PREVALENCE, INTENSITY AND FACTORS ASSOCIATED WITH SOIL TRANSMITTED HELMINTHS INFECTION AMONG CHILDREN IN CHILILABOMBWE DISTRICT, COPPERBELT PROVINCE, ZAMBIA-CROSS SECTIONAL STUDY

By

Sibongile Tembo

A dissertation submitted in partial fulfilment of the requirements for the award of
Master of Science in Epidemiology

THE UNIVERSITY OF ZAMBIA

LUSAKA

April, 2019

COPYRIGHT

DECLARATION

I hereby declare that works presented in this study for the Master of Science in Epidemiology has not been presented whether wholly or in part for any other study programme and is not being submitted for any other Masters programme. The result is entirely the results of my own independent investigation. The various resources to which I am indebted have been acknowledged.

Signed: …….

Sibongile Tembo (Candidate)

APPROVAL

This dissertation of Sibongile Tembo has been approved as fulfilling the requirements for the award of Master of Science in Epidemiology by the University of Zambia.

Examiner 1:

Name: …… Signature…… Date: ……

Examiner 2:

Name: …… Signature…… Date: ……

.

Examiner 3:

Name: …… Signature…… Date: ……

Chairperson Board of Examiners:

Name: …… Signature…… Date: …….

Supervisor: Ms. Jessy Zgambo Signature…… Date: ……

ABSTRACT

Soil transmitted helminths (STH) are among the Neglected Tropical Diseases (NTDs) of Poverty. They are a common type of parasitic infections in the world, caused by three main species commonly known as roundworms, whipworms and hookworms. This study investigated the prevalence, intensity and factors associated with soil transmitted helminths among children in Chililabombwe district of Zambia. The study was conducted between October and December, 2017.

A cross sectional design was used, consisting of 411 guardian – child pairs. A questionnaire and checklist was used to collect data on factors associated with helminth infection. Stool samples were collected and examined for presence of parasites using formal-ether concentration and Kato Katz techniques. Geometric mean was used to report intensity of infection. Bivariate and multivariate logistic regression was used to determine factors associated with worm infestations. An investigator led stepwise regression was used to identify factors associated with developing STH infection and level of significance was set at 0.05.

Prevalence of soil transmitted helminth infection was 14.4% and the most dominant parasite was round worms (14.1%). The overall intensity of infection was light (<5000epg) with a few heavy infections (>50000epg). Factors independently associated with soil transmitted helminth infection after adjusting for other variables were residence (AOR=0.26; 95% CI [0.09-0.73]), household income (AOR=2.49; 95% CI [1.01-6.12]) and overcrowding (AOR =1.33; 95% CI [1.09-1.62]).

This indicates that reinfection is common even after deworming. Hence policy makers should advocate for improved living conditions in urban areas coupled with reduced household overcrowding.

Key Words: Soil transmitted helminths, *Ascaris lubricoides, Trichuris trichiura,* Hookworms, Intensity, Neglected tropical diseases of poverty, Zambia

DEDICATION

I dedicate this dissertation to God Almighty for being the source of my strength throughout this programme. Thank you God for your unending love and guidance, may your name be praised. I also dedicate this work to my parents Edward Tembo and Margarete Chola Musebe for their values and morals that they handed down to me during the course of their lives. Continue resting in peace. Not forgetting my siblings and friends for the support during the course of my programme. Thank you! My love for you can never be quantified. God bless you.

ACKNOWLEDGEMENT

This research would not have been possible without the help and support of numerous people. Precisely, I would like to thank my supervisors Ms. Jessy Zgambo, Ms. Lungowe Sitali and Ms. Patricia Mubita who provided valuable guidance and mentorship throughout the course of my research. Special tributes also goes to Mr. Zimba Japhet, Dr Jeremiah Banda, Dr Chongwe, Dr Mweene, Dr Halwindi, Mr. Banda, Mr. Mumbi and the entire school of public health for providing the necessary skills to enable the success of this research project. I also wish to extend my gratitude to Ministry of Higher Education for sponsoring my Master's Degree Programme and for providing a financial grant to support this research. Furthermore, my sincere gratitude goes to Chililabombwe District Health Office under the leadership of Dr M Chakulimba (District Health Director) for granting permission to conduct research in the district and availing the district laboratory staff, equipment and infrastructure to undertake the study. To Mrs. Mwale, Mr. Sianongo and the team, your efforts and contributions can never go without being recognized.

Finally, I would say thank you to my data collectors, family and friends. Prominent among these are Mr. Mabvuto Tembo, Mr. Chella Musonda, and Mr. Francis Katayi Pande for your unwavering support rendered to me, this was emotional, financial and spiritual support. Mr. Bwalya, Mr. Chella Makumba and Mr. Kamayani Mapeesho and the MPH class of 2016 for the support and encouragements. Thank you for making my journey easy. God bless you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

CDC	Center for Disease Control
DHO	District Health Office
EPG	Egg per Gram
ID	Identity Number
IQR	Interquartile Range
MOH	Ministry of Health
NTD	Neglected Tropical Diseases
SD	Standard Deviation
STH	Soil Transmitted Helminth
UNZA	University of Zambia
UNZA BREC	University of Zambia Biomedical Research Ethics Committee
WHO	World Health Organization

DEFINITION OF TERMS

Deworming round: Distribution of antiparasitic drugs to a large of individuals during one defined time period.

Disability-adjusted life years (DALY): One DALY can be thought of as one year of healthy life.

Egg per gram: The number of parasite eggs in 1 gram of stool, it is an indirect measure of the intensity of helminth infection

Intensity of infection: The number of helminths infecting an individual.

Mass drug administration (MDA): The periodic distribution of drugs to the entire population at risk in a region, irrespective of the individual infection status.

Morbidity: The detectable and measurable consequences of a disease.

Prevalence of infection: The percentage of individuals in a population infected by helminths.

School-age children: Children between 5 and 14 years of age, regardless of whether they enrolled in school.

Soil transmitted helminth infection: Parasitic diseases acquired through contact with contaminated soil.

CHAPTER 1: INTRODUCTION

1.1 Background

Soil transmitted helminths are among the neglected tropical diseases (NTDs) of poverty. They are a common type of parasitic infection in the world, caused by four main species commonly known as roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*) and hookworms (*Ancylostoma duodenale* and *Necator americanus*) (Tchuenté, 2011). Soil transmitted helminths (STHs) spend part of their life cycles outside of the human hosts. Adult worms inhabit intestines of humans, reproduce sexually, and produce eggs that are released to the environment through defecation. Once in the environment, eggs are not infective until they undergo embryonation, and reach the appropriate larval stage (Gentry et al., 2016). The mode of transmission is different for each species. *Ascaris lumbricoides and Trichuris trichiura* are transmitted to humans by ingestion of eggs through contaminated food or hands with faecal matter. Hookworm infection is acquired by invasion of the infective larval stages through the skin (A. *duodenale* larvae are also orally infective).

The clinical manifestation of soil transmitted helminths varies between light and heavy infection. Light infection of helminths usually shows no symptoms while symptoms in heavy infections include abdominal pain, diarrhea, blood and protein loss, rectal prolapse, and physical and cognitive growth retardation (CDC, 2013). The diseases have major health and socio-economic repercussions, and significantly contribute to public health problems in developing countries (Tchuenté, 2011). World estimates suggests that more than 1.5 billion people (24% of the world's population) worldwide are affected, and the greatest numbers of infection occurs in sub-Saharan Africa, the Americas, China and east-Asia (WHO, 2018).

According to a study conducted by (Pullan et al., 2014) on global numbers of infection and disease burden attributed to soil transmitted helminths infection in 2010, 819.0 million people were infected with *A. lumbricoides*, 464.5 million with *T. trichiura* and 438.9 million with hookworm. Approximately 4.98 million disability adjusted years lost to STH with 68% to hookworms, 22% to *A. lumbricoides* and the remaining 13% to *T. trichiura* and the majority of the cases occurred in Asia (67% and YLDs 68%). In sub-Saharan Africa an estimated 198 million people are infected with hookworms, 173 million with *A. lumbricoides* and 162 million with *T. trichiura* **(**WHO, 2012). They affect the poorest and most deprived communities.

A study conducted in Kafue district, Lusaka province among pre-school children indicates that soil transmitted helminths are prevalent in Zambia. Prevalence of helminth infection was 17% (20% *A. lumbricoides* and 8.3% hookworm) (Siwila et al., 2010). A similar study conducted by (Halwindi et al., 2016) in Siavonga and Mazabuka district in Zambia reported a prevalence of 12.1% and 7.4% for *A. lumbricoides* and hookworms respectively.

Mass drug administration (MDA) to the most risky population including school-aged children (SAC) is the principal strategy to control soil transmitted helminth infection. Studies indicate that reinfection is possible after chemotherapy (Jia et al., 2012 and Zerdo et al., 2016). Different studies have highlighted not wearing shoes, eating unwashed vegetables, education levels of guardians, socio economic status, area of residence and sanitation as some of the risk factors associated with soil transmitted helminths (Khan et al., 2004, Menzies et al., 2014, Siwila and Olsen, 2015).

A lot of prevalence surveys on helminths in school-aged children have been conducted according to the Zambia's master plan towards the elimination of neglected tropical diseases-2015 to 2020 under the Ministry of Health. Little research has been conducted to determine the intensity and

risk factors associated with developing soil transmitted helminths among children at community level particularly on the Copperbelt. The study determined the prevalence, intensity and factors associated with soil transmitted helminths among children in Chililabombwe District, Copperbelt Province, Zambia.

1.2 Problem Statement

Globally there have been a lot of studies on soil transmitted helminths with estimates of over 1.5 billion people at risk with the greatest number of people infected in the Sub-Saharan Africa (WHO, 2018). Despite the administration of deworming drugs during child health week and school health services, little research has been conducted to establish the intensity and local factors associated with reinfection of soil transmitted helminths. Reinfection can be prevented by regular deworming accompanied by good sanitation and hygiene practices which can help achieve a long term impact (WHO, 2004).

In Zambia, soil transmitted helminths in children have been inadequately studied. Studies conducted in Kalabo, Mazabuka and Kafue districts by (Shawa et al., 2014) and (Siwila et al., 2010) reveal that the disease is prevalent in Zambia especially among children aged between 1-8 years and the Ministry of Health surveillance weekly reports reaffirms it but these studies did not look at intensity of infection. Heavy intensity of infection determines the severity of morbidity caused by the disease. It is for this reason that this study was conducted to determine the prevalence, intensity and factors associated with soil transmitted helminths among children in Chililabombwe on the Copperbelt Province of Zambia.

2.3 General Objectivities

To determine the prevalence, intensity and factors associated with soil transmitted helminths infection among children aged between 1-15 years in Chililabombwe on the Copperbelt Province of Zambia.

2.3.1 Specific Objectives

1. To determine the prevalence and intensity of soil transmitted helminths infection among children aged between 1-15 years in Chililabombwe.

2. To assess the socioeconomic and behavioral characteristics associated with soil transmitted helminths infection among children aged between 1-15years in Chililabombwe.

3. To assess the environmental and service related characteristics associated with soil transmitted helminths infection among children aged between 1-15years in Chililabombwe.

2.4 Research Questions

1. What is the prevalence and intensity of soil transmitted helminths infection among children aged between 1-15 years in Chililabombwe?

2. What are the socioeconomic and behavioral characteristics associated with soil transmitted helminths infection among children aged between 1-15years in Chililabombwe?

3. What are the environmental and service related characteristics associated with soil transmitted helminths infection among children aged between 1-15years in Chililabombwe?

1.5 Justification

The Ministry of Health has reported the prevalence of Soil transmitted helminths and other intestinal worms in different parts of Zambia especially among school aged children but there are no such organized reports on infection intensity of STH. Prevalence varies from place to place which in turn influences administrative chemotherapy. Information on intensity is important in order to track the disease and assess its impact on the health of the child. Intensity also gives a benchmark against which to gauge success of deworming activities. The study provides an up-to-date map of helminth infection in the district which identifies the population and age groups at risk of infection. This may assist to improve the geographical targeting and cost effectiveness of the deworming programme among children

1.6 Organization of Dissertation

- Chapter 1 looks at the introduction of the study. It discusses the background, problem statement, objectives and the justification of the study.

- Chapter 2 gives a critical review of the existing literature associated with the subject matter.

- Chapter 3 looks at the study methodology which was undertaken in order to meet the research objectives.

- Chapter 4 looks at the results of this study. It describes the study participants, prevalence, intensity and risk factors associated with Soil Transmitted Helminths at both univariable and multivariable analysis.

- Chapter 5 discusses the study findings. It chapter gives a critical review of the results in comparison with what has been researched on the subject matter.

- Chapter 6 gives the conclusion and recommendation of the study. It gives a brief summary of the results and possible action points to prevent development of Soil Transmitted Helminths

- Reference list of articles, books and technical reports that were reviewed and cited in the study

- Appendices contains the information sheet, consent form, assent form, questionnaire, checklist and other supporting forms

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

Approximately 1.5 billion people are affected with soil transmitted helminths worldwide with the greatest infections occurring in Sub – Saharan Africa (WHO, 2018). There are common in developing countries especially among the poor and mainly among school aged children and preschool aged children affecting their health and development (Tchuenté, 2011). Eight percent (8%) of the world's estimates are contributed by Nigeria, Ethiopia and Democratic Republic of Congo (Pullan and Brooker, 2012). Globally *A. lumbricoides* has the widest distribution (Pullan and Brooker, 2012) though studies in different locations have shown different results. For example a study done in Ethiopia showed hookworms to be more prevalent with 32.1% recorded in mothers and 2.3% in children (Belyhun et al., 2010).

Deworming activities are carried out in areas where helminths are endemic. Depending on the intensity of infection, deworming activities are conducted once or twice a year among the population at risk (Saboyá et al., 2013). World Health Organization expert committee in 1987 recommended the following classes of intensity for each helminth in stools as shown in Table 2.1.

Table 2. 1: WHO classification of Helminths (Montresor et al., 1988)

Species	**Light intensity infections**	**Moderate intensity infection**	**Heavy intensity infection**
A. lumbricoides	1-4,999 epg	5,000-49,999 epg	50,000 epg
T. trichiura	1-999 epg	1,000-9,999 epg	10,000 epg
Hookworm	1-1,999 epg	2,000-3,999 epg	4,000 epg

The degree of hookworm intensity varies according to the age, species and nutritive intake of iron. Annually, 150 000 deaths are attributed to morbidity caused by heavy infection of soil transmitted helminths (Montresor et al., 1998). Finding the intensity and factors associated with soil transmitted helminths infections is cardinal. This will help identify control measures that are relevant to the control and prevention of infections (Alelign et al., 2015).

2.2 Risk Factors associated with Soil Transmitted Helminths

2.2.1 Age group and sex

Age and sex have been widely reported as risk factors for soil transmitted helminths. Different age groups have been reported to be more prone to infection than the other age groups. According to Khan et al., (2004), the disease is more prevalent in younger children than in older children. In contrast, Naish et al., (2004) reported the disease to be more common in older children (5-15 years) than younger children (1-4 years). This was also reported in studies by (Muñoz-Antoli et al., 2014) and (Alelign et al., 2015) who found the disease to be more prone in the age group of 6-11 years and 10-14 years respectively. In contrast, Tchuem Tchuenté et al., (2003) study on helminths infections among school children in Loum, Cameroon revealed that age was not a factor but the number of species increased with age. Tchuem Tchuenté et al., (2003), found the prevalence of soil transmitted helminths to be different between males and females. Males were found to be more prone to infection than females. Surveys for schistosomiasis and soil transmitted helminths in Luangwa, Kalabo and Serenje Districts of Zambia indicated no association between helminths infections and sex but found age to be associated with it. They found children below the age of eight years to be more prone to infection (Shawa et al., 2014). Therefore, there has been no

conclusion in relation to age and sex. Studies have shown different findings concerning age and sex in different locations.

2.2.2 Water, Sanitation and Hygiene (WASH)

Water, sanitation and hygiene have been reported to have a role in soil transmitted helminths infection. Household water source is a potential risk factor for soil transmitted helminths infection. Drinking from a tap and river was found to be associated with soil transmitted helminths infection in the studies by (Belyhun et al., 2010, Muñoz-Antoli et al., 2014) and (Mwale and Siziya, 2016) respectively.

Systematic review and meta-analysis on the effect of sanitation on soil-transmitted helminths infection revealed that there is no association between lack of sanitation and reduction in soil transmitted helminths (Ziegelbauer et al., 2012). Ziegelbauer et al., (2012) concluded that those that reported a reduction included only one species but not combined species. This is because the species have different mode of transmission and hence the risk factors are different.

Figure 2.1 illustrates the stages of development of *Ascaris lumbricoides* eggs in the soil, transmission mode to the human host and its development in the human host.

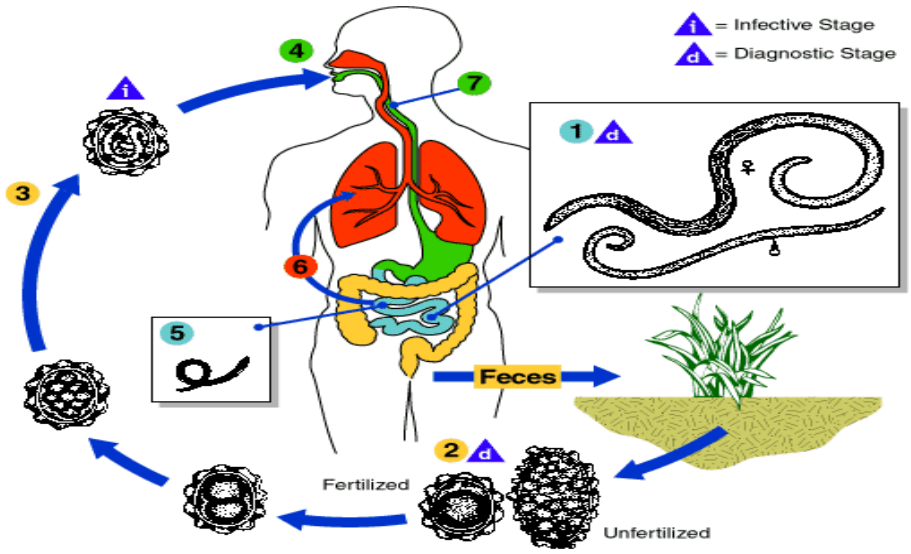

Figure 2.1: Life cycle of *Ascaris lumbricoides* (CDC, 2017)

Figure 2.2 illustrates the stages of development of *Trichuris trichiura* eggs in the soil, transmission mode to the human being and its development in the human host.

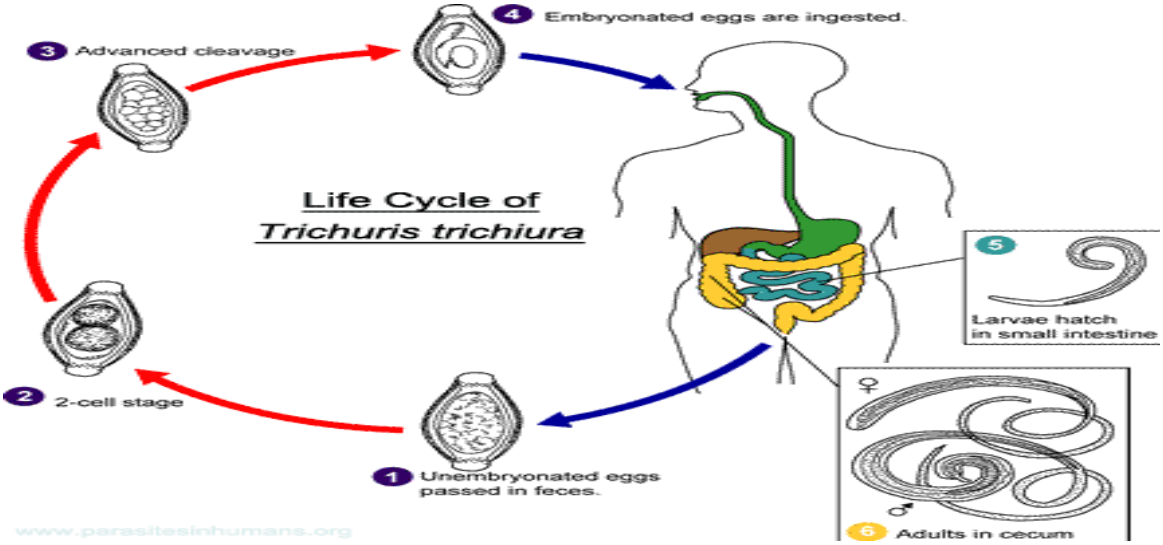

Figure 2.2: Life cycle of Trichuris trichiura (CDC, 2017)

Figure 2.3 illustrates the stages of development of hookworm eggs in the soil, transmission mode to the human host and its development in the human host.

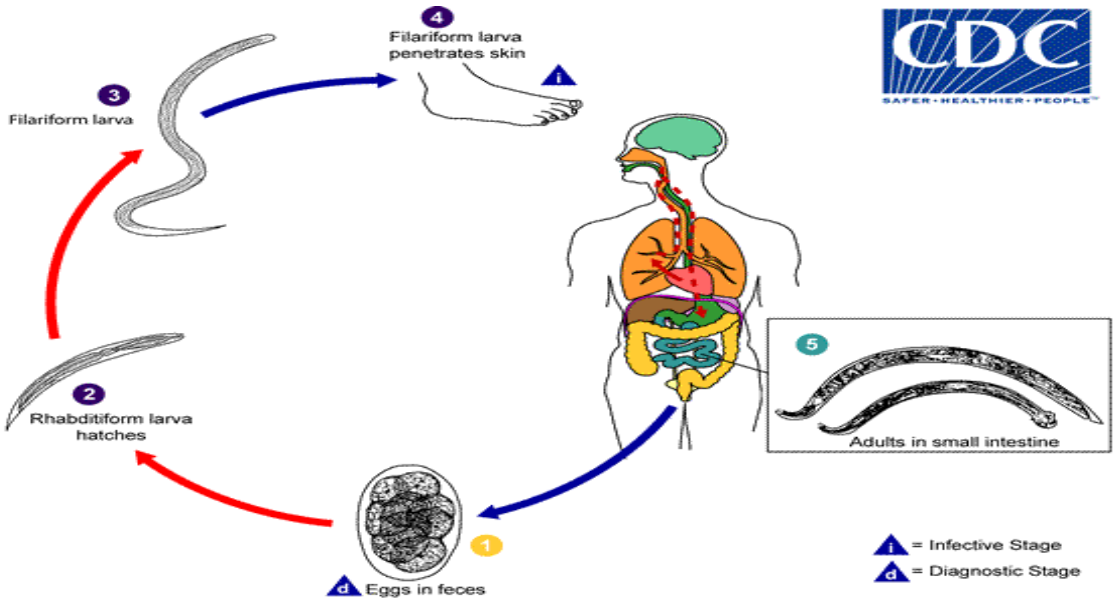

Figure 2.3: Life cycle of the Human Hookworm (CDC, 2017**)**

In other studies, adequate sanitation at community level was reported to be associated with the reduction of soil transmitted helminths transmissions between 40 and 50% reduced odds of infection (Pullan and Brooker, 2012). This was also supported by the findings in a cluster randomized study on WASH in schools which revealed that the intervention reduces *A. lumbricoides* and that provision of latrines could reduce hookworm infection as well (Freeman et al., 2013). Availability and use of latrines reduces the chances of contracting soil transmitted helminths (Eric C. et al., 2016). Long term impacts can be achieved by regular deworming accompanied by adequate sanitation and hygiene (WHO, 2004).

A population based cohort study conducted on the prevalence and risk factors for soil transmitted helminths infection in mothers and their infants in Butajira, Ethiopia reported that the use of soap was significantly associated with maternal infection and increased risk was seen for infrequent soap users compared to daily users in mothers (Belyhun et al., 2010). According to his study, hand hygiene has a significant role in the reduction of soil transmitted helminths. In another study, lack of hand hygiene such as not washing hands was also associated with the increased odds of soil transmitted helminths infection (Alelign et al., 2015).

2.2.3 Exposed bare feet

Hookworm is transmitted usually through contact with infected faeces through the sole of the foot, legs, and buttocks. Children without shoes are more vulnerable to hookworm infection, and boys are more likely than girls to go without shoes (Freeman et al., 2013). Pupils without shoes showed a significantly and substantially greater difference of hookworm reinfection (Ibid). Other studies have also reported that walking bare foot is associated with hook worm infection (Muñoz-Antoli et al., 2014, Alelign et al., 2015, Elyana et al., 2016).

2.2.4 Literacy of Parents

A study on Role of employment status and education of mothers on the prevalence of intestinal parasitic infections in Mexican rural school children reported that low education levels of parents had 3.3 times the risk of infection compared to those with educated parents (Quihui et al., 2006). The parent's levels of education contribute to the development of soil transmitted helminths infections because of poor hygiene practices such as hand washing and poor sanitation (Tilahun et al., 2015). Another study on intestinal polyparasitism among Orang Asli and Malay communities in rural Terengganu, Malaysia concluded that low levels of mothers' education is a key risk factor

for intestinal polyparasitism among Orang Asli mothers (Elyana et al., 2016). A study conducted in Ndola, Zambia also found that children whose parents are not educated are 3.5 times more at risk of infection compared to children whose parents were educated (Mwale and Siziya, 2015).

2.2.5 Climate factors

High and low land surface temperature and extreme arid environments limit soil transmitted helminths species transmission (Pullan and Brooker, 2012). Factors that increase the risk of soil transmitted helminths are warmth and adequate moisture (Alelign et al., 2015). In the same study Alelign et al., explained that transmission is common because of the free-living infective stage development and survival of soil transmitted helminths. *A. lumbricoides* eggs can remain active in the soil for several months and are more resistant to extreme temperatures while larva can remain dormant in the human body for several months. These features allow seasonal transmission of *A. lumbricoides* in environments that are hostile for several years (Alelign et al., 2015). The prevalence of *A. lumbricoides* and *T. trichiura* in Africa and the Middle East is generally <4% in areas with temperatures exceeding 35^0C and drops to < 1% by 40^0C. The prevalence of hook worm infection is still high in higher temperatures and only drops to < 2% temperatures exceeding 40 ^{0}C (Ibid).

2.2.6 Urbanization and Settlement Patterns

Urban infection for hookworms is less common than in other settings (Median infection prevalence of 2.4% vs. 7.7% in peri-urban and rural areas). *A. lumbricoides* and *T. trichiura* higher infection were observed in urban and peri-urban than in rural settings (8.2% vs. 0.0% and 3.0% vs. 0.0% respectively (Pullan and Brooker, 2012). There was a significant hookworm infection reduction in urban areas although substantial transmission can still occur due to influences of socio-economic

status, sanitation, overcrowding and hygiene behaviors (Pullan and Brooker, 2012). However, another study showed that children living in rural areas are more prone to hookworm infection than those in urban areas (Alelign et al., 2015).

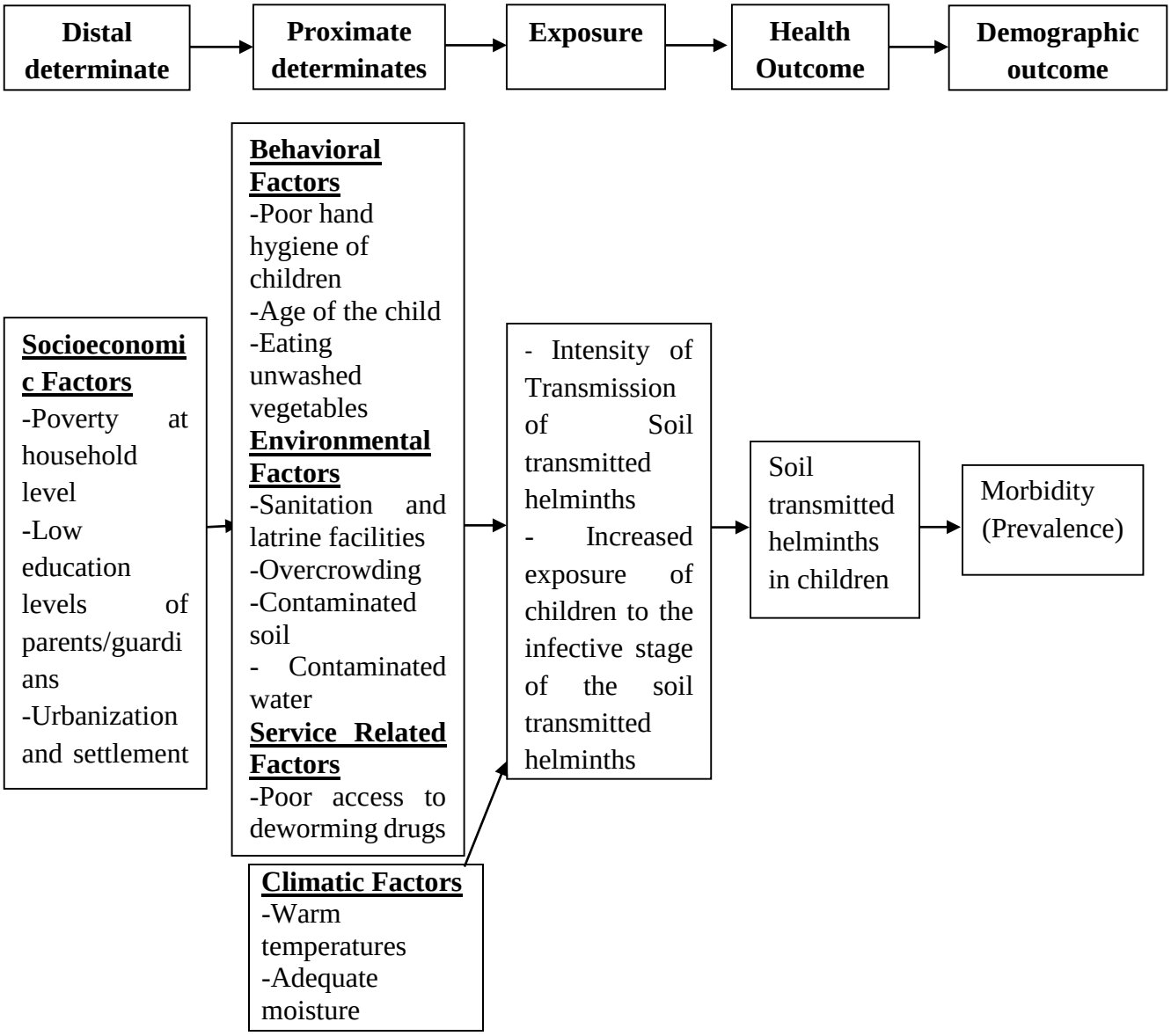

Figure 2.4: Conceptual Framework on Risk Factors Associated with Soil Transmitted Helminths Infection modified from (Chola, 2014)

CHAPTER 3: METHODOLOGY

3.1 Study Design

A cross-sectional study design was adopted in collecting data that was a basis in determining the prevalence, intensity and factors associated with soil transmitted helminths infection among children. This was a community based study conducted between October and December, 2017.

3.2 Study Setting

The study was conducted in Chililabombwe district in the Northern part of Copperbelt province. The district is approximately 40 km from the provincial capital Ndola with a total surface area of 1,029 sq. /km and projected population of 114,282 (CSO, 2010). 4,155 under 1 year, 19,512 under five years, 20,125 under 15 years, 21,247 5-14years and 49,243 above 15years (CSO, 2010). It lies North of Democratic Republic of Congo, East of Mufulira, South of Chingola and South west of Solwezi. The district's main activity is mining with small scale farming in the peri – urban areas and trading. The health care service is provided by the Ministry of Health and Konkola Copper Mine with six privately registered clinics and four government clinics providing curative, preventive and promotive health services.

3.3 Study Population

The study population included children aged between 1-15 years and their parents/guardians, who are residents of Chililabombwe.

Eligibility Criteria

3.3.1 Inclusion Criteria

- Children aged between 1-15 years who lived in Chililabombwe for more than 1 year.

3.3.2 Exclusion Criteria

- Children aged between 1 – 15 years who received Anti helminths treatment within 3 months were excluded from the study
- Visitors were excluded from the study

3.4 Sample Size Determination

The sample size was estimated using a formula for survey sample size estimation at 95% level of confidence.

$$n = \frac{(Z_{1-\alpha/2})^2 \times p \times (1-p)}{d^2}$$

Where n = the required sample size

$Z_{1-\alpha/2}$ = value of the standard normal distribution (1.96) corresponding to a significance level of 0.05 for a 2-sided test.

d = margin of error (0.05)

p = 0.3341

Sample size (n) = 341.87 ~ 342 adjusting for 20% nonresponse rate n= 411 children.

The prevalence (p = 0.3341) assumption of the study was based on a survey conducted in Chililabombwe (MOH, 2012/2014).

3.5 Sampling Method

The district was stratified according to the Health centre catchment areas. There are five catchment areas in the district. These are Chimfunshi (7,005), Kasumbalesa (10,187), Kakoso (18,080), Lubengele (81,108) and Konkola (2,067). The proportions were obtained by dividing the catchment area population by the total population multiplied by the calculated sample size as shown in Table 3.1.

Table 3. 1: Population Proportionate to Size

Location	**Chimfunshi**	**Kasumbalesa**	**Kakoso**	**Lubengele**	**Konkola**	**Total**
Population	7,005	10,187	18,080	81,108	2,067	118,447
Sample size	24	35	63	281	8	411

The catchment area sample sizes were sub divided according to the total number of zones. Systematic sampling was used to select households by selecting the k^{th} household. The interval was determined by dividing the total number of households in each zone by the required sample size. Total households were obtained from the District Health Office projected households per catchment area and zone. The sampling starting point was a random number selected between 1 and k (i^{th} household) in each zone using the Health Centre zone population distribution. In an event that the household picked did not meet the criteria or there were no residents present, substitution method was used to select the next household. In an event were the selected households had more than one child aged 15 and below, simple random sampling was used to select the participant.

Simple random sampling was achieved by writing participant numbers on pieces of paper, placing in a plastic bag, mixing and asking the participant to select one paper

3.6 Data Collection Techniques and Tools

Data was collected by the principal investigator with the help of three research assistants who were trained by the principal investigator prior to data collection. The research assistants were trained by the researcher in data collection, administration of questionnaires, stool collection and monitoring and evaluation of the project.

Primary data was collected by administering questionnaires to the study participants in both English and Bemba (languages commonly spoken in Chililabombwe). The questionnaires included questions on demographic, socio-economic, service related and environmental characteristics. Stool was collected and examined by a trained laboratory technician/scientist for prevalence and intensity and a data extraction checklist was used to collect laboratory results. Data was entered directly into STATA for cleaning (checking for completeness, coding, etc.).

To validate the data collection tools (questionnaire and checklist); a pilot study was conducted in Nchanga South, Nchanga North and Kalilo in Chingola district. Each research assistant administered five questionnaires to the target group and collected stool samples which were submitted to the laboratory for analysis. The gaps which were identified were discussed and corrected to ensure that all salient issues were captured and included in the questionnaire and checklist.

3.6.1 Parasitological Methods

Stool was collected in the morning using a small mouthed, tight and leak proof container with aid of a spatula. The containers were labeled with the participant's identification number, sex, age, time and date of collection. The specimen were stored and transported in ice boxes within 6 hours to the laboratory. The stool was analyzed under a microscope for parasites using concentration technique (formol ether method) and Kato-Katz technique was used for quantification. Two separate slides per technique were prepared and read by two separate technicians. For Kato-Katz, slides were read twice; first within 30-60mins for detection of hookworm eggs and again after approximately 2 hours for analysis of round worms and whipworms. This was because hook worms eggs dissolve faster. The number of helminth eggs in each of the two thick smears prepared from a single fresh stool sample collected from each participant were added and then multiplied by 24, as recommended by the WHO for the template used. Egg counts as epg were used to classify the intensity of infection as slight, moderate or high, respectively as for *A. lumbricoides* 1-4999 epg, 5000-49 999 epg and $\geq$ 50 000 epg, for *T trichuria* 1-999 epg, 1000-9999 epg and $\geq$ 10 000 epg. For Hookworm, 1-1 999 epg, 2 000-3 999 epg and $\geq$ 4 000 epg. The remaining sample was discarded in yellow biohazard bags which were then taken for incineration.

3.7 Data Processing and Quality Control

Two separate slides per sample were prepared and read by two separate technicians. A sample of 10% drawn for quality assurance was cross checked by the laboratory in-charge. After every day of work, the researcher went through the field questionnaire and checklist to check for accuracy and completeness of data. Data from data collection tools was entered directly into the computer in coded form using STATA version 13 for data cleaning, processing and statistical analysis.

3.8 Data Analysis Plan

Data was analyzed using STATA software version 13 (Stata Corporation, College Station, TX, USA). A histogram was used to graphically check for normality (graphs not shown). For normally distributed variables such as age of the child, mean and standard deviation was calculated. For non-normally distributed variables such as number in a shared room, median and interquartile range was calculated. To test for any differences in normally distributed variables (age of child) and non-normally distributed variables (number in a shared room), a two sample t-test and Wilcoxon rank sum test was used respectively.

Categorical variables such as sex were first reported as absolute frequencies with associated percentages; Chi-square test was used to ascertain association with development of soil transmitted helminths. For variables whose expected frequencies were less than 5, Fishers exact Chi-square test was used. To compare egg count values between the different catchment areas, Kruskal-Wallis H test was used as opposed to one way analysis of variance (ANOVA) since egg count per gram was not normally distributed. Geometric mean was used to report intensity as opposed to arithmetic mean because it gives a more accurate measure of central tendency. The following formula for geometric mean was used:

Geometric mean = exp [$\sum$ log (epg +1) ÷ n] – 1 (Montresor et al., 1998)

Where 3 log (epg +1) is the sum of the logarithm of each individual epg, one egg is added to each count to permit calculation of the logarithm in case of epg = 0.

An investigator led stepwise multiple logistic regression model was used to identify factors associated with developing soil transmitted helminthes. Subtracting of variables in the model was influenced by literature review. Selection of the best model was guided by the likelihood ratio test,

Akaike Information Criteria and Bayesian Information Criteria after estimation of the nested models by eliminating variables one at a time.

3.9 Ethical Consideration

Informed consent and assent was sought after the participants had understood all the matters surrounding the study before proceeding with data collection. Participants that refused to participate in the study were excluded. The purpose of the study was explained to participants. The participants had access to information on the study, what was expected of them (submission of stool specimen and answering of questionnaires), possible risks (participants might feel embarrassed to submit stool) and were allowed to ask questions. Participation was voluntary and participants had the right to decline participation, end interviews or decide to withdraw from the study at any point. All the eligible participants had an equal chance to participate in the study through random selection. The laboratory analyst was blinded to avoid misclassification of results. This was done by coding the areas with random numbers rather than using actual names. Any remaining specimens were discarded in an approved manner and were not stored.

To maintain confidentiality, the data collected was de-identified so that the participants were not linked to their responses. The specimen bottles did not carry the participant's names but each participant was given an identification number and only the principal investigator had access to the data base. All the research assistants signed a confidentiality form. To maintain privacy of the participants, the interviews were conducted at the participant's home in a place conducive for them. The submission of stool made the participants to be uncomfortable hence the process of stool collection was conducted in their homes (toilets). No major risks to the participants were expected

during the study as participants were only required to answer only a few questions. Out of these questions only a few required personnel information.

Some of the benefits to participants in the study were to acquire knowledge on soil transmitted helminths status. The study may help policy makers make informed decision on the management and treatment of helminthic infections. Children found positive for soil transmitted helminths were advised to seek medical attention at the nearest health centre.

Approval for the study to be conducted was sought from the University of Zambia Biomedical Ethics Research Committee (UNZABREC). Permission was also sought from Chililabombwe District Health Office.

3.10 Dissemination Plan

The results of the study will be disseminated in thesis, journals, manuscripts, conferences and oral or poster presentation. The manuscript will be published online to contribute to the scientific board of knowledge. The thesis will be shared with the University of Zambia, School of Public Health for academic reference. The manuscript will also be shared with Chililabombwe District Health Office and the Epidemic Preparedness Committee in order to improve the current policy and management of Soil transmitted helminths in the district.

3.11 Limitations

This study has certain limitations that need to be considered while interpreting the results. Firstly, we excluded those who were dewormed in the last 3 months, hence the measured prevalence were for the population at risk. Secondly, most of the questions were self-reported and therefore obtaining accurate information is not possible. Residents were not comfortable to respond to some

personal questions such as household income, number sharing a room and total members. Hence we had 28 % of our questionnaires missing some values. This might have affected the power of the study. This was handled by including all in the analysis. Finally, geographical boundaries of catchment area zones were difficult to assess. Hence we failed to present data on prevalence and intensity per zone.

CHAPTER 4: RESULTS

4.1 Demographic Characteristics of Study Participants

There were 411 children – guardian pairs in the study. Table 4.1 shows the demographic characteristics of the study participants stratified by soil transmitted helminths infection. Age of children ranged from 1 to 15 years with a mean of six years and seven years for helminthic and non-helminthic infection respectively. Most of the children with helminthic infection were females (31/59; 52.5%).

Table 4.1: Demographic characteristics of study participants stratified by soil transmitted helminth (STH) infection

	Infected (N=59)		Uninfected (N=352)		
Characteristic	**(n)**	**(%)**	**(n)**	**(%)**	**P-value**
Age of child					
Mean (SD)	6 (3.5)		7 (3.7)		0.112[a]
Sex of child					
Female	31	52.5	185	52.7	0.981[b]
Male	28	47.5	166	47.3	
Age of guardian					
Mean (SD)	37 (10.3)		36 (11)		0.696 [a]
Sex of guardian					
Female	43	74.1	279	79.7	0.335[b]
Male	15	25.9	71	20.3	
Marital status of guardian					
Married	47	79.7	263	74.9	0.434[b]
Not Married	12	20.3	88	25.1	
Residence					
Urban	48	81.4	241	68.5	**0.045[b]**
Rural	11	18.6	111	31.5	

[a]Two sample t-test. [b]Chi-square test.

A total of 48/59 (81.4%) with helminthic infection and 241/352 (68.5%) with non-helminthic infection lived in the urban areas of Chililabombwe. Age of guardian ranged from 17 to 77 years

with a mean of 36 years and 37 years for helminthic and non-helminthic infection respectively. A total of 43/59 (74%) guardians in the helminthic group and 279/352 (80%) guardians in the non-helminthic group were females. Most of the guardians in the study were married (47/9; 79.7%, Table 4.1).

A total of 33/59 (55.9%) guardians in the helminthic group and 187/352 (53.7%) guardians in the non-helminthic group had attained at least secondary education and above. Formal employment status of guardians was 18.6% (11/59) for the helminthic group and 17.6% (62/352) for the non-helminthic group. About 50% (28/56) and 57% (187/330) of the guardians earned less than K500 per month in the helminthic and non-helminthic group respectively.

On average, household members were 6 (IQR=4, 8) and a house consisted of two bedrooms and three people sharing a room. There was a significant difference between helminthic and non-helminthic children in relation to residence and number in a shared room ($P<0.05$). About 43/59 (72.9%) and 251/351 (71.5%) children in the helminthic and non-helminthic group respectively reported washing their hands with soap after using the toilet. 72.9% (43/59) and 74.3% (257/346) children in the helminthic and non-helminthic group respectively played bare foot. The majority of the guardians washed their vegetables before cooking in the helminthic (53/59; 89.9%) and non-helminthic (317/352; 90.2%) groups as shown in Table 4.2.

Table 4.2: Socio economic and behavioral characteristics of study participants stratified by STH infection

Characteristic	Infected (N=59) (n)	(%)	Uninfected (N=352) (n)	(%)	P-value
Education of guardian					
No formal education	3	5.1	25	7.2	0.925 [a]
Primary	23	39.0	139	39.1	
Secondary and above	33	55.9	187	53.7	
Occupation of guardian					
Self-employment	38	64.4	219	62.9	0.915[c]
Formal employment	11	18.6	62	17.8	
Unemployment	10	17.0	67	19.3	
Household income					
0-500	28	50.0	187	56.7	**0.284[a]**
501-1000	18	32.1	67	20.3	
1001-2000	5	8.9	31	9.4	
2001-3500	2	3.6	31	9.4	
3501-5000	2	3.6	10	3.0	
>5001	1	1.8	4	1.2	
Total bedrooms in a household					
Median(IQR)	2 (2-3)		3 (2-3)		**0.579[b]**
Total members in a household					
Median(IQR)	6 (4-8)		6 (4-8)		**0.8049[b]**
No. in a shared room					
Median(IQR)	3 (2-4)		3 (2-3)		**0.0417[b]**
Hand washing					
Yes	48	81.4	295	85.1	0.473[c]
No	11	18.6	52	15.0	
Hand washing with soap					
Yes	43	72.9	251	71.5	0.829[c]
No	16	27.1	100	28.5	
Wearing shoes					
Yes	43	72.9	257	74.3	0.821[c]
No	16	27.1	89	25.7	
Washing of vegetables before cooking					
Yes	53	89.8	317	90.1	0.957[c]
No	6	10.2	35	9.9	

[a]Fishers exact - Chi-square test. [b]Two-sample Wilcoxon rank sum test (Mann –Whitney test).

[c] Chi-square test

Most of the study participants had access to piped water in the helminthic group (44/59; 74.6%) and non-helminthic group (224/351; 63.8%) and water was available most of the times. A total of 28/59 (47.5%) children with helminth infection in the study had access to flushable toilets and 175/351 (49.9%) of non-helminthic infection used pit latrines. In both the helminthic and non-helminthic groups 85% (50/59 and 298/349 respectively) of the children had been dewormed before as shown in Table 4.3.

Table 4.3: Environmental and service related characteristics of study participants stratified by STH infection

Characteristic	Infected (N=59)		Uninfected (N=352)		P-value
	(n)	(%)	(n)	(%)	
Source of water					
Piped	44	74.6	224	63.8	0.108[a]
Unpiped	15	25.4	127	36.2	
Availability of water					
Available	45	76.3	278	79.0	**0.654[a]**
Not available	11	18.6	50	14.2	
Scarce	3	5.1	24	6.8	
Sanitation					
Flushable toilet	28	47.5	121	34.5	0.139[a]
Pour flush toilet	6	10.2	55	15.7	
Pit latrine	25	42.4	175	49.9	
History of deworming					
Yes	50	84.8	298	85.4	0.898[a]
No	9	15.3	51	14.6	
Previous deworming					
Six months ago	41	80.4	224	68.3	0.08[a]
I can't remember	10	19.6	104	31.7	

[a] Chi-square test.

4.2 Prevalence and Intensity of STH Infection

The overall prevalence of STH infection was 14.36% (59/411) with *A. lumbricoides* (14.1; 58/411) being the main species followed by hookworm (0.2%; 1/411) while whipworm showed no infection (0%). The proportion of heavy infection was 3.4% (2/59), 11.9% (7/59) moderate infection and 84.7% (50/59) light infection of total positive cases. All the heavy infections were due to *A. lumbricoides*. The overall geometric mean egg count per gram of stool was 0.25.

The distribution of the STH infection was analysed according to age group and residence. The highest prevalence of STH was recorded in the age group 1-5 years in Kasumbalesa, Lubengele and Konkola while in Kakoso it was in the age group 6-10 years. Chimfunshi catchment area recorded no positive sample. There was no significant difference in egg count among the five catchment areas (p-value >0.05) as shown in Figure 4.1.

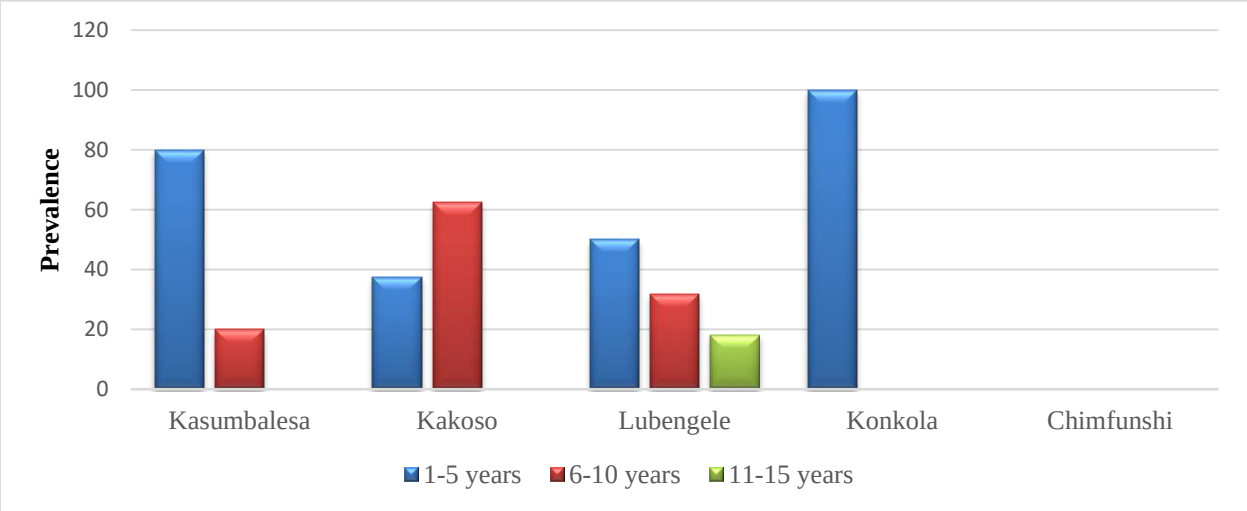

Figure 4.1: Prevalence of soil transmitted helminth infection by age group and residence

4.3 Risk factors associated with Soil Transmitted Helminth Infection

Table 4.4, 4.5 and 4.6 show how each demographic, socioeconomic, behavioral, environmental and service related factor interacts with STH infection (bi-variate analysis) and how all the factors interact with STH infection (multivariate analysis).

Table 4.4: Demographic Factors Associated with STH Infection

	Univariate		Multivariate	
Variable	**OR(95% CI)**	**P-value**	**OR(95% CI)**	**P-value**
Age of child	0.95 (0.88,1.02)	0.225	0.92 (0.82,1.05)	0.208
Sex of child				
Female	1		1	
Male	1.01 (0.58,1.75)	0.981	1.04 (0.49,2.20)	0.921
Age of guardian	1.01 (0.98,1.03)	0.607	1.02 (0.98,1.06)	0.436
Sex of guardian				
Female	1		1	
Male	1.37 (0.72,2.61)	0.336	2.01 (0.76,5.27)	0.158
Marital status of guardian				
Married	1		1	
Not Married	0.76 (0.39,1.50)	0.435	0.46 (0.16,1.35)	0.157
Residence				
Urban	1		1	
Rural	0.50 (0.25,0.99)	0.048	0.30 (0.06,1.44)	0.133

One year increase in age of child decreased the odds of infection by 8% and this decrease was as high as 1.05 and as low as 0.82 however, this was not statistically significant (P-value>0.05). Table 4.4 shows that all the demographic factors of both children and guardians were not associated with having soil transmitted helminths.

Table 4.5: Socio-economic and Behavioral Factors Associated with STH Infection

	Univariate		Multivariate	
Variable	**OR(95% CI)**	**P-value**	**OR(95% CI)**	**P-value**
Education of guardian				
No formal education	1		1	
Primary	1.41 (0.39,5.05)	0.598	0.75 (0.13,4.20)	0.742
Secondary and above	1.47 (0.42,5.15)	0.546	0.65 (0.12,3.59)	0.618
Occupation of guardian				
Self-employment	1		1	
Formal employment	1.02 (0.49,2.12)	0.952	0.52 (0.17,1.59)	0.25
Unemployment	0.86 (0.41,1.82)	0.693	0.72 (0.21,2.43)	0.598
Household Income				
0-500	1		1	
501-1000	1.79 (0.93,3.45)	0.08	2.93 (1.09,7.87)	**0.033**
1001-2000	1.08 (0.39,3.00)	0.887	1.58 (0.38,6.58)	0.529
2001-3500	0.43 (0.10,1.90)	0.266	0.77 (0.13,4.58)	0.777
3501-5000	1.34 (0.28,6.42)	0.718	3.11 (0.41,23,47)	0.271
>5001	1.67 (0.18,15.48)	0.652	1.25 (0.07,21,62)	0.878
Total bedrooms in the household	0.92 (0.66,1.28)	0.605	1.00 (0.59,1.71)	0.978
Total members in the household	0.99 (0.89,1.09)	0.789	0.84 (0.67,1.04)	0.11
No. in a shared room	1.27 (1.09,1.49)	0.003	1.46 (1.14,1.88)	**0.003**
Hand washing				
Yes	1		1	
No	1.30 (0.63,2.67)	0.474	0.50 (0.10,2.37)	0.381
Hand washing with soap				
Yes	1		1	
No	0.93 (0.50,1.73)	0.829	1.08 (0.34,3.39)	0.896
Wearing shoes				
Yes	1		1	
No	1.07 (0.58,2.00)	0.821	1.13 (0.33,3.87)	0.84
Washing of vegetables before cooking				
Yes	1		1	
No	1.02 (0.41,2.56)	0.957	0.57 (0.09,3.48)	0.539

Households with income between K501 and K1000 had 2.93 times increased odds of infection compared to households with income less than k501 while controlling for other variables. This was statistically significant (95% CI 1.90- 7.87 P=0.033) as shown in Table 4.6.

Table 4.6: Environmental and Service related Factors Associated with STH Infection

	Univariate		Multivariate	
Variable	**OR(95% CI)**	**P-value**	**OR(95% CI)**	**P-value**
Source of water				
Piped	1		1	
Unpiped	0.60 (0.32,1.12)	0.111	0.62 (0.11,3.59)	0.597
Availability of water				
Available	1		1	
Not available	1.36 (0.65,2.81)	0.407	1.99 (0.61,6.50)	0.252
Scarce	0.77 (0.22,2.67)	0.683	4.04 (0.50,32.71)	0.19
Sanitation				
Flushable toilet	1		1	
Pour flush toilet	0.47 (0.18,1.20)	0.116	0.63 (0.19,2.05)	0.44
Pit latrine	0.62 (0.34,1.11)	0.107	0.73 (0.20,2.7)	0.641
History of deworming				
Yes	1		1	
No	1.05 (0.49,2.27)	0.898	0.24 (0.02,2.50)	0.235
Previous deworming				
Six months ago	1		1	
I can't remember	0.53 (0.25,1.09)	0.084	1.01 (0.34,3.01)	0.989

Children who were not dewormed had 76% reduced odds of infection compared to children who were dewormed before. This was not statistically significant (95% CI 0.02- 2.50 P=0.235) as shown in Table 4.6. The best model (Table 4.7) was chosen based on Akaike information criteria, Bayesian information criteria and Likelihood ratio test (0.9863) compared to the full model. The best predictors of Soil transmitted helminths were number in a location, shared room and household income (P-value 0.01, 0.003 and 0.033 respectively) as shown in Table 4.7.

Table 4.7: Factors associated with Soil Transmitted Helminth Infection from the best model

Characteristics	AOR(95% CI)	P-value
Age of child	0.94 (0.84,1.05)	0.26
Sex of child		
Female		
Male	1.03 (0.50,2.12)	0.943
Sex of guardian		
Female	1	
Male	2.16 (0.88,5.29)	0.092
Marital status of guardian		
Married	1	
Not Married	0.51 (0.20,1.31)	0.161
Education of guardian		
No formal education		
Primary	0.86 (0.16,4.54)	0.859
Secondary and above	0.94 (0.19,4.74)	0.945
Occupation of guardian		
Self-employment		
Formal employment	0.51 (0.18,1.46)	0.211
Unemployment	0.85 (0.28,2.62)	0.783
Household Income		
0-500	1	
501-1000	2.49 (1.01,6.12)	**0.047**
1001-2000	1.50 (0.42,5.33)	0.533
2001-3500	0.68 (0.13,3.54)	0.646
3501-5000	2.50 (0.39,16.16)	0.335
>5001	1.27 (0.09,18.58)	0.863
Location		
Urban	1	
Rural	0.26 (0.09,0.73)	**0.01**
Hand washing		
Yes	1	
No	0.65 (0.18,2.38)	0.514
No. in a shared room	1.33 (1.09,1.62)	**0.004**
History of deworming		
Yes	1	
No	0.25 (0.03,2.03)	0.197

The more people shared a room the greater the risk of developing soil transmitted helminths (95% CI 0.09, 1.62 P=0.004) as shown in Table 4.7.

CHAPTER 5: DISCUSSION

Results of the current study showed that Soil Transmitted Helminths infections are still endemic and continue to be a major public health concern among children in Chililabombwe district with 14.4% of participants infected with at least one STH species. Thus out of the three STH species, *A. lumbricoides* infection was the most predominant, followed by hookworm infection. No infection was recorded due to *T. trichiura* species. A study by Mwale and Siziya (2015) also showed *A. lumbricoides* infection to be more prevalent compared to the *T. trichiura* and hookworm. Global estimates also reveal that *A. lumbricoides* infection has the widest distribution of infection (Pullan and Brooker, 2012).

Most of the children had light intensity of infection. This could be explained by the mass chemotherapy in the district which is done twice a year. The heaviest intensity was observed in older children (11-15 years). This is consistent with the study done by Tchuem Tchuenté et al., (2003) in Cameroon which showed that intensity of infection increased with age. There was no significant difference between egg count and catchment areas. The observed intensity calls for deworming once a year according to WHO classification of soil transmitted helminth infection.

Prevalence (14.4%) recorded in this study is lower than that recorded during a survey conducted in the district by the Ministry of Health in 2012/2014 (33.41%). The ministry of Health conducted a total enumeration of the school aged children. Taking into account the sample size, the recorded prevalence in the study is still high. The national objectives are to reduce morbidity of STH infection to a level where it will be no longer a public health problem and to reduce the prevalence to less than 10% in order to achieve the national goals of eliminating high intensity of soil

transmitted helminths in school age children and communities at risk. This reaffirms that the prevalence recorded in the study is still high.

Factors independently associated with infection in this study were overcrowding, residence and household income. Overcrowding was measured by the number of people in a shared room. The more people shared a room the greater the risk of developing soil transmitted helminths. This was consistent with the study by Menzies et al., (2014) in Latin America who found that household overcrowding was 1.81 times greater risk of soil transmitted helminth infection compared to those with less than three occupants per room in the first three years of life of a child. Romero-Sandoval et al., (2017) also found overcrowding to be a contributor of helminth infection in school aged children in Chencha, southern Ethiopia. In an overcrowded place, it's hard to keep cleanliness and prevent faecal contamination and pollution of premises hence the risk is high. Children who lived in urban areas were more prone to infection than children who lived in rural areas**.** Menzies et al., (2014) also found urban areas to be more prone to infection than rural area. This could be explained by the fact that Chililambobwe district is mostly peri-urban with poor sanitation.

The investigator also found a significant association between household income and soil transmitted helminths. Household income less than K1000 was strongly associated with soil transmitted helminth infections. Household income was taken as a proxy measure of poverty. Poverty may have an influence on sanitation, access to clean water, personal hygiene and education attainment**.** Even though the factors mentioned were not statistically significant in the study. Other studies also found that being lower in socio economic status was a contributor of soil transmitted helminth infections (Menzies et al.,2014 and Ngui et al., 2015).

We found no significant association between behavioural, service related and environmental factors in this study area. The socioeconomic characteristics of an individual were the main drivers of worm infestation in the area. The socioeconomic characteristic has influence on health, household income, residence, food and the hygiene practices of an individual.

CHAPTER 6: CONCLUSION AND RECOMMEDATION

6.1 Conclusion

This study ascertains that soil transmitted helminth infection are present in Chililabombwe. The most common species is *A. lumbricoides*. The overall intensity of infection is light with a few heavy infections. The factors independently associated with worm infestation were overcrowding, residence and household income. This indicates that reinfection is common even after deworming. Hence policy makers under the Ministry of local government, Ministry of health and Ministry of finance should advocate for factors to improve the living conditions of communities. Socioeconomic characteristics of the individual are important proximate determinate of health. Chililambobwe has similar socioeconomic characteristics with most communities in Zambia. Thus we may conclude that the findings can be generalised to other districts. However, further studies are required to prove this hypothesis.

6.2 Recommendation

i. Ministry of Health in conjunction with the Ministry of Education should conduct research on the nutritional and educational impacts of worm infestation in children in the study area.
ii. The Ministry of Health through the District Health Office should ensure that zonal geographical and populations boundaries are evaluated to enhance programme activities.
iii. The local authority should intensify inspections of communities and schools to improve living standards of children.
iv. The results of this study can be used to assist the Ministry of Local Government, Health and Finance with policy development in child health.

v. The Ministry of Health through the District Health Office should ensure that the deworming programme is coupled with health education and WASH activities.

REFERENCES

ALELIGN, T., DEGAREGE, A. & ERKO, B. 2015. Soil-transmitted helminth infections and associated risk factors among schoolchildren in Durbete Town, Northwestern Ethiopia. *Journal of Parasitology Research,* 2015.

BELYHUN, Y., MEDHIN, G., AMBERBIR, A., ERKO, B., HANLON, C., ALEM, A., VENN, A., BRITTON, J. & DAVEY, G. 2010. Prevalence and risk factors for soil-transmitted helminth infection in mothers and their infants in Butajira, Ethiopia: a population based study. *BMC Public Health,* 10**,** 1.

CENTRAL STATISTICS OFFICE. 2010.Zambia National Census Report.

Chola 2014. DETERMINANTS AND PATTERNS OF FERTILITY IN ZAMBIA

ELYANA, F. N., AL-MEKHLAFI, H. M., ITHOI, I., ABDULSALAM, A. M., DAWAKI, S., NASR, N. A., ATROOSH, W. M., ABD-BASHER, M. H., AL-AREEQI, M. A. & SADY, H. 2016. A tale of two communities: intestinal polyparasitism among Orang Asli and Malay communities in rural Terengganu, Malaysia. *Parasites & Vectors,* 9**,** 398.

FREEMAN, M. C., CLASEN, T., BROOKER, S. J., AKOKO, D. O. & RHEINGANS, R. 2013. The impact of a school-based hygiene, water quality and sanitation intervention on soil-transmitted helminth reinfection: a cluster-randomized trial. *The American Journal of Tropical Medicine and Hygiene,* 89**,** 875-883.

GENTRY, J., STURM, B. & PETERSON, A. T. 2016. Predictive Mapping of Transmission Risk of a Soil-Transmitted Helminth across East Africa: Findings from Community Prevalence Surveys. *Journal of Public Health in Developing Countries,* 2**,** 150-161.

HALWINDI, H., MAGNUSSEN, P., OLSEN, A. & LISULO, M. 2016. POTENTIAL CONTRIBUTION OF ADULT POPULATIONS TO THE MAINTENANCE OF

SCHISTOSOMIASIS AND SOIL-TRANSMITTED HELMINTH INFECTIONS IN THE SIAVONGA AND MAZABUKA DISTRICTS OF ZAMBIA. *Journal of Biosocial Science*, 1-11.

HOTEZ, P. J., BETHONY, J., BOTTAZZI, M. E., BROOKER, S. & BUSS, P. 2005. Hookworm:"the great infection of mankind". *PLoS Med,* 2, e67.

https://www.cdc.gov/parasites/sth/index.html (Accessed on 23.01.2019)

https://www.cdc.gov/dpdx/ascariasis/modules/Ascariasis Life Cycle.gif (Accessed on 20.09.18)

https://www.cdc.gov/dpdx/hookworm/modules/Hookworm Life Cycle.gif(Accessed on20.09.18)

http://www.who.int/en/news-room/fact-sheets/detail/soil-transmitted-helminth-infections (Accessed on 22.09.2018)

https://www.cdc.gov/dpdx/trichuriasis/modules/Trichuris_LifeCycle.gif (Accessed on 20.09.18)

JIA, T.-W., MELVILLE, S., UTZINGER, J., KING, C. H. & ZHOU, X.-N. 2012. Soil-transmitted helminth reinfection after drug treatment: a systematic review and meta-analysis. *PLoS neglected tropical diseases,* 6**,** e1621.

KHAN, A., SULTANA, A., DAR, A. M. K., RASHID, H. & NAJMI, S. A. A. 2004. A study of prevalence, distribution and risk factors of intestinal helminthic infestation in district BAGH (AZAD KASHMIR). *Pak Arm Force Med J,* 2**,** ISSN 0030–9648.

MCDMCH: Zambia's master plan towards the elimination of neglected tropical diseases -2015 to 2020. Ministry of Health, Lusaka

MENZIES, S. K., RODRIGUEZ, A., CHICO, M., SANDOVAL, C., BRONCANO, N., GUADALUPE, I. & COOPER, P. J. 2014. Risk factors for soil-transmitted helminth infections during the first 3 years of life in the tropics; findings from a birth cohort. *PLoS Negl Trop Dis,* 8**,** e2718.

MONTRESOR, A., CROMPTON, D. W., HALL, A., BUNDY, D., SAVIOLI, L. & ORGANIZATION, W. H. 1998. Guidelines for the evaluation of soil-transmitted helminthiasis and schistosomiasis at community level: a guide for managers of control programmes.

MUÑOZ-ANTOLI, C., PAVÓN, A., MARCILLA, A., TOLEDO, R. & ESTEBAN, J. 2014. Prevalence and risk factors related to intestinal parasites among children in Department of Rio San Juan, Nicaragua. *Transactions of The Royal Society of Tropical Medicine and Hygiene,* 108**,** 774-782.

MWALE, K. & SIZIYA, S. 2015. Intestinal Infestations in Under-Five Children in Zambia. *International Journal of MCH and AIDS,* 4**,** 40.

MWALE, K. & SIZIYA, S. 2016. Intestinal Infestations in Under-Five Children in Zambia. *International Journal of MCH and AIDS (IJMA),* 4**,** 40-46.

NAISH, S., MCCARTHY, J. & WILLIAMS, G. 2004. Prevalence, intensity and risk factors for soil-transmitted helminth infection in a South Indian fishing village. *Acta Tropica,* 91**,** 177-187.

NGUI, R., AZIZ, S., CHUA, K. H., AIDIL, R. M., LEE, S. C., TAN, T. K., SANI, M. M., ARINE, A. F., ROHELA, M. & LIM, Y. A. 2015. Patterns and risk factors of soil-transmitted Helminthiasis among Orang Asli subgroups in Peninsular Malaysia. *The American journal of tropical medicine and hygiene,* 93**,** 361-370.

PULLAN, R. L. & BROOKER, S. J. 2012. The global limits and population at risk of soil-transmitted helminth infections in 2010. *Parasites & Vectors,* 5**,** 1.

PULLAN, R. L., SMITH, J. L., JASRASARIA, R. & BROOKER, S. J. 2014. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasites & Vectors,* 7**,** 1.

QUIHUI, L., VALENCIA, M. E., CROMPTON, D. W., PHILLIPS, S., HAGAN, P., MORALES, G. & DÍAZ-CAMACHO, S. P. 2006. Role of the employment status and education of mothers in the prevalence of intestinal parasitic infections in Mexican rural schoolchildren. *BMC Public Health,* 6**,** 1.

ROMERO-SANDOVAL, N., ORTIZ-RICO, C., SÁNCHEZ-PÉREZ, H. J., VALDIVIESO, D., SANDOVAL, C., PÁSTOR, J. & MARTÍN, M. 2017. Soil transmitted helminthiasis in indigenous groups. A community cross sectional study in the Amazonian southern border region of Ecuador. *BMJ open,* 7**,** e013626.

SABOYÁ, M. I., CATALÁ, L., NICHOLLS, R. S. & AULT, S. K. 2013. Update on the mapping of prevalence and intensity of infection for soil-transmitted helminth infections in Latin America and the Caribbean: a call for action. *PLoS Negl Trop Dis,* 7**,** e2419.

SHAWA, S. T., MWASE, E. T. & SIMONSEN, P. E. 2014. Surveys for schistosomiasis and soil transmitted helminths in Luangwa, Kalabo and Serenje Districts of Zambia. *Medical Journal of Zambia,* 41**,** 174-180.

SIWILA, J. & OLSEN, A. 2015. Risk factors for infection with soil transmitted helminths, Cryptosporidium spp., and Giardia duodenalis in children enrolled in preschools in Kafue District, Zambia. *Epidemiology Research International,* 2015.

SIWILA, J., PHIRI, I. G., ENEMARK, H. L., NCHITO, M. & OLSEN, A. 2010. Intestinal helminths and protozoa in children in pre-schools in Kafue district, Zambia. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* 104**,** 122-128.

TCHUEM TCHUENTÉ, L. A., BEHNKE, J., GILBERT, F., SOUTHGATE, V. & VERCRUYSSE, J. 2003. Polyparasitism with Schistosoma haematobium and soil-transmitted helminth infections among school children in Loum, Cameroon. *Tropical Medicine & International Health,* 8**,** 975-986.

TCHUENTÉ, L. T. 2011. Control of soil-transmitted helminths in sub-Saharan Africa: diagnosis, drug efficacy concerns and challenges. *Acta Tropica,* 120**,** S4-S11.

WHO, 2012. Soil-transmitted helminthiases. Eliminating soil-transmitted helminthiases as a public health problem in children: progress report 2001–2010 and strategic plan 2011–2020. 2012, World Health Organisation; Geneva

World Health Organization, 2004. Prevention and control of schistosomiasis and soil-transmitted helminthiasis: World Health Organization.

World Health Organization, 2006. Preventive chemotherapy in human helminthiasis. *Coordinated use of Anthelminthic Drugs in Control Interventions: a Manual for Health Professionals and Programme Managers*.

ZERDO, Z., YOHANES, T. & TARIKU, B. 2016. Soil-transmitted helminth reinfection and associated risk factors among school-age children in Chencha District, southern Ethiopia: a cross-sectional study. *Journal of parasitology research,* 2016.

APPENDICES

Appendix I: Information Sheet

Study Title: Prevalence, Intensity and Factors Associated with Soil Transmitted Helminths Infection among Children in Chililabombwe District, Copperbelt Province, Zambia – Cross sectional study

Introduction

My name is **Sibongile Tembo**, a student from the University of Zambia, School of Public Health conducting the above named study. This study is seeking to interview parents with children aged between 1-15 years, and therefore you been selected to participate because you meet this inclusion criteria. Your participation is entirely voluntarily. If you do not want to participate, there will be no penalty. You may stop your participation any time and can decide not to answer some questions that may make you feel uncomfortable. However, your participation and your responses are very important in understanding the intensity and factors associated with the infection and will provide insights in designing relevant interventions. We will read the information below and you can ask questions about anything you do not understand before deciding whether or not to participate.

Purpose

The main objective of the study is to determine the prevalence, intensity and factors associated with developing soil transmitted helminths infection among children aged between 1-15 years in Chililabombwe.

Procedure

Participation in this study will entail two visits. The first visit will require the parents and child to answer a short questionnaire, while the second visit will involve collection of the child's stool. The findings obtained from the study will help policy makers make informed decision on the management and treatment of helminthic infections. This is supposed to be a private and confidential exercise done in an enclosed area. If you agree to participate, you will be asked to sign an informed consent form, after which a face-to-face interview will be conducted, with the help of a research assistant. The research assistant will ask you a set of questions which you are expected to respond to. The questions will ask about issues relating to the risk factors associated with soil transmitted helminths (worms). Your child will also be required to answer some questions and provide stool to analyze for the presence or absence of worms. There will be no names required or written on the questionnaire or on the consent form. This will take about 25-30 minutes.

Confidentiality and Privacy

Information collected from you will be for research purposes only and strictly private and confidential. No information about you, your child or your household will be disclosed to others without your written permission, except to protect your rights or welfare, or if required by law. Names will not be used at any point and are of no purpose for this study and no information will be included that would reveal your identity on publications or in conferences.

Benefits

Some of the benefits to participants in the study are to acquire knowledge on soil transmitted helminths status. Children found positive for soil transmitted helminths will be referred to the nearest health centre for medical attention. The information gathered from this study will be useful in improving planning for control programmes and operational research of these infections.

Risks and Discomfort

This study poses no more than minimum risks. While it is acknowledged that you will spend some time responding to questions, the data collection exercise will be conducted by trained data collectors to ensure efficiency and reduce time spent on the study. There is also a risk that, submission of stool may make the child feel uncomfortable, hence the process of stool collection will be conducted in your own homes (toilets).

Compensation

There will be no reimbursement for your participation in the study.

Contact Information

If you have any questions regarding this study or your results, please contact Sibongile Tembo, phone number **+260 978 929 588** or email mutepatembo@gmail.com, Flat No 3 Nchanga South Hospital, Chingola.

For any questions pertaining to rights to conduct this study please contact the Chairperson, The University of Zambia Biomedical Research Ethics Committee, P.O Box, 50110, Ridgeway Campus, Lusaka. **Tel: +260-1-256067** or unzarec@unza.zm.

Appendix II: Consent Form

Study Title: Prevalence, Intensity and Factors Associated with Soil Transmitted Helminths Infection among Children in Chililabombwe District, Copperbelt Province, Zambia – Cross sectional study

I confirm that I have understood the information provided to me for the above study and that all my questions and concerns were addressed. The risks of the study have also been explained to my satisfaction. I understand that my participation is voluntary and that am free to withdraw from the study at any time without any consequences**.** I have also been informed that I can decide not to answer questions that make me feel unconformable

Signature…….or Thumb print…….Date……. (Participant)

My signature as witness certifies that the subject signed this consent form in my presence as his or her voluntary act.

Signature…….or Thumb print…….Date……. (Witness).

Appendix III: Assent form

Study Title: Prevalence, Intensity and Factors Associated with Soil Transmitted Helminths Infection among Children in Chililabombwe District, Copperbelt Province, Zambia – Cross sectional study

My name is **Sibongile Tembo** from the University of Zambia. I am doing a study on what contributes to the development of worms. I am asking you to take part in the study because I want to learn more about worms and the contributing factors. If you agree, we will ask you to answer some questions on whether you wear shoes when playing or not, you wash your hands with soap after using the toilets. We will also ask you to submit some stool for us to test whether they contain any worms. If the stool contains worms, you will be referred to the nearest health center for medical attention. Answering these questions will take about 15 minutes and you do not need to write your name on the paper.

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Even if you start, you can stop later if you want. You may refuse to answer any question that you do not want to answer or questions that make you feel uncomfortable. You may ask questions about the study. If you decide to be in the study I will not tell anyone else what you say or do in the study. Even if your guardians or friends ask, I will not tell them about what you say or do in the study. Your guardian was asked if it is alright for you to be in this study. Even if they say it is alright, it is still your choice whether or not to take part. You can ask any question you have, now or latter. If you think of a question later, you or your guardian can contact me on +260 978 929 588 or email mutepatembo@gmail.com, Flat No 2 Nchanga South Hospital, Chingola.

Sign this form only if you have had your questions answered and you have talked to your legal guardian about the research, and agree to take part in this study.

Signature……or Thumb print…….Date…… (For children aged 7 – 15 years)

Signature…….or Thumb print…….Date……. (Parent/guardian)

My signature as witness certifies that the subject signed this assent form in my presence as his or her voluntary act.

Signature…….or Thumb print…….Date……. (Witness)

Appendix IV: Questionnaire

The University of Zambia

School of Public Health

Study Title: Prevalence, Intensity and Factors Associated with Soil Transmitted Helminths Infection among Children in Chililabombwe District, Copperbelt Province, Zambia – Cross sectional study

Principal Investigator: …….

Date of interview: ……..

Location: …….

Instructions to Interviewer: Please obtain consent and assent from each participant before administering the questionnaire. Read each question and choice of answers aloud to the participant. You may repeat the question and answers if necessary.

INTERVIEW DETAILS

Participant ID: ……

Interviewer: (Name) ……..

DATA ENTRY INFORMATION

Date of data entry: ……..

Data entered by: (Name) ……..... Signature ……

Questionnaire

SECTION 1: SOCIO – DEMOGRAPHIC
1. Sex of parent or guardian 1. Female 2. Male
2. Age of the parent or guardian
3. What is the total number of household members?
4. How many bedrooms does the house contain?
5. On average, how many people share a bedroom?
6. What is your current marital status? 1. Single 2. Married 3. Divorced 4. Windowed 5. Others (specify) ……
7. What is your highest level of education? 1. No formal education 2. Primary 3. Secondary 4. Tertiary 5. Others (specify) ……

8. What is your occupation?

1. Self employed
2. Formal employment
3. Unemployed
4. Others (specify) ……..

9. How much do you earn per month on average?

1. 0-500
2. Between 500-1000
3. More than 1000 < 2000
1. More than 2000 < 3500
2. More than 3500 < 5000
3. More than 5000

Question 10, 11 and 12 to be answered by the child

10. Do you wear shoes when playing?

1. Yes
2. No

SECTION 2: BEHAVIOURAL FACTORS

11. Do you wash your hands after visiting the toilet?

1. Yes
2. No

12. Do you use soap after using the toilet?

1. Yes

2. No

3. Others (specify) ……

13. How do you handle vegetables before cooking?

1. Wash them
2. Do not wash them

SECTION 3: ENVIRONMENTAL FACTORS?

14. What is the main source of drinking water for members of your household?

1. Piped water
2. Well
3. Borehole
4. Communal tap
5. River
6. Others (specify)……...

15. Is your source of water available the whole day?

1. Available
2. Not available
3. Scarce
4. Others (specify)……

16. What kind of toilet facility do members of your household usually use?

1.Flushable

2. Pour flush

3. Pit latrine

4. Open defecation

5. Others (specify)…….

SECTION 4: SERVICE RELATED FACTORS

18. Has the child been dewormed before?

1. Yes
2. No

19. If yes, when was the child dewormed?

1. Few days ago
2. Last month
3. Two months ago
4. Three months ago
5. Six months ago
6. I can't remember

Thank you

Appendix V: Laboratory data extraction tool (Checklist)

District: ……..
Location: ……
Collected by: ……..
Date of collection: …….
Time: ……..

Sample No	**Patient ID**	**Sex & Age**	**Date of analysis**	**Time**	**Results**			
					Type	**Present/Absent**	**Eggs/slide**	**Eggs/gram**
					Round worms			
					Hookworms			
					Whipworms			
					Others*			

***Other parasites identified**
Analyzed by: …… Sign …….
Checked by: ……. Sign …….

Appendix VI: List of variables for Round Worms and Whipworms Laboratory

Variable	Operational Definition	Indicator	Scale of Measurement
Response Variable			
Round worms and Whipworms	Presence of eggs or larvae in the stool	Present/absent	Dichotomous
Predictor Variables			
<u>Demographics</u> 1. Age	Children aged between 1-15 years	Number	Continuous
2. Sex	State of being male or female	Proportion	Categorical
3. Marital Status of guardians	The status of being single, married or divorced	Proportion	Categorical
<u>Socioeconomic Factors</u> 1. Occupation of guardians	Parents employment status i.e. self-employed, formal employed or unemployed	Proportion	Categorical
2. Education of guardians	Parents education level i.e. No formal education, Primary, Secondary & Tertiary	Proportion	Categorical
3. Household income	Monthly earnings on average	Proportion	Categorical
4. Family size	Total number of household members	Number	Discrete
5. Overcrowding	Number of persons sleeping in one room	Number	Discrete

Behavioral Factors 1. Hand washing	Evidence of hand washing facility i.e. Available, not available	Proportion	Dichotomous
2. Use of soap	Soap available or not available	Proportion	Dichotomous
3. Vegetables	How vegetables are handled before cooking: washed or not washed	Proportion	Dichotomous
Environmental Factors 1. Availability of water	Availability of water i.e. available , not available ,scarce	Proportion	Categorical
2. Source of drinking water	Water facilities i.e. tap, well, borehole, communal tap or river	Proportion	Categorical
3. Sanitation	Type of toilet i.e. Flushable, Pit latrine, Open defecation	Proportion	Categorical
4. Type of settlement	Area of residence i.e. urban, rural, peri-urban	Proportion	Categorical
Service related Factors Deworming	Previous history of deworming i.e. dewormed or not dewormed	Proportion	Dichotomous

Appendix VII: List of variables for Hookworms

Variable	**Operational Definition**	**Indicator**	**Scale of Measurement**
Response Variable			
Hookworms	Presence of eggs or larvae in the stool	Present/absent	Dichotomous
Predictor Variables			

Demographics 1. Age	Children aged between 1-15 years	Number	Continuous
2. Sex	State of being male or female	Proportion	Categorical
3. Marital Status of guardians	The status of being single, married or divorced	Proportion	Categorical
Socioeconomic Factors 1. Occupation of guardians	Parents employment status i.e. self-employed, formal employed or unemployed	Proportion	Categorical
2. Education of guardians	Parents education level i.e. No formal education, Primary, Secondary & Tertiary	Proportion	Categorical
3. Household income	Monthly earnings on average	Proportion	Categorical
4. Exposed bare foot	Children playing without wearing shoes or with shoes	Proportion	Categorical
5. Family size	Total number of household members	Number	Discrete
6. Overcrowding	Number of persons sleeping in one room	Number	Discrete
Environmental Factors 1. Availability of water	Availability of water i.e. available , not available ,scarce	Proportion	Categorical
2. Source of drinking water	Water facilities i.e. tap, well, borehole, communal tap or river	Proportion	Categorical

3. Sanitation	Type of toilet i.e. Flushable, Pit latrine, Open defecation	Proportion	Categorical
4. Type of settlement	Area of residence i.e. urban, rural, peri-urban	Proportion	Categorical
Service related Factors Deworming	Previous history of deworming i.e. dewormed or not dewormed	Proportion	Dichotomous

Appendix VIII: List of variables for intensity

Variable	**Operational Definition**	**Indicator**	**Scale of Measurement**
Response Variable			
Intensity	Eggs per gram of faeces	Count	Discrete
Predictor Variables			
Demographics 4. Age	Children aged between 1-15 years	Number	Continuous
5. Sex	State of being male or female	Proportion	Categorical
6. Location	Area of resident		Ordinal
Service related Factors Deworming	Previous history of deworming i.e. dewormed or not dewormed	Proportion	Dichotomous

Appendix IX: Ethical Clearance

THE UNIVERSITY OF ZAMBIA

BIOMEDICAL RESEARCH ETHICS COMMITTEE

Telephone: 260-1-256067
Telegrams: UNZA, LUSAKA
Telex: UNZALU ZA 44370
Fax: + 260-1-250753
E-mail: unzarec@unza.zm
Assurance No. FWA00000338
IRB00001131 of IORG0000774

Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia

7th September, 2017.

Your Ref: 037-06-17.

Ms. Sibongile Tembo,
University of Zambia,
School of Public Health,
P.O Box 50110,
Lusaka.

Dear Ms. Tembo,

RE: RESUBMITTED RESEARCH PROPOSAL: "A CROSS SECTIONAL STUDY TO DETERMINE THE PREVALENCE, INTENSITY AND FACTORS ASSOCIATED WITH SOIL TRANSMITTED HELMINTHS INFECTION AMONG CHILDREN IN CHILILABOMBWE DISTRICT, COPPERBELT PROVINCE, ZAMBIA" (REF. No. 037-06-17)

The above-mentioned research proposal was presented to the Biomedical Research Ethics Committee on 4th September, 2017. The proposal is approved.

CONDITIONS:

- This approval is based strictly on your submitted proposal. Should there be need for you to modify or change the study design or methodology, you will need to seek clearance from the Research Ethics Committee.
- If you have need for further clarification please consult this office. Please note that it is mandatory that you submit a detailed progress report of your study to this Committee every six months and a final copy of your report at the end of the study.
- Any serious adverse events must be reported at once to this Committee.
- Please note that when your approval expires you may need to request for renewal. The request should be accompanied by a Progress Report (Progress Report Forms can be obtained from the Secretariat).
- Apply in writing to National Health Research Authority for permission before you embark on the study.
- **Ensure that a final copy of the results is submitted to this Committee.**

Yours sincerely,

Dr. S. H Nzala PhD
VICE-CHAIRPERSON

Date of approval: 7th September, 2017.

Date of expiry: 6th September, 2018.

Appendix X: Authorisation Letter to Conduct Research

P.O. Box 210391
Telephone: 02-383380
Telefax: 02-383518
Chililabombwe

In reply please quote .....
All communication should be addressed to the
District Health Director

Republic of Zambia
MINISTRY OF HEALTH
CHILILABOMBWE DISTRICT

CDHO/117/17

2nd June, 2017

The Assistant Dean-Postgraduate
University of Zambia
School of Public Health
P.O. Box 50110
Lusaka

Dear Dr. Halwindi,

RE: REQUEST FOR AUTHORITY TO UNDERTAKE A RESEARCH STUDY- SIBONGILE TEMBO

The above subject refers.

As an institution, we have no objection to your student conducting a research study by means of administering a questionnaire in our community. Soil transmitted Helminthes are of public health concern to us too.

We would appreciate if the findings of this research are shared with us as this will enhance evidence based interventions.

We wish her well as she undertakes this study.

Yours Faithfully,

REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH
02 JUN 2017
DISTRICT MEDICAL OFFICER
CHILILABOMBWE DISTRICT HEALTH OFFICE
P.O. BOX 210391, CHILILABOMBWE

Dr M. Chakulimba
District Health Director