The Prevalence and Factors Associated with Intestinal Parasite Infections among Children Aged 12–59 Months in Rwanda

"Case Study: Nyamasheke District"

Hakizimana Evariste

Department of Global Health Policy and Financing

Division of Global Health Policy and Financing

Graduate School of Public Health

Yonsei University

The Prevalence and Factors Associated with Intestinal Parasite Infections among Children Aged 12–59 Months in Rwanda

"Case Study: Nyamasheke District"

Directed by Professor Tai-Soon Yong

A Master's Thesis

Submitted to the Department of Global Health Policy and Financing,
Division of Global Health Policy and Financing,
and the Graduate School of Public Health at Yonsei University,
in partial fulfillment of the
requirements for the degree of
Master of Public Health

Hakizimana Evariste

December 2022

This certifies that the Master's thesis

of Hakizimana Evariste is approved.

_____

Thesis Committee Member: **Tai-Soon Yong**

_____

Thesis Committee Member: **Sohee Park**

_____

Thesis Committee Member: **Moonsoo Yoon**

The Graduate School of Public Health

Yonsei University

December 2022

Contents

List of Tables

List of Figures

Appendix

List of Acronyms

IPIs: Intestinal parasitic infections

MDA: Mass Drug Administration

UNICEF: United Nations International Children's Emergency Fund

ASEAN: The Association of Southeast Asian Nations

WHO: World Health Organization

LIS: Laboratory Information System

CI: Confidential interval

R-MoH: Rwanda Ministry of Health

OR: Odd Ratio

IEC: Communicative Informative Education

E. coli: *Entamoeba coli*

E. histolytica: *Entamoeba histolytica*

G. lamblia: *Giardia lamblia*

A. lumbricoides: *Ascaris lumbricoides*

Taenia ssp: *Taenia saginata species*

SPSS: Statistical Package for Social Sciences

GoR: Government of Rwanda

Abstract

Background: In developing countries, intestinal parasitic infections are public-health burden and the major cause of illness. In addition, IPIs contribute to many health threats, including growth retardation, mental health-related disorders, and lack of appetite, especially in children. Around the globe, 450 million people are affected by IPIs, most of them are children.

Purpose: This study primarily aims to assess the prevalence and risk factors associated with intestinal parasitic infections among children aged 12─59 months in Nyamasheke District, Rwanda. The finding will provide important support for implementing appropriate IPI-control measures in this study area.

Methods: This cross-sectional descriptive study was carried out using secondary data from 1,048 children aged 12─59 months, whose stools were examined in laboratories to detect intestinal parasites, and whose results were registered in the Laboratory Information System in 2020. We extracted all required information from this database to conduct the present study. Using a random multistage sampling technique, the general characteristics of the population were determined using Chi-square, while descriptive statistics, based on frequencies and percentages, were used to calculate the prevalence of IPIs among children aged 12─59 months in Nyamasheke District. In addition, a binomial logistic regression was used to identify factors associated with IPIs among children aged 12─59 months in this area.

Results: The prevalence of intestinal parasites among children aged 12-59 months was 53.2%. The association between intestinal parasites and each child's place of residence was statistically significant (OR=1.9, CI=95% p-value=0.031). In addition, the association between intestinal parasites and the mother or child caretaker's literacy was statistically significant (OR=5.09, CI=95: %: 1.0─3.4, p-value <0.001). Children from farming households were 2.8 times more likely to have IPIs than children from non-farming families (OR=2.8, CI=95: %:1.9─4.1, p-value <0.001). Similarly, a significant association was found between intestinal parasites and food safety (OR=4.9, CI=95: %: 2.9─8.1, p-value <0.001). Another association was found between intestinal parasitic infections and a children's hands safety after using the toilet and washing fruit before eating (p-value <0.001). However, there was no statistically significant association between intestinal parasitic infections and age, sex, or using piped water and detergent to clean kitchenware, (p-value is ≥ 0.05). The dominant parasite was *Ascaris* lumbricoides with a prevalence of 13.1%, followed by *Giardia lamblia* (10.9%), *Entamoeba coli* (10.5%), *Entamoeba histolytica* (7.9%), *Trichuris trichiura* (6.5%), *hookworm* (1.7%) and *Taenia ssp.* (1.4%).

Conclusion: There is an urgent need for community health education on hand- and food-hygiene practices, IPI-transmission risk factors, and mass drug administration for mothers and caretakers responsible for very young children in Nyamasheke District, Rwanda. The information collected here will help public-health providers and partners develop control plans for highly endemic areas in Rwanda.

Keywords: Intestinal parasites, risk factors, hygiene practices, sanitation.

Chapter 1: General Introduction

1.1. Background

In developing nations, intestinal parasitic infections are a great burden on the public health system and a major cause of illness and mortality worldwide (Farrell et al. 2018). They cause more than 33% of deaths globally (Mulatu et al. 2015). People in developing countries are more likely to contract parasitic illnesses, due to poor environmental sanitation and sanitary practices. (Campbell et al. 2016).

Globally, around 3.5 billion people and 450 million people suffer from these infections, with children being the most affected (Arani et al. 2008). IPIs stunt children's growth and increase their risk of contracting other diseases. While mortality from intestinal parasite protozoan infections is a relatively unfamiliar problem, morbidity and indirect effects cause many health-related problems, including gastrointestinal disorders, diarrhea, dysentery, vomiting, lack of appetite, hematuria, abdominal distension, and mental health-related disorders, which can lead to mortality (Vaumourin et al. 2015). *Ascaris lumbricoides, Entamoeba histolytica*, and *Giardia lamblia* are common in children under five years old in developing countries around the globe. *A. lumbricoides* infects 1.5 billion people worldwide, resulting in an annual morbidity rate of 335 million and 60,000 associated mortalities.

In European countries, recent studies have shown that 5.9% of children have intestinal parasitic infections.

In the ASEAN nations, 200 million individuals are infected with intestinal helminth infections, which are caused by soil-transmitted helminths. Notably, *A. lumbricoides* infects 126.7 million people, *Trichuris trichiura* 115.3 million and *hookworm* 77.0 million; Syria accounts for 42.5% of IPIs, Qatar 33.9%, and Palestine 74.6%(Bdir and Adwan 2010; Khan, Nisa, and Khan 2017; Bakarman, Hegazi, and Butt 2019).

In African countries, such as Ethiopia, 48% of preschool and school children suffer from IPI, as do, 54.8% of children in Nigeria (Karshima 2018). Infection causes short- and long-term health problems (complications) that impact children's growth. IPIs can have long-term effects on children's physical growth and cognitive development. For example, in Rwanda, preschool and school children have an overall prevalence of 45.2% (Karema, Fenwick, and Colley 2015). The predominant parasites are *A. lumbricoides* observed in 38.6% of children, followed by *hookworm* in 31.6%.

1.2. Problem statement

Worldwide, intestinal protozoan and helminthic infections are relatively prevalent. However, they are dispersed from one place to another based on levels of personal and communal hygiene, sanitation, and climatic and environmental conditions.

According to WHO estimates, 3.5 billion people worldwide have intestinal protozoan infections, and 450 million are sick as a result. Nearly all parasitic infections occur in developing nations. More than 95% are brought on by poverty, low income, lack of awareness, illiteracy, improper hand washing after urinating, open defecation, contaminated drinking water, improper toilet use, improper food, and cultural practices,

among other factors. If nothing is done to stop the spread of parasitic infections, people will continue to be infected. (Torgerson et al. 2015).

To reduce the health burden this creates, WHO set a target for implementing a regular mass drug-administration (MDA) program for all preschool and school children in 46 targeted African countries, including Rwanda, by 2010 (WHO 2010).

Despite the effort invested in this initiative, intestinal parasitic infections remain a public-health concern. Moreover, according to LIS (Laboratory Information System) in Nyamasheke District, this highest has highest use of medicines for treating intestinal worms in children aged 12─59 months, based on health-facility clinical reports. The data show that IPIs are the main reason why children aged 12─59 are brought to health facilities by their mothers' or caretaker. However, no prior scientific study has examined the prevalence of IPIs and associated risk factors among children aged 12─59 months in this study area.

The present study aims to assess the prevalence of IPIs and associated factors among children aged 12─59 months in Nyamasheke District, Rwanda. In addition, it provides valuable data for policymakers, decision-makers, and program planners implement successful interventions to reduce this public-health burden.

1.3. Research objectives

1.3.1. Purpose

The main purpose of this study is to assess the prevalence of IPIs and to identify associated factors among children aged 12─59 months in Nyamasheke District, Rwanda.

1.3.2. Specific objectives

The study aims to achieve the following objectives:

First: To describe the relationship between sociodemographic factors and IPIs in children aged 112─59 months in Nyamasheke District.

Second: To identify the prevalence of intestinal parasitic infections among children aged 12─59 months in Nyamasheke District.

Third: To identify the factors associated with intestinal parasitic infections among children aged 12─59 months in Nyamasheke District.

1.4. Significance of the study

This study is significant because its findings provide evidence-based, comprehensive data related to factors that are strongly associated with the transmission of IPI in the study area. The results of the study will help public-health service providers and other interested parties develop strategies for controlling IPIs in the study area and other highly endemic areas. It also provides as necessary data that can be used to investigate the subject further. This work offers three interesting and useful dimensions, as follows:

1.4.1. Health facilities and community interest

The outcomes of this study offer suggestions and recommendations health facilities to apply in practice. Members of the society will also become aware of the healthcare burden and ready to comply with possible solutions.

1.4.2. Ministry of Health

This document provides evidence-based information about the prevalence of IPIs in the study area and the severity of the problem. This will enable the Ministry of Health and various health-administration institutions to carry out early planning and to take adequate measures to prevent intestinal parasitic infections among children aged 12─59 months and other age groups.

1.4.3. Scientific interest

It is essential for researchers to meet their institution's demands and for a graduate student to write a thesis to obtain a master's degree.

1.5. Structure of the study

This work consists of

1.5.1. Chapter 1: General introduction
1.5.2. Chapter 2: Literature review

1.5.3. Chapter 3: Methods

1.5.4. Chapter 4: Data analysis and results

1.5.5. Chapter 5: Discussion

1.5.6. Chapter 6: Conclusion and recommendations

1.5.7. References

1.5.8. Appendix

Chapter 2. Literature Review

This chapter has three main sections: an introduction, a definition of key terms, and an analytical framework.

2.1. Introduction

To identify the factors that cause intestinal parasitic infections among children aged 12─59 months in Nyamasheke District, the present study carries out a literature review to locate relevant prior studies.

2.2. Definition of key concepts

2.2.1. Parasites

Disease-causing organisms that lives on or in humans or other animals and derive their nourishment from their hosts.

2.2.2. Intestinal parasitic infections

Intestinal protozoan and helminthic infections confirmed by stool examinations.

2.2.3. Intestinal protozoa

Unicellular organisms that infect and multiply inside the intestine of the host. Intestinal protozoa contribute significantly to the burden of infectious diseases worldwide, especially diarrheal diseases.

2.2.4. Intestinal helminths

Commonly known as parasitic worms, intestinal helminths are large multicellular parasites, which can generally be seen with the naked eye when they are mature.

2.2.5. Hygiene and hygiene practices

Conditions and practices that maintain health and prevent the spread of diseases. They comprise ways of preventing parasitic intestinal infections, for example, by washing hands properly, using soap and water, and times that are critical for hand washing (Spruce 2013).

2.2.6. Sanitation and sanitation practices

The effective use of tools and actions to keep our environment healthy. These include latrines or toilets to manage waste, food preparation, safe water, washing stations, and effective drainage.

2.2.7. Personal hygiene

Maintaining bodily cleanliness.

2.2.8. Public-health interventions

The process of curtailing infections among people by installing Water Aid tippy taps, providing soap and water for hand washing and training people to apply proper sanitation and hygiene practices.

2.2.9. Risk factor

Something that increases the chance of infections or disease development.

2.3. Analytical framework

2.3.1. Theoretical framework

This cross-sectional descriptive study was carried out in a western province of Rwanda, and specifically in Nyamasheke District, to assess the IPI prevalence and associated risk factors among children aged 12─59 months. The researcher used secondary data drawn from the LIS database. Socio-demographic and hygiene-practice-related behaviors were the independent variables, and intestinal parasitic infections were the dependent variables. The researcher chose to use jamovi 2.2.5 software for the data analysis and descriptive statistics to generate a data summary, based on percentages and frequencies. A chi-square was used to analyze the relationship between the independent and dependent variables. In addition, a binomial logistic regression was used to assess the factors associated with IPIs (https://www.jamovi.org. 2021).

2.3.2. Conceptual framework

The conceptual framework that underpins this study provides a structure for the pertinent ideas and variables in this investigation and their connections. The present study finds that the prevalence of IPIs among children aged 12─59 months in Nyamasheke District is influenced by certain risk factors, including socio-demographic factors and hygiene-related behaviors (handwashing practices and food hygiene). These factors can be classified in the following ways:

2.3.2.1. Socio-demographic factors

Children aged 12─59 months whose families live in rural areas are subjected to intestinal parasitic infections because they experience poor environmental hygiene, in contrast to children from urban areas. In rural parts of this district, children of this age play in open ground (soil), many also come from families whose houses have poor hygiene facilities and are poorly built. Such an environment naturally leads to more infections among these children than would be experienced by children in cities or towns (urban areas), where hygiene and cleanliness are better maintained. The occupation of the children's mothers or caretakers and their level of literacy are additional factors that contribute to the highest prevalence of IPIs among children of this age in the district. Children from farming families may get IPIs because their mothers or caretakers take them along during farming activities; it is easy for these children to be infected because they are in direct contact with contaminated soil. The mother's or caretaker's level of literacy also plays a crucial role in influencing intestinal parasitic infections in children; this can be explained by the fact that education raises a mother or child caretaker's awareness of some health risks that threaten-children and how to prevent them. Children from illiterate households get more IPIs than children from literate families.

2.3.2.2. Hygiene-related behaviors

Poor handwashing practices (not washing children's hands after they use the toilet, or before eating**)** is one way for these children to be contaminated by IPIs. Children at this age do not understand the importance of washing their hands after using the toilet or before

eating. Moreover, they like to touch everything they see with their hands, including their own feces, soil, and contaminated water, all of which may expose them to pathogenic germs and lead to infections. Children aged 12─59 months are not aware of hand hygiene. Therefore, their parents (mothers or caretakers) must take responsibility for this.

Poor food-hygiene practices (not using piped water to wash fresh food before cooking or fruits before eating) increase the risk of intestinal parasitic infection. Unwashed fresh food and fresh fruit carry the eggs of intestinal worms, since we are still determining their safety from the garden to the market. They facilitate direct transmission once they are consumed (swallowed). Unless piped water and soap are used to clean, they can acquire hidden stocks of intestinal worm eggs, deposited by flies or small insects that circulate in the environment. These flies transport several small eggs on their legs, put them on kitchen tools, and open the doors to IP infection whenever a child is fed using that contaminated tool.

Intestinal parasites can be controlled by educating mothers or caretakers about handwashing; this will reduce the transmission of IPIs to children aged 12─59 months. To reduce transmission and re-infection by intestinal parasites in the long run, it is important to wash fresh food before cooking and fresh fruit before eating, clean kitchenware with piped water and soap, and treat affected children.

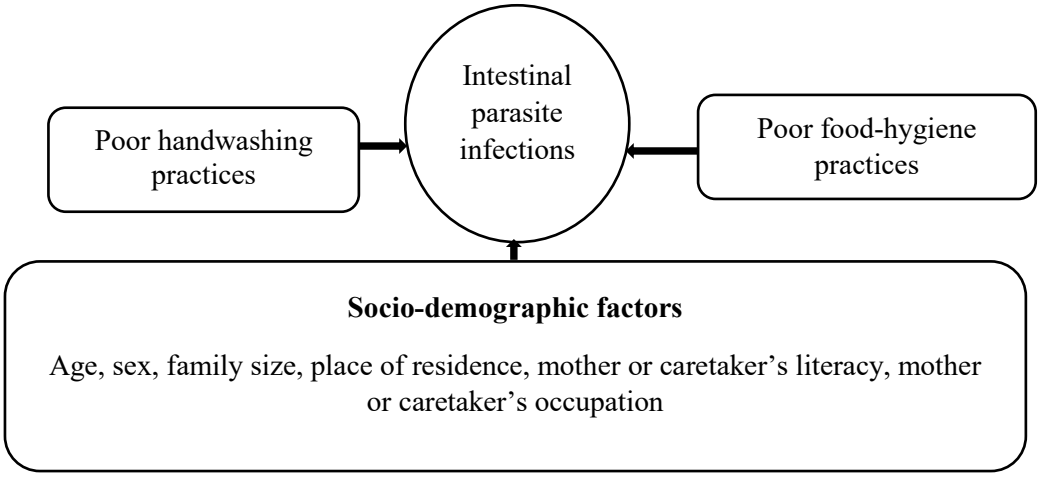

Figure 1. Conceptual framework depicting intestinal parasites among children aged 12─59 months in Nyamasheke District, Rwanda.

Source: Illustration provided by the researcher

2.4. Prior studies of IPI prevalence and associated factors

Intestinal parasitic infections lead to public-health problems. According to WHO, 3.5 billion people live with intestinal parasitic infections. Of these, 450 million suffer from their infections, and many of these are children. According to UNICEF, 663 million people lack treated water, and 2.billion lack ameliorated sanitation facilities (Aschale et al. 2021).

A study conducted by Yentur Doni et al. (2015) on the prevalence and risk factors associated with intestinal parasites among the children of farmers in the southeastern Anatolian region of Turkey found that farmers and their family members had a greater chance of coming into contact with contaminated soil than other citizens─and also that some parasites could penetrate the skin. The children of farmers were selected using the probability sampling method. Data were collected using a structured questionnaire and

laboratory stool analysis. The data analysis was carried out using SPSS version 11.5. The prevalence of IPIs was 44.6% and the factors associated with IPIs were age, gender, household illiteracy, poverty, the absence of toilets, bathrooms, and kitchens at the place of residence; the lack of safe potable water, geophagia (a soil eating habit), and being the child of a seasonal farmworker; the p-value was <0.05.(Yentur Doni et al. 2015).

In 2006, Vikram Mehraje et al. carried out a cross-sectional survey in Ghosia Colony, Gulshan Town, Karachi, Pakistan, to assess the prevalence and factors associated with IPIs among children in an urban slum of Karachi. In the simple random sample of 350 children aged 1─5 years, the prevalence of intestinal parasitic infections was 52.8%. A structured pre-test questionnaire and a stool test were used to obtain the results. SPSS software was used for the statistical analysis. Living in rented households (AOR=2.0; 95% CI: 1.0; 3.9) and a history of excessive crying (AOR=1.9; 95% CI: 1.0; 3.4) were significantly associated with IPIs. The most common parasite was *G. lamblia*, followed by *A. lumbricoides* (Mehraj et al. 2008).

In 2019, a community-based cross-sectional study carried out in Sekota, Waghimra Zone, Ethiopia revealed the prevalence and risk factors associated with intestinal parasitic infestations among preschool children in that town. The prevalence of intestinal parasites among preschool children was 29.9%. Stool samples collected from 378 preschool children were examined in the laboratory. The data were analyzed using Epi-data version 4.2.0.0 and SPSS-version 23 statistical software. This study indicated that children from low-income families were more likely to get IPIs than other children. Other factors included the

presence of animals in the living room (AOR, 95% CI) (3.1, 1.8–5.3), and a parent being employed as a government employee (AOR, 95% CI), (3.4, 1.1–10.0). According to the researcher the statistics reflected the fact that children of this age enjoy playing in the soil and tend to put their fingers in their mouths (Kassaw et al. 2019).

In 2015 in Northwest Ethiopia, a cross-sectional study investigated the prevalence and risk factors associated with parasitic intestinal infections among children under five at the University of Gondar Hospital, a sample of children under-five was selected using a systematic random sampling technic. When the children's stools were analyzed, the highest prevalence found was 9.02%, using wet-mount microscopy exams, and 17.3% using the formalin-ether concentration technique. The predominant parasites were *A. lumbricoides, Hymenolepis nana*, and *G. lamblia*. This study found a statistical association between age, handwashing habits, and parental fingernail cutting with IPIs (Aleka et al. 2015).

A cross-sectional study carried out by Butera et al. in 2016 on the prevalence of intestinal parasites and their associated risk factors among children under two in a rural parts of Rutsiro District, Rwanda examined 353 fresh stool samples from children under two to detect IPIs. Hygiene, sanitation, and socio-demographic and economic data were collected using a questionnaire. The study revealed that 44.8% of subjects were infected with at least one intestinal parasite. *A. lumbricoides* was most common with a high prevalence of 28.5%. *E. histolytica* had a prevalence of 25.95%, and *G. lamblia* of 6%. Poor sanitation and the use of untreated water were found to be the main risk factors with a p-value <0.05 (Butera et al. 2019).

In 2018, Acharya et al. (2021) conducted another study at the Kanti Children's Hospital in Kathmandu, Nepal to assess the prevalence of intestinal parasites among children attending the outpatient department. The researchers determined, through a fresh-stool examination of 300 children that 25.67% were infected with intestinal parasites. The parasite with the highest prevalence was *E. histolytica* (14%), followed by *G. lamblia* (8.67%). Drinking underground water continues to be seen as a risk factor (Acharya, Subedi, and Devkota 2021).

A study conducted by Princess Nora Bint Abdul Rahman University, Riyadh, Saudi Arabia, in 2015 assessed the prevalence of intestinal parasite infections and associated risk factors among preschool children. A pre-designed questionnaire and single stool-sample examinations were the tools used to collect data from 255 preschool children; they revealed that the highest infection rate in these children was 23.3%. The prevalent parasite was *Giardia lamblia* (37. 8%). The parents' literacy, mothers' occupations, poor hygiene, and moderate socioeconomic standards were associated with IPIs (Al-Megrin 2015).

Similarly, in 2010 a study of the prevalence and risk factors associated with *G. lamblia* infection among children with acute diarrhea in Thi Qar, southern Iraq, 33.3% of children aged 24─48 months from a sample of 396 were infected with IPIs. *G. lamblia* was the dominant IPIs, accounting for 28.2% of infections. This percentage of IPIs in children was associated with the mother's illiteracy, larger families and children drinking untreated water (khudair Hussein 2010).

A 2018 Egyptian study, on the prevalence of intestinal parasitic infections and their associated risk factors among preschool and school children found that 42.6% of 996 randomly selected preschool and school children were infected with IPIs. *A. lumbricoides* and *E. histolytica* had the highest prevalence (12.7% each). The risk factors in this region were socioeconomic: low-income families living in rural dwellings and eating unwashed vegetables, without sufficient safe drinking water or handwashing facilities (Elmonir et al. 2021).

A study carried out in Ethiopia in 2018 on the prevalence and factors associated with intestinal parasites among children of aged 6─59 months in Boricha District, South Ethiopia found a high rate of IPIs (48.7%) among 624 children aged 6─59 months, selected using a stratified sampling method. The main contributing factors were poor sanitation facilities, large family size, walking barefoot, and eating unwashed vegetables and fruit. This study also showed that the presence of IPIs was associated with stunted growth (Tsegaye, Yoseph, and Beyene 2020).

A Brazilian study has identified residence, age, the consumption of raw or inadequately cooked vegetables, and water quality as the main risk factors (Maia et al. 2009). IPIs prevalence is linked more closely to poor personal hygiene and environmental cleanliness than to climate. Socioeconomic issues and erratic elements, such as food instability, droughts, and floods, all play a role (Cissé 2019). Transmission is further aided by a lack of access to clean drinking water and a lack of knowledge about cleanliness (Mwita-AMREF et al. 2009). Most intestinal parasites enter the body through the mouth, usually

through raw food, unwashed hands, polluted water, or undercooked vegetables. Hookworm larvae also enter through the skin. Such oral-fecal infections are generally caused by poor personal cleanliness, improper garbage disposal, and poor handling of human excreta (Benetton et al. 2005). Vegetables may become contaminated with infectious eggs if untreated human feces from infected people is used as a crop fertilizer. Handling food without destroying or removing infective eggs from hands, clothing, hair, raw vegetables and fruit, or cooked food that has been (re)infected by handlers or containers can also result in infection (Mas-Coma, Bargues, and Valero 2018). Other mechanical vectors of transmission include flies, which can spread infectious cysts or eggs from contaminated areas or filthy restrooms to contaminate food and/or drink. Geo-phage is also associated with IPIs (Gadisa and Jote 2019).

Over time, intestinal parasite transmission can be reduced through improved sanitation, a clean/safe water supply, food hygiene, health education, and the treatment of affected people (Ngonjo et al. 2012). A study conducted to determine the frequency of waterborne protozoan parasites in western Cameron, found that intestinal parasite infestations were less common in Bawa village (7.1%), than in Nloh village (15.7%), which had inadequate sanitation (Richardson et al. 2011). Health education increases people's knowledge of good personal cleanliness and healthy habits, helping to prevent the spread of intestinal parasites and re-infection. Communities must be trained to wash hands frequently, safeguard water supplies from feces, and handle food safely (Dada and Aruwa 2014). According to Richardson et al. (2012), Bawa village in western Cameron achieved an 84% decrease in

water-borne diarrheal infections was achieved in Bawa village through improved educational programs on sanitation and hygiene, including conferences and seminars. IPIs can be acquired by consuming food or water that has been contaminated with the small eggs or cysts of intestinal parasites. Food-related behaviors that can contaminate food with intestinal parasites include consuming raw vegetables or street foods, especially in public places, and improper cooking, in which food is only partially cooked, preparers fail to wash their hands thoroughly with soap before handling food or change a baby's diaper before handling food (Kudah, Sovoe, and Baiden 2018).

Chapter 3. Methods

This chapter focuses on the techniques and steps used to carry out this study: the research design, area of study, study population, and sample size.

3.1. Research design

This cross-sectional descriptive study incorporates socio-demographic, hygiene-related behaviors, and stool-examination results recorded in LIS during the treatment of children. The researcher used recorded data for the year 2020.

3.2. Study area

The present study was carried out in Rwanda, specifically in Nyamasheke District. Rwanda is located in central- East Africa, to the east of the Democratic Republic of the Congo; Uganda lies to the north, Burundi to the south, and Tanzania to the west. Nyamasheke District covers 1,175 square kilometers; the study area is one of seven districts in western

Rwanda (Rutsiro, Karongi, Nyabihu, Rusizi, Ngororero, Rubavu, and Nyamasheke); the study year was 2022). Most of this area is surrounded by Lake Kivu; the border separates it from the Democratic Republic of Congo and serves as a water source for many households. The area is composed of fifteen administrative sectors, twenty health centers, and two hospitals (Bushenge Provincial Hospital and Kibogora District Hospital). The population of Nyamasheke District is estimated to be approximately 381,804, with a density of 324.9/km^2. A large part of Nyamasheke District is rural and the rest is composed of small cities (the urban area). Agriculture, small businesses, and fishing are the main source of income for the residents.

3.3. Study population

The present study investigated 1,048 children aged 12─59 months. Their stools were examined for intestinal parasites in the laboratory, and registered in the Laboratory Information System for the year 2020.

3.4. Sample size

To select 1,048 children for this study, a random multistage-sampling (by selection) method was used. LIS consists of 20 health centers and 2 hospitals in this district. Thus, 45 children were selected from every health center and 74 children from every hospital.

3.4.1. Inclusion criteria

The study targeted all children aged 12─59 months whose stools had been examined in laboratories and registered in LIS in 2020.

3.4.2. Exclusion criteria

Children who were younger than 12 months or older than 59 months during the 2020 study period were excluded.

3.5. Variables

3.5.1. Dependent variables

Intestinal parasitic infections.

3.5.2. Independent variables

3.5.2.1. Socio-demographics factors

Age, sex, family size, residence, and the mothers' or caretaker's literacy, and occupation.

3.5.2.2. Poor food-hygiene practices

Not washing fresh food before cooking, not washing fresh fruit before eating, and not using piped water and soap to clean kitchenware.

3.5.2.3. Poor hand hygiene

The failure to wash child's hands, using piped water and soap after he or she has used the restroom and before eating.

3.6. Data Collection

The researcher used all of the required information recorded in LIS from 1,048 children aged 12─59 months: sociodemographic characteristics, hygiene-related behaviors, and stool results. The researcher considered all of the results in the database (negative or positive).

3.7. Limitations of the study

The database contained examined samples of IPIs and other clinical exams with results. However, it took too long to select all the required information. Using research tools, the researcher encountered missing values, duplications, and some information written in French. After extracting the necessary data, the researcher translated some of the French information to English, removing duplications and missing values within the Excel file.

Chapter 4. Data Analysis and results

The data-set was imported into Jamovi 2.2.5 software and analyzed. Next, the researcher interpreted the results and instigated discussions. To test the significance of the coefficients and parameter estimates, p-values were used to assess the level of significance, which was 0.05 and 95% as a confidential interval. The research objectives set by the researcher were used to structure the presentation of results and their interpretation.

4.1. Socio-demographic characteristics of children aged 12─59 months in Nyamasheke District and their association with intestinal parasites

Before the analysis and interpretation, the children's socio-demographic characteristics are described. The first characteristic is the place of residence, whether urban or rural area. The second characteristic is the children's sex: male and female. The third is age; the children are grouped into two categories: group 1: (12─23 months) and group 2: (24─59 months). The fourth characteristic is the mother or child caretakers' literacy, the fifth is the mother or caretaker's occupation; and the last is family size.

In the place of residence category, 994 (90.1%) of the children aged 12─59 months were from rural areas; of these, 449 (46.7%) had no intestinal parasites and 495 (52.4%) had some IPIs. One hundred and four (9.9%) of the children were from urban areas; of these, 41(39.4%) had no IPIs, while 63 (60.6%) had some IPIs. There was no significant difference in the infection rates between children aged 12─59 months from urban and rural areas since the p-value was >0.05. (Table 1)

Table 1. Relationship between the place of residence of children aged 12─59 months and IPIs

				Intestinal parasites				
Variable	**Category**	**Total**		**Negative results**		**Positive results**		
		n=1048	**100%**	**46.80%**		**53.20%**		p-value
Place of residence	Urban	104	9.90%	41	39.4 %	63	60.6 %	0.114
	Rural	944	90.10%	449	47.6 %	495	52.4 %	

In terms of the participants' sex, 535 (51.0%) were male, of whom; 252(47.1%) had no IPIs and 283 (52.9%) have some IPIs. The other 513 (49%) were female; 238(46.4%) had no IPIs, and 275(53.6%) had some intestinal parasitic infections; there was no significant difference in the infection rates observed between boys and girls (p-value >0.05) (see Table 2).

Table 2. Relationship between the sex of children aged 12─59 months and IPIs

Variable	Category	Intestinal parasites						
		Total		Negative results		Positive results		
		n=1048	100%	46.80%		53.20%		p-value
Children's sex	Male	535	51.0 %	252	47.1 %	283	52.9 %	0.818
	Female	513	49.0 %	238	46.4 %	275	53.6 %	

In the first age group, 139 (13.3%) of children were aged 12─23months; of these, 59 (42.4%) had no IPIs, and 80 (57.6%) have some IPIs. In the second age group, 999 (86.7%) of the children were aged 24─59 months; 431 (47.4%) had no IPIs, and 478 (52.6%) had some IPIs (see Table 3).

Table 3. Relationship between the two age groups and IPIs

Variable	Category	Intestinal parasites						
		Total		Negative results		Positive results		
		n=1048	100%	46.80%		53.20%		p-value
Age-group	12─23 months	139	13.30%	59	42.4 %	80	57.6 %	0.274
	24─59 months	909	86.70%	431	47.4 %	478	52.6 %	

Regarding mother or caretaker's literacy, 794 (75.8%) children had illiterate mothers or caretakers, who could not read or write; of these, 292 children (36.8%) had no IPIs and 502 (63.2%) had some IPIs. In addition, 254 (24.2%) children had literate (educated) mothers. Of these, 198(78.0%) had no IPIs and 56 (22.0%) had some IPIs. There was a significant difference in the infection rates of children whose mothers were educated and those whose mothers had no formal education, as the p-value was significant (p-value: <0.001) (see Table 4).

Table 4. Relationship between the mother or caretaker's literacy and IPIs

				Intestinal parasites				
Variable	**Category**	**n=1048**		**Negative results**		**Positive results**		p-value
Mother or caretaker's literacy	No	794	75.80%	292	36.8 %	502	63.2 %	<0.001
	Yes	254	24.20%	198	78.0 %	56	22.0 %	

Regarding the mother or caretaker's occupations, 815 (77.8%) of the children had mothers or caretakers who were farmers; 336 (41.2%) had no IPIs and 479 (58.8%) had some IPIs. By contrast, of the 223 (22.8%) of children whose mothers or caretakers were not farmers, 154 (66.1%) had no IPIs and 79 (33.9%) had some IPIs. There was a significant difference in the infection rates of the children of farmers and non-farmers as the p-value<0.05. (Table 5)

Table 5. Relationship between mother or caretaker's occupation and IPIs

				Intestinal parasites				
Variable	**Category**	**n=1048**		**Negative results**		**Positive results**		p-value
Mother or caretaker's occupation	Farmer	815	77.80%	336	41.2 %	479	58.8 %	<0.001
	Not a farmer	233	22.20%	154	66.1 %	79	33.9 %	

Regarding family size, 861 (82.2%) of children aged 12─59 months came from families with 2-5 members living in the same house; of these, 418 (48.5%) of the children had no IPIs, while 443 (51.5) had some IPIs. However, 187 (17.8%) of the children aged 12─59 months came from families with 6-9 people living in the same house; of these, 72 (38.5%) had no IPIs, while 115 (61.5%) had some IPIs. Significantly, the two groups had different infection rates, as the p-value was less than 0.05. (see Table 6)

Table 6. Relationship between family size and IPIs

		Intestinal parasites					
Family size	**n=1048**	**100%**	**No**		**Yes**		p-value
2_5 people	861	82.2 %	418	48.5 %	443	51.5 %	0.013
6_9 people	187	17.8 %	72	38.5 %	115	61.5 %	

Regarding the association between intestinal parasites and washing fresh food before cooking, 825 (78.7%) of the children ate food that had not been washed before cooking. Of these, 298 (36.1%) had no intestinal parasitic infections, while 527 (63.9%) had some IPIs. Another 223 (21.3%) ate food that was washed before cooking; of these 192 (86.1%) had no IPIs, and 31(13.9%) had some IPIs. The infection rates were statistically significant, as the p-value was less than 0.05. (Table 7)

Table 7. Relationship between IPIs and washing fresh food before cooking

Variable	**Category**	**Intestinal parasites**						
Washing fresh food before cooking		**n=1048**	**100%**	**No**		**Yes**		p-value
	No	825	78.7%	298	36.1 %	527	63.9 %	<0.001
	Yes	223	21.3%	192	86.1 %	31	13.9 %	

Here, 830 (79.2%) children came from households that didn't use piped water or detergent to clean kitchenware, 300 children (36.1%) had no intestinal parasitic infections, and 530 (63.9%) had some IPIs. In addition, 218 (20.8%) children came from households that did use piped water and detergent to clean kitchenware; of these, 190 (87.2%) had no IPIs, and 28 (12.8%) had some IPIs. There was a significant difference in these infection rates, as the p-value was less than 0.05(<0.001) (see Table 8).

Table 8. Relationship between IPIs and the use of piped water and detergents to clean kitchenware

Variable	Category	Intestinal parasites						
using piped water and detergent to clean kitchenware		**n=1048**	**100%**	**No**		**Yes**		p-value
	No	830	79.2 %	300	36.1 %	530	63.9 %	<0.001
	Yes	218	20.8 %	190	87.2 %	28	12.8 %	

The association between intestinal parasitic infections and washing children's hands with soap and water before eating was as follow: 880 (84.0%) of the children were not expected (by their mothers or caregivers) to wash their hands before eating, using piped water and soap. Of these, 328 (37.3%) had no intestinal parasites, while 552 (62.7%) had some IPIs. Another 168 (16.0%) did wash their hands using piped water and soap; of these, 162 (96.4%) had no IPIs while 6 (3.6%) had some IPIs. There was a significant difference in the infection rates as the p-value was less than 0.05 (see Table 9).

Table 9. Relationship between IPIs and washing fresh food before eating

Variable	Category	Intestinal parasites						
Wash children's hands with soap and water before eating		**n=1048**		**No**		**Yes**		p-value
	No	880	84%	328	37.3 %	552	62.7 %	<0.001
	Yes	168	16%	162	96.4 %	6	3.6 %	

Regarding hand-washing with soap and water after using the restroom, a total of 922 (88%) of the children did not wash their hands after using the restroom; of these, 372 (40.3%) had no IPIs, while 550 (59.7%) had some IPIs. Another 126 (12%) of the children did wash their hands after using the restroom. Of these, 118 (93.7%) had no IPIs, while 8 (6.3%) had

some IPIs. There was a significant difference in the infection rates, as the p-value was less than 0.05 (see Table 10).

Table 10. Relationship between IPIs and washing a child's hands with soap and water after using the restroom

Variable	Category	Intestinal parasites						
Washing a child's hands with soap and water after using the restroom		**n=1048**		**No**		**Yes**		p-value
	No	922	88%	372	40.3 %	550	59.7 %	<0.001
	Yes	126	12%	118	93.7 %	8	6.3 %	

Regarding the association between intestinal parasitic infections and washing fruit before eating, the data show that 918 (87.6%) of the children ate unwashed fruit; of these, 367 (40.0%) had no IPIs, while 551(60.0%) had some IPIs. In addition, 130(12.4%) ate washed fruit; of these 123(94.6%) had no IPIs, while 7(5.4%)had some IPIs. There was a significant difference in the infection rate as the p-value was less than 0.05 (see Table 11).

Table 11. Relationship between IPIs and washing fruit before consuming (eating) it

Variable	Category	Intestinal parasites						
washing fresh fruit before eating them		**n=1048**		**No**		**Yes**		p-value
	No	918	87.6%	367	40.0 %	551	60.0 %	<0.001
	Yes	130	12.4%	123	94.6 %	7	5.4 %	

4.2. Prevalence of intestinal parasites among children aged 12─59 months, Nyamasheke District, 2021(n=1048)

Out of a total of 1,048 children aged 12─59 months, 53.2% were found to be infected with at least one intestinal parasite, 46.8% had no parasites. (see Table 12)

Table 12. Prevalence of IPIs among children aged 12─59 months

Variables	Frequency	Percentage
Children with intestinal parasite infections		
No	490	46.8
Yes	558	53.2

Based on the prevalence of parasitic infections by species, *Ascaris lumbricoides* was the most prevalent at 13.1%, followed by *G. lamblia* at 10.9%, *E. coli* at 10.5%, *E. histolytica* at 7.9%, *Trichuris trichiura* at 6.5%, *hookworm* at 1.7% and *Taenia ssp.* at 1.4%. (see Table 13)

Table 13. Prevalence of intestinal parasitic infections by species

Giardia lamblia	Frequency	Percentage
No	934	89.1
Yes	114	**10.9**
Entamoeba histolytica	Frequency	Percentage
No	965	92.1
Yes	83	**7.9**
Ascaris lumbricoides	Frequency	Percentage
No	911	86.9
Yes	137	**13.1**
Entamoeba coli	Frequency	Percentage
No	938	89.5
Yes	110	**10.5**
Hookworm	Frequency	Percentage
No	1030	98.3
Yes	18	**1.7**
Trichuris trichiura	Frequency	Percentage
No	980	93.5
Yes	68	**6.5**
Taenia spp.	Frequency	Percentage
No	1033	98.6
Yes	15	**1.4**

Descriptive statistics applied.

4.3. Factors associated with intestinal parasites in children aged 12─59 months, Nyamasheke District, 2021 (n=1048)

Based on the binomial-logistic-regression findings in Table 14, it is clear that the following factors were associated with the likelihood of intestinal parasitic infections among children

aged 12─59 in Nyamasheke District. Based on the p-values, we can say that intestinal parasite infections are someway related to the place of residence (OR=1.9207, CI=95: %:1.06─3.47, p-value=0.031). The researcher found a statistically significant association between this variable and IPIs, as their p-values were less than 0.05. Children from rural areas were 1.9 times more likely to have IPIs than children from urban areas. The mother or caretaker's literacy had an impact on intestinal parasitic infections (OR=5.09, CI=95%:3.4-7.6, p-value <0.001). There was a statistical difference in the infection rates: children from illiterate families were 5.09 times more likely to be infected than children from literate families. The mother or caretaker's occupation (OR=2.8, CI=95: %:1.9─4.1, p-value <0.001) was also associated with IPIs and statistically significant. Children from farming families were 2.8 times more likely to have IPIs than children from non-farming families. As with failing to wash fresh food before cooking, this variable was associated with IPIs in Nyamasheke District the p-value was less than 0.05 and is statically significant (OR=4.9, CI=95: %:2.9─8.1, p-value <0.001). Children from families that did not wash fresh food before cooking were 4.9 times more likely to be infected by IPIs than those who did wash fresh food before cooking. Failing to wash children's hands with soap and water before eating was also associated with IPIs, as the p-value was <0.001(OR=8.4, CI=95: %:3.3─21.4). Children from households that did not wash hands with soap and water before eating were 8.4 times more likely to have IPIs than those from households that did use soap and water to clean their hands before eating. Failing to wash children's hands with soap and water after they use the restroom was associated in some way with IPIs in children

aged 12─59 months in Nyamasheke District because the p-value was <0.001and thus statistically significant (OR=4.7, CI=95: %:1.9─11.5). Children from families that could not use soap and water to clean their hands after they use the restroom were more likely to suffer from IPIs than children from families that did wash their hands after they use the toilet. Regarding unwashed fresh fruit, children from households that did not wash fresh fruit before eating were 9.7 times more likely to acquire IPIs than those from families that did wash fresh fruit before consuming it (OR=9.7, CI=95: %:4.1─22.8, p-value <0.001). However, this study cannot say definitely that other variables such as children's sex, and age group or the family's size, and use of piped water and detergent to clean kitchenware, are linked to IPIs because their p-value were equal to 0.655, 0.218, 0.515,0.126, respectively, all of which are greater than 0.05.However, the more frequently parents or caretakers wash fresh food before cooking it, wash a child's hands with soap and water before eating, and after using the toilet, and wash fresh fruit before eating it, the less likely their children to get the IPIs. (see Table 14)

Table 14. Factors associated with IPIs among children aged 12─59 months

			95% Confidence Interval	
Predictor	**p-value**	**Odds ratio**	**Lower**	**Upper**
Place of residence				
Urban		**1**		
Rural	0.031	1.9207	1.0619	3.474
Sex of children				
Male		**1**		
Female	0.655	0.9267	0.6633	1.295
Age-group:				
12-23 months		**1**		
24-59 months	0.218	1.349	0.838	2.171
Mother or caretaker's literacy				
Yes		**1**		
No	< .001	5.0995	3.409	7.628
Mother or caretaker's occupation:				
Not a farmer		**1**		
Farmer	< .001	2.8519	1.9392	4.194
Family size:				
2─5 persons		**1**		
6─9 persons	0.515	0.8671	0.5644	1.332
Washing fresh food before cooking				
washing		**1**		
Not washing	< .001	4.9206	2.9823	8.119
Using piped water and detergent to clean kitchenware				
Yes		**1**		
No	0.126	1.6544	0.8678	3.154
Washing children's hands with soap and water before eating				
Yes		**1**		
No	< .001	8.4507	3.3249	21.478
Washing children's hands with soap and water after they use the restroom				
Yes		**1**		
No	< .001	4.7458	1.957	11.508
Washing fresh fruit before eating them				
Yes		1		
No	< .001	9.762	4.165	22.88

Binomial logistic regression applied

Chapter 5. Discussion

5.1. Prevalence of intestinal parasite infections among children aged 12─59 months in Nyamasheke District

Out of a total of 1,048 children, 53.2% were found to be infected with intestinal parasites. The findings are similar to those of Chirdan et al. which investigated the prevalence of intestinal parasites in children attending daycare centers in Jos, Central Nigeria, where 57.8% of children aged 0─59 months were infected with IPI. A study of the prevalence of intestinal parasites and associated factors among children aged 6─59 months attending the Mekane Eyesus Primary Hospital, in north-central Ethiopia reported an 18.0% prevalence of IPIs and attributed this to farming activities and a habit of eating unwashed fruit/vegetables (Eyayu et al. 2021). According to that study, the most prevalent intestinal parasite was *A. lumbricoides,* at 13.1%, this result was much higher than that of a study carried out in a metropolitan city in Bangladesh, which found IPIs in only 1.4% of pediatric patients(Nipa et al. 2022), and a much lower result than the prevalence of ascariasis in 18.75% of children aged 1─5 years in Makurdi, Benue State, Nigeria (Okoh et al.).

5.2. Factors that contribute to the transmission of IPIs among children aged 12─59 in Nyamasheke District

Based on the results of the present study, it is evident that some socio-demographic factors, as well as poor hand and food-hygiene practices, are the main factors contributing to the highest prevalence of IPIs among children aged 12─59 months in Nyamasheke District.

In the present study, 60.6% of children aged 12─59 months from rural areas had intestinal parasites and were 1.09 times more likely to have IPIs than children from urban areas, 52.4% of whom had intestinal parasites. These results are in line with a study of Kassala town, Sudan, where children displaced from rural areas were 22.2% more likely to be infected than those from urban areas (12.9%). In that study, children from farming households were more likely to be infected with IPIs. There was a significant association between farming and intestinal parasites (p-value <0.05). A similar Ethiopian study found that children from farming families were more likely to be infected with IPIs than those from non-farming families (Eyayu et al. 2021). Heath education is needed to increase the adoption of healthy hygiene practices and lifestyles. In the present study, the mother or caretaker's level of education was found to be associated with intestinal parasites (p-value <0.05). Children from illiterate households were more likely to be infected with IPIs than those from literate families. Another study (Shadma Mumtaz et al.) investigated patients at a tertiary care hospital in Karachi and showed that IPIs in children were caused by their parents' ignorance of hygiene and sanitation practices. Pathogenic organisms can be eliminated by hand washing with soap, washing fresh food before cooking, and washing fresh fruit before eating it. The present study shows that many infected children do not wash their hands regularly with soap before eating or after using the restroom. In addition, many households do not wash fresh fruit before eating it or fresh food before cooking it. A similar study of the frequency and risk factors for parasitic intestinal infection in children

under five at a tertiary care hospital in Karachi reported the same results. They indicate that the prevalence of IPIs in Karachi is strongly associated with poor hygiene (p-value <0.001).

The above results indicate that IPIs remain a public-health problem in this area. The information provided in this study will help both public-health advocates (public and private health facilities, institutions, and researchers) and local authorities by raising awareness of this health burden and developing new strategies for dealing with it. IPIs can be prevented by various different sectors. Given the methodology used in this study, it is clearly possible to generalize the results to all children aged 12─59 months in Nyamasheke District.

Chapter 6. Conclusion and recommendations

This investigation has revealed a high prevalence of intestinal parasites in the study area. *Ascaris lumbricoides, Giardia lamblia and Entamoeba coli* are shown to be the predominant IPIs. The results also show that children who live in rural areas, those who have illiterate mothers or caretakers, or live in farming households, the lack of hand washing with soap before eating, and after using the restroom were significant factors in the transmission of IPIs to children aged 12─59 months in Nyamasheke District. Other transmission-risk factors include the failure to wash fresh food and fresh fruit before cooking and eating it. The results confirm that IPIs remain a public-health concern in this district.

Effective control and prevention programs should therefore be incorporated into public-health policies. Handwashing, food-hygiene campaigns, and efforts to raise the awareness of mothers and caretakers are needed to reduce the prevalence of IPIs. In addition, further studies are needed to investigate other factors associated with IPIs in Nyamasheke District.

References

Acharya, Anuja, Janak Raj Subedi, and Ravi Prasad Devkota. 2021. "Prevalence of intestinal parasites among children attending outpatient department of Kanti Children's Hospital, Kathmandu, Nepal", Nepalese Journal of Zoology, 5: 1-7.

Al-Megrin, WA. 2015. "Risk factors among preschool children in Riyadh, Saudi Arabia", Res J Parasitol, 10: 31-41.

Aleka, Yetemwork, Workineh Tamir, Meseret Birhane, and Agersew Alemu. 2015. "Prevalence and associated risk factors of intestinal parasitic infection among under five children in University of Gondar Hospital, Gondar, Northwest Ethiopia", Biomedical Research and Therapy, 2: 1-7.

Arani, Abolfath Shojaei, Reza Alaghehbandan, Lame Akhlaghi, Maryam Shahi, and Abdolaziz Rastegar Lari. 2008. "Prevalence of intestinal parasites in a population in south of Tehran, Iran", Revista do Instituto de Medicina Tropical de São Paulo, 50: 145-49.

Aschale, Awoke, Metadel Adane, Melaku Getachew, Kebede Faris, Daniel Gebretsadik, Tadesse Sisay, Reta Dewau, Muluken Genetu Chanie, Amare Muche, and Aregash Abebayehu Zerga. 2021. "Water, sanitation, and hygiene conditions and prevalence of intestinal parasitosis among primary school children in Dessie City, Ethiopia", PLoS One, 16: e0245463.

Bakarman, Marwan A, Moustafa A Hegazi, and Nadeem S Butt. 2019. "Prevalence, characteristics, risk factors, and impact of intestinal parasitic infections on school children in Jeddah, Western Saudi Arabia", Journal of Epidemiology and Global Health, 9: 81.

Bdir, Sami, and Ghaleb Adwan. 2010. "Prevalence of intestinal parasitic infections in Jenin Governorate, Palestine: a 10–year retrospective study", Asian Pacific Journal of Tropical Medicine, 3: 745-47.

Benetton, MLFN, AV Gonçalves, MEF Meneghini, EF Silva, and M Carneiro. 2005. "Risk factors for infection by the Entamoeba histolytica/E. dispar complex: an epidemiological study conducted in outpatient clinics in the city of Manaus, Amazon Region, Brazil", Transactions of the Royal Society of Tropical Medicine and Hygiene, 99: 532-40.

Butera, Eric, Assumpta Mukabutera, Etienne Nsereko, Cyprien Munyanshongore, Nadine Rujeni, Ivan Emile Mwikarago, Patricia Jean Moreland, and Manasse Nzayirambaho Manasse. 2019. 'Prevalence and risk factors of intestinal parasites among children under two years of age in a rural area of Rutsiro district, Rwanda–a cross-sectional study', Pan African Medical Journal, 32.

Campbell, S. J., S. V. Nery, C. A. D'Este, D. J. Gray, J. S. McCarthy, R. J. Traub, R. M. Andrews, S. Llewellyn, A. J. Vallely, G. M. Williams, S. Amaral, and A. C. Clements. 2016. 'Water, sanitation and hygiene related risk factors for soil-

transmitted helminth and Giardia duodenalis infections in rural communities in Timor-Leste', Int J Parasitol, 46: 771-79.

Cissé, Guéladio. 2019. 'Food-borne and water-borne diseases under climate change in low-and middle-income countries: Further efforts needed for reducing environmental health exposure risks', Acta tropica, 194: 181-88.

Dada, EO, and CE Aruwa. 2014. 'Microorganisms associated with urine contaminated soils around lecture theatres in Federal University of Technology, Akure, Nigeria', International Journal of Applied Microbiology and Biotechnology Research, 2: 79-85.

Elmonir, Walid, Haitham Elaadli, Anan Amer, Hammed El-Sharkawy, Mohamed Bessat, Samy F Mahmoud, Mustafa Shukry Atta, and Wael F El-Tras. 2021. 'Prevalence of intestinal parasitic infections and their associated risk factors among preschool and school children in Egypt', PLoS One, 16: e0258037.

Eyayu, Tahir, Amilaku Wubie, Teklehaimanot Kiros, Tegenaw Tiruneh, Shewaneh Damtie, Meslo Sema, Aynework Abebaw, Ermias Sisay Chanie, and Lemma Workineh. 2021. 'Prevalence of Intestinal Parasitosis and Its Associated Factors Among Children Aged 6 to 59 months Attending Mekane Eyesus Primary Hospital, Northcentral Ethiopia', Global Pediatric Health, 8: 2333794X211036605.

Farrell, Sam H, Luc E Coffeng, James E Truscott, Marleen Werkman, Jaspreet Toor, Sake J de Vlas, and Roy M Anderson. 2018. 'Investigating the effectiveness of

current and modified World Health Organization guidelines for the control of soil-transmitted helminth infections', Clinical Infectious Diseases, 66: S253-S59.

Gadisa, Eshetu, and Kefiyalew Jote. 2019. 'Prevalence and factors associated with intestinal parasitic infection among under-five children in and around Haro Dumal Town, Bale Zone, Ethiopia', BMC pediatrics, 19: 1-8.

The jamovi project (2021). jamovi. (Version 2.2) (Computer Software). Retrieved from https://www.jamovi.org.

Karema, C, A Fenwick, and GD Colley. 2015. 'Mapping of Schistosomiasis and Soil-Transmitted Helminthiasis in Rwanda 2014: Mapping Survey Report', Rwanda Biomedical Center: Kigali, Rwanda: 47.

Karshima, Solomon Ngutor. 2018. 'Prevalence and distribution of soil-transmitted helminth infections in Nigerian children: a systematic review and meta-analysis', Infectious diseases of poverty, 7: 1-14.

Kassaw, Mesfin Wudu, Ayele Mamo Abebe, Kenean Getaneh Tlaye, Alemu Birara Zemariam, and Biruk Beletew Abate. 2019. 'Prevalence and risk factors of intestinal parasitic infestations among preschool children in Sekota town, Waghimra zone, Ethiopia', BMC pediatrics, 19: 1-10.

Khan, Wali, N-u Nisa, and A Khan. 2017. 'Prevalence and risk factors associated with intestinal parasitic infections among food handlers of Swat, Khyber Pakhtunkhwa', Pakistan. J Food Nutr Res, 5: 331-6.

khudair Hussein, Tariq. 2010. 'Prevalence and related risk factors for Giardia lamblia infection among children with acute diarrhea in thi-qar, southern Iraq', Thi-Qar Medical Journal (TQMJ), 4: 201068-74.

Kudah, Catherine, Simon Sovoe, and Frank Baiden. 2018. 'Parasitic contamination of commonly consumed vegetables in two markets in Ghana', Ghana medical journal, 52: 88-93.

Maia, MMM, MA Fausto, ELM Vieira, MLFN Benetton, and M Carneiro. 2009. 'Intestinal parasitic infection and associated risk factors, among children presenting at outpatient clinics in Manaus, Amazonas state, Brazil', Annals of Tropical Medicine & Parasitology, 103: 583-91.

Mas-Coma, S, MD Bargues, and MA Valero. 2018. 'Human fascioliasis infection sources, their diversity, incidence factors, analytical methods and prevention measures', Parasitology, 145: 1665-99.

Mehraj, Vikram, Juanita Hatcher, Saeed Akhtar, Ghazala Rafique, and Mohammad Asim Beg. 2008. 'Prevalence and factors associated with intestinal parasitic infection among children in an urban slum of Karachi', PLoS One, 3: e3680.

Mulatu, Getamesay, Ahmed Zeynudin, Endalew Zemene, Serkadis Debalke, and Getenet Beyene. 2015. 'Intestinal parasitic infections among children under five years of age presenting with diarrhoeal diseases to two public health facilities in Hawassa, South Ethiopia', Infectious diseases of poverty, 4: 1-8.

Mwita-AMREF, Nzomo, Mary O'Neil-MSH, Josephat Nyagero-AMREF, and Loris Elqura-MSH. 2009. 'Competency Gaps in Human Resource Management in the Health Sector: An Exploratory Study of Ethiopia, Kenya, Tanzania, and Uganda'.

Ngonjo, TW, JH Kihara, M Gicheru, P Wanzala, SM Njenga, and CS Mwandawiro. 2012. 'Prevalence and intensity of intestinal parasites in school age children in Thika District, Kenya', African Journal of Health Sciences, 21: 153-60.

Nipa, Nusrat Jahan, Nasima Akter, Hasina Momotaj Hira, Farhana Akter, Dilshad Jahan, Salequl Islam, Ayukafangha Etando, Kona Chowdhury, Rahnuma Ahmad, and Mainul Haque. 2022. 'Intestinal Parasitic Infections among the Pediatric Patients in a Metropolitan City of Bangladesh with Emphasis on Cryptosporidiosis'.

Okoh, ME, IW Nyinoh, LN Utume, and TT Terzunwe. 'Prevalence of Ascariasis among children in Makurdi, Benue State, Nigeria'.

Richardson, DJ, KR Richardson, KE Richardson, J Gross, P Tsekeng, B Dondji, and S Foulefack. 2011. 'Malaria, intestinal parasitic infection, anemia, and malnourishment in rural Cameroonian villages with an assessment of early interventions', Journal of the Arkansas Academy of Science, 65: 72-97.

Spruce, Lisa. 2013. 'Back to basics: hand hygiene and surgical hand antisepsis', AORN Journal, 98: 449-60.

Torgerson, Paul R, Brecht Devleesschauwer, Nicolas Praet, Niko Speybroeck, Arve Lee Willingham, Fumiko Kasuga, Mohammad B Rokni, Xiao-Nong Zhou, Eric M Fèvre, and Banchob Sripa. 2015. 'World Health Organization estimates of the

global and regional disease burden of 11 foodborne parasitic diseases, 2010: a data synthesis', PLoS medicine, 12: e1001920.

Tsegaye, Berhan, Amanuel Yoseph, and Hunachew Beyene. 2020. 'Prevalence and factors associated with intestinal parasites among children of age 6 to 59 months in, Boricha district, South Ethiopia, in 2018', BMC pediatrics, 20: 1-7.

Vaumourin, Elise, Gwenaël Vourc'h, Patrick Gasqui, and Muriel Vayssier-Taussat. 2015. 'The importance of multiparasitism: examining the consequences of co-infections for human and animal health', Parasites & vectors, 8: 1-13.

WHO, World Health Organization. 2010. "Soil-transmitted helminthiasis. Number of children treated 2007-2008: update on the 2010 global target', Weekly Epidemiological Record, 85: 141-47.

Yentur Doni, N., G. Gürses, Z. Şimşek, and F. Yıldız Zeyrek. 2015. "Prevalence and associated risk factors of intestinal parasites among children of farm workers in the southeastern Anatolian region of Turkey", Annals of Agriculture and Environemental Medicine, 22: 438-42.

Appendix

Administrative map of Africa