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RESEARCH ARTICLE

Prevalence, Intensity, and Factors Associated with Soil-Transmitted Helminths Infection among Children in Zambia: A Cross-sectional Study

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Abstract:

Background:

Soil-transmitted helminths 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. The diseases have major health and socio-economic repercussions and significantly contribute to public health problems in developing countries.

Objectives:

This study investigated the prevalence, intensity, and factors associated with soil-transmitted helminths among children in Chililabombwe district of Zambia.

Methods:

A cross-sectional design was used, consisting of 411 guardian – child pairs aged between 17-77 years and 1-15 years, respectively. This was conducted between October and December 2017. Systematic sampling and simple random sampling were used to select the household and 411 participants, respectively. The study used a structured pre-tested questionnaire and stool tests to obtain information on socio-demographic, environmental, behavioral, and service-related factors associated with helminth infection. Stool samples were collected and examined for the presence of parasites using formol-ether concentration and Kato-Katz techniques. Geometric mean was used to report the intensity of infection. An investigator-led stepwise regression was used to identify factors associated with developing Soil-Transmitted Helminth infection and the level of significance was set at 0.05.

Results:

Prevalence of soil-transmitted helminth infection was 59/411 (14.4%) and the most dominant parasite was roundworms 58/411 (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]).

Conclusion:

Our findings indicate that STH infections are still prevalent. Low household income, residence, and overcrowding are the factors associated with infection. This indicates that reinfection is common even after deworming.

Keywords: Soil-transmitted helminths, *Ascaris lumbricoides*, *Trichuris Trichiura*, Hookworms, Intensity, Neglected tropical diseases of poverty, Zambia.

Article History	Received: Mar 05, 2019	Revised: May 13, 2019	Accepted: Jun 11, 2019

1. INTRODUCTION

Soil-transmitted helminths (STH) are among the neglected tropical diseases (NTDs) of poverty, despite being a public health problem in tropical countries. 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*) [1]. The diseases have major health and socio-economic repercussions and significantly contribute to public health problems in

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developing countries [1]. World estimates show that more than 1.5 billion people (24% of the world's population) worldwide are affected, and the greatest numbers of infection occur in sub-Saharan Africa, the Americas, China, and east-Asia [2]. Global numbers of infection and disease burden attributed to soil-transmitted helminths infection in 2014 were 819.0 million people were infected with *A. lumbricoides*, 464.5 million with *T. trichiura*, and 438.9 million with hookworm [3]. 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%) [3]. In sub-Saharan Africa, an estimated 198 million people are infected with hookworms, 173 million with *A. lumbricoides*, and 162 million with *T. trichiura* [4].

Prevalence surveys on helminths in many districts of Zambia have been conducted [5]. Studies conducted in Kafue, Siavonga, and Mazabuka districts in Zambia between 2010 and 2017 among pre-school children indicate that soil-transmitted helminths are common with prevalence ranging from 12.1% to 17% [6, 7]. Mass drug administration (MDA) to the riskiest population including school-aged children (SAC) is the principal strategy to control soil-transmitted helminth infection in Zambia.

Reinfection, however, is possible after chemotherapy [8, 9]. Reinfection can be prevented by regular deworming accompanied by good sanitation and hygiene practices [10]. 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 among children at the community level, particularly on the Copperbelt. Information on intensity is important in order to track the infection, assess its impact on the health of the child, and determine the severity of morbidity caused by the infection. Intensity also gives a benchmark against which to gauge the success of deworming activities. Therefore, the study aimed to determine the prevalence, intensity, and factors associated with soil-transmitted helminths among children in Chililabombwe District, Copperbelt Province, Zambia. This will help in finding control measures that are relevant to the control and prevention of infections.

2. MATERIALS AND METHODS

2.1. 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. The study population included children aged between 1-15 years, their parents/guardians and only usual residents of Chililabombwe. This was a community-based study conducted between October and December 2017.

2.2. Study Site

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: 4,155 under 1 year, 19,512 under five years, 20,125 under 15 years, 21,247 5-14 years, and 49,243 above 15 years (CSO, 2010). It lies North of Democratic Republic of Congo, East of Mufulira, South of Chingola and Southwest of Solwezi. The district's main activity is mining with small scale farming in the peri–urban areas and trading.

2.3. Study Variables

The main outcome variable was soil-transmitted helminths (binary outcome) and the predictor variables were the demographic, socio-economic, behavioural, service-related, and environmental characteristics.

2.4. Sample Size

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

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

n = 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), the prevalence (p = 0.3341) assumption of the study was based on a survey conducted in Chililabombwe [5]. This gave a sample size of 341.87 approximately 342 children. This sample was inflated by 20% to 411 guardian - child pairs to account for a non-response rate.

2.5. Sampling Procedure

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. Systematic sampling was used to select households. Total households were obtained from the District Health Office projected households per catchment area. The sampling starting point was a random number selected between the calculated intervals in each catchment area using the Health Centre zone population distribution. In an event that the household picked did not meet the criteria (children aged 1-15 years) or there were no residents present, substitution method was used to select the next household. In an event where 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. Once a child is enrolled in the study, the guardian or parent was automatically enrolled in the study after obtaining consent and assent. We planned to exclude children who had received anti-helminths medication within 3 months and visitors. We did not exclude any child because during the course of the study we found that our participants were dewormed more than 6 months ago. This is because the district conducts periodic deworming and the last deworming was conducted in April 2017.

Therefore, all selected children were included in the study.

2.6. Data Collection

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, behavioural, service-related, and environmental characteristics. To validate the data collection tools (questionnaire and checklist), a pilot study was conducted in Nchanga South, Nchanga North, and Kalilo in Chingola district. The gaps identified were discussed and corrected to ensure that all salient issues were captured and included in the questionnaire and checklist. The questionnaire was completed by interviewing children and parents or guardians. A checklist was used to record laboratory results.

2.7. Stool Sample Collection

After the interviews, stool was collected the next morning by the research assistants with the help of parents or guardians 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 specimens were stored and transported in ice boxes within 6 hours to the laboratory.

2.8. Laboratory Methods

The stool was analyzed under a microscope for parasites using concentration technique (formol-ether method) and Kato-Katz technique was used for quantification. Two techniques were used because of Kato-Katz has low sensitivity for a single sample; it is recommended to collect consecutive stool samples that are subjected to multiple Kato-Katz thick smear tests in order to enhance the sensitivity. Two separate slides per technique were prepared and read by two separate technicians for quality assurance. A sample of 10% drawn for quality assurance was cross-checked by the laboratory in-charge. For Kato-Katz, slides were read twice; first within 30-60 minutes for the detection of hookworm eggs and again after approximately 2 hours for the analysis of roundworms and whipworms. This was because the glycerin in the Kato-Katz dissolves the hookworm eggs faster after about an hour. 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, divided by 2 and then multiplied by 24, as recommended by the WHO for the template used. Egg counts as egg per gram of stool were used to classify the intensity of infection as slight, moderate, or high. 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 [11]

2.9. Statistical Methods

Data were analysed using STATA software version 13 (Stata Corporation, College Station, TX, USA). For normally distributed variables, the mean and standard deviation were reported. For non-normally distributed variables, the median and interquartile range were reported. To check for differences in normally distributed variables (age of child and age of guardian) and non-normally distributed variables (number of bedrooms, total household members and number of shared rooms), a two-sample t-test and Wilcoxon rank sum test were used, respectively. Categorical variables were first reported as absolute frequencies with associated percentages; Chi-square test was used to ascertain the association between categorical independent variables and development of soil-transmitted helminths. To compare egg count values between the different catchment areas, the Kruskal-Wallis H test was used because egg count per gram was not normally distributed. The bivariable and multivariable logistic regression model was used to identify factors associated with developing soil-transmitted helminths. Odds ratio (OR) and 95% confidence interval (CI) were reported. Cut off point for statistical significance was set at 5%.

3. RESULTS

3.1. Demographic Characteristics of Study Participants

There were 411 children – guardian pairs in the study. Age of children ranged from 1 to 15 years with a mean of 6 years and 7 years for helminthic and non-helminthic infection, respectively (Table **1**). Most of the children with helminthic infection were females 52.5% (31/59). A total of 81.4% (48/59) with helminthic infection and 68.5% (241/352) 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 (SD 10.3 years) and 37 years (SD 11 years) for helminthic and non-helminthic infection, respectively. A total of 74% (43/59) guardians in the helminthic group and 80% (279/352) guardians in the non-helminthic group were females. Most of the guardians with helminthic children in the study were married 79.7% (47/59). A total of 55.9% (33/59) guardians in the helminthic group and 53.7% (187/352) guardians in the non-helminthic group had attained at least secondary education and above. Employment status of guardians was 18.6% (11/59) for the helminthic group and 17.8% (62/352) for the non-helminthic group. About 50% (28/59) and 57% (187/352) 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 72.9% (43/59) and 71.5% (251/352) children in the helminthic and non-helminthic group, respectively, reported washing their hands with soap after using the toilet. Nearly 72.9% (43/59) and 74.3% (257/352) children in the helminthic and non-helminthic group, respectively, played barefoot. The majority of the guardians washed their vegetables before cooking in the helminthic 89.9% (53/59) and non-helminthic 90.2% (317/352) groups as shown in Table **2**.

Table 1. Demographic characteristics of study participants stratified by soil-transmitted helminth (STH) infection.

Characteristic	Infected (N=59) n (%)	Uninfected (N=352) 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 (74.0)	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)	

* Mean of the age of child and guardian with associated standard deviation.[a]Two sample t-test.[b]Chi-square test.

Table 2. Socioeconomic and behavioral characteristics of study participants stratified by STH infection.

Characteristic	Infected (N=59)		Uninfected (N=352)		P-value
	(n)	(%)	(n)	(%)	
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	

(Table 2) contd.....

Characteristic	Infected (N=59)		Uninfected (N=352)		P-value
	(n)	(%)	(n)	(%)	
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. [c]Chi-square test

Table 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.

Most of the study participants had access to piped water in the helminthic group 74.6% (44/59) and non-helminthic group 63.8% (224/352) and water was available most of the times. A total of 47.5% (28/59) children with helminth infection in the study had access to flushable toilets and 49.9% (175/352) of non-helminthic infection used pit latrines. In both the helminthic and non-helminthic groups, 85% of the children had been dewormed before as shown in Table **3**.

3.2. 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). 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 per catchment area. 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 of 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 Fig. (**2**).

3.3. Risk Factors Associated with Soil-Transmitted Helminth Infection

The best predictors of Soil-transmitted helminths were number in a residence shared room and household income (P-value 0.01 and 0.004, respectively) as shown in Table **4**.

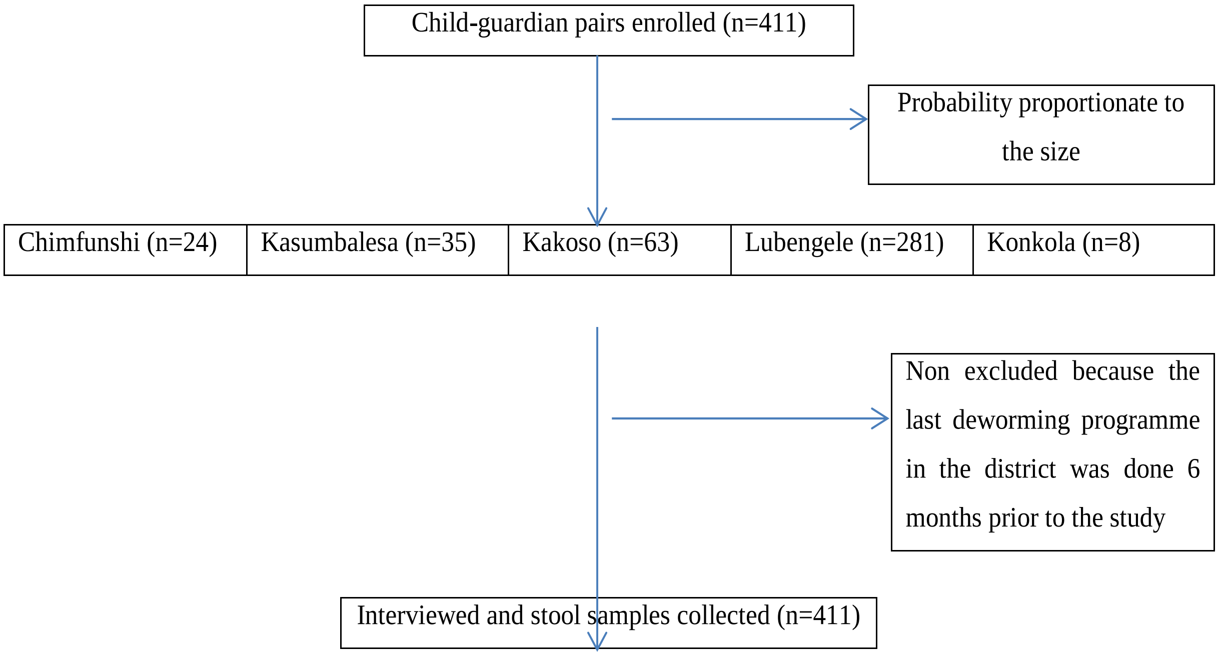

Fig. (1). Trial diagram: Prevalence, Intensity, and Factors Associated with Soil-Transmitted Helminths Infection among Children in Zambia: A Cross-sectional study.

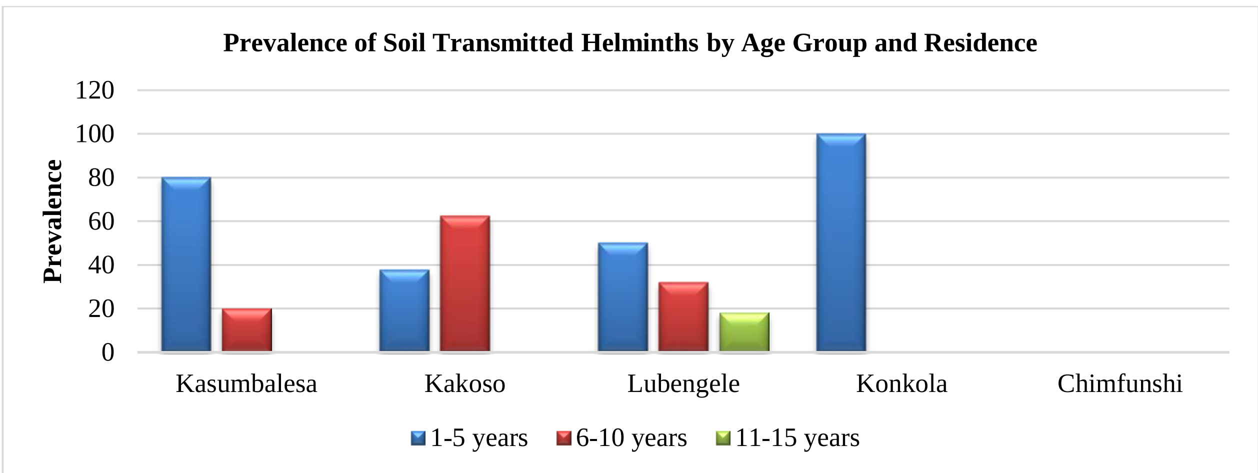

Fig. (2). Prevalence of Soil-Transmitted Helminths by Age Group and Residence.

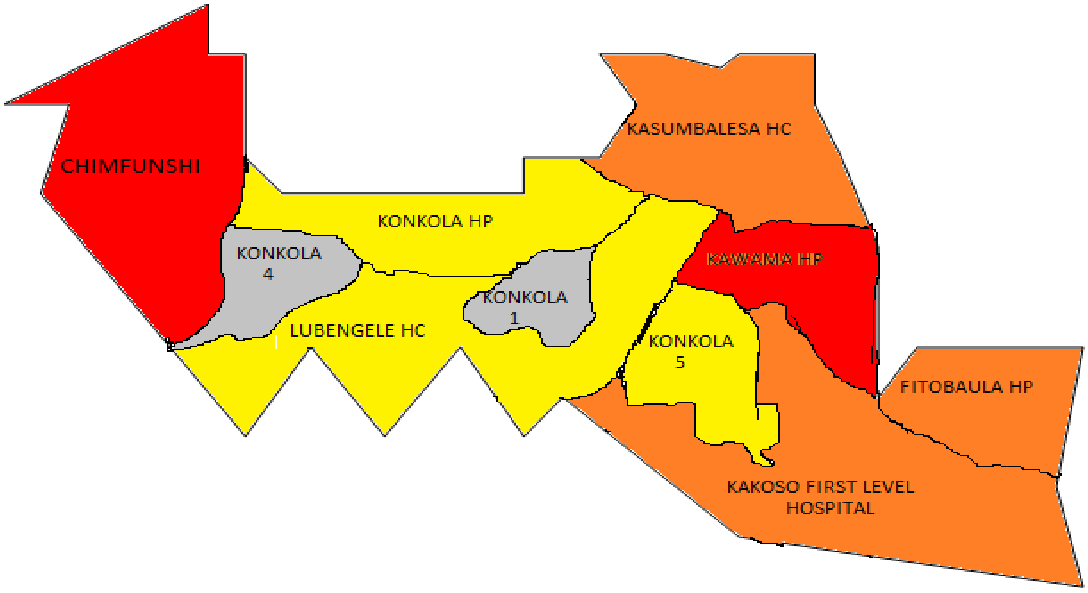

Fig. (3). Map showing prevalence by residence.
Key: Lubengele – 75%; Kakoso – 14%; Kasumbalesa – 8%; Konkola – 3%

Table 4. Factors associated with Soil-Transmitted Helminth Infection from the best model

Variable	Univariable		Multivariable	
	OR(95% CI)	**P-value**	**AOR(95% CI)**	**P-value**
Age of child	0.95(0.88,1.02)	0.225	0.94(0.84,1.05)	0.26
Sex of Child				
Female				
Male	1.01(0.58,1.75)	0.981	1.03(0.50,2.12)	0.943
Sex of Guardian				
Female	1		1	
Male	1.37(0.72,2.61)	0.336	2.16(0.88,5.29)	0.092
Marital Status of Guardian				
Married	1		1	
Not Married	0.76(0.39,1.50)	0.336	0.51(0.20,1.31)	0.161
Education of Guardian				
No formal education	1			
Primary	1.41(0.39,5.05)	0.598	0.86(0.16,4.54)	0.859
Secondary and above	1.47(0.42,5.15)	0.546	0.94(0.19,4.74)	0.945
Occupation of Guardian				
Self-employment	1		1	
Formal employment	1.02(0.49,2.12)	0.952	0.51(0.18,1.46)	0.211
Unemployment	0.86(0.41,1.82)	0.693	0.85(0.28,2.62)	0.783
Household Income				
0-500	1		1	
501-1000	1.79(0.93,3.45)	0.08	2.49(1.01,6.12)	**0.047**
1001-2000	1.08(0.39,3.00)	0.887	1.50(0.42,5.33)	0.533
2001-3500	0.43(0.10,1.90)	0.266	0.68(0.13,3.54)	0.646
3501-5000	1.34(0.28,6.42)	0.718	2.50(0.39,16.16)	0.335
>5001	1.67(0.18,15.48)	0.652	1.27(0.09,18.58)	0.863

(Table 4) contd.....

Variable	Univariable		Multivariable	
	OR(95% CI)	**P-value**	**AOR(95% CI)**	**P-value**
Location				
Urban	1		1	
Rural	0.50(0.25,0.99)	0.048	0.26(0.09,0.73)	**0.01**
Hand Washing				
Yes	1		1	
No	1.30(0.63,2.67)	0.474	0.65(0.18,2.38)	0.514
No. in a shared room	1.27(1.09,1.49)	0.003	1.33(1.09,1.62)	**0.004**
History of Deworming				
Yes	1		1	
No	1.05(0.49,2.27)	0.898	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 3.4.

4. DISCUSSION

The study findings 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 (14.1%), followed by hookworm infection (0.2%). No infection was recorded due to *T. trichiura* species (0%). A hospital-based study conducted in Ndola at Arthur Davison Hospital also showed *A. lumbricoides* infection to be more prevalent compared to the *T. trichiura* and hookworm [12]. Studies conducted in India, Ethiopia, and Cameroon also showed *A lumbricoides* to be the most common species [13 - 15]. Global estimates also reveal that *A. lumbricoides* infection has the widest distribution of infection [16]. The prevalence recorded for hookworm in this study is much lower than that recorded in Luangwa, Kalabo, and Serenje districts of Zambia ranging from 12.1% to 35% [17].

Most of the children had a 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 could be explained by the fact that the deworming programme only targets less than five years children hence leaving the older children vulnerable to infection. As children interact with the other children, their playful behaviour exposes them to contaminated soil, water, and food hence the risk of re-reinfection is high in older children. The study conducted in Cameroon also showed that the number of species increased with age [18]. Another study done in Western Uganda showed heavy infection to be more in older children (above 5 years) than in younger children (less than 2 years) [19]. There was no significant difference in egg count among catchment areas. The observed intensity calls for deworming once a year according to the WHO classification of soil-transmitted helminth infection. The study, however, showed no significant association between age group and soil-transmitted helminths. This is contrary to the study conducted in India [20].

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%) and in Mazabuka district (17%) [5, 7]. Ministry of Health conducted a total enumeration of the school-aged children. Many factors like water supply, sanitation type, personal hygiene, socioeconomic status of the community, climate, educational status, and culture contribute to the differences in the prevalence and distribution of soil-transmitted helminths. Taking into account the sample size, the recorded prevalence in the study is still high. The national strategic plans are to reduce the morbidity of STH infection to a level where it will no longer be a public health problem and to reduce the prevalence to less than 10% in order to achieve the national goals of eliminating the 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. A study in Latin America 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 the life of a child [21]. Another study in Chencha, Southern Ethiopia also found that overcrowding to be a contributor to helminth infection in school-aged children [22]. Other studies also found that when the family number increases, the occurrence of STH also increases [23, 24]. In an overcrowded place, it is hard to keep cleanliness and prevent faecal contamination and pollution of premises hence the risk is high. In addition, intra-transmission is possible in overcrowded households hence the risk is high. Children who lived in urban areas were more prone to infection than children who lived in rural areas. Another study found urban areas to be more prone to infection than rural area [21, 25]. This could be explained by the fact that Chililambobwe district is mostly peri-urban with poor sanitation.

The study also found a significant association between household income and soil-transmitted helminths. Household income less than K1000 were 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 above were not statistically significant in this study. Other studies have found that being lower in socioeconomic status was a contributor to soil-transmitted helminth infections [21, 26 - 29].

Our findings showed no association between deworming and worm infestation (p-value 0.197). This is contrary to what was found in the study done in Ndola at Arthur Davison Hospital [12]. This could be explained by the periodic deworming in children less than five years which took place six months prior to the study.

We found no significant association between behavioural, service-related, and environmental factors in this study area. This is contrary to other studies [15, 21, 30, 31]. In the current study, the socioeconomic characteristics of an individual were the main drivers of worm infestation. The socioeconomic characteristic has an influence on health, household income, residence, food, and the hygiene practices of an individual.

5. LIMITAIONS

This study has certain limitations that need to be considered while interpreting the results. 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. In additional, geographical boundaries of catchment area zones were difficult to assess. Hence we failed to present data on prevalence and intensity per zone.

CONCLUSION

This study ascertains that soil-transmitted helminth infection is 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 are household income, residence, and overcrowding. This indicates that reinfection is common even after deworming. Hence policymakers should advocate for factors to improve the living conditions of communities. Socioeconomic characteristics of the individual are an 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.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the University of Zambia Biomedical Ethics Research Committee (REF. NO. 037-06-17). Permission was also sought from Chililabombwe District Health Office (CDHO/117/17).

HUMAN AND ANIMAL RIGHTS

No animals/humans were used for studies that are the basis of this research.

CONSENT FOR PUBLICATION

Informed written assent and consent were obtained from each child and study subject's parents.

AVAILABILITY OF DATA AND MATERIALS

The data sets used/or analyze during the current study are available from the corresponding author on request.

FUNDING

The study was funded by Ministry of Higher Education.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

My gratitude goes to the Ministry of Higher Education for sponsoring my Master's Degree Programme and for providing a financial grant to support this research.

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