and Mokoloko towns and they are mostly Egba. Therefore, the common language being spoken is the Yoruba with the Egba dialect. It has some motorable (graded) roads which are linked by State and Federal road networks for inter and intra city connections. In the area of health services, Obafemi/Owode Local Government is blessed with competent staff and facilities (22 health clinics and 12 health posts). Farming is the predominant occupation but in recent times however, the people of the area engage themselves in quarry business, artisan works and handcrafts, such as dye making and pottery. Also, for administrative convenience, Obafemi/Owode Local Government is politically divided into 12 wards, viz: Mokoloki, Oba, Ofada, Egbeda, Owode, Kajola, Ajura, Obafemi, MolokoAsipa Ajebo, Onidundu and Alapako-Oni wards.

The residents were mainly of the low to middle socio-economic class as evidenced by their occupational types, which is predominantly farming. The study area has public as well as private health facilities. The public health facilities are run by Obafemi/Owode Local Government, providing preventive and curative health services on out-patient basis and referrals are made as the need arises. The private health facilities comprise both formal and informal health sectors. The University College Hospital, Ibadan also has a health service post situated at Aladura community within the local government.

Obafemi/Owode local Government bas three major zones of Oba, Obafemi and Owode with 63, 50 and 48 primary schools respectively. The combined eligible school population is 161.

3.2 Study Design

This is a descriptive cross-sectional study.

3.3 Study Population

Primary school pupils between the ages 5 to 14 years (school-aged) enrolled in school in Obafemi/Owode Local Government Area of Ogun State, Nigeria were selected and included in this study.

3.4 Sample Size Determination

The desired sample size was obtained using the following formula (for estimating single proportion):

$$n = \frac{Z_{\alpha}^{2}pq}{d^{2}}$$

Where:

n = desired sample size

$Z\alpha$ = standard normal deviation of 1.96 which corresponds to 95% confidence level

p = proportion of school-age children estimated to have the main outcome variable (i.e are chronically malnourished) = 0.25 (Mwaniki and Makokha, 2013)

q = 1 -p = 0.75

d = degree of accuracy set at 5% = 0.05

Applying the formula:

$$n = \frac{1.96^2 \times 0.25 \times 0.75}{0.05^2}$$

= 288.12

Making provision for a non-response rate of 0.1 and a design effect, D of 1.5,

n = 288.12 x 1.1 x 1.5 = 475.398

This approximates to 475 pupils.

3.5 Sampling Technique

This study employed a multi stage sampling technique.

Stage 1: Obafemi/Owode Local Government Area is very extensive and is divided into three major zones of Oba, Obafemi and Owode. Obafemi zone was purposively selected because of the presence of a functional health facility managed by the Department of Epidemiology and Medical Statistics of the University of Ibadan. It is a referral and co-ordinating centre of the proposed School Health Programme.

Stage 2: Two out of the four educational zones in Obafemi (Ajebo and Ogunmakin) were selected by purposive sampling technique.

Stage 3. From a list drawn up of all the public and private primary schools in the two selected educational zones, a random selection of eleven functional and accessible schools (6 public and 5 private) was made.

Stage 3: Random selection of children was done based on proportionate to size allocation of sample size to schools.

Stage 4: 460 randomly selected children met all aspects of the inclusion criteria and are included in this study.

3.5.1 Inclusion criteria:

All assenting children (aged between 5 and 14 years) enrolled in a school, who:

1) Were within the ages 5 to 14 years,

2) Had not taken preventive chemotherapy treatment within the past 3 months leading up to the study,

3) Where in an apparent state of good health.

3.5.2 Exclusion criteria:

Children who were acutely ill at the time of study

3.6 Data collection

Stool samples were collected from the children as well as a 24-hour recall of their food intake. A semi-structured interviewer administered questionnaire was used to gather information on socioeconomic and household characteristics as well as hygiene habits of the study participants.

3.6.1 Anthropometric Measurements: height (in meters) and weight (in Kilograms) were measured.

Weight: Measurement was taken using a digital weighing scale after checking for error and readings were taken to the nearest 0.1 kg. Study participants were weighed standing still and without support with arms hanging freely by the sides of the body and palms facing the thighs. The participants were barefoot or with socks, belts and other accessories were removed and pockets emptied with body weight evenly distributed between both feet.

Height: Measurements were taken with a portable stadiometer to the nearest 0.01 m with the subjects barefoot or with socks, standing erect with heels together and with their heads in the Frankfurt plane (i.e. looking straight ahead).

3.6.2 Stool Sample Collection: Every child was supplied with a pre-coded wide mouthed; screw capped and leak proof plain (no vacuum) plastic container as well as wooden applicator sticks and a pair of disposable latex gloves.

The children were instructed on how to collect the sample before receiving the specimen collection materials and told to bring along freshly passed stool samples not more than 10 grams to school on predetermined survey days. Specimen bottle codes were same as code on each child's individual questionnaire.

The samples were received early, recorded appropriately and transported to the college laboratory of the Department of Medical Microbiology and Parasitology of the University College Hospital, University of Ibadan.

3.6.3 Dietary Intake Assessment: this was assessed using a 24-hour dietary recall questionnaire. Foods consumed by the children within the previous 24 hours were obtained and classified into the nine relevant food groups: Basic staples, vitamin A rich fruits and vegetables, other fruits, other vegetables, legumes and pulses, meat or fish, oils, dairy, and Eggs. Each food group was given a score of one out of nine and these were used to calculate food/dietary diversity.

A minimum of food group score out of nine was then considered as adequate dietary intake.

3.7 Study Variables

3.7.1 Dependent Variable: the dependent variable is nutritional status. It is assessed based on the two anthropometric indices; stunting and wasting. Stunting is classified as any Height-for-Age Z-score less than -2 Standard deviations while wasting is classified as any BMI-for-Age Z-score less than -2 standard deviations.

3.7.2 Independent Variables: Soil-transmitted Helminthiasis is the main independent variable. It is assessed by presence of at least one of the parasites *Ascaris lumbricoides*, *Trichuris trichiura* and Hookworm in stool. Covariates are age, gender, type of school, dietary adequacy and other socio-demographic socio-economic and household variables.

3.8 Data Analysis

3.8.1 Statistical Data Analysis

After manual verification of the completeness of questionnaires administered, data was entered into Statistical Package for the Social Sciences (SPSS) version 16.0. Data cleaning was then carried out to check for inconsistencies. Quantitative variables were summarized using means and standard deviations while frequencies and proportions were used to summarize categorical variables.

WHO Anthroplus software version 1.0.4 was used to compute anthropometric indices Height-for-age Z-scores (HAZ) and Body-Mass-Index-for-age Z-scores (BAZ). WHO Anthro plus is a World Health Organization software for personal computers, it was developed to monitor the growth of school-age children and adolescents. Three indicators that are included in Anthro plus are weight-for-age (WAZ) to assess underweight, height-for-age (HAZ) to assess stunting and BMI-for-age to assess wasting/thinness. This software enables monitoring growth in individuals and populations of children from birth to 19 years of age.

Weight-for-age (WAZ) is not recommended for use in children over the age of 10 years, it was therefore excluded from use in this study.

According to the World Health Organization (WHO) recommendation for classifying stunting and wasting, children with height-for-age and Body-mass-index-for age Z-scores between -2.99 and -2.00 were considered as have mild to moderate stunting and wasting respectively, while those with Z-scores less than or equal to -3.00 were classified as severely stunted or wasted respectively.

Table 3.1 WHO Cut-offs for Variables used in the Assessment of Nutritional Status

Z-score for Variables	Nutritional Status
HAZ -2SD to +2SD	Normal
BAZ -2SD to +1SD	Normal
HAZ < -2SD	Stunting
HAZ < -3SD	Severe Stunting
BAZ < -2SD	Wasting
BAZ < -3SD	Severe Wasting
BAZ > +1SD	Overweight
BAZ > +2SD	Obesity

HAZ, Height-for-age – Z score; BAZ, Body mass index (for age – Z score)

The student-t test was used to compare means of anthropometric index weight-for-age (HAZ) score and BAZ score while the chi-squared test was used to analyze qualitative variables.

Multiple logistic regression analysis was used to assess the association between various risk factors and helminthiasis, stunting, wasting and co-existence of stunting and wasting.

The details of the analysis of the various variables are shown in table 3.2 below:

Table 3.2: Statistical Data Analysis Summary

S/N	Variables	Test
1.	Mean of Age	Mean and standard deviation
2.	Prevalence of soil-transmitted helminthiasis, dietary inadequacy and malnutrition (i.e stunting and wasting)	Frequencies and proportion
3.	Associations between sex, age, religion, school type, class, father's level of education, mother's level of education, father's occupation, mother's occupation, type of house lived in, family structure, source of drinking water, source of cooking fuel, type of home latrine used, type of school latrine used, shoe wearing habit, hand washing before eating, hand washing habit after toilet use and soil-transmitted helminth infection status, stunting, wasting, stunting with wasting co-occurrence	Chi square
4.	Compare means between age, height weight, HAZ score and BAZ score of STH infected and non-infected children	Independent t- test
5.	Risk factors for soil-transmitted helminthiasis	Logistic regression
6.	Risk factors for chronic malnutrition (i.e stunting)	Logistic regression
7.	Risk factors for acute malnutrition (i.e. wasting)	Logistic regression
8.	Risk factors for co-occurrence of acute malnutrition (stunting) and chronic malnutrition (wasting)	Logistic regression

3.8.2 Stool Sample Analysis

Based on WHO recommendations, Kato-Katz thick smear technique was used for stool sample analysis. Analysis was done by competent qualified staff of the Medical Microbiology Department accustomed to daily sample analysis. Kato-Katz templates with a thickness of 1.5mm were used. A single smear test was performed on each sample. Kato-Katz slides were examined microscopically in a systematic manner within 30 – 60 minutes of preparation and identification of parasite eggs, including *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm) and hookworm was done. Samples found to be positive for any of these three parasites underwent egg burden counts and the number of helminth eggs obtained for each parasite specie was multiplied by a factor of 24 in order to determine the number of eggs per gram (epg) of feces. Egg counts were used to classify infection intensities into light, moderate, or heavy infections respectively as follows:

For *Ascaris lumbricoides*: 1 – 4,999 epg, 5,000 – 49,999 epg and ≥ 50,000 epg;

For *Trichuris trichiura*: 1 – 999 epg, 1,000 – 9,999 epg and ≥ 10,000 epg;

And for hookworms (*Ancylostoma dueodenale/Necator americanus*): 1 – 1,999 epg, 2,000 – 3,999 epg and ≥ 4,000 epg.

3.9 Ethical Considerations

The study was approved by the Research Ethics Committee/Institutional Review Board of University College Hospital, University of Ibadan, Nigeria. Permissions were sought from all the relevant authorities: first was the Ogun State Education Board. Before commencement of the study, the research team conducted meetings with head teachers, teachers, parents and guardians of all selected schools. During these meetings, the objectives of the study including the study procedures to be followed, information to be requested, sample to be taken, study benefits and potential risks and discomforts were explained. Written informed consent for all children who participated in the study was sought from parents and legal guardians after they had been clearly informed about the study. Children were also requested to give assent and were informed of their right to refuse to participate in the study and to withdraw at any time during the study without any forms of victimization. Stool sample collection procedure was fully explained to parents and children and sterile disposable materials for collection were provided.

Confidentiality of data: All forms and documents were stripped of participant's names; unique numbers/identifiers will be used for identification. Only appropriate individuals involved in the research implementation and analysis were allowed to handle documents containing participants' information.

Beneficence to participants: All parents and guardians of participating children were assured that infected participating children with STH will be given a 200mg dose of anthelminthic medicine, Albendazole. Parents of children who have one form or the other of nutritional impairment would be informed of their child's nutritional state through parent/teachers association (PTA) meetings

Non-maleficence to participants: The risk of harm to study participants was estimated as minimal. Password protected computerized systems will be used for data management.
Voluntariness: Participation in this research was entirely voluntary. Eligible individuals were assured of their choice to either participate in the study or not as well as their right to quit the study at any time.

3.10 Dissemination of results

The results of this study will be disseminated to the guardians of children who participated in this study and appropriate health authorities.

CHAPTER FOUR

RESULTS

4.1 Socio-Demographic Characteristics of the Study Participants

A total of 460 children aged between 5 and 14 years were included in this study. Of these, 239(52.0%) were female, 316 (68.7%) were between the ages 10 to 14 years while 144 (31.3) were aged between 5 to 9 years, 276(60.0%) attend government (public) schools and majority 401(87.2) are of the Yoruba tribal origin. Almost all (99.8%) of the children come from either a Christian 356 (77.4) or Muslim 103 (22.4) religious background and over half of them (55.5%) were from primary school classes four to six.

Two hundred and thirty three (50.7%) had mothers with at least a secondary school level of education while mothers of two hundred and twenty seven (49.3%) were either not educated or had attended primary school only. Also, two hundred and eighty eight (62.6%) of the study participant's fathers had at least secondary school education while one hundred and seventy two fathers(37.4%) were either not educated or had attended primary school only. Mud house accommodation was the predominant house-type (66.7%). 261 children (56.7%) had more than at most three siblings and over half (59.6%) of the children were from a monogamous family. The mean age of the study participants was 10.35 (±2.39) years

Table 4.1: Socio-Demographic Characteristics of the Study Participants

Variable	Frequency n=460	Percentage %
Age (years)		
5 – 9	144	31.3
10 – 14	316	68.7
Sex		
Male	221	48.0
Female	239	52.0
Religion		
Christianity	356	77.4
Islam	103	22.4
Traditional	1	0.2
Ethnicity		
Yoruba	401	87.2
Hausa	11	2.4
Igbo	27	5.9
Others	21	4.6
School Type		
Public	276	60.0
Private	184	40.0
Father's level of Education		
None	36	7.8
Primary	136	29.6
Secondary	221	48.0
Tertiary	67	14.5
Mother's Level of Education		
None	43	9.3
Primary	184	40.0
Secondary	88	40.9
Tertiary	45	9.8
Father's Occupation		
Unemployed	42	9.1
Trader	21	4.5
Farmer	364	79.2
Artisan	16	3.5
Civil Servant/ other professional	17	3.7

Table 4.1: Socio-Demographic Characteristics of the Study Participants (Cont.)

Variable	Frequency n=460	Percentage %
Mother's Occupation		
Unemployed	33	7.2
Trader	350	76.1
Farmer	51	11.1
Artisan	8	1.7
Civil Servant/ other professional	18	3.9
House Type		
Mud house	307	66.7
Cement	153	33.3
No. of Siblings		
0 – 3	261	56.7
≥ 4	199	43.3
Family Structure		
Monogamous	274	59.6
Polygamous	186	40.4

4.2 Household Characteristics and Hygiene Habits of the Study Participants

As seen from table 4.2 below, well or river were the two main primary sources of drinking for the study participants (42.2% and 27.2% respectively). Bush attack 157 (34.1%) and use of pit latrines 155 (33.7%) were the predominant latrine types in homes of the children. More than half (51.7%) of the children do not always wear shoes; a quarter however (27.2%) reported wearing shoes often while 68 (14.8%), some never wear their shoes except when coming to school. Majority (94.1%) of the school children reported that they always wash their hand before eating. High proportions (87.2%) also wash hands after defecation. About two thirds (62.6%) of the total number of children reported that they swim. Most swim in rivers (69.1%), some lakes (18.8%) and lesser proportion ponds (9.4%). Some however swim in conventional swimming pools.

Table 4.2: Household Characteristics and Hygiene Habits of the Study Participants

Variable	Frequency n=460	Percentage %
Primary Source of Drinking Water		
Pond / lake	13	2.8
River	125	27.2
Well	204	44.4
Bore hole	33	7.2
Pipe borne water	25	5.4
Packaged water (e.g. sachet water)	60	13.0
Home Latrine		
Potty	15	3.3
Bush	157	34.1
Open Field	38	8.3
Cement (pit latrine)	155	33.7
Water Closet	95	20.7
School Latrine		
Potty	6	1.3
Bush	255	55.4
Open Field	19	4.1
Cement (Pit latrine)	100	21.7
Water Closet	80	17.4
Shoe Wearing Habit		
Always	222	48.3
Often	125	27.2
Seldom	45	9.8
Never	68	14.8
Wash Hands Before Eating		
Yes	433	94.1
No	27	5.9
Wash Hands after Defecation		
Yes	401	87.2
No	59	12.8
Swim in Rivers, Lakes or Ponds		
Yes	280	60.9
No	180	39.1

4.3 Class of the Study Participants

Figure 4.1 shows the class distribution of the study participants. 68(14.8%) of them were in kindergarten, 28 (6.1%) in primary one, 46 (10.0%) in primary two, 63(13.7%) in primary three, 96(20.9%) in primary 4, 85 (18.5%) in primary 5 and 74 (16.1%) of them were in primary six.

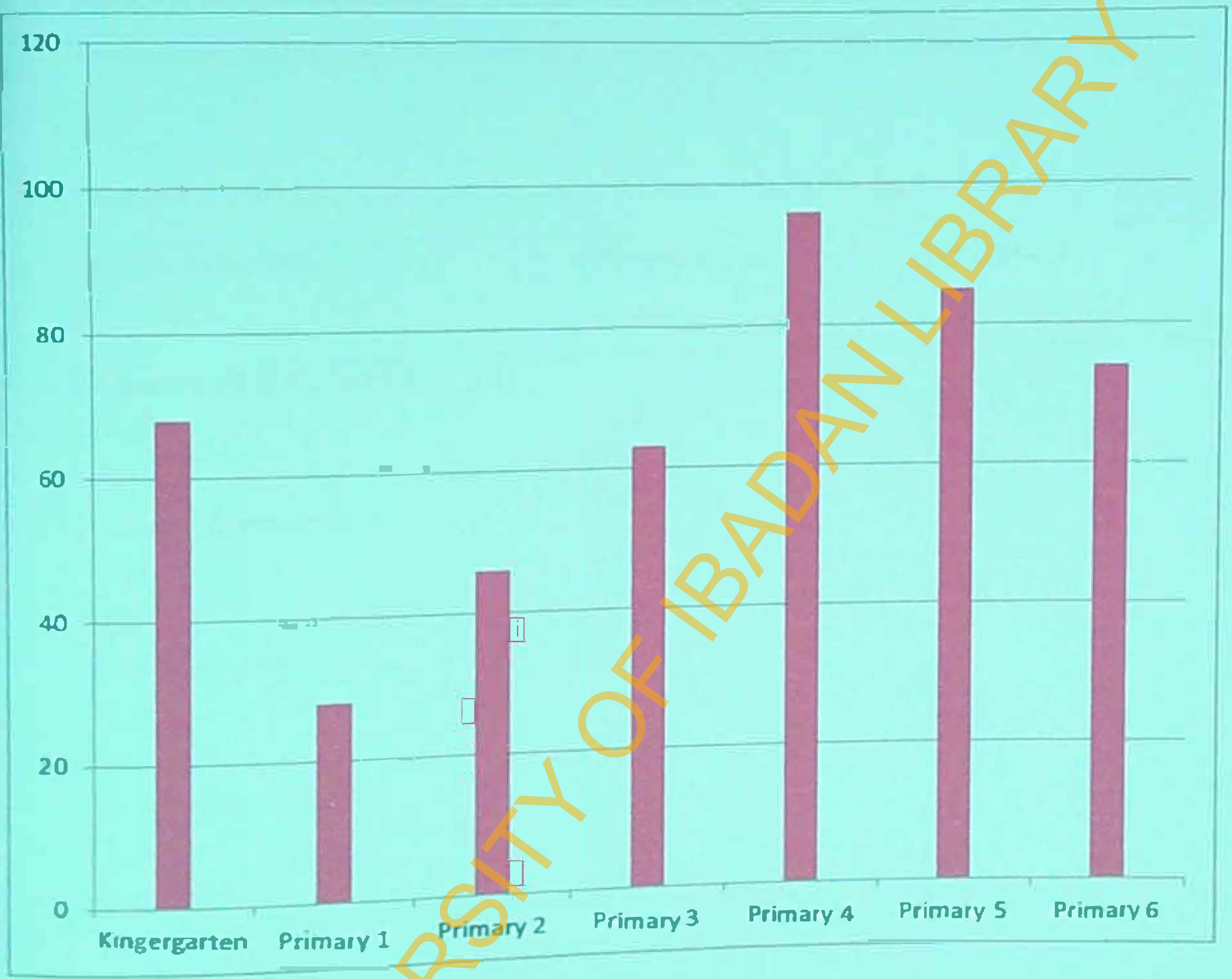


Figure 4.1: Class of the Study Participants

4.4 Prevalence of Soil-Transmitted Helminthiasis among the Study Participants

Table 4.3 gives the prevalence of STH among the respondents. A total of 134 of 460 children studied were infected with soil-transmitted intestinal helminths, giving an overall point prevalence of 29.1%. Specifically, the prevalence for *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworm was 28.7%, 0.7% and 0.7% respectively.

Table 4.3 Prevalence of Soil-Transmitted Helminthiasis among the Study Participants

STHs Infections	Frequency n=460	Percentage %
Overall STH Positivity		
Yes	134	29.1
No	326	70.9
Ascaris lumbricoides		
Yes	132	28.7
No	328	71.3
Trichuris trichiura		
Yes	3	0.7
No	457	99.3
Hookworm Infection		
Yes	3	0.7
No	457	99.3

Figure 4.2 Venn Diagram Showing Mono-parasitism and Poly-parasitic Interactions among 134 Infected Study Participants

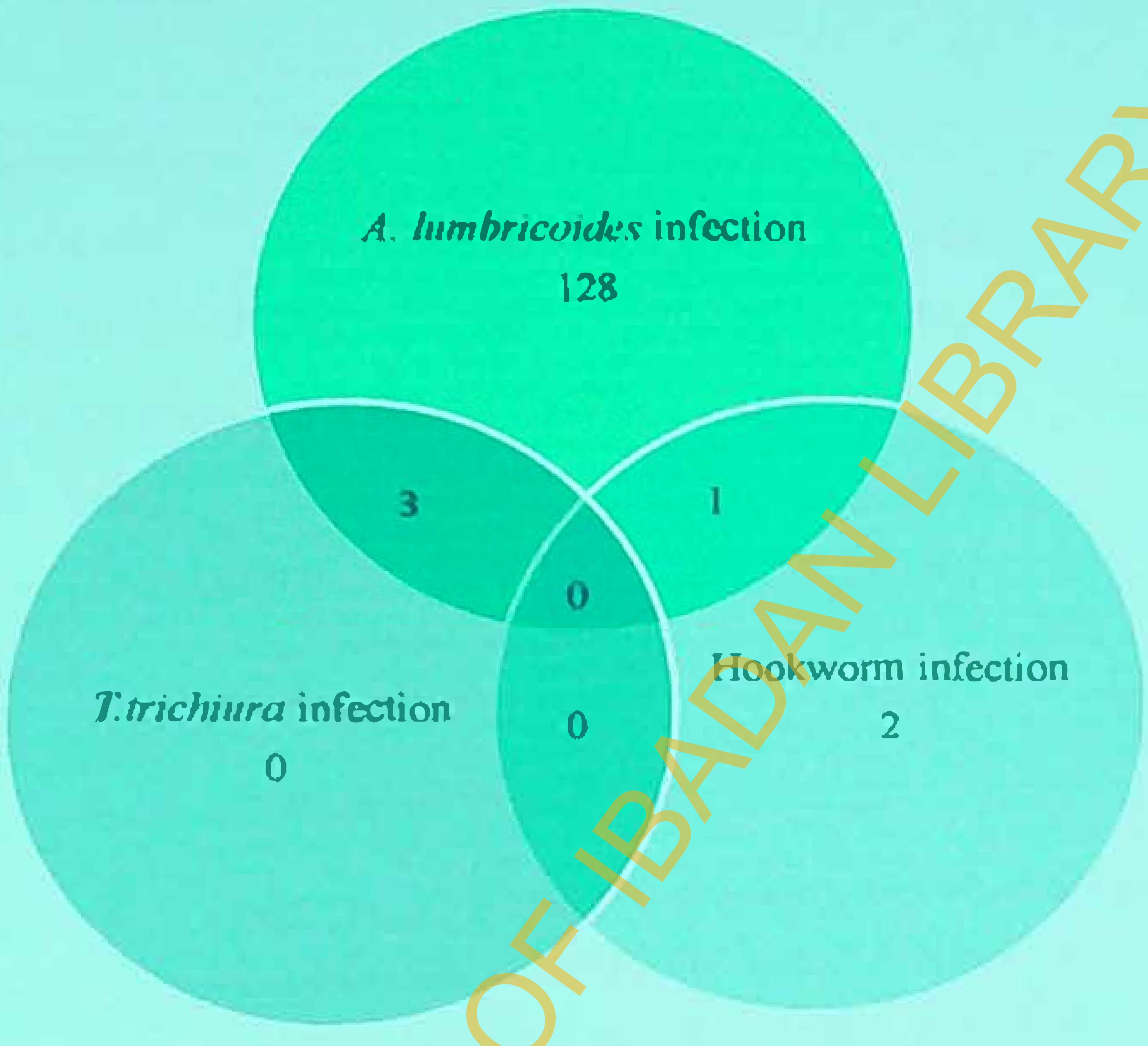


Table 4.4: Intensity of Soil-Transmitted Helminthiasis (in eggs per gram of feces) among 134 Infected Study Participants

Parasite Intensity	Frequency n=134	Percentage %
Ascaris lumbricoides		
Light (1 - 4,999)	86	65.6
Moderate (5,000 - 49,999)	46	34.4
Trichuris Trichiura		
Light (1 - 999)	2	66.7
Moderate (1,000 - 9,999)	1	33.3
Hookworm		
Light (1 - 1,999)	3	100.0

As shown in table 4.4 above, eighty six (65.6%) *A. lumbricoides* infections were of light intensity while 46 (34.3) were of moderate intensity. Two *T. trichiura* infections of light intensity as well as one infection of moderate intensity were also observed. All three hookworm infections observed were of light intensity. Overall, infections were either of light or moderate intensity, no heavy intensity infection was observed.

Table 4.5: Proportions of Mono-parasitism and Poly-parasitism among 134 Infected Study Participants

Type of infection	No. of species	Species associated	n (%)
Mono-parasitism	**1 specie (n =130)**	*A. lumbricoides*	128 (95.5)
		T. trichiura	0 (0.0)
		Hookworms	2 (1.5)
		Total mono-parasitism	**130 (97.0)**
Poly-parasitism	**2 species (n = 4)**	*T. trichiura* & *A. lumbricoides*	3(2.2)
		T. trichiura & Hookworms	0 (0.0)
		A. lumbricoides & Hookworms	1(0.8)
		Total poly-parasitism	**4 (3.0)**

As shown in table 4.5, 4(3.0%) of 134 infected children had co-infections. Of these, none harbored triple infections. *Ascaris lumbricoides* prevailed in mono-parasitic and poly-parasitic associations with both *Trichuris trichiura* and hookworm. There were no light infections for *Trichuris trichiura* which was also not found in combination with hookworm. No triple infection with all three parasites (*A.lumbricoides, T.trichiura* and hookworm) was found.

4.5 Prevalence of Malnutrition among the Study Participants

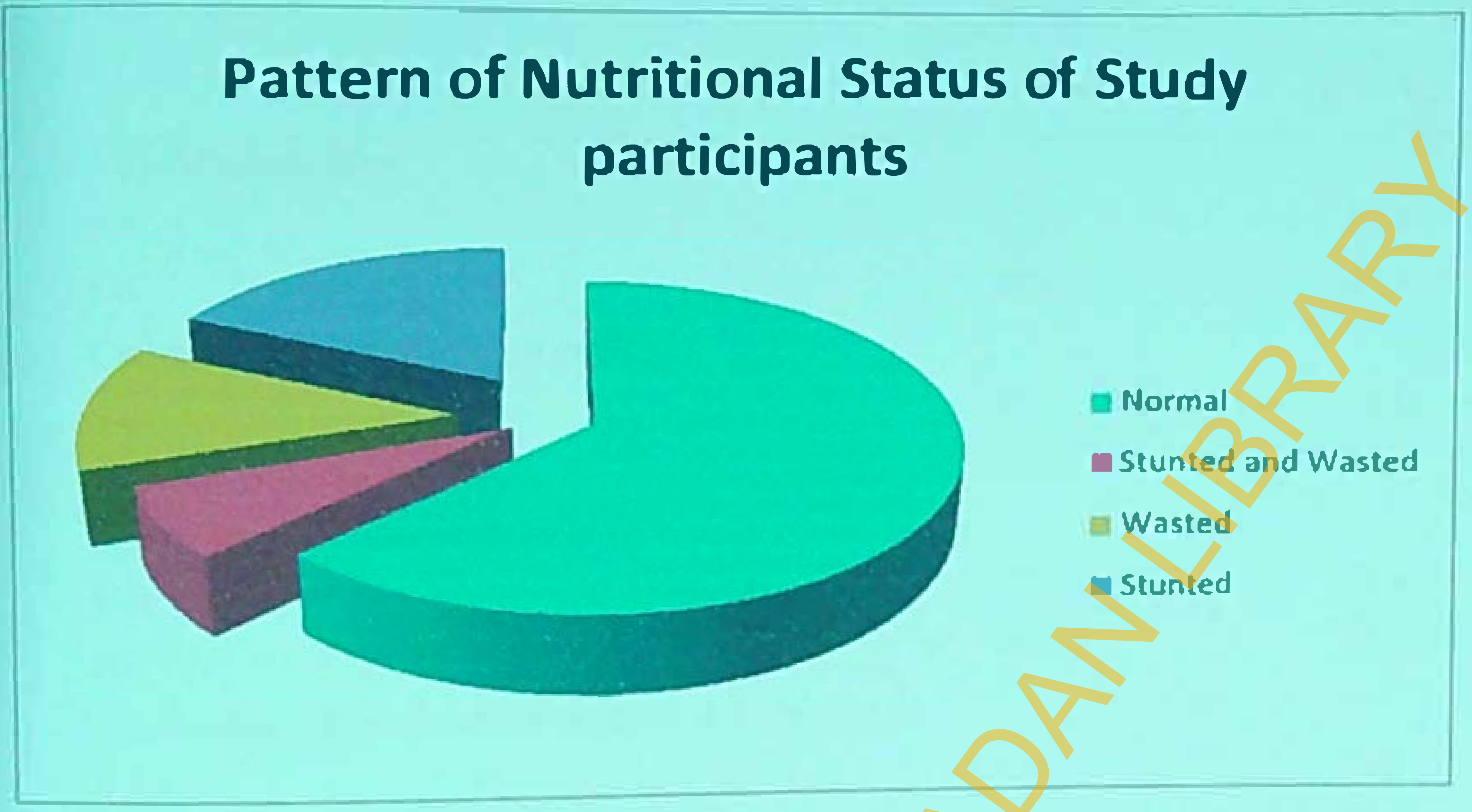


Figure 4.3 Nutritional Status Distributions of the Study Participants

Table 4.6 Prevalence of Malnutrition among the Study Participants

Malnutrition	Frequency n=460	Percentage %
Any Malnutrition		
Yes	172	37.4
No	288	62.6
Chronic Malnutrition (Stunting)		
Yes	83	18.0
No	377	82.0
Acute Malnutrition (Wasting)		
Yes	57	12.4
No	403	87.6
Acute and Chronic Malnutrition Co-existence		
Yes	32	7.0
No	423	93.0

Table 4.6 shows the proportions of children suffering from acute and chronic malnutrition as well as their co-existence. 83 (18.0%) children were stunted, 57(12.4%) were wasted while 32(7.0%) were both stunted and wasted. Overall, 172 (37.4%) study participants were malnourished.

Table 4.7: Prevalence of Chronic Malnutrition (Stunting) among the Study Participants

Stunting Index (Height-for-Age Z-Scores)	Frequency n=460	Percentage %
Normal (+2 to -2 SD)	345(75.0)	75.0
Mild to moderate Stunting (-2 to -3 SD)	71(15.4)	15.4
Severe Stunting (< -3SD)	44(9.6)	9.6

From table 4.7 above, 71 (15.4%) of the study participants had mild to moderate stunting while 9.6% were severely stunted. Overall, 25% of the children where stunted.

Table 4.8: Prevalence of Acute Malnutrition (Wasting) among the Study Participants

Wasting Index (Body-Mass-Index -for-Age Z-Scores)	Frequency n=460	Percentage %
Normal (+2 to -2 SD)	343	74.6
Mild to moderate Wasting (-2 to -3 SD)	54	11.7
Severe Wasting (< -3SD)	35	7.6
Overweight	18	3.9
Obese	10	2.2

Table 4.8 above shows that 54 (11.7%) study participants were moderately wasted while 35(7.6%) were severely wasted. Some children however were overweight (3.9%) and some obese (2.2%).

4.6 Dietary Assessment of the Study Participants

Table 4.9 gives a summary of the dietary pattern of the respondents. A larger proportion of the children's diets were derived from less than four food groups. The most prevalent food diversity among the children were meals composed of three food groups 199 (43.3). Study participants who had a dietary diversity score of 0, eat nothing the previous day.

Table 4.9: Dietary Intakes of the Study Participants

Dietary Diversity Score	Frequency n=460	Percentage %
0	7(1.5)	1.5
1	34(7.4)	7.4
2	181(39.3)	39.3
3	199(43.3)	43.3
4	34(7.4)	7.4
5	3(0.7)	0.7
6	2(0.4)	0.4

Table 4.10: Dietary Adequacy of the Study Participants

Dietary Intake	Frequency n=460	Percentage %
Inadequate (0 – 4 food groups)	253	91.7
Adequate (> 4 food groups)	23	8.3

The dietary assessment of the sampled children summarized in table 4.10 above shows that over 90% of the children consume diets derived from less than four food groups and consequently are nutrient inadequate.

4.7 Association of Soil-Transmitted Helminthiasis with Nutritional Status

From table 4.11 below, a slight difference in proportions was seen when the nutritional index stunting, was assessed for individuals within STHs infected and uninfected groups. Stunting, a measure for chronic malnutrition, was however not statistically significantly associated with STHs infection among the study participants.

Table 4.11: Association of Soil-Transmitted Helminthiasis with Chronic Malnutrition

	Stunting			
Soil-Transmitted Helminthiasis	**Yes**	**No**	**Total**	**p-value**
Present	27 (20.1)	107 (79.9)	134	0.451
Absent	56 (17.2)	270 (82.8)	326	

Table 4.12: Association of Soil-Transmitted Helminthiasis with Acute Malnutrition

Soil-Transmitted Helminthiasis	Wasting		Total	p-value
	Yes	No		
Present	19 (14.2)	115 (85.8)	134	0.456
Absent	38 (11.7)	288 (88.3)	326	

From table 4.12, slight difference in proportions was seen when the nutritional index wasting, was assessed for individuals within STHs infected and uninfected groups. Wasting, a measure for acute malnutrition, was however not statistically significantly associated with STHs infection among the study participants.

Table 4.13: Association of Soil-Transmitted Helminthiasis with Co-existence of Acute and Chronic Malnutrition

Soil-Transmitted Helminthiasis	Stunting and Wasting Co-existence Yes	No	Total	p-value
Present	9 (6.7)	125 (93.3)	134	0.897
Absent	23 (7.1)	303 (92.9)	326	

From the table 4.13 below, notable difference in proportions was not observed when co-existence of the nutritional indices, stunting and wasting was assessed for individuals within STH infected and uninfected groups. Stunting and wasting co-existence was also not statistically significantly associated with STH infection status.

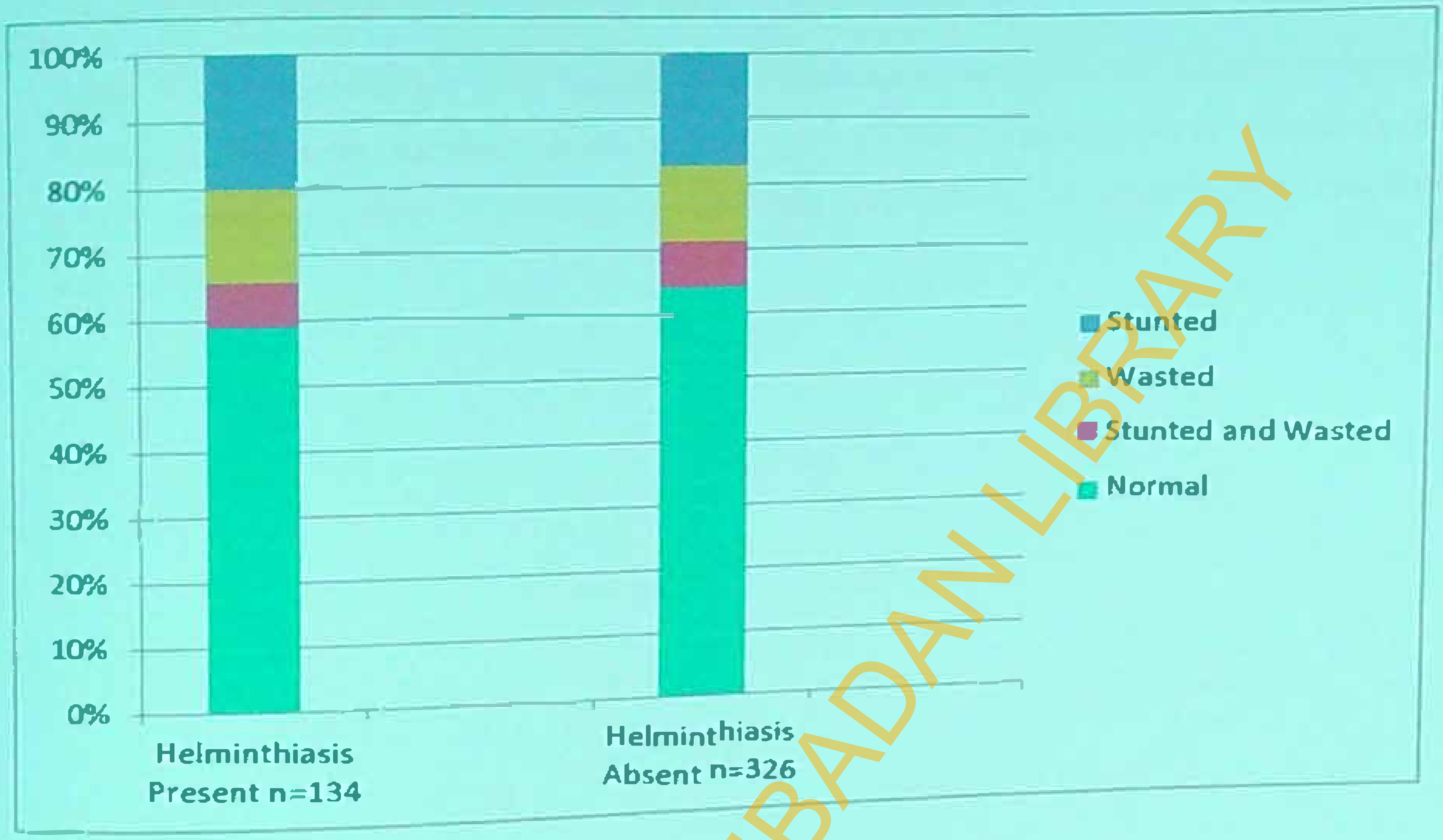
Table 4.14: Comparison of Mean Height-for age Z-score of Helminth Infected and Non-infected Study Participants

Variable	Mean	Standard deviation	t	p-value
Soil-Transmitted Helminthiasis				
Present	-1.34	1.95	2.301	0.022
Absent	-0.94	1.74		

* Statistically significant at $p < 0.05$

As shown in table 4.14 above, there is a significant association between infection with STH and mean height-for-age Z-score

Figure 4.4: Nutritional Status Disaggregated by Helminths Infection Status among 460 Study Participants



4.8 Associations of the Socio-Demographic Characteristics of the Study Participants with Chronic Malnutrition (Stunting)

Table 4.15 summarizes the results of multivariate analysis of socio-demographic characteristics with stunting. It shows age (p = 0.009), fathers level of education (p = 0.013) and the number of siblings a child has (p = 0.014), are significantly associated with stunting.

Table 4.15: Associations of the Socio-Demographic Characteristics of the Study Participants with Chronic Malnutrition (Stunting)

Variables	Stunting Yes	No	Total	p-value
Age (years)				
5 – 9	16 (11.1)	128 (88.9)	144	0.009*
10 – 14	67 (21.2)	249 (78.8)	316	
Sex				
Male	41 (18.6)	180 (81.4)	221	0.785
Female	42 (17.6)	197 (82.4)	239	
Religion				
Christianity	68 (19.1)	288 (80.9)	356	0.292
Islam	15 (14.6)	88 (85.4)	103	
School-type				
Public	56 (20.3)	220 (79.7)	276	0.125
Private	27 (14.7)	157 (85.3)	184	
Father's Level of Education				
< Secondary	41 (23.8)	131 (76.2)	172	0.013*
≥ Secondary	42 (14.6)	246 (85.4)	288	
Mother's Level of Education				
< Secondary	45 (19.8)	182 (80.2)	227	0.327
≥ Secondary	38 (16.3)	195 (83.7)	233	

* Statistically significant at $p < 0.05$

Table 4.15: Associations of the Socio-Economic Characteristics of the Study Participants with Chronic Malnutrition (Stunting) (cont.)

Variables	Stunting Yes	Stunting No	Total	p-value
Father's Occupation				
Unemployed	10 (23.8)	32 (76.2)	42	0.254
Trader, artisan/ farmer	70 (18.2)	315 (81.1)	385	
Civil servant/other qualified professional	3 (9.1)	30 (90.9)	33	
Mother's Occupation				
Unemployed	5 (15.2)	28 (84.8)	33	0.728
Trader, artisan/ farmer	72 (18.0)	329 (82.0)	401	
Civil servant/other professional	6 (23.1)	20 (76.9)	26	
House Type				
Mud house	58 (18.9)	249 (81.8)	307	0.502
Cement/brick	25 (16.3)	128 (83.7)	153	
Family Structure				
Monogamous	53 (19.3)	221 (80.7)	274	0.379
Polygamous	30 (16.1)	156 (83.9)	186	
No. of Siblings				
0 – 3	37 (14.2)	224 (85.8)	261	0.014*
≥ 4	46 (23.1)	153 (76.9)	199	

* Statistically significant at $p < 0.05$

4.9 Associations of the Household Characteristics and Sanitation Habits of the Study Participants with Chronic Malnutrition (Stunting)

As shown in Table 4.16, multivariate analysis of household characteristics and hygiene habits of the respondents with stunting revealed that primary source of drinking water ($p = 0.021$), major source of fuel for cooking ($p = 0.010$) and type of latrine used in school ($p = 0.001$) are the factors significantly associated with stunting.

Table 4.16: Associations of the Household Characteristics and Sanitation Habits of the Study Participants with Chronic Malnutrition (Stunting)

Variable	Stunting Yes	Stunting No	Total	p-value
Primary Source of Drinking Water				0.021*
Open source	70 (20.5)	272 (79.5)	342	
Closed source	13 (11.0)	105 (89.0)	118	
Major Source of Cooking Fuel				0.010*
Firewood	49 (23.0)	164 (77.0)	213	
Other Sources	34 (13.8)	213 (86.2)	247	
Home Latrine				0.124
Soil-based latrine	42 (21.2)	156 (78.8)	198	
Water-based latrine	41 (15.6)	221 (84.4)	262	
School Latrine				0.034*
Soil-based latrine	58 (21.2)	216 (78.8)	274	
Water-based latrine	25 (13.4)	161 (86.6)	186	
Shoe Wearing Habit				0.216
Never/rarely	16 (14.2)	97 (85.8)	113	
Always/often	67 (19.3)	280 (80.7)	347	
Wash Hands Before Eating				0.163
Yes	49 (16.2)	253 (83.8)	302	
No	34 (21.5)	124 (78.5)	158	
Wash Hands After Toilet Use				0.019*
Yes	49 (15.3)	272 (84.7)	321	
No	34 (24.5)	105 (75.5)	139	

* Statistically significant at $p < 0.05$

4.10 Regression Analysis of Factors Associated with Chronic Malnutrition (Stunting)

Table 4.17 shows the results of the logistic regression of factors associated with stunting. Study participants who were within the ages 5 to 9 years were about 2.3 times less likely to be stunted than those who were aged 10 to 14 years (odds ratio = 0.431, 95% confidence interval 0.235 – 0.790, p=0.007) while study participants with less than four siblings were about 1.8 times less likely to be stunted (odds ratio = 0.565, 95% confidence interval 1.343 – 0.931, p=0.025) compared to those having four or more siblings.

Table 4.17: Logistic Regression Coefficients of Risk Factors for Chronic Malnutrition (Stunting)

Variable	Odds ratio	95% Confidence interval	p-value
Helminthiasis			
Absent	1.048	0.609 – 1.804	0.865
Present (ref)	1.000		
Dietary Intake			
Inadequate	0.821	0.347 – 1.939	0.652
Adequate (ref)	1.000		
Age (years)			
5 to 9	0.431	0.235 – 0.790	0.007*
10 to 14 (ref)	1.000		
Gender			
Male	0.943	0.569 – 1.562	0.820
Female (ref)	1.000		
Father's Education			
< Secondary	1.652	0.975 – 2.798	0.062
≥ Secondary (ref)	1.000		
No. of Siblings			
0 – 3	0.565	0.343 – 0.931	0.025*
≥ 4 (ref)	1.000		
Primary Source of Drinking Water			
Open source	1.765	0.908 – 3.433	0.094
Covered source (ref)	1.000		
School Latrine			
Soil Based	1.562	0.912 – 2.676	0.104
Water Based (ref)	1.000		
Wash Hands after Toilet Use			
Yes	0.616	0.355 – 1.069	0.085
No (ref)	1.000		

* Statistically significant at $p < 0.05$

4.11 Associations of the Socio-Demographic Characteristics of the Study Participants with Co-existence of Stunting and Wasting

Table 4.18 gives the summary of the multivariate analysis of socio-demographic characteristics with co-existence of stunting and wasting. It reveals age ($p < 0.001$), school type ($p = 0.004$), father's occupation ($p = 0.035$) and the number of siblings a child has ($p = 0.008$) as significantly associated factors with co-existence of stunting and wasting.

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Table 4.18: Associations of the Socio-Demographic Characteristics of the Study Participants with Co-existence of Stunting and Wasting

Variables	Stunting with Wasting Co-existence Yes	No	Total	p-value
Age (years)				<0.001*
5 – 9	1 (0.7)	143 (99.3)	144	
10 – 14	31 (9.8)	285 (90.2)	316	
Sex				0.335
Male	18 (8.1)	203 (91.9)	221	
Female	14 (5.9)	225 (94.1)	239	
Religion				0.937
Christianity	25 (7.0)	331 (93.0)	356	
Islam	7 (6.8)	96 (93.2)	103	
School-type				0.004*
Public	27 (9.8)	249 (90.2)	276	
Private	5 (2.7)	179 (97.3)	184	
Father's Level of Education				0.126
< Secondary	16 (9.3)	156 (90.7)	172	
≥ Secondary	16 (5.6)	272 (94.4)	288	
Mother's Level of Education				0.658
< Secondary	17 (7.5)	210 (92.5)	227	
≥ Secondary	15 (6.4)	218 (93.6)	233	
Father's Occupation				0.035*
Unemployed	0 (0.0)	42 (100.0)	42	
Trader, artisan/ farmer	32 (8.3)	353 (91.7)	385	
Civil servant/ other professional	0 (0.0)	33 (100.0)	33	

* Statistically significant at $p < 0.05$

Table 4.18: Associations of the Socio-Demographic Characteristics of the Study Participants with Co-existence of Stunting and Wasting (cont.)

Variables	Stunting with Wasting Co-existence		Total	p-value
	Yes	No		
Mother's Occupation				
Unemployed	2 (6.1)	31 (93.9)	33	0.969
Trader, artisans/ farmer	28 (7.0)	373 (93.0)	401	
Civil servant/ other professional	2 (7.7)	24 (92.3)	26	
House Type				
Mud house	26 (8.5)	281 (91.5)	307	0.071
Cement/brick	6 (3.9)	147 (96.1)	153	
Family Structure				
Monogamous	16 (5.8)	258 (94.2)	274	0.253
Polygamous	16 (8.6)	170 (91.4)	186	
No. of Siblings				
0 – 3	11 (4.2)	250 (95.8)	261	0.008*
≥ 4	21 (10.6)	178 (89.4)	199	

* Statistically significant at $p < 0.05$

4.12 Associations of the Household Characteristics and Sanitation Habits of the Study Participants with Co-existence of Stunting and Wasting

As shown in Table 4.19, multivariate analysis of household characteristics and hygiene habits of the respondents with co-existence of stunting and wasting revealed that primary source of fuel for cooking ($p = 0.001$) and type of latrine used at home ($p = 0.001$) are the factors significantly associated with the co-occurrence of stunting and wasting.

Table 4.19: Associations of the Household Characteristics and Sanitation Habits of the Study Participants with Co-existence of Stunting and Wasting

Variable	Stunting with Wasting Co-existence Yes	No	Total	p-value
Primary Drinking Water Source				
Open source	28 (8.2)	314 (91.8)	342	0.077
Closed source	4 (3.4)	114 (96.6)	118	
Source of Cooking Fuel				
Firewood	25 (11.7)	188 (88.3)	213	< 0.001*
Other Sources			247	
Home Latrine				
Soil-based latrine	23 (11.6)	175 (88.4)	198	0.001*
Water-based latrine	9 (3.4)	253 (96.6)	262	
School Latrine				
Soil-based latrine	17 (6.2)	257 (93.8)	274	0.442
Water-based latrine	15 (8.1)	171 (91.9)	186	
Shoe Wearing Habit				
Never/rarely	10 (8.8)	103 (91.2)	113	0.362
Always/often	22 (6.3)	325 (93.7)	347	
Wash Hands Before Eating				
Yes	18 (6.0)	284 (94.0)	302	0.246
No	14 (8.9)	144 (91.1)	158	
Wash Hands After Toilet Use				
Yes	18 (5.6)	303 (94.4)	321	0.084
No	14 (10.1)	125 (89.9)	139	

* Statistically significant at $p < 0.05$

4.13 Regression Analysis of Factors Associated with Co-existence of Stunting and Wasting

Table 4.20 shows the results of the logistic regression of co-existence of stunting and wasting and its determinants. Study participants who were within the ages 5 to 9 years were about seven times less likely to be both stunted and wasted (odds ratio = 0.115, 95% confidence interval 0.589 – 3.428, p=0.047) than those who were aged 10 to 14 years , while study participants with soil-based latrine types at home were about three times more likely to be both stunted and wasted (odds ratio = 3.216, 95% confidence interval 1.351 – 7.867, p=0.013) compared to those using water-based latrine types at home. Also, Study participants who wash their hands after toilet use were about two times less likely to be both stunted and wasted (odds ratio = 0.471, 95% confidence interval 0.209 – 1.065, p=0.009) compared to children who do not was their hands after using the toilet.

Table 4.20: Logistic Regression Coefficients of Risk Factors for the Co-existence of Stunting and Wasting

Variable	Odds ratio	95% Confidence interval	P value
Helminthiasis			
Absent	1.420	0.589 – 3.428	0.435
Present (ref)	1.000		
Dietary Intake			
Inadequate	0.488	0.144 – 1.654	0.250
Adequate (ref)	1.000		
Age (years)			
5 to 9	0.115	0.014 – 0.968	0.047*
10 to 14 (ref)	1.000		
Gender			
Male	1.270	0.576 – 2.798	0.553
Female (ref)	1.000		
School Type			
Public	1.360	0.439 – 4.214	0.594
Private (ref)	1.000		
Type of House			
Mud house	2.378	0.875 – 6.464	0.089
Cement/Brick type (ref)	1.000		
No. of Siblings			
0 – 3	0.558	0.244 – 1.274	0.166
≥ 4 (ref)	1.000		
Drinking Water Source			
Open source	1.824	0.568 – 5.851	0.312
Covered source (ref)	1.000		
Home Latrine			
Soil Based	3.261	1.351 – 7.867	0.013*
Water Based (ref)	1.000		
Wash Hands after Toilet Use			
Yes	0.471	0.209 – 1.065	0.009*
No (ref)	1.000		

* Statistically significant at $p < 0.05$

4.14 Associations of the Socio-Demographic Characteristics of the Study Participants with Soil-Transmitted Helminths Infection

Table 4.21 shows the multivariate analysis of socio-demographic characteristics with helminth infection. It reveals that religion ($p < 0.001$), mother's level of education ($p=0.026$), mother's occupation ($p=0.013$) and the number of siblings a child has ($p=0.022$) are factors associated with STH.

Table 4.21: Associations of Socio-Demographic Characteristics of the Study Participants with Soil-Transmitted Helminthiasis

Variables	Helminthiasis Present	Helminthiasis Absent	Total	p-value
Age (years)				
5 – 9	41 (28.5)	103 (71.5)	144	0.834
10 – 14	93 (29.4)	223 (70.6)	316	
Sex				
Male	72 (32.6)	149 (67.4)	221	0.117
Female	62 (25.9)	177 (74.1)	239	
Religion				
Christianity	89 (25.0)	267 (75.0)	356	<0.001*
Islam	44 (42.7)	59 (57.3)	103	
School-type				
Public	89 (32.2)	187 (67.8)	276	0.072
Private	45 (24.5)	139 (75.5)	184	
Father's Level of Education				
< Secondary	59 (34.3)	113 (65.7)	172	0.059
≥ Secondary	75 (26.0)	213 (74.0)	288	
Mother's Level of Education				
< Secondary	77 (33.9)	150 (66.1)	227	0.026*
≥ Secondary	57 (24.5)	176 (75.5)	233	
Father's Occupation				
Unemployed	14 (33.3)	28 (66.7)	42	0.314
Trader, artisan/ farmer	114 (29.6)	271 (70.4)	385	
Civil servant/Other professional	6 (18.2)	27 (81.8)	33	

* Statistically significant at $p < 0.05$

Table 4.21: Associations of Socio-Demographic Characteristics of the Study Participants with Soil-Transmitted Helminthiasis (cont.)

Variables	Helminthiasis Present	Absent	Total	p-value
Mother's Occupation				
Unemployed	17 (51.5)	16 (48.5)	33	0.013*
Trader, artisans/ farmer	110 (27.4)	291 (72.6)	401	
Civil servant/ qualified professional	7 (26.9)	19 (73.1)	26	
House Type				
Mud house	90 (29.3)	217 (70.7)	307	0.901
Cement/brick	44 (28.8)	109 (71.2)	153	
Family Structure				
Monogamous	71 (25.9)	203 (74.1)	274	0.065
Polygamous	63 (33.9)	123 (66.1)	186	
No. of Siblings				
0 – 3	65 (24.9)	196 (75.1)	261	0.022*
≥4	69 (34.7)	130 (65.3)	199	

* Statistically significant at $p < 0.05$

4.15 Associations of the Household Characteristics and Sanitation Habits of the Study Participants with Soil-Transmitted Helminths Infection

As shown in Table 4.22 multivariate analysis of household characteristics and hygiene habits of the respondents with STH revealed that primary source of water for drinking (p= 0.049), type of latrine used at home (p=0.011) and type of latrine used at school (p=0.006) are factors associated with STH.

Table 4.22: Associations of Household Characteristics and Hygiene Habits of the Study Participants with Soil-Transmitted Helminthiasis

Variable	Helminthiasis			
	Present	Absent	Total	p-value
Primary Source of Drinking Water				
Open source	108 (31.6)	234 (68.4)	342	0.049*
Closed source	26 (22.0)	92 (78.0)	118	
Home Latrine				
Soil-based latrine	70 (35.4)	128 (64.6)	198	0.011*
Water-based latrine	64 (24.4)	198 (75.6)	262	
School Latrine				
Soil-based latrine	93 (33.9)	181 (66.1)	274	0.006*
Water-based latrine	41 (22.0)	145 (78.0)	186	
Shoe Wearing Habit				
Never/rarely	27 (23.9)	86 (76.1)	113	0.158
Always/often	107 (30.8)	240 (69.2)	347	
Wash Hands Before Eating				
Yes	84 (27.8)	218 (72.2)	302	0.390
No	50 (31.6)	108 (68.4)	158	
Wash Hands After Toilet Use				
Yes	89 (27.7)	232 (72.1)	321	0.314
No	45 (32.4)	94 (67.6)	139	

* Statistically significant at $p < 0.05$

Note: Primary drinking water sources: pond/lake, river and well are considered as open sources to contamination while water sources: borehole, pipe-borne water and packaged water (e.g. sachet water) are classified as closed water sources to contamination

4.16 Regression Analysis of Factors Associated with Soil-Transmitted Helminthiasis

Following multivariate analysis with logistic regression, controlling for other variables in the model, as shown in table 4.23, children with no more than three siblings are about 1.6 times less likely to have soil-transmitted helminthiasis (odds ratio = 0.607, 95% confidence interval 0.392 – 0.940, p-value = 0.025) than children who have more than four siblings. Likewise, children who use soil-based latrines in school are 1.8 times more likely to be infected with STH (odds ratio = 1.815, 95% confidence interval 1.130 – 2.915, p-value = 0.014) when compared to those who use water based latrines in school.

Table 4.23: Logistic Regression Coefficients of Risk Factors for Soil-Transmitted Helminthiasis

Variable	Odds ratio	95% Confidence interval	P value
Age (years)			
5 to 9	0.946	0.567 - 1.577	0.831
10 to 14 (ref)	1.000		
Gender			
Male	1.271	0.823 – 1.962	0.280
Female (ref)	1.000		
School Type			
Public	0.826	0.477 – 1.429	0.494
Private (ref)	1.000		
Mother' Education			
< Secondary	1.307	0.771 – 2.216	0.320
≥ Secondary (ref)	1.000		
Father's Education			
< Secondary	1.185	0.708 – 1.983	0.518
≥ Secondary (ref)	1.000		
Mother's Occupation			
Unemployed	1.682	0.501 – 5.650	0.400
Trader/Artisan/Farmer	1.000	0.226 – 1.585	0.302
Qualified Professionals (ref)	0.599		
Family Structure		0.487 – 1.173	0.213
Monogamous	0.756		
Polygamous (ref)	1.000		
No. of Siblings		0.392 – 0.940	0.025*
0 – 3	0.607		
≥ 4 (ref)	1.000		
Primary Source of Drinking Water		0.659 – 1.995	0.628
Open source	1.147		
Covered source (ref)	1.000		
Home Latrine		0.885 – 2.293	0.145
Soil Based	1.424		
Water Based (ref)	1.000		
School Latrine		1.130 – 2.915	0.014*
Soil Based	1.815		
Water Based (ref)	1.000		

* Statistically significant at $p < 0.05$

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 DISCUSSION

The aim of this study was to investigate the association between soil-transmitted helminthiasis (STH) and nutritional status of school-age children in primary schools at Obafemi/Owode local government area of Ogun state, Nigeria. The prevalence of STH among the children was 29.1%. Chronic and acute forms of malnutrition measured by anthropometric indices stunting and wasting had prevalence values of 25% and 19.3% respectively. Although no direct significant associations were found between STH infection and overall chronic and acute forms of malnutrition, mean Z-score values for stunting between STH infected and non-infected groups revealed that stunting was significantly higher among children infected with STH than in children not infected with STH.

5.1.1 Prevalence of Soil-Transmitted Helminthiasis among the School-Age Children

An STH prevalence of 29.1% was found among school-age children in this study. Similar reports from various parts of Nigeria have recognized soil-transmitted helminthiasis as an important public health problem among school-age children (Asaolu et al., 2002; Egwunyenga and Atakiru, 2005; Amaechi et al., 2013). These, along with findings from this study agree with de Silva et al. (2003) who estimated that between 25 and 35 percent of school-age children are infected with one or more of the soil transmitted helminthes.

The three intestinal helminthes observed were *Ascaris lumbricoides*, *Trichuris trichiura* and Hookworm. Of these, *A. lumbricoides* had the highest prevalence (28.7%). This phenomenon was previously reported by Adeyeba and Akinlabi (2002) and Saka et al. (2006) in similar cohorts of Nigeria School Aged Children. Studies carried out in Honduras (Sanchez et al., 2013) and Ethiopia (Debalke et al., 2013) however found Trichuris trichiura to be the more prevalent helminth infecting School-age children. The variation in prevalence patterns could be due to the differing seasonal patterns of transmission of individual STH Species. Hookworm infection prevalence was low at 0.7%. This is because the study was carried out during the dry season. Hookworm infection transmission has been found to be highly seasonal and occurs least during the month of February (Ogomaka et al; 2013), the month before which stool sample collection and analysis for this study was done.

The intestinal helminth infection triad of *A. lumbricoides* + *T. trichiura* + Hookworm predicted to be common in rural communities in Nigeria and other African countries by de Silva et al. (2013) was not so in this study. This difference in infection pattern could be due to the difference in the study population, geographical area of study, the type of settlements, variation in environmental factors like level of sanitation and level of education as well as presence of school health services (Saka et al., 2006). Co-infection with two species of STH was however found in some individuals.

5.1.2 Prevalence of Malnutrition among the School-Age Children

Majority of the studied children were within the WHO reference values for growth and nutrition. This is uncommon for a Nigeria rural population (UNICEF, 2009). In fact, the proportion of children estimated to be suffering chronic and acute malnutrition (as measured by stunting and wasting respectively) identified in this study were 16% and 3.7% below current national figures of 41% for stunting and 23% for wasting among children five years and under.

The overall prevalence of stunting was 25%. This agrees with findings of 24.5% and 28.9% among school children in Kenya (Mwaniki and Makokha, 2013) and Zambia (Gillespie and Kadiyata, 2004). It is however lower than the range of 48 – 56% obtained for children from countries under Partnership for Child Development (Ghana, Tanzania, Indonesia, India and Vietnam (Partnership for Child Development, 1998) while it is high when compared with prevalence of 5.7% among Turkish children (Gur et al., 2006), 13% in children in the western region of Nepal (Joshi et al., 2011) as well as 14.2% in a cohort of children in Sagamu, an urban area of Ogun State (Fetuga et al., 2011). This difference in prevalence is likely to stem from differential nutritional intake, socio-economic and cultural differences rather than differences in their genetic potential to achieve maximum height (Senbanjo et al., 2011).

The burden of stunting found in this study is high. It depicts that one of every four Nigerian school-age children is stunted. As this study was school based, it only assessed school-going children. Results of studies in Ghana and Tanzania have shown that non-enrolled children were more undernourished than children enrolled in school (Fentiman and Hall, 1997; Beasley et al., 2000). Also, the rate of enrollment of children in school is very low in Nigeria (Senbanjo et al., 2011). Between year 2000 and 2006, the net enrollment ratio for Nigerian primary and secondary schools ranged from 25 to 72. Therefore, the prevalence of 25% may just be a tip of the burden of stunting in the whole school-age population.

Few children assessed were served with four or more food groups (8.3%). This finding was lower than that of studies by UNICEF (2009) and Mwaniki and Makokha (2003) among similar cohorts of Pakistani and Kenyan School-aged children respectively. They found 42.2% and 45.2% of children consumed four or more food groups in their respective studies, based on food groupings. The consumption of a varied diet is known to be associated with increased intake of energy and micronutrients, which lead to better health (Gibson and Hotz, 2001).

The prevalence of wasting in this study (19.3%) is higher than that found by Shakya et al. (10.5%) among public school children in Eastern Nepal. Wasting, a measure of short term nutritional deficit could have been caused by severe short term deprivation of food in the children's immediate nutritional history as evidence by the intake of inadequate diets (91.7%) by the study participants.

Coexistence of stunting and wasting in this study (7%) was much higher than the 1% prevalence found by Joshi et al. (2011) in a cohort of school-age children in Western Nepal. This may be due to a lower socio-economic status of the children schooling in the area assessed by this study.

Of interest also, are the levels of overweight (3.9%) and obesity (2.2%) found in this study. A similar Nigerian report from Sagamu town in Ogun state (Fetuga et al., 2011) also found a low prevalence of overweight and obesity (3.0% and 0.5% respectively). Indeed, literature has suggested that overweight and obesity are not common nutritional problems among Nigerian School-age children (Ansa et al., 2001).

5.1.3 Intensity of Soil-Transmitted Helminth Infections among the School-Age Children

Majority of the *Ascaris lumbricoides* infections found in this study were of light intensity (65.6%). This agrees with a report by Bethony et al. (2006) who previously stated that most conditions of Ascariasis are mild and often show little or no symptoms. The low prevalence found for Hookworm and *Trichuris trichiura* infections (0.7% and 0.7% respectively) in this study make it difficult to compare their infection intensities with similar studies.

A study on the nutritional effects of STH by Sanchez et al. (2013) has reported light intensity infections as the most prevalent infection type for Ascariasis. In a similar fashion, most T. trichiura and hookworm infections were of light intensity (73.4% and 94.1% respectively).

5.1.4 Effect of Soil-Transmitted Helminthiasis on the Nutritional Status of the School-Age Children

The main objective of this study was to ascertain potential associations of STH infections with the children's nutritional status, but study data did not support such associations. Despite significant associations were not found between STH and the overall forms of malnutrition (stunting, wasting and co-existence of stunting and wasting), this current study observed a consistently higher proportion of STHs infections among stunted and wasted school age children than those not stunted or wasted.

Various studies have examined factors associated with malnutrition among school-age children (Amaechi et al., 2013; Fiorentino et al., 2013; dos Santos et al., 2014) while some others (Saka et al., 2006; Joshi et al., 2011; Babatunde et al., 2011) have examined factors associated with soil-transmitted helminth infections. Senbanjo et al. (2011) in looking at chronic malnutrition among a sample of school-aged children in Abeokuta, Nigeria, found that attendance of public schools, polygamous family setting, low maternal education and low social class were significantly associated risk factors. Very few studies however have sought to investigate associations between Helminthic infections and nutritional status of school-age children assessed by means of anthropometry.

Further investigations of mean Z-score values in this study, revealed significant negative association between infection with STH and mean Height-for-age Z scores among infected and non-infected children. Such significant association was however not found for the mean Body-mass-index for age Z- scores. This implies that the presence of STH infection predisposes to a lower Height-for-age Z score. This association was previously found in a study carried out in Honduran school-age children by Sanchez et al. (2013). Thus, examining anthropometric Z-score means as suggested by Sanchez et al. (2013) might be useful in providing additional insight into the impact of STH on children's nutrition status as they may reveal subtle changes missed when focusing only on end outcomes (i.e overall stunting or wasting).

5.2 STUDY LIMITATIONS

i) This study made use of a cross-sectional study design. This did not allow for direct causal relationship between STH and nutritional status to be established. Longitudinal studies are better suited for the establishment of direct causality.

ii) Better suited, more accurate alternatives to the use of anthropometry in assessing nutritional status, such as biochemical methods of assessment, were not available to this study due to financial constraints. The use of anthropometry to assess nutritional status of the children is less precise as compared to biochemical assessments which have given reports of significant associations between STH and malnutrition.

iii) Apart from a single stool sample being analyzed per participant, the study was also carried out during the dry season. These may have underestimated the STH prevalence found in the study.

iv) Recently, Tarafder et al. (2010) suggested that Kato-katz method of stool analysis, which is used in this study, is reasonably accurate for the identification of *T.trichiura* and *A.lumbriciodes* but not for hookworms.

5.3 CONCLUSION

The prevalence of Soil-transmitted Helminthiasis found in this study was 29.1%. This prevalence, which is relatively high for a fall season of infection transmission, could be due to the endemic nature of the infection in the study area.

Infection intensities observed in this study were exclusively light to moderate. This is as expected during the dry season, the period in which STH infection transmission occurs least.

The study prevalence of chronic (25%) and acute (19.3%) malnutrition agrees with findings in existing literature. Similar cohorts of children in urban areas in Nigerian have been shown to have a lower prevalence, mainly because they are better off socio-economically and sanitation wise.

From the results of this study, direct associations between STH and malnutrition were not found. This may be due to the multifactorial nature of malnutrition causality. Also, longitudinal studies are best suited for the establishment of direct causal association. Longitudinal studies however, are very expensive to execute especially in resource poor settings of developing countries such as Nigeria. This raises the need for alternatives to essential research and although they are less suited for establishing causality, cross sectional studies, such as this study, can help delineate the suspected bi-directional nature of STHs infections and malnutrition.

Notwithstanding, Soil-Transmitted Helminthiasis and poor nutritional status remain as major public health problems among school-age children in Nigeria. The prevalence data provided by this study contributes with accurate and updated information to map out the situation of STH infections and malnutrition among this important age group in Nigeria.

5.4 RECOMMENDATIONS

The high prevalence of soil-transmitted helminth infections as well as malnutrition among the school-age children shows a pressing need for appropriate long term and short term preventive and corrective measures in order to prevent an increase in nutritional morbidities as well as morbidities related to parasitic infection. In view of these, my recommendations are as follow:

i) Regular screening of school-age children for infection with soil-transmitted helminths should be set up and monitored by appropriately instituted and regulated governmental organizations.

ii) Periodic administration of Preventive Chemotherapy (PC) to school-age children for soil-transmitted helminthiasis, as recommended by the World Health Organization (WHO, 2012) should be implemented by appropriately commissioned governmental organizations. This will reduce infection prevalence as well as ease infection intensity among infected children.

iii) Health promotion to improve sanitation habits among the children will help to prevent parasitic infections of soil-transmitted helminths.

iv) Nutritional surveillance and specific nutritional interventions to improve and maintain adequate nutrition among children, such as the introduction of free meals for children at schools should be implemented and sustained by the government as a fiscal policy.

v) Nutrition education programs should be done in schools and communities in which school children live to promote healthy lifestyles and eating habits.

vi) Provision of support such as adequate financing and trained personnel for the execution of longitudinal studies should be done. These will help in determining direct causality between malnutrition and various infections including soil-transmitted helminthiasis. Thus, a clearer understanding of the interactions between infection and malnutrition would be available and used to delineate directionality of infection/malnutrition causality. Knowledge generated will then be used to set-up pragmatic and sustainable interventions at all levels of interaction.

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APPENDIX 1: INFORMED CONSENT FORM

Title of the research:

Effect of Soil-Transmitted Helminthiasis on the Nutritional Status of School-Age Children in Selected Primary Schools at Obafemi/Owode Local Government Area in Ogun State, Nigeria

Name and affiliation of researcher of applicant:

This study is being conducted by Miss C.A Adeoye of the department of Epidemiology and Medical Statistics, College of Medicine, University of Ibadan, Oyo State.

Sponsor of research:

This study is sponsored by self

Purpose of research:

The purpose of this research is to assess the effect of Soil-transmitted Helminthiasis on the nutritional status of school-age children in selected primary schools at Obafemi/Owode Local Government Area in Ogun state, Nigeria

Procedure of the research, what shall be required of each respondent and approximate total number of respondents that would be involved in the research:

Primary schools will be randomly selected from three wards in Obafemi/Owode local government of Ogun state, and 634 questionnaires will be proportionately distributed within these wards. 634 pupils ages 5 – 14 will be recruited as respondents for this research.

Expected duration of research and respondent(s)' involvement:

I expect to carry out this research in 12 weeks, and I expect each participant to answer the questionnaire for approximately 15 minutes.

Risk(s):

There is no anticipated risk(s) for participating in this study.

Costs to the respondents, if any, of joining the research:

Respondent's participation in this study will not cost them anything.

Benefit(s):

The goal of this study is to assess the prevalence of Soil-transmitted Helminth infections, worm burden as well as nutritional status of school-age children. Findings from this study will give an insight on the relationship between soil-transmitted helminth infections and nutritional status.

Confidentiality:

All information collected in this study will be given code numbers and no name will be recorded. This cannot be linked to you in anyway and your name and or any identifier will not be used in any publication or reports from this study.

Voluntariness:

Your participation in this study is entirely voluntary.

Alternatives to participation:

If you choose not to consent to your child/ward participating, this will not be used against him/her in their school.

Due inducement(s):

Your child/ward will be compensated with a little incentive comprising a Bobo drink and a biscuit, but they will not be paid any fees for participation in this research.

Consequences of participants' decision to withdraw from research and procedure for orderly termination of participation:

You can also choose to withdraw your child/ward from the research at anytime. Please note that some of the information that has been obtained about them before you chose to withdraw them may have been modified or used in reports and publications. These cannot be removed anymore. However the researchers promise to make effort in good faith to comply with your wishes concerning them as much as is practicable.

Any apparent or potential conflict of interest:

None

Benefit(s):

The goal of this study is to assess the prevalence of Soil-transmitted Helminth infections, worm burden as well as nutritional status of school-age children. Findings from this study will give an insight on the relationship between soil-transmitted helminth infections and nutritional status.

Confidentiality:

All information collected in this study will be given code numbers and no name will be recorded. This cannot be linked to you in anyway and your name and or any identifier will not be used in any publication or reports from this study.

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You can also choose to withdraw your child/ward from the research at anytime. Please note that some of the information that has been obtained about them before you chose to withdraw them may have been modified or used in reports and publications. These cannot be removed anymore. However the researchers promise to make effort in good faith to comply with your wishes concerning them as much as is practicable.

Any apparent or potential conflict of interest:

None

Statement of person obtaining informed consent:

I have fully explained this research to.. and have given sufficient information, including benefits, to make an informed decision.

DATE: .... SIGNATURE: ....

NAME: ....

Statement of person giving consent:

I have read the description of the research or have it translated into language I understand. I have discussed it with the person in charge to my satisfaction. I understand that my child/wards participation is voluntary. I know enough about the purpose, methods, risks and benefits of the research study to judge that I want my child/ward to take part in it. I understand that I may freely stop my child/ward being part of this at any time. I have received a copy of this consent form and additional information sheet to keep for myself.

DATE: .... SIGNATURE.......................................

NAME: ....

WITNESS' SIGNATURE (if applicable): ....

WITNESS' NAME: ....

Detailed contact information including contact address, telephone, fax, e-mail and any other contact information of researcher, institutional HREC and head of the institution:

This research has been approved by the Ethics Committee of the University of Ibadan and the chairman of this Committee can be contacted at Biode Building, Room T10, 2nd Floor, Institute for Advanced Medical Research and Training, College of Medicine, University of Ibadan, E-mail: uiuchirc@yahoo.com

In addition, if you have any question about your child/wards participation in this research, you can contact the principal investigator, Name: ....

Department: .... Phone: ....

E-mail: ....

APPENDIX 2: STUDY QUESTIONNAIRE

QUESTIONNAIRE NUMBER....................

EFFECT OF SOIL-TRANSMITTED HELMINTHIASIS ON THE NUTRITIONAL STATUS OF SCHOOL-AGE CHILDREN IN SELECTED PRIMARY SCHOOLS AT OBAFEM-OWODE LOCAL GOVERNMENT AREA IN OGUN STATE, NIGERIA

Dear Respondent,

I am a postgraduate student of the department of Epidemiology and Medical Statistics, Faculty of Public Health, college of medicine, university of Ibadan. This is an interviewer administered structured questionnaire to gather detailed information on socio-demographic characteristics, Soil-transmitted Helminth infection history as well as nutritional status among enrolled, school-age children in Obafemi/Owode local government area of Ogun State, Nigeria. Kindly be sincere in giving answers to the questions asked as all information supplied will be treated with high confidentiality. Kindly listen carefully to the questions as you are requested to respond to all the questions as much as possible. If you do not understand a question, feel free to ask the interviewer to explain it to you again. Please do not give wrong information as this may affect the accuracy of the data that will be collected.

Thank you,

ADEOYE, Comfort Abeni

Assent form:

Now that the study has been well explained to me and I fully understand the study process, I assent and will be willing to take part in the study.

..../...

Signature/Thumbprint of participant/Interview date

IDENTIFICATION

LGA ....

Zone ....

Name of school ....

Name of Interviewer ....

Date of Interview ....

SECTION I: RESPONDENTS PERSONAL DATA

S/N	Question	Options	Answer's Code
1	Age, as at your last birthday	______	
2	Date and Month of Birth	DD______/MM______	
3	Sex	1. Male 2. Female	
4	Ethnicity	1. Yoruba 2. Hausa 3. Igbo 4. Others (Please Specify): ______	
5	Religion	1. Christianity 2. Islam 3. Traditional (Please Specify) ______ 4. None/Others ______	
6	Class	1. Primary 1 2. Primary 2 3. Primary 3 4. Primary 4 5. Primary 5 6. Primary 6 7. Other (specify) ______	

SECTION II: SOCIO-ECONOMIC CHARACTERISTICS OF PARENTS/GUARDIANS

S/N	Question	Options	Answer's Code
7.	Father/Male Guardian's level of education	1. Illiterate 2. Primary/Quoranic School 3. Secondary 4. Tertiary 5. Others (Specify) ______	
8	Father/Male Guardian's occupation	1. Unskilled workers (manual) e.g. Laborers 2. Petty Trader: e.g. Meat seller 3. Skilled workers (manual) e.g. Drivers, Carpenters, Goldsmith etc. 4. Skilled workers (Non-manual) e.g. Clerks, Typists, Receptionist, Police 5. Major Trader: e.g. Motor spare parts dealer 6. Qualified Professional/Academia: e.g. Nurses, Lawyers, University lecturer etc. 7. Others (specify) ______	
9	Mother/Female Guardian's level of education	1. Illiterate 2. Primary School 3. Secondary 4. Tertiary 5. Others (Specify) ______	
10	Mother/Female Guardian's occupation	1. Unskilled workers (manual) e.g. Laborers 2. Petty Trader: e.g. Meat seller 3. Skilled workers (manual) e.g. Tailor, Hairdresser etc. 4. Skilled workers (Non-manual) e.g. Clerks, Typists, Receptionist, Police 5. Major Trader: e.g. Wholesale food stuff dealer 6. Qualified Professional/Academia: e.g. Nurses, Lawyers, University lecturer etc. 7. Others (specify) ______	

11	House Type	1. Duplex 2. Flat 3. Bungalow 4. Face –to-face 5. Others (specify) ______	
12	How many siblings (i.e. brothers and sisters) do you have?	______	
13	How many wives does your father have? (Please Specify)	______	
14	Do your father and mother live together?	1. Yes 2. No	

SECTION III: SANITATION FACILITIES/ HYGIENE HABITS OF THE RESPONDENT

S/N	Question	Options	Answer's Code
15	What is your primary source of water for drinking?	1. Pond/lake 2. Spring/river 3. Rain water 4. Well 5. Bore hole 6. Pipe borne water 7. Pure water sachet 8. Others (please specify) ______	
16	What is your secondary source of water for drinking?	1. Pond/lake 2. Spring/river 3. Rain water 4. Well 5. Bore hole 6. Pipe borne water 7. Pure water sachet 8. Others (please specify) ______	
17	What is your source of water for other domestic uses	1. Pond/lake 2. Spring/river 3. Rain water 4. Well 5. Bore hole 6. Pipe borne water 7. Pure water sachet 8. Others (please specify) ______	
18	What is your major source of fuel for cooking?	1. Firewood 2. Kerosene stove 3. Coal pot 4. Gas 5. Other (specify) ______	
19	If answer to Q17 above is firewood, how do you get your firewood?	1. Buy 2. Gift 3. Gather	
20	If answer to Q18 above is gathering, where do you gather firewood? (please specify)	______	
21	Do you join in gathering the firewood?	1. Yes 2. No	
22	If answer to Q20 above is yes, how often do you join in gathering the firewood?	1. Always 2. Often 3. Seldom	
23	How often do you wear your shoes/sandals when at school?	1. Always 2. Often 3. Seldom 4. Never	

24	How often do you wear your shoes/sandals when at home?	1. Always 2. Often 3. Seldom 4. Never	
25	Do you always wash your hands before eating?	1. Yes 2. No	
26	If answer to Q24 is No, how often do you wash your hands before eating	1. One third of the time 2. Half the time 3. Two thirds of the time 4. Three quarters of the time	
27	Do you usually wash your hands with soap and water before eating?	1. Yes 2. No	
28	Do you always wash your hands after using the toilet?	1. Yes 2. No	
29	If answer to Q27 above is No, how often do you wash your hands after using the toilet?	1. One third of the time 2. Half the time 3. Two thirds of the time 4. Three quarters of the time	
30	Do you usually wash your hands with soap and water after using the toilet?	1. Yes 2. No	
31	Where do you defecate at school?	1. Potty 2. Bush 3. Open field 4. Pit latrine 5. Water closet system 6. River 7. Others (specify) ________	
32	Where do you defecate at home?	1. Potty 2. Bush 3. Open field 4. Pit latrine 5. Water closet system 6. River 7. Others (specify) ________	
33	At home, is the place of defeacation within or outside your house/compound	1. Outside House 2. Outside Compound 3. Within House 4. Within Compound	
34	If answer to question 32 above is outside house/compound, how far is it?	1. Far 2. Not too far 3. Near	
35	Do you swim after school, during weekends or during holidays?	1. Yes 2. No	
36	Where do you usually swim when you swim?	1. Pond 2. Lake 3. River 4. Swimming pool 5. Others (specify) ________	

SECTION IV: RESPONDENTS KNOWLEDGE ON STH/DEWORMING HISTORY

S/N	Question	Options	Answer Code
37	Have your parents/guardians, or anyother person ever given you deworming drugs?	1. Yes 2 No	
38	Have your parents/guardians or any other person ever given you herbal remedies or concoctions to deworm you?	1 Yes 2 No	
39	Do you know the name of the deworming medication you were given	1 Yes	

		2. No	
40	If answer to Q38 is yes, please specify name of deworming drug(s)	1. ______ 2. ______	

SECTION V: ANTHROPOMETRIC NUTRITIONAL DATA

S/N	Question	Options	Answer Code
41	Weight	______ (Kg)	
42	Height	______ (m)	
43	Stunting (Height-for-age Index <2SD)	1. Yes 2. No	
44	Thinness (BMI-for—age Index < 2SD)	1. Yes 2. No	
45	Underweight (Weight-forage < 2SD)	1. Yes 2. No	

NB: Childs Age: ___/______ (Years/Months)

SECTION VI: PARASITOLOGICAL FINDINGS

S/N		Eggs/slide	Eggs/gram (epg)	Heavy-intensity threshold	Heavy-intensity Infection	
					Yes	No
46	*Ascaris lumbricoides*			>50 000 epg		
47	*Trichuris trichiura*			≥10 000 epg		
48	**Hookworms**: *Necator americanus*			≥4000 epg		
49	*Ancylostoma duodenale*			≥4000 epg		

50. Macroscopy: ______________________

SECTION VII: DIETARY ASSESSMENT USING FOOD FREQUENCY QUESTIONNAIRE

I would like to know your normal eating pattern over the past months. Please tick everything you normally eat or drink under the appropriate column. For example you can indicate whether you normally eat the food once a day by ticking (1X a day) or otherwise as applicable to you. Thank you

LIST OF FOODS	FREQUENCY OF CONSUMPTION								
	>3X a month	<3X a month	>3X a week	2X a week	1X a week	2X a day	1X a day	Rarely/Occasionally (e.g. Seasonal fruits)	Never
Cereals and cereal products									
Rice									
Maize									
Sorghum									
Wheat/Flour									
Oat									
Semovita									
Bread									
Spaghetti									
Corn flakes									
Root, Tuber, plantain & their Products									
Yam									
Cassava									
Sweet Potatoes									
Cocoyam									
Plantain									
Yam flour									
Plantain flour									
Meat, poultry and fish products									
Chicken									
Beef									
Lamb									
Pork									
Turkey									
Eggs									
Chicken liver									
Beef liver									
Crab									
Fish and fish products									

Mackerel									
Cat fish									
Titus									
Dried fish									
Fruits and Vegetables									
Mango									
Pawpaw									
Pine apple									
Apple									
Water melon									
Garden egg									
Sugar cane									
Orange									
Banana									
Cashew									
Carrot									
Tomato									
Ripe pepper									
Asparagus									
Spinach									
Bitter leaf									
Pumpkin leaf									
Milk and Milk product									
Raw cow milk (e.g. Wara)									
Processed milk									
Yoghurt									
Ice-cream									
Cheese									
Legumes and grains									
Cowpea									
Soybeans									
Groundnut									
Fats and oil/ oil seeds									
Palm oil									
Vegetable oil									
Margarine									
Butter									
Beverages									
Bournvita									
Milo									

Others									
Caffeine									
Cocoa or cocoa products									
Chocolate									

SECTION D: TWENTY FOUR HOUR DIETARY RECALL

Now I would like you to tell me everything you had to eat and drink after you woke up yesterday morning. Include everything you ate and drank at home and away, even snacks, tea or coffee.

Date: .... Day of the week: ....

Item No. (a)	Food/Drink Addition (b)	Description of Food or Drink (use volume, size or Price) (c)	Place Taken (d)	Time (e)	Amount (how much did you actually eat/drink?) (f)	Weight equiv.* (g)

1. Was food intake usual? (Yes/No) If no, how was it unusual? 2. Was it was a feast day? (Yes/No)	4. Probe for supplements (iron, antimalarial, vitamins, other supplements) (Yes/No) If yes, specify
3. Probe for sickness (Y/N). If yes, did sickness affect appetite (Yes/No) If yes, how? (Increase or Decrease	5. Probe for fermented beverages consumed

* Do not fill this column of the form

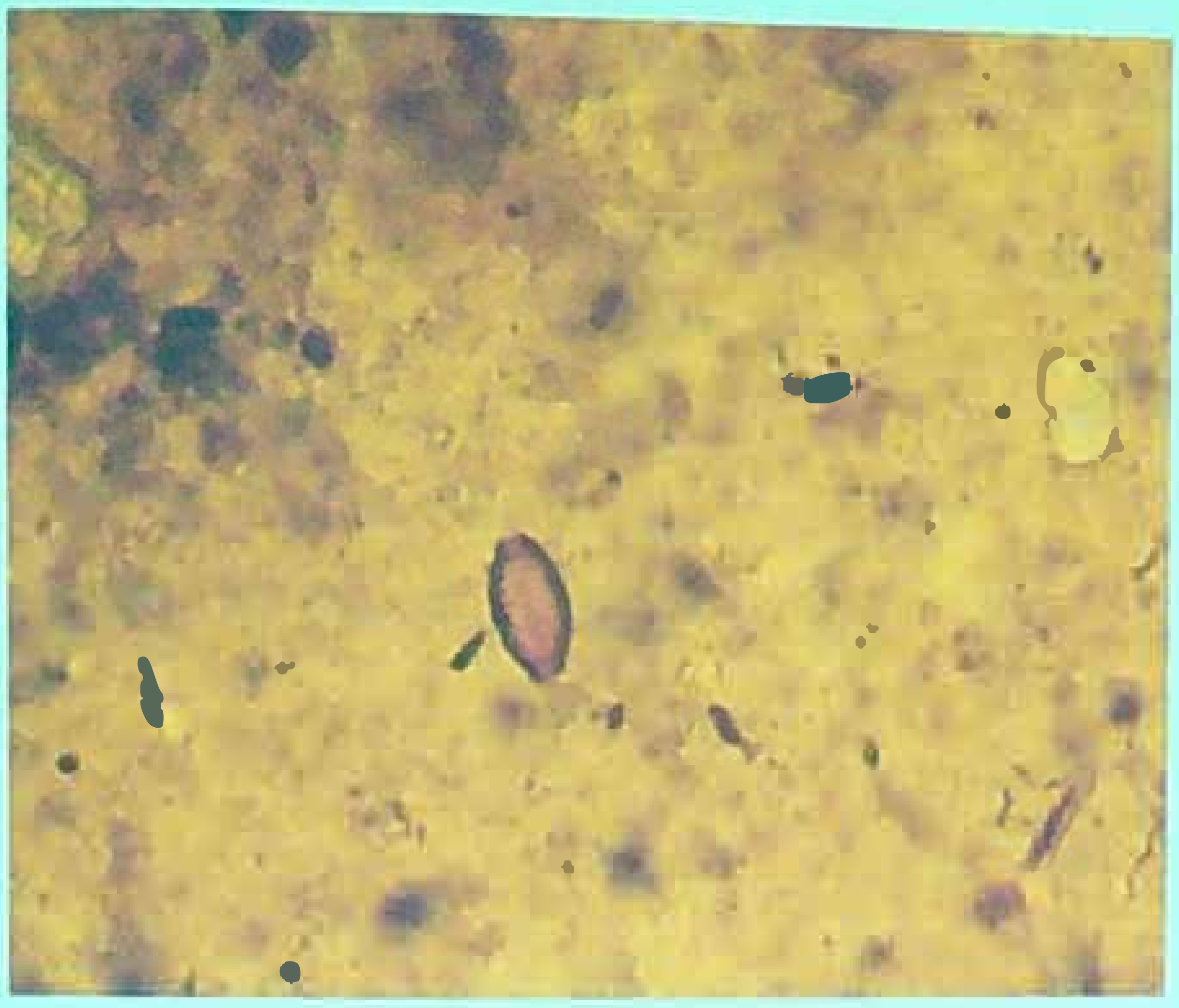
Please probe for sickness and state type and symptoms of sickness:

Type of sickness ____

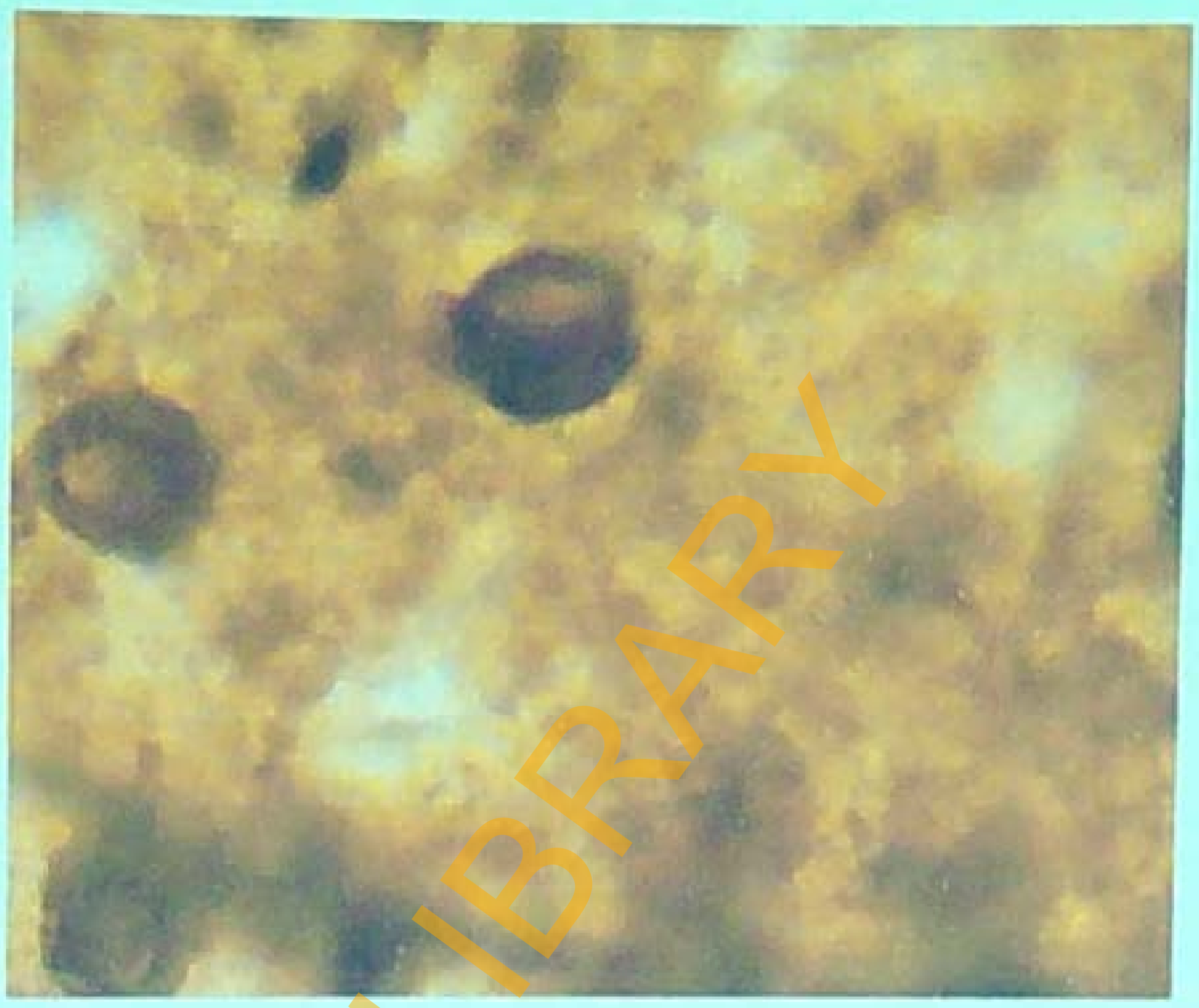
Symptoms of sickness ____

Please note presence of oedema (Yes/No) ______________________________

APPENDIX 3: Snapshots of Parasites Observed during Lab Analysis of Stool Sanmples



Trichuris trichiura



Ascaris lumbricoides

Microbiologist: Mr. Dele Ajayi

APPENDIX 4: School One, MAME Comprehensive College (Private)

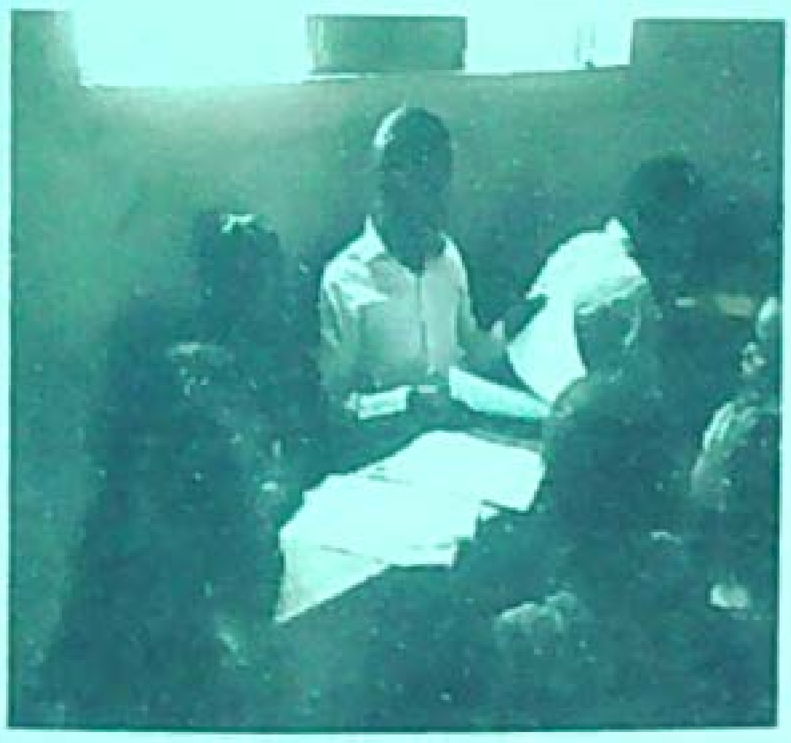






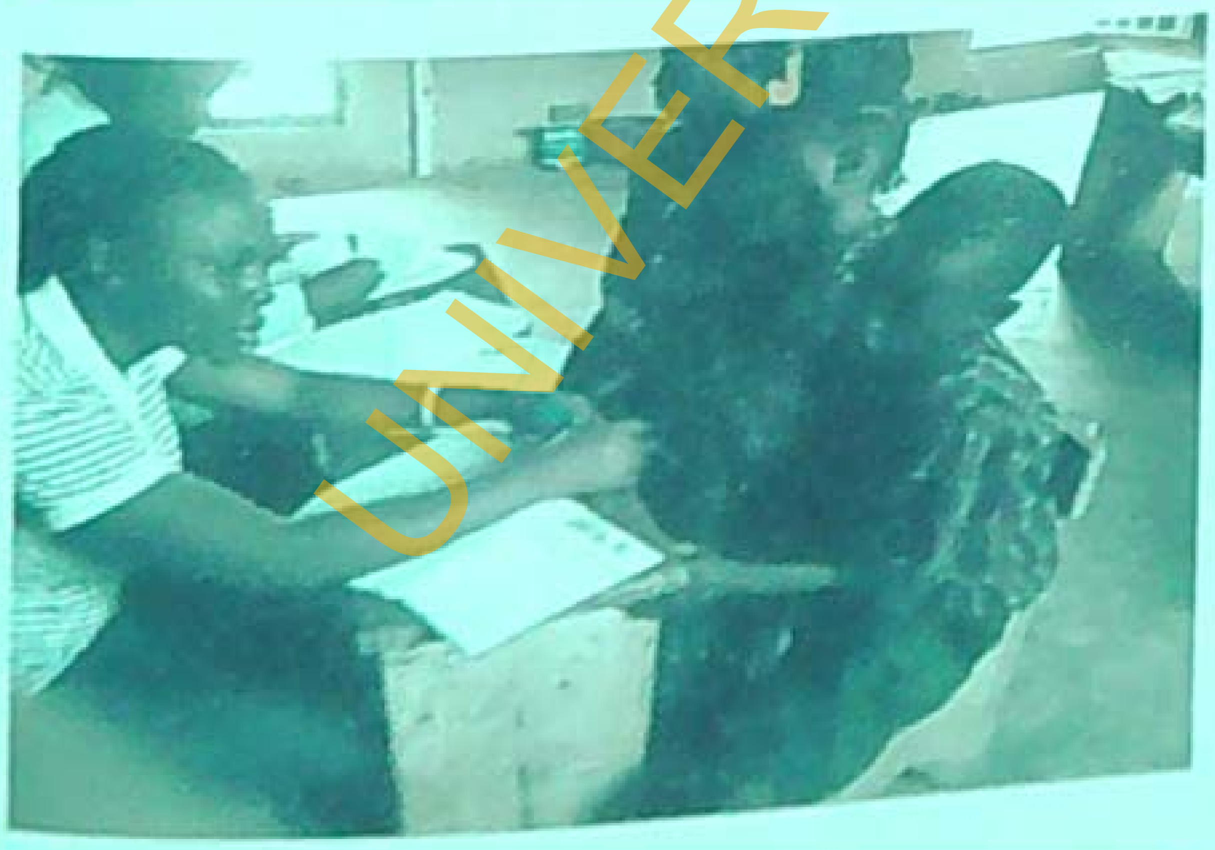

APPENDIX 5: School Two, Christ the Redeemer Nursery and Primary School (Private)










APPENDIX 6: School Three, Emmanuel Group of Schools (Private)

APPENDIX 7: School Four, OOLG Primary School, Seriki Sotayo (Public)

APPENDIX 8: School Five, Saint Peters Primary School, Alapako-Oni (Public)

APPENDIX 9: School Six, Ancient of Days Nursery and Primary School (Private)

APPENDIX 10: School Seven, OOLG Primary School, Ogunmakin (Public)

APPENDIX 11: School Eight, OOLG Primary School, Ladijo (Public)

APPENDIX 12: School Nine, Anglican Central School, Ajebo (Public)

APPENDIX 13: School Ten, Saint Peters Anglican School, Abatan (Public)

APPENDIX 14: School Eleven, GOD First Nursery and Primary School (Private)

APPENDIX 15: Researcher (Miss Abeni Adeoye) at the Northern Border of Obafemi/Owode Local Government Area on Schools Recruitment Visit Day One

ThankYOU DEAR HEAVENLY FATHER! Thank YOU DEAR LORD JESUS! Thank YOU BLESSED HOLY SPIRIT! I Love YOU! It was YOU from Start to Finish.