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PREVALENCE OF INTESTINAL PARASITES AND ASSOCIATED RISK FACTORS AMONG UNDER-FIVE CHILDREN ATTENDING KIBOGORA LEVEL TWO TEACHING HOSPITAL, RWANDA

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Abstract:
This study aimed to assess the prevalence of intestinal parasites and associated risk factors among under-five children attending Kibogora Level Two Teaching Hospital in Rwanda. Specific objectives were: to determine the prevalence of intestinal parasites among under-five years children attending Kibogora Level Two Teaching Hospital, Rwanda, to identify the source of water and their utilization in intestinal parasitic occurrence among under-five years children attending Kibogora Level Two Teaching Hospital, Rwanda; and to identify the risk factors associated with intestinal parasites occurrence among under-five children attending Kibogora Level Two Teaching Hospital, Rwanda. Methods: retrospective cross-sectional study design with quantitative approaches at Nyamasheke in June 2022. The study includes a target population of 772 children and a sample size of 263. A questionnaire was administered to collect data on

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hygiene, sanitation, socio-demographic and economic characteristics (risk factors), and secondary data from 2019-2022 were used. Results: the prevalence of intestinal parasites was 102 (38.7%). In this study the prevalence of *Ascaris* 56 (21.3%) was the highest followed by amoeba (*Entamoeba histolytica*) 24 (9.1%), *Giardia lamblia* 8 (3.0%), *Trichomonas intestinalis* 7 (2.6%) and *Ankilostoma duodenale* 7 (2.6%). Other intestinal parasites detected such as *Necator americanus* and *Trichiuris trichiura* were identified at less than one percent prevalence. A chi-squared test was used to establish a relationship between different variables. The chi-squared shows that there is no statistically significant association between the marital status category of the children and having latrines at home with a chi-squared value of 3.293 and a p-value 0.183 of there was no statistically significant association. utensils drying site with a chi-squared value of 5.422 and p-value of .000 there was a statistically significant association. Drinking boiled water with a chi-squared value of 7.857a and p-value of .97. Washing hands before a meal with a chi-squared value of 7.857a and p-value of 98. Washing hands after defecation with a chi-squared value of 3.293 and p-value of .193, there is no statistical significance. Finally, the high prevalence of intestinal parasitic infections in under-five children warrants strict control measures for microbial reduction through the utensils-drying site, improved hygiene and sanitation, and treatment of drinking water should be considered.

Keywords: assessment, prevalence, intestinal protozoan, risk factors among under-five children

1. Introduction

Intestinal parasitic infections are among the most common infections worldwide (Shimokawa et al., 2019). Intestinal parasitic infections vary from place to place in relation to the pattern of transmission of the disease. They are frequently distributed throughout the world and are highly prevalent in many regions (Hailegebriel et al., 2020). It is estimated that nearly one-quarter of the world's population harbors one or more intestinal worms with the majority of them living in developing countries (Rasti et al., 2017).

Protozoa and helminthic parasites are the known parasites that affect the gastrointestinal cavity (Osman et al., 2015). Intestinal parasites such as hookworms including *Ascaris lumbricoides*, *Trichuris trichiura*, to name a few are the most prevalent and affect about one-sixth of the world population (Ibrahim & Soliman, 2010). Ascaris lumbricoides is responsible for about 1.2 billion infections globally while *Trichirus trichiura* and hookworm infection account for about 795 million and 740 million, respectively (Ibrahim & Soliman, 2010).

Whole populations are geographically at risk, children are observed to disproportionally carry the greatest burden of infection (Rasti et al., 2017). Over 270 million pre-school age children and over 600 million school-age children live in areas where these parasites are intensely transmitted and hence are in need of treatment and preventive interventions (Elawad, n.d.). Parasitic infections are a major public health problem in developing countries because of poor social and economic conditions, poor sanitation, and improper hygienic practices. Among many other consequences of these infections, they cause iron deficiency anemia, growth retardation, intestinal obstruction in children, and other physical and cognitive development problems (Omrani et al., 2015). This hinders their academic achievement and slows down the rate of economic development (Omrani et al., 2015). Students are active in unsanitary environments and rarely employ good sanitary behavior (Osman et al., 2015).

These potential carriers are often crowded together for long periods of time for example, in school. The problems are more serious in Sub-Saharan Africa, Asia and Latin America associated with inadequate water supply, environmental sanitation, fast population growth, and other economic and social problems (Osman et al., 2015). About 12% of the global disease burdens caused by intestinal parasites are observed among children with age ranges from 5 to 14 years in developing countries (Sateriale et al., 2021). Up to 270 million preschool and 600 million school children are living in area where there is high transmission of parasitic worms, particularly in Africa (Rasti et al., 2017). Among the protozoan parasite, *E. Histolytic*a and *Giardia lamblia* are the most dominant cause of intestinal morbidity in children.

High prevalence of intestinal parasitic infection were reported among school children in Sub Saharan African countries including 27.7% to 95% (Trabelsi et al., 2010) in Ethiopia, 90% in Central Sudan (Trabelsi et al., 2010), 50.0% in Rwanda (Emile et al., 2013), and 48.7% in Tanzania (Wumba et al., 2010). In South Africa, a study of the prevalence of intestinal parasite infections in primary school children found that more than 50% had worm infestation. Likewise, a study conducted in Nigeria among secondary and primary schools found that 52.5% were infected with different intestinal parasites. In the same country, a similar study was conducted to determine the prevalence of gastrointestinal helminths found that 66.7% of the study participants were infected with one or more helminth species. A study of the prevalence of intestinal parasites and associated risk factors in a health center in Ethiopia found that 62.3% of the participants had at least one of the intestinal parasitic infections (Butera et al., 2019).

These indicators represent a critical issue for Rwanda as they put Rwandan children at risk of intestinal parasitosis. It has been determined that poor sanitation and inadequate hygiene play a key role in intestinal parasite infections. Hygiene practices continue to be an issue, according to the Rwanda Demographic and Health Survey (RDHS, 2014/2015).

A study conducted in Rutsiro District of Rwanda on the prevalence and risk factors of intestinal parasites among children under two years old found that at almost one in two children, that is 44.8% were found to be infected with at least one intestinal parasite (Butera et al., 2019). These infections result into growth retardation, reduced mental development, school absenteeism, low academic performance, susceptible to malnutrition and infection among school-age children. This fact indicates the problem and severity of intestinal parasitic infection in Rwanda. Continuous monitoring of intestinal parasitic infection and their associated risk factors are essential among under-five children in the country.

2. Problem Statement

Infections with intestinal parasites have a considerable negative impact on public health in underdeveloped nations and are a major cause of morbidity and mortality globally. Overcrowding, inadequate environmental sanitation, and unhygienic habits are some of the factors that contribute to the developing world being disproportionately impacted (Emile et al., 2013). Many people worldwide are infected with these diseases, with children being the most afflicted and more likely to exhibit clinical symptoms. Intestinal parasites, are among the most common infections in the world and have been responsible for considerable morbidity and mortality with the highest burden being in developing countries (Amer et al., 2017).

Children under 5 years are more vulnerable of the infection with an estimate of about 12% of the global intestinal parasites burdens due to poor access to safe water supply and hygiene (Emile et al., 2013). The presence of intestinal parasitic infections may have multiple effects among children including physical and mental developments. The presence of chronic and heavy intestinal parasitic infection causes intestinal bleeding, malabsorption of nutrients, nutritional deficiency, destruction of cells and tissues and other associated effect (Kabatende et al., 2020). The overall effect of these results in growth retardation, reduced mental development, school absenteeism, low academic performance, susceptible to malnutrition and infection. To overcome the burden of intestinal parasites is still very high in Rwanda, accounting for more than 40% of school-age and under-five year children (Butera et al., 2019).

In addition, these infections cause enormous health defects that need close diseases prevention and control measures such as introduction of preventive therapy aimed at risk populations of pre-school aged and school aged children have been initiated in many targeted countries, including Rwanda.

Targeting the parasitic infections, the Rwandan Ministry of Health in collaboration with its health sector development partners launched a Mass Drug Administration (MDA) program of anthelminthic in 2008 (Hailegebriel et al., 2020). For the control and prevention of these infection, provision of fundamental infrastructure, together with education and promotion in the hygiene behavior and targeted drug management proved effective (Ruberanziza et al., 2019). Despite these efforts these infections and their preventable associated risk factors are still most predominant in Rwanda. Therefore, it is worth to undertake an assessed study for the prevalence of intestinal parasites and associated risk factors among under-five children, who are among the most affected by these infections. The objective of this researchwasto determine the prevalence of intestinal parasites among under-five-years children, to identify source of water and their utilization in intestinal parasitic occurrence among under-five years children and to identify the risk factors associated with intestinal parasites occurrence among under-five children attending Kibogora Level Two Teaching Hospital, Rwanda.

The research questions were: What is prevalence of intestinal parasites among under-five years children? what source of water and their utilization in intestinal parasitic occurrence among under-five year children? What are the risk factors associated with the intestinal parasites occurrenceamong under-five children attending Kibogora Level Two Teaching Hospital, Rwanda? Intestinal parasites of different species of helminths and protozoa inhabit the gastrointestinal tract of humans especially in the tropics where sanitation and hygiene are poor (WHO, 2011). Helminths are transmitted to human through his interaction with contaminated soil in his daily activities. Intestinal helminths are classified into three major groups: nematodes such as Ascaris lumbricoides and hookworms (*Ancylostoma duodenale* and *Necator americanus*), *Strongyloides stercoralis*, *Trichuris trichiura* and *Enterobius vermicularis*. Common trematodes include *Schistosoma* (*Schistosoma haematobium*, *Schistosoma japonicum*, *Schistoso mamasoni*) (Kabatende et al., 2020) and cestodes such as *Taenia solium*, *Taenia saginata* and *Hymenolepis nana*. Intestinal protozoa are mainly categorized into amoebas such as Entamoebahistolytica, flagellates such as *Giardia lamblia*, cilliates such as *Balantidium coli* and *Coccidia* that comprise *Cryptosporidium* and *Cyclospora* species (Sulieman et al., 2020).

According to WHO (2010) estimates, 18.1 million school-aged children in sub-Saharan Africa (SSA) almost half were infected by one or more parasitic helminths. Intestinal parasitic infections are most prevalent in poor segments of populations with low household income, poor personal hygiene, improper environmental sanitation, overcrowding and limited access to safe water (Hailegebriel et al., 2020). Amoebic dysentery resulting from *Entamoeba histolytica* is the second most common cause of death from parasitic diseases worldwide after malaria (Wumba et al., 2010). It is estimated that *Entamoeba histolytica* infects 40-50 million people resulting in approximately 100 000 deaths annually (Audrey Chuat, 2019).

Helminths have three main stages of life cycle: egg, larvae, and adult (Hailegebriel et al., 2020). The eggs have tough resistant walls to protect the embryo as it develops; they hatch to release larvae either within a host or into external environment. Adult forms are essentially parasites of human causing soil transmitted helminthiasis, but also affect domesticated mammals. Nematodes have direct life cycles which require no intermediate hosts or vectors. The parasitic infections occur through fecal contamination of soil, food stuffs and water supplies. The main mode of transmission is fecal-oral, where eggs or larvae passed in faeces of one host are ingested by another (Trabelsi et al., 2010). When the faeces are not properly disposed it results to contamination of the environment (Cookson & Stirk, 2019).

3. Epidemiology of Intestinal Parasites

Parasites found in the human gastrointestinal tract can be categorized into two groups, protozoa and helminths. the soil transmitted helminths (*Ascaris lumbricoides*, hookworms and *Trichiuris trichiura)* are the most prevalent, infecting an estimated on sixth of the global population. Infection rates are highest in children living in Sub-Saharan Africa, followed by Asia and then Latin America and the Caribbean (Michael O. Harhay, 2010). In SSA, it is estimated that approximately a quarter of population is infected with one or more helminths, typically the nematode worms, which are the most prevalent of all GI parasites (Elias et al., 2018).

In 2006, estimates propose that of 181 million school aged in SSA almost half (89 million) were affected by one or more of these parasitic infections. While whole population will be geographically at risk, children are observed to disproportionally carry the greatest burden of infection (Michael O. Harhay, 2010). This disproportion has behavioral, biological and environmental bases. Children tend to be more active in the infected environment and rarely employ good sanitary behaviors. Frequently these potential carriers are crowded together for large period of time for example schools or orphanages, increasing the likelihood of transmission or environmental contamination with parasite.

4. Empirical Review and Theoretical Review

4.1 General Transmission Methods of Intestinal Protozoa and Helminths

The main routes of entry of intestinal parasites into the human body are: ingestion, skin penetration, inhalation and autoinfection (Omrani et al., 2015). Intestinal helminths infections occur mostly by ingestion of eggs from contaminated soils, for example, in cases of *Ascaris lumbricoides, Trichiuris trichiura* and occasionally in *Enterobius vermicularis* (Amer et al., 2017).

Infection by ingestion of infective cysts occurs in protozoa such as *Entamoeba histolytica, Balantidium coli* and *Giardia lamblia*. Infection by active skin penetration of the larvae occurs in case of hookworms, *Schistosomes* and *Strongyloide sstercoralis* (Rasti et al., 2017). Autoinfection occur in cases of *Enterobius vermicularis, Taenia solium* and *Hymenolepis nana,* and also *Cryptosporidium* (Wumba et al., 2010). Adult helminths live in the intestines where they produce thousands of eggs each day (Emile et al., 2013) which contaminate the soil. Infections happen when the eggs attached to fruits or vegetables are ingested if these are not properly cooked, washed or peeled. The eggs may also be ingested in contaminated water or ingested by children who play in contaminated soils and put their hands in mouth (Ibrahim & Soliman, 2010).

The transmission of most parasitic infections is fecal-oral, resulting from poor sanitation hence contamination of water sources with human faeces (Hailegebriel et al., 2020). The parasite eggs and cysts have been found to adhere to dust, utensils, finger nails, door handles (Butera et al., 2019), and currency notes and coins (Omrani et al., 2015). Flies and cockroaches may serve as vectors by ingesting the cysts and/or eggs present in faeces and depositing them in food or mechanically carry them on their bodies (Digiani, 2010).

Studies done in China show that indiscriminate disposal of human faeces and its use in farming contributed greatly to high levels of STH among the population (Hailemeskel et al., 2020) *Entamoeba histolytica* and *Giardia lamblia* are the most common intestinal protozoa that are transmitted through drinking contaminated water. Their cysts also contaminate the environment and water supplies (Digiani, 2010).

4.2 Intestinal Parasites in Rwanda

In southern Rwanda in 2003,It was reported that 55% 2004 school aged children were infected with hookworm, *Ascarislum bricoides* or *Trichuris trichiura* (Kabatende et al., 2020). There is increasing recognition that these parasites can impair the growth and development of children of all ages. These infections are regarded as a serious public health problem as they cause iron deficiency anemia, growth retardation in children and other physical and mental health problem. Intestinal parasites in primary schools are a major public health problem in Rwanda (Ruberanziza et al., 2019). It is believed that in Rwanda, more than 75% children were infected by intestinal worms in 2007. Highest prevalence of neglected diseases is found in tropical and subtropical regions. Tapeworms, pinworms, and roundworms are the most common helminths in the United States. The study performed at Kirambo Health Center revealed that females were slightly more prevalent than males with 62.2 and 59.3 respectively. Patients presented high level of intestinal parasites was aged less than 10 years old with 87.7%. the risks factors showed by this study were use of uncovered toilets, drinking unboiled water, use of stagnant water, poor body and food hygiene which increase the rate of intestinal parasites (Karemera John, 2018). The study performed at Ngoma Primary School this year in February showed the following results of 120 children 39 were found infected with one or more intestinal parasites. The prevalence of *Giardia lamblia*, *Entamoeba coli* and *Entamoeba histolytica*, *Ascaris lumbricoides*, hookworm and *Taenia solium* infections as determined by formol ether concentration technique were 13.3%, 7.5%, 5.8%, 3.3%, 1.7% and 0.8% respectively (Butera et al., 2019).

5. Risks Factors Associated with Intestinal Parasites

Health education access, water availability, participation in school health clubs, functional toilet availability, hand washing habits, environmental hygiene, shoe wearing habits, open defecation practices, and health facility visit were variables used to assess the potential associated factors of high parasitic infection in the study of 2014 among school children in Ethiopia (Hailemeskel et al., 2020).

Other risks associated with intestinal parasitic infections but have correlation with those stated in the previous paragraph are personal hygiene factors, environmental factors, social economic status and genetic factors. Interactions of these factors influence the infection rate and morbidity associated with intestinal parasites infections (Hailegebriel et al., 2020)

5.1 Personal Hygiene Factors

It has been reported that in all tropical, subtropical and temperate regions where standards of hygiene are low, infection of intestinal parasites follow ingestion of food and/or water contaminated with intestinal parasites (Hailegebriel et al., 2020). Walking without wearing shoes in moist soils has been associated with high intensity of hookworm infections as a result of skin penetration (Butera et al., 2019). The filarial form larvae of the hookworms, *Strongyloides stercoralis* and *Schistosomes* may also penetrate into the human body when people swim in contaminated waters or work in the farms without protective gear (Ruberanziza et al., 2019).

5.2 Environmental Factors

Moist and warm soils are required to complete the life cycles of hookworms, hence transmission can occur year round in tropical and subtropical countries, while in cooler or drier climates, transmission occurs only in warmer or wet seasons (Emile et al., 2013).

5.3 Human Behavior and Social Economic Factors

Specific occupations and behavior influence the prevalence and intensity of intestinal parasitic infections with intestinal parasites have been found to be endemic among this remote farming community, showing a strong association between low social economic status and the prevalence of intestinal parasitic infections. Sub-factors that significantly correlate with social economic status include; household crowding, literacy, use of protective clothing, defecating practices, food handling practices and source of drinking water. These factors have been identified as being important determinants for prevalence and intensity of infection with intestinal parasites in any locality (Testad et al., 2013).

5.4 Genetic Factors

Over dispersion is a common feature of population distribution patterns of intestinal parasitic infections in human indicating that certain human populations may have increased genetic susceptibility (Krogsgaard et al., 2015). Epidemiological studies suggest that particular populations of individuals could be more predisposed to acquiring heavy hookworm infections despite multiple exposures to parasites and even anthelminthic chemotherapy, indicating genetic influence (Bharti et al., 2018)

6. Some Intestinal Parasites Their Transmission, Life Cycle Pathology, Prevention and Treatment

6.1 Hookworms

6.1.1 Life Cycle of Hookworms

Adult hookworms inhabit the small intestines of human where they lay eggs containing segmented ova that are passed out in faeces and hatch in moist warm soils into larvae. While *Ancylostoma duodenale* can be ingested the usual method of infection is through skin penetration of filariform larvae; this is usually caused by walking barefoot or working without protective gear in soils contaminated with fecal matter. The larvae hatch and penetrate the skin then migrate through the vascular system to the lungs, and from there up to the trachea, and are swallowed. They then pass down the digestive system into the small intestines where they mature into adult worms. They mate inside the host and the female lays up to 240.000 eggs per day and some may lay about 18 to 54 million egg during their life time which pass out in feces (Emile et al., 2013).

6.1.2 Pathology of Hookworm Infections

Symptoms of hookworm infections are related to the intensity, thus light infections are often asymptomatic whereas a mild to heavy infections disrupts the nutritional status of the host (Maurelli et al., 2021). Ground itch, which is an allergic reaction at the site of larvae penetration, is common in patients infected with *Necator americanus* (Hailegebriel et al., 2020). Additionally, cough and pneumonitis may result as larvae begin to break into the alveoli and travel up the trachea. Once the larvae reach the small intestines, the individual may suffer from diarrhea and other gastro-intestinal discomfort (Mockenhaupt et al., 2016).

Heavy intensity of hookworm infection causes major morbidity due to intestinal blood loss, iron deficiency anemia, and protein malnutrition. The most significant risk of hookworm infection is anemia, secondary to loss of iron and protein in the gut. Studies done in Brazil among urban and indigenous children have shown that heavy hookworm infections affect learning capacity and impair physical and mental growth of students (Chandrashekhar et al., 2011). This in the long run hinders educational achievements and economic development (Leonidas et al., 2013)

6.1.3 Diagnosis and Treatment of Hookworm Infections

Diagnosis of hookworm infections is by demonstration of characteristic eggs in faeces by direct microscopy or by concentration methods. The recommended treatments are albendazole and mebendazole, which are effective both in intestinal stage and during the stage the larvae is still migrating under the skin (Mark Jourdan et al., 2018). WHO (2012) also recommends anthelminthic treatment in pregnant women after first trimester while for patients who suffer from anemia ferrous sulfate should be administered (Bharti et al., 2018).

6.2 *Ascaris lumbricoides*

6.2.1 Life Cycle

Ascaris lumbricoides adult worms reside in small intestines where they pass out eggs containing unsegmented ova together with faeces. The female can lay up to 240 000 eggs per day for a year The fertilized eggs require moist soils and warm temperatures to embryonate and become infective if ingested. These eggs can persist in the soil for up to 10 years or more because of a lipid layer that makes them resistant (Al-Tameemi & Kabakli, 2020). Once ingested, the eggs hatch in the small intestines into larvae that penetrate the walls of duodenum and get into the circulation and migrate into the lungs. They are coughed and swallowed into the small intestines where they mature into adults (Maurelli et al., 2021).

6.2.2 Pathology of *Ascaris lumbricoides* Infections

Ascaris lumbricoides infections are usually asymptomatic, clinical disease is largely restricted to individuals with heavy infection (Maurelli et al., 2021). Symptoms are related to either to larvae migrating stage or adult worms in the large intestines. Heavy infections lead to intestinal obstruction especially at ileocolic valve causing colicky abdominal pain, vomiting and constipation (Maurelli et al., 2021). Migrating larvae may cause inflammation and hypersensitive reactions in the lungs leading to formation of granuloma and eosinophils infiltration. This condition in the lungs can lead to Loffler's pneumonia in which pools of blood and dead epithelial cells clog air spaces in the lungs (Shah & Shahidullah, 2018).

6.2.3 Diagnosis and Treatment of *Ascaris lumbricoides*Infections

Eggs may be detected in stool samples by microscopy or concentration by formalin ether technique. During pulmonary phase, the larvae may be found in fluid aspirated from lungs or detected in sputum (Bharti et al., 2018). Sero-diagnosis techniques such as IHA and IFAT are useful in diagnosis of extra intestinal ascariasis (Bharti et al., 2018). The treatment recommended by WHO are albendazole, mebendazole, levamisole or pyrantelpamoat (Bharti et al., 2018). Corticosteroids can be used to treat some symptoms such as inflammation (Sateriale et al., 2021).

6.3 *Entamoeba histolytica*

6.3.1 Life cycle

Entamoeba histolytica developmental stages generally consists of feeding trophozoites or cysts stages both of which may be present in stool of infected person. The trophozoites stage exists in host's tissues, body fluids and loose stool. While trophozoites are ideally suited for their parasitic mode of existence, they do not survive long outside the host and if ingested they are easily destroyed by gastric acid in the host's stomach. Cysts are usually found in formed stool and survive outside the host in water, soil and or food especially on moist conditions. Human get infected by ingestion of cysts in fecally contaminated water, food or hands but they may also be transmitted through anal-oral sex (Bharti et al., 2018). The excystment occurs in the stomach and trophozoites move to the small intestines then to large intestines where they live and multiply and pass out cysts or trophozoites in faeces (Emile et al., 2013).

6.3.2 Pathology of *Entamoeba histolytica* Infections

Amoebiasis can be asymptomatic, or may lead to amoebic dysentery or liver abscesses. In acute amoebiasis, there is severe dysentery with bloody diarrhea, mucus and necrotic mucosa accompanied by acute abdominal pain tenderness and fever. The amoeba trophozoites can bore into intestines causing lesions. In extra intestinal amoebiasis, the liver is chiefly invaded, resulting in amoebic hepatitis or liver abscesses which can be fatal if untreated. Less frequently abscesses may be seen in lung, spleen, brain, kidney, skin and gonads leading to severe pathological conditions (Cross et al., 2020).

6.3.3 Diagnosis and Treatment of *Entamoeba histolytica*

The protozoan infections are diagnosed by showing the presence of trophozoites in loose stool and cysts in formed stool or colonic scrapings from ulcerated areas in cases of amoebiasis (Trabelsi et al., 2010). Diagnosis of amoebiasis by microscopic identification of the cysts and protozoa in stool samples is insensitive and unable to distinguish invasive *Entamoeba histolytica* which causes intestinal and extra-intestinal amoebiasis from the commensal *Entamoeba dispar* (Mark Jourdan et al., 2018). The alternative to microscopy diagnosis is ELISA which identifies *Entamoeba histolytica* antigens in stools or antibody in serum. Serological techniques that have been used for immunodiagnosis of amoebiasis are complement fixation, IFAT and latex agglutination (Cross et al., 2020). Prevention of amoebiasis requires interruption of the fecal-oral spread of the infectious cyst stage of the parasite (Omrani et al., 2015). Since the cysts are resistant to low doses of chlorine or iodine.

In developing countries water must be boiled before it is safe to drink and raw vegetables must be washed with soap and then soaked in vinegar for 15 minutes before they can be eaten (Ibrahim & Soliman, 2010). Since amoebiasis often spreads through households, it is important to screen family members for intestinal amoebiasis infections (Ibrahim & Soliman, 2010). Intestinal infections are usually treated with nitromidazole derivatives as they are effective against trophozoites stage. Since these medications have no effects on cysts, the treatment is followed by agents such as paromomycin or diloxanidefuroate. Liver abscesses are treated with drugs like metronidazole and chloroquine (Hailegebriel et al., 2020).

6.4 *Giardia Lamblia*

6.4.1 Life Cycle and Transmission of *Giardia lamblia*

Mature cysts are the infective form of *Giardia lamblia* and infection is initiated when cysts are ingested in contaminated water or food or through direct fecal oral contact which may occur during oral sex (Amer et al., 2017). The cysts are highly resistant to environmental conditions, being able to survive in cold mountain streams; stomach acids, chlorine and even UV treated water (Butera et al., 2019). It is consequently, the cause of many infections occurring in recreational facilities (Mark Jourdan et al., 2018).Once the cysts are ingested excystation occurs in the duodenum releasing numerous trophozoites which are in active stage of feeding and motility (Mark Jourdan et al., 2018). The trophozoites undergoes asexual replication through longitudinal binary fission, the resulting trophozoites form cysts which then pass through the digestive system in the faeces. While the trophozoites may be found in the faeces, only the cysts are capable of surviving outside of the host (Shah & Shahidullah, 2018).

The cyst can survive for weeks to months in cold water hence can be present in contaminated wells and water systems, especially stagnant water sources, such as naturally occurring pools, water storage systems, and even clean-looking mountain streams (Shah & Shahidullah, 2018). They may also occur in city reservoirs and persist after water treatment, as the cysts are resistant to conventional water treatment methods, such as chlorination, *Giardia lamblia* is a potential zoonotic with threats from livestock and other domesticated animals especially in settings where animals are closely integrated in the community (Amer et al., 2017).

6.4.2 Pathology of *Giardia lamblia* Infections

*Giardia lamblia*does not penetrate the intestinal wall but feed on mucous secretions. The trophozoites attach themselves with the help of the sucking discs onto the surface of the epithelial cells in the duodenum hence may cause inflammation. Large number of trophozoites may lead to malabsorption especially of fat-soluble substances such as vitamin B12 (Caler and Lorenzi, 2010). Patients may complain of dull epigastric pain, flatulence and chronic diarrhea of steatorrhea type (Cross et al., 2019).

6.4.3 Diagnosis and Treatment of *Giardia lamblia*

Giardia lamblia infections can be diagnosed by microscopic identification of cysts in formed stool and trophozoites in diarrhea stool using normal saline and iodine preparation. Multiple stool examinations are recommended, since the cysts and trophozoites are not shed consistently (Butera et al., 2019). Trophozoites of *Giardia lamblia*may be detected in the bile aspirated from duodenum by incubation and by enterotest (Butera et al., 2019). For detection of *Giardia lamblia* in faeces specimens, a fluorescent method using monoclonal antibodies is extremely sensitive and specific, anti-giardia antibodies, in patient serum, may be detected by ELISA and IFAT (Maurelli et al., 2021). Treatment of giardiasis is carried out with metronidazole and furazolidone. Metronidazole is very effective but has potential carcinogenicity in rats (Emile et al., 2013). Tinidazole has proven more effective than metronidazole as a single dose (Butera et al., 2019)

7. General Method of Prevention and Control of Intestinal Parasitic Infections

Prevention and control of intestinal parasitic infections is aimed at reducing morbidity and re-infection among populations. Intervention measures are also aimed at reducing environmental contamination with parasites eggs and cysts and interrupting their life cycles.

7.1 Environmental Sanitation and Hygiene

Proper disposal of human and animal waste, prevents contamination of food and drinking water sources, especially intestinal parasitic infections that are transmitted by fecal-oral route (Omrani et al., 2015). Control of flies and other vectors in food selling points prevents dispersal of infective stages of intestinal parasites in food (Sakti et al., 2018). Studies indicate that washing hands, raw vegetables, fruits and utensils prevent cross contamination of food with eggs and cysts of intestinal parasites. Adequate cooking of food destroys all stages of intestinal parasites; however, microwave cooking does not reliably kill all parasites in food stuff because heating is uneven and may permit survival of some parasites (Ibrahim & Soliman, 2010). Foods sold in markets may be contaminated by hands that have not been washed after defecation or from flies that land on both food and faeces hence increased risks of transmission of intestinal parasites to consumers (Bharti et al., 2018)

7.2 Health Education

Intestinal parasitic infections can be prevented or greatly reduced through cost effective interventions such as avoiding ingestion of contaminated food stuff. Food safety measure help prevents intestinal parasitic infections which are transmitted through food and water. Proper food handling techniques should be applied and asymptomatic carriers should be removed from food handling occupations and treated (Emile et al., 2013). Health education involves the following; drug treatment for those already infected, because they can act as reservoir for intestinal parasites, sanitary and personal hygiene improvement to avoid re-infection and break their life cycles preventing person to person transmission, hygienic food handling techniques and hand washing (Ndishimye, 2020).

Proper personal hygiene, for example, washing of hands with soap after visiting toilets and before handling food should be practiced. A study done in Nigeria showed that washing hands greatly reduced infection with STH among urban residents (Hailegebriel et al., 2020). People should be educated on proper sanitation, which involves promotion of use of latrines hence discouraging the use of human excreta as fertilizer in agriculture (Cross et al., 2019). Such latrines should include the pour flush and septic tanks, which are superior from hygienic point of view to traditional latrines (Krogsgaard et al., 2015).

Toilets should be kept clean and flies should be controlled, to prevent them from mechanically carrying cysts and eggs to food. Health education should be multidisciplinary where various stakeholders were involved to educate the public on sanitation and personal hygiene in controlling intestinal parasitic infection.

7.3 Treatment of Water

Safe drinking water is a proven intervention measure that consistently reduce diarrheal disease incidence among users in developing countries in the world. Chlorination and / or filtration of drinking water have been hailed as a major method of ensuring safe drinking water. However, some cysts and oocytes are resistant to chlorination (Butera et al., 2019).

7.4 Chemotherapy

The popular approach to control of intestinal parasitic infections is through school deworming programs. According to WHO, institutions have a number of advantages as they allow policymakers to use the existing infrastructure and institutions for dispensation of medical treatment. Furthermore, students already plan to attend school on regular basis hence health education can be incorporated (Utzinger et al., 2010). A much larger and rapidly growing children population in developing countries remains untreated and suffering from more than one parasitic infection (Wumba et al., 2010). In 2012, 285 million children in need of treatment received anthelminthic drugs corresponding to a global coverage of 32.6% (Utzinger et al., 2010).

In developing countries, groups at higher risk of STH are often treated without prior diagnosis; these groups identified by WHO are pre-school and school age children, women of child bearing age and adults in occupation such as medical laboratory technicians, where there is high risk of infection. WHO strategy for reduction of intestinal parasitic infections is by control of morbidity through periodic treatment of the people at risk such as pre-school and school-age children living in endemic areas. For such groups they recommend deworming without previous diagnosis (Archer et al., 2021).

Treatment should be given once every three months. Periodic deworming can be integrated with school health programs as they allow easy provision of health and hygiene educational components such as hand washing and provision of proper sanitation. Integration of STH control programs in the school system has been effective in Nigeria (Anderson & Medley, 2018). Studies have shown that deworming in schools reduce the burden of disease in neighboring untreated schools, in addition it has benefits of reducing adult infection rates since children are significant source of transmission (Bharti et al., 2018). The recommended medicines albendazole 400mg and mebendazole 500mg are effective, inexpensive and easy to administer by non-medical personnel such as teachers (Sateriale et al., 2021). These medications are donated to the national Ministries of Health through WHO with the global target of eliminating morbidity due to STH by 2020 (Hailegebriel et al., 2020).

7.5 Integrated Methods

Studies have demonstrated that combined treatment to eliminate the helminths, improved sanitation aimed at reducing environmental contamination and health education to control the spread and transmission of intestinal parasites, are more efficient in elimination of intestinal parasites among populations than any single method.

7.6 Conceptual Framework

First of all, an independent variable is the variable you manipulate, control, or vary in an experimental study to explore its effects. In other words, independent variables are like causes. Whereas, dependent variablesare expected to change as a result of an experimental manipulation of the independent variable or variables i.e., dependent variables are like the effects. Intermediate variables are part of the effects that the exposure has on the outcome. Intermediate variables lie in the causal pathway of interest, meaning that the exposure affects the outcome through affecting the intermediate variable, i.e., the exposure has an indirect effect on the outcome.

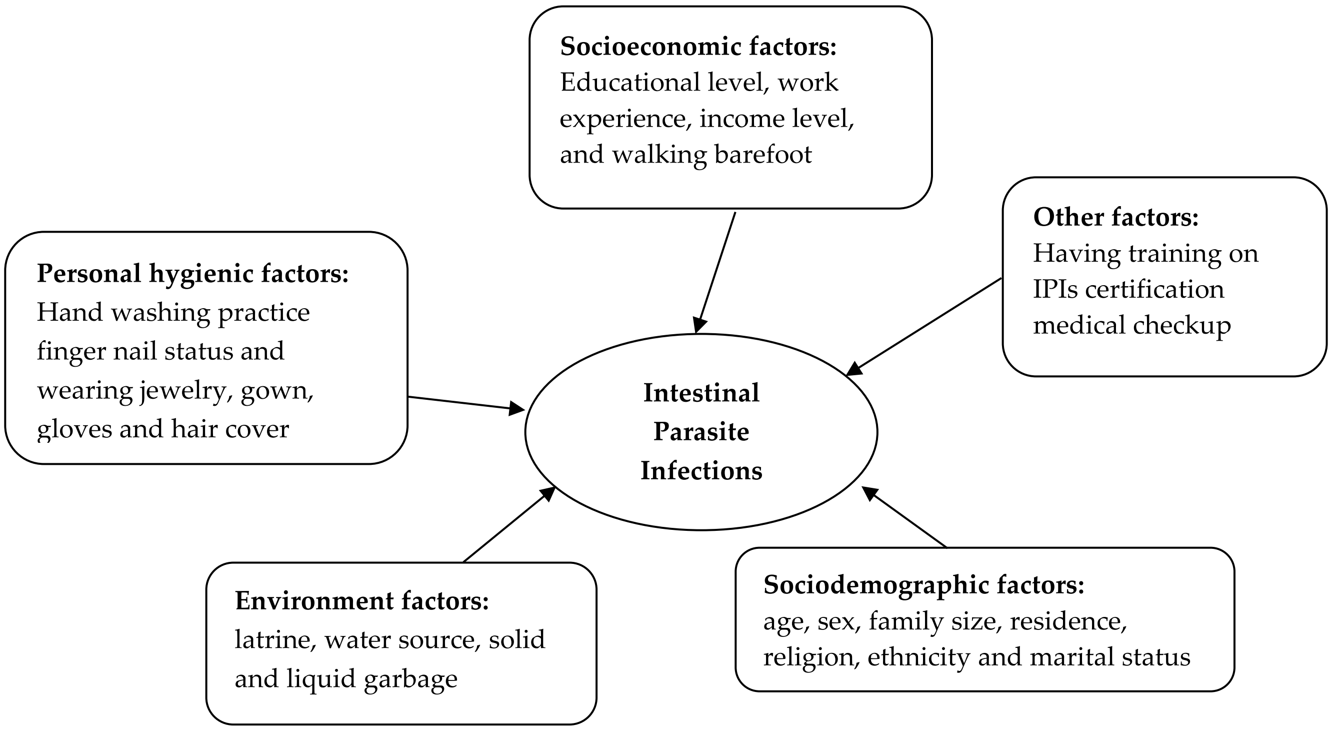

Figure 1: Conceptual frame work

In Figure 1, dependent variables are intestinal parasites. Independent variables are educational level, work experience, income level and walking bare foot (social economic factors), hand washing practices, finger nail status, wearing jewelry, gown, gloves, and hair cover (personal hygienic factors), latrines, water source, and soil and liquid garbage (environmental factors). Intermediate variables are age, sex, family size, residence, religion, ethnicity and marital status.

From this figure, dependent variables (intestinal parasites) depend on independent variables lack of hand washing, poor socio-economic, eating unwashed fruits and vegetable, use human feces as fertilizer and drinking of contaminated water, intermediate variables ages and gender.

8. Methodology

The study was taking place at one of Second Teaching Hospital located in Rwanda, Western Province, Nyamasheke district, Kibogora cell, Kanjongo sector. The district is among Kivu belt districts which lies on the shores of Lake Kivu. The District of Nyamasheke is subdivided into fifteen (15) administrative Sectors Ruharambuga, Bushekeri, Bushenge, Cyato, Gihombo, Kagano, Kanjongo, Karambi, Karengera, Kirimbi, Macuba, Nyabitekeri, Mahembe, Rangiro and Shangi), 68 Cells and 588 Villages (Imidugudu). Kibogora Level Two Teaching Hospital serves about 400.000 people per year with two hundred seventy-three beds and about three hundred employees.

The study adopted a quantitative approach to collect data from the respondents. First advantage of this research approach is the use of statistical data as a tool for saving time and resources. Bryman (2001, p.20) argues that quantitative research approach is the research that places emphasis on numbers and figures in the collection and analysis of data. Imperatively, quantitative research approach can be seen as being scientific in nature. study adopted a cross-section design to determine the prevalence of intestinal parasites and associated risk factors among under-five children. Data to determine the prevalence of intestinal parasites were retrospectively collected from the laboratory registers from January 2019 to May, 2022. On other hand, to assess the risk factors associated with intestinal parasites occurrence, data were collected from the parents or children guardians.

9. Results and Discussion

9.1 Data Presentation and Analysis

9.1.1Demographical Characteristics of Respondents

The total number of participants who attended Kibogora Level Two Teaching Hospital was 263 (Table 1). Over half of participants were male 15 (5.7%); females were 248 (94.3%). Religion was divided into three group as following: Muslims were 18 (4.9%), Christians were 241 (91.6%), none were 4 (3.4%). The majority were married 241 (91.6%) while singles were 13 (4.9%), widowers were 9 (3.4%) Furthermore, on occupation, 111 (42.2 %) were classified as civil servants, 149 (56.7%) were farmers. The socioeconomic statuswas classified as: Category One were 40 (15.2%), Category Two were 202 (76.8%), Category Three were 18 (6.8%) and Category Four were 3 (1.1 %).

Table 1: Socio-demographic characteristics of the parent and children's guardian respondents (N=263)

Characteristics	Frequency	Percentage (%)
Gender		
Female	248	94.3
Male	15	5.7
Religion		
Muslims	18	4.9
Christians	241	91.6
None	4	3.4
Socio-economic category		
Category One	40	15.2
Category Two	202	76.8
Category Three	18	6.8
Category Four	3	1.1
Marital status		
Single	13	4.9
Married	241	91.6
Widow	9	3.4
Occupation		
Civil servants	111	42.2
Farmers	149	56.7
None	3	1.1
Total	**263**	**100**

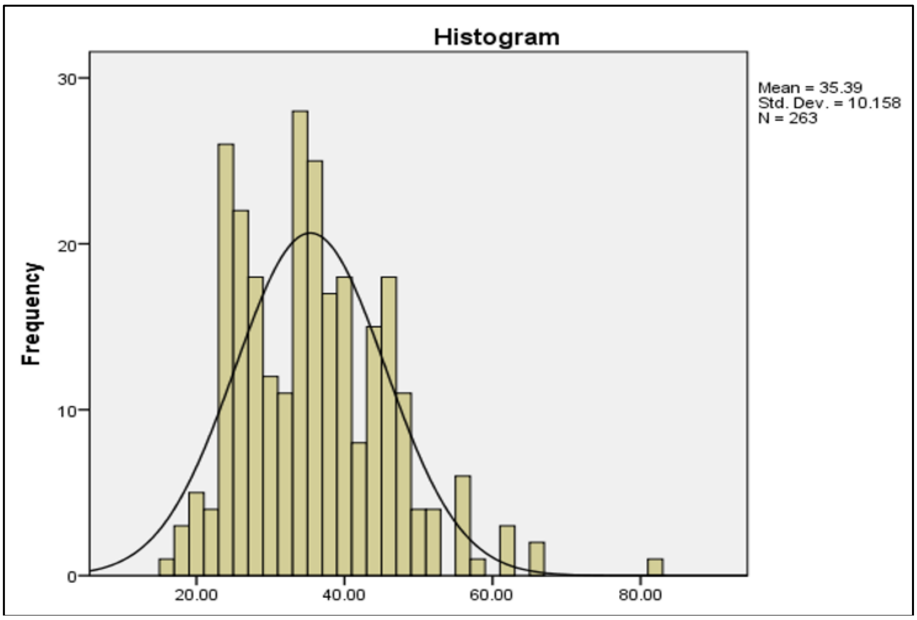

Figure 2: Age of parents and guardians of under-five year children attending a Kibogora Level Two Teaching Hospital in Rwanda, 2022

Were present statistic age of participants. The mean of age was 35.3, the mode was 25 years, and the median of age was 35.3. The standard deviation was 10.158 (Figure 2).

9.2 Prevalence of Intestinal Parasites among Under-Five Year Children

The total of 263 patients attended Kibogora Level Two Teaching Hospital for stool examination was investigated. Results shown in table above it highlights five (5) species of intestinal parasites of helminths and protozoan. In these parasites seven are pathogenic and one of non-pathogenic (*Ascaris lumbricoides*). Also, the proportion of helminths is slight exceed the number of intestinal protozoans. These parasites were differentiated based on morphological characteristics. The overall prevalence of intestinal parasites was 102 (38.7%). The most prevalent intestinal parasites were identified in helminths are *Ascaris lumbricoides* while the medical protozoans are *Entamoeba histolitica*, *Giardia lamblia* and *Trichomonas intestinalis*, *Ankilostoma duodenale.*

A total of 263 children under the age of five were selected for the study (Table 2). Microscopic stool sample examination revealed that approximately one in two children out of the 263 children surveyed were found to be infected with at least one intestinal parasite. The prevalence of *Ascaris lumbricoides* 56 (21.3%) was the highest followed by amoeba (*Entamoeba histolytica*) 24 (9.1%), *Giardia lamblia* 8 (3.0%), *Trichomonas intestinalis* 7 (2.6%) and *Ankilostoma duodenale* 7 (2.6%). Other intestinal parasites detected such as *Necator americanus* and *Trichiuris trichiura* were identified at less than one percent prevalence.

Table 1: Prevalence of intestinal parasites among under-five year children

Intestinal parasites	May 2019 - April 2020				May 2020 - April 2021				May 2021 - April 2022				Confirmed cases (n=263)		Grand totals & percentages
	95 Children under five years				89 Children under five years				79 Children under five years						
	Tested for intestinal parasites		Confirmed cases & percentages		Tested for intestinal parasites		Confirmed cases & percentages		Tested for intestinal parasites		Confirmed cases & percentages				
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	M&F
Ascaris lumbricoides	28	17	18 (18.9%)	11 (11.5%)	26	15	10 (11.2%)	6 (6.7%)	15	9	7 (8.8%)	4 (5%)	35	21	**56 (21.3%)**
Entamoeba histolitica	12	8	4 (4.2%)	2 (2.1%)	11	9	7 (7.8%)	5 (5.6%)	13	11	3 (3.7%)	2 (2.5%)	14	10	**24 (9.1%**
Giardia lambrias	3	5	0 (0%)	1(1%)	4	7	2 (2.2%)	2 (2.2%)	7	4	2 (2.5%)	1 (1.2%)	4	4	**8 (3.0%)**
Trichomonas Intestinalis	7	4	2 (2.1%)	1 (1%)	3	2	0 (0%)	1 (1.1%)	6	3	2 (2.5%)	1 (1.2%)	4	3	**7 (2.6%)**
Ankilostoma duodenale	6	5	1(1%)	1 (1%)	4	8	1 (1.1%)	2 (2.2%)	6	5	1 (1.2%)	1 (1.2%)	3	4	**7 (2.6%)**
Total	**56**	**39**	**25 (26.3%)**	**16 (16.8%)**	**48**	**41**	**20 (22.4%)**	**16 (17.9%)**	**47**	**32**	**15 (18.9%)**	**9 (11.3%)**	**60**	**42**	**102 (38.7%)**

9.3 Water Sources and Utilization

In the 263 participants, looking at water source at home (20.2%) uses spring while (79.8%) use wells and rivers. A half reported that they never wash hands before meal (54.8%), 57.0% never wash their hands after defecation, and (88.6%) with no available utensils dry site at home, (87.8%,) use animal’s wastes or faces as fertilizer, 11.4% have no washing sites, eating raw food 6.5%, and 1.1% have no latrines at home. The factors associated with having any intestinal parasites included farming, water treatment, and water source (Table 3).

Table 3: Water sources and utilization

Variables	Answers	Frequency	Percent (%)
Drinking unboiled water	Always	21	8.0
	Occasionally	185	70.3
	Never	57	21.7
Washing hands before meal	Always	21	8.0
	Occasionally	98	37.3
	Never	144	54.8
Washing hands after defecation	Always	5	1.9
	Occasionally	108	41.1
	Never	150	57.0
Eating raw food	Yes	17	6.5
	No	246	93.5
Have water source at home	Spring	53	20.2
	Wells or rivers	210	79.8
Using animals or faces fertilizer	No	32	12.2
	Yes	231	87.8
Availability of latrine	Yes	260	98.9
	No	3	1.1
Available wash sites	Yes	234	89.0
	No	29	11.0
Availability of utensils dry site at home	Yes	30	11.4
	No	233	88.6

9.4 Risk Factors Associated with Intestinal Parasites among Under-five Year Children

Table 4 shows the relationship between demographic characteristics and what the children provided as their daily hygiene-related variables.

A chi-squared test was used to establish relationship between different variables. The chi-squared shows that there is a statistically significant association between marital status category of the children and having latrine at home with chi-squared value of

8.290 and p-value of .01 there was statistically significant association. Drinking boiled water with chi-squared value of 7.857[a] and p-value of .97 Washing hands before meal with chi-squared value of 7.857[a] and p-value of .98 Washing hands after defecation with chi-squared value of 3.293 and p-value of .193 there is no statistical significance. There is a statistically significant association between Religion category of the children and having utensils washing site with chi-squared value of 5.422[a] and p-value of .000* there was statistically significant association.

Table 4: Associations between demographic characteristics and water sources and utilization

	Drinking boiled water		**Washing hands before meal**		**Washing hands after defecation**		**Having water source at home**		**Having latrine at home**		**Having utensils washing site**	
	(χ2) value	**p-value**	**(χ2) value**	**p-value**	**(χ2) value**	**p-value**	**(χ2) value**	**p-value**	**(χ2) value**	**p-value**	**(χ2) value**	**p-value**
Sex	.248a	0.883	.926[a]	0.69	3.293a	0.193	.913a	0.339	. 913a	0.668	3.665a	0.56
Marital Status	7.857[a]	0.97	7.857[a]	0.98	3.293	0.193	.164[a]	0.559	8.29	.01*	3.048[a]	0.218
Religion	5.634[a]	0.228	1.274[a]	0.866	3.620[a]	0.46	2.172[a]	0.338	.277[a]	0.871	5.422[a]	.000*
Occupation	.709[a]	0.95	.832[a]	0.305	2.079[a]	0.721	.734[a]	0.94	.756[a]	0.695	1.976[a]	0.372
Ubudehe category	4.649a	0.59	2.830a	0.83	17.619a	.007*	1.479a	0.687	15.319	.002*	.980[a]	0.806

*Person's Chi-square Tests was used with Fisher Exact Tests where appropriate. Significance was set at p<.05 at 95 CI.

10. Discussion of Findings

Most of the existing data on intestinal parasitic infections has been based on children of under-five years old. This study accessed the prevalence of intestinal parasites associated risk factors in children under-five years old found that prevalence of intestinal parasites was 38.7% which is higher than the current study conducted in Rutsiro discovered that in one of two children (32.8%) were found to be infected with at least one intestinal parasite.

Ascaris lumbricoides (28.5%) was the most prevalent infection followed by *Entamoeba histolytica* (25.95%) and *Giardia lamblia* (19.6%) (Butera et al., 2019). Comparing with above previous findings, in this study the prevalence of *Ascaris lumbricoides* 56 (21.3%) was the highest followed by amoeba (*Entamoeba histolytica*) 24 (9.1%), *Giardia lamblia* 8 (3.0%), *Trichomonas intestinalis* 7(2.6%) and *Ankilostoma duodenale* 7 (2.6%). Other intestinal parasites detected such as *Necator americanus* and *Trichiuri strichiura* were identified at less than one percent prevalence. The only types of intestinal parasitic infections among the primary school students studied were protozoa; helminthso it can affect the children under-five years old.

We found that in your study water source at home (20.2%) uses spring while (79.8%) use wells and rivers. A half reported that they never wash hands before meal (54.8%), 57.0% never wash their hands after defecation, and (88.6%) with no available utensils dry site at home, (87.8%,) use animal's wastes or faces as fertilizer, 11.4%have no washing sites, eating raw food 6.5%, and 1.1% have no latrines at home. The factors associated with having any intestinal parasites included farming, water treatment, and water source and also the current study conducted at Huye District water source at home was (15.33%) uses spring while (57.8%) use wells and rivers. A half reported that they never wash hands before meal (62.8%), 63.0% never wash their hands after defecation, and (87.6%) with no available utensils dry site at home, (59.8%), use animal's wastes or faces as fertilizer, 1.4% have no washing sites, eating raw food 11.5%, and 0.1% have no latrines at home we conclude that there is impact of factor associated with the area or location of population are, so the risk factors associated with the intestinal parasite in our study we found that the children provided as their daily hygiene-related variables. A chi-squared test was used to establish relationship between different variables. The chi-squared shows that there is a statistically significant association between marital status category of the children and having latrine at home with chi-squared value of 8.290 and p-value of .01 there was statistically significant association. Drinking boiled water with chi-squared value of 7.857[a] and p-value of .97 washing hands before meal with chi-squared value of 7.857[a] and p-value of .98 washing hands after defecation with chi-squared value of 3.293 and p-value of .193 there is no statistical significance. There is a statistically significant association between religion category of the children and having utensils washing site with chi-squared value of 5.422 and p-value of .000 there was statistically significant association.

11. Summary of Findings

A total number of 263 children under-five years old. Prevalence of intestinal parasites was 102 (38.7%). The most prevalent intestinal parasites were identified in helminths are *Ascaris lumbricoides* while the medical protozoans are *Entamoeba histolitica*, *Giardia lamblia* and *Trichomonas intestinalis*, *Ankilostoma duodenale* so prevalence of each intestinal parasite was distributed us follow *Ascaris lumbricoides* 56 (21.3%) was the highest followed by amoeba (*Entamoeba histolytica*) 24 (9.1%), *Giardia lamblia* 8 (3.0%), *Trichomonas intestinalis* 7 (2.6%) and *Ankilostoma duodenale* 7 (2.6%). Other intestinal parasites detected such as *Necator americanus* and *Trichiuris trichiura* were identified at less than one percent prevalence. The study shows that there were more factors that influencing the intestinal parasites was water source at home (20.2%) uses spring while (79.8%) use wells and rivers. A half reported that they never wash hands before meal (54.8%), 57.0% never wash their hands after defecation, and (88.6%) with no available utensils dry site at home, (87.8%,) use animal's wastes or faces as fertilizer, 11.4%have no washing sites, eating raw food 6.5%, and 1.1% have no latrines at home. Children provided as their daily hygiene-related variables. A chi-squared test was used to establish relationship between different variables. The chi-squared shows that there is a statistically significant association between marital status category of the children and having latrine at home with chi-squared value of 8.290 and p-value of .01 there was statistically significant association. Drinking boiled water with chi-squared value of 7.857 and p-value of .97 washing hands before meal with chi-squared value of 7.857 and p-value of .98 washing hands after defecation with chi-squared value of 3.293 and p-value of .193 there is no statistical significance. Non proper utensils washing site with chi-squared value of 5.422 and p-value of .000 there was statistically significant association.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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