



## Intestinal Parasitic Infections and their Relationship with Healthy Living Behavior and Nutritional Status in Children

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### Abstract

Intestinal parasitic infection is an infectious disease still found in tropical countries with inadequate implementation of Clean and Healthy Living Behavior (PHBS). Parasites that generally infect the intestines are soil-borne worms and protozoa. The worms that infect a lot are Soil Transmitted Helminths (STH), namely *Ascaris lumbricoides*, *Trichuris trichiura*, and Hookworm. Cryptosporidiosis is an infectious disease caused by infection with the protozoan *Cryptosporidium* sp. that causes watery diarrhea. Nutritional status is an important factor in the immune system. The purpose of this study was to identify STH and *Cryptosporidium* sp infections and link them with the application of PHBS and nutritional status in elementary school students in Wori District, North Minahasa Regency. This type of research is descriptive-analytic with a cross-sectional design. The sample amounted to 160 respondents from six elementary schools taken by purposive sampling. STH examination using the native method and *Cryptosporidium* sp examination using Zn modification staining, nutritional status measurement was carried out based on BMI / U. This study concluded that 100% of respondents were not infected with *Cryptosporidium* sp parasites, 8% of respondents were infected with Soil-Transmitted Helminth and there was no relationship with nutritional status respondents where 87% of respondents have normal nutritional status, 5% undernourished, 6% well-nourished and 2% obese.

### INTRODUCTION

Intestinal parasitic infection is an infectious disease still found in tropical countries with inadequate application of clean-living behavior. Parasites that generally infect the intestines are soil-borne worms and protozoa. The worms that infect a lot are Soil Transmitted Helminths (STH), namely *Ascaris lumbricoides*, *Trichuris trichiura*, and Hookworm. Cryptosporidiosis is an infectious disease caused by infection with the protozoan *Cryptosporidium* sp that causes watery diarrhea. This parasite infection is usually found through contamination of water, food, soil, or on dirty hand surfaces; because it is contaminated by human and animal feces containing infectious agents, it is classified as a waterborne and soil-transmitted disease. These parasites spread

evenly throughout the world. During 2001-2010 it became the leading cause of *waterborne outbreak* in the United States. Information on *Cryptosporidium* sp infection in Indonesia is very limited because there have not been many research publications on this infection (Wijayanti, 2017).

Anyone can be infected with STH and *Cryptosporidium* sp but people with low immune status will show more severe symptoms than those with good immune status. Immunity status is related to nutritional status, and sensitive nutrition and specific nutrition interventions are related to nutritional status (Migang *et al.*, 2020). Nutritional status is an important factor in the immune system; If a person's nutrition decreases, it will experience a decrease in immune function due to a lack of

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energy intake, and macro and micronutrients (Fast & Sudargo, 2021). Publications on the nutritional status of school children in North Sulawesi were not found, but data from the North Sulawesi Provincial Health Office in 2016 there were 21 cases of malnourished toddlers with a percentage of malnutrition of 1.4%. The nutritional status of toddlers in the North Minahasa Health Office, based on data from the annual report of the nutrition program in 2016, is known that the nutritional status of toddlers who are well nourished as many as 11364 children, malnourished as many as 227 children and malnourished as many as 3 children (Latta *et al.*, 2017).

Elementary school children are an age group that is susceptible to parasitic infections, this is because they have the habit of playing or contact with the soil by not paying attention to personal and environmental hygiene, where this can be a risk factor for worm infections. The government's mass treatment program has been implemented to reduce the incidence of worm infections in school children, but it will not have an impact if it is not followed by the implementation of clean and healthy behavior (Dc *et al.*, 2019). Research conducted by Lalangpuling *et al.* (2019) at SD GMIM Wori which is one of the schools in the Wori sub-district area shows that 60% of students still have the habit of playing dirt (Lalangpuling *et al.*, 2021).

Based on initial observations that have been made at SD Inpres Tiwoho which is one of the elementary schools in Tiwoho Village, Wori District, North Minahasa Regency. Where it was found that these children still have habits that do not pay attention to cleanliness such as playing barefoot, some children are also seen playing in the gutter, and on the coast, there are even found children who when defecating not in the latrine but on the beach, besides that when making observations there are houses around the garbage dump. So that these conditions can be a risk factor for infection. Based on the above background, the author is interested in researching the description of intestinal parasite infection examination and its relationship with nutritional status and clean and healthy living behavior (PHBS) in elementary school students in Wori District, North Minahasa Regency.

## METHOD

This type of research is descriptive-analytic. The study was conducted from February to May 2022. Specimen collection was carried out in six elementary schools in Wori District, North Minahasa Regency, namely GMIM Budo Elementary School, Pontoh Small Elementary School, Lansa Elementary School, Talawaan Bajo Elementary School, Lantung Elementary School and Kima Bajo Elementary School. The research began by coordinating with the school and Community Health Center of Wori District. The involvement of the school includes permission, and coordinating parents in their children's willingness as research respondents; Health workers from the Wori Community Health Centre coordinate to accompany research activities and are responsible for measuring students' height and weight to determine nutritional status. The respondents' parents were socialized with the purpose of the study and provided informed consent to be signed as a form of approval, then explained how to collect fecal specimens for examination. Specimen collection is carried out for five days. The respondents involved in this study were 160 students with a sampling technique, namely purposive sampling with the criteria of respondents not taking antihelminth drugs in the last 3 months, fecal specimens not mixed with water and urine, and sufficient sample volume for examination. Examination of intestinal parasite infection using the native method for STH examination and Ziehl-Neelsen (Zn) staining modification for *Cryptosporidium* *sp* examination, sample examination was carried out in the Parasitology laboratory Department of Technology Medical Laboratory Poltekkes Kemenkes Manado. Determination of nutritional status is obtained by measuring height and weight then determined nutritional status using an application based on the Z score value. Data on Clean and Healthy Living Behavior was obtained from interviews with students and parents of respondents. This research has been approved by the Manado Health Polytechnic Ministry of Health Research Ethics Committee No. KEPK.01/09/181/2023.

## RESULT AND DISCUSSION

Wori District is one of the sub-districts

in North Minahasa Regency. The research was conducted in six (6) elementary schools located in Wori District, namely GMIM Budo Elementary School, Pontoh Small Elementary School, Lansa Elementary School, Talawaan Bajo Elementary School, Lantung Elementary

**Table 1.** Characteristics and Clean and Healthy Living Behavior (PHBS) of Elementary School Children in Wori District in 2023

Respondents' Characteristics	Total (n)	Percentage (%)
<b>Gender</b>		
Man	93	58
Woman	67	42
Total	160	100
<b>Age (years old)</b>		
6	6	4
7	18	11
8	20	13
9	35	22
10	34	21
11	36	23
12	11	7
Total	160	100
<b>Parents' Work</b>		
Laborer	14	9
Farmer	71	44
Fishermen	32	20
Unpaid Workers	5	3
Private	37	23
Government employee	1	1
<b>Hand Washing</b>		
Yes	136	85
No	24	15
Total	160	100
<b>Sucking Fingers</b>		
Yes	75	47
No	85	53
Total	160	100
<b>Eating Food Dropped on the Ground</b>		
Yes	51	32
No	109	68
Total	<b>160</b>	<b>100</b>
<b>Playing the Soil</b>		
Yes	64	40
No	96	60
Total	<b>160</b>	<b>100</b>

School and Kima Bajo Elementary School. The total sample size of the six elementary schools was 160 respondents with the characteristics of respondents and the application of clean and healthy living behaviors seen in Table 1.

The majority of respondents are male at 58% with the highest age being 11 years old at 23%. The majority of respondents' parents' jobs were as farmers at 44%. Respondents aged six (6) to twelve (12) years, where this age is an age that actively play in the environment and often ignores cleanliness so that it can be classified as a risk group for infection with *Cryptosporidium sp* parasites. Table 1. shows the application of respondents' Clean and Healthy Living Behavior. 15% of respondents do not have the habit of washing hands and 47% of respondents have the habit of sucking fingers. The habit of eating fallen food again was carried out by 32% of respondents. 40% of respondents have the habit of playing with soil. From the table, there are still many respondents who have not implemented PHBS properly. Meanwhile, one of the risk factors for infection is unclean and unhealthy behavior.

The results of microscopic examination of intestinal parasite infection showed that 8% of respondents were infected with STH intestinal worms and all respondents did not have *Cryptosporidium sp* protozoan infection. STH torture uses a native method with eosin and lugol dyes while *Cryptosporidium sp* examination uses ZN-modified staining. The presentation of this infection follows government requirements, namely 10%, this may be caused by the geographical location

of Wori Village which is in a coastal area. Examination of STH infections in children living in highland areas shows higher positive results compared to those living in lowland areas (Ni Made Nuryanti, 2018). Correct and sensitive laboratory examination will help in the diagnosis of infection, treatment, and prevention of transmission of helminth infections. Currently, available examinations use conventional and molecular methods, but these two methods have disadvantages and advantages. Conventional examination is easy to do with simple equipment but has a low sensitivity value, whereas molecular examination has high sensitivity but costs more. So a fast and accurate inspection method is needed for the STH examination (Khurana & Sethi, 2017). The conventional Kato Katz method is the method most widely used in studies in the Southeast Asia region for examining STH infections (Dunn *et al.*, 2016).

Cryptosporidiosis is an infectious disease caused by infection with the parasite *Cryptosporidium sp*. *Cryptosporidium sp* infection is a major factor in the occurrence of diarrhea in malnourished children and AIDS sufferers in developing countries. In 2009 – 2010 in the United States, there was an extraordinary occurrence of cryptosporidiosis caused by water pollution (water-born disease) (Ludington & Ward, 2015). Cryptosporidiosis occurs with the entry of parasite oocysts through the mouth or breathing (inhalation). The excitation process occurs with the release of sporozoites which then enter the intestinal epithelial cells, then develop asexually and

**Table 2.** Results of *Soil-Transmitted Helminths* (STH) and *Cryptosporidium sp* Examination of Elementary School Children in Wori District in 2023

Examination Results	Total (n)	Percentage (%)
<i>Soil-Transmitted Helminths</i>		
Positive	13	8
Negative	147	92
Total	<b>160</b>	<b>100</b>
<i>Cryptosporidium, sp</i>		
Positive	0	0
Negative	160	100
Total	<b>160</b>	<b>100</b>

form microgametes and macrogametes will be followed by the formation of thick-walled oocysts capable of sporulating in the host's body. After that, thick-walled oocysts will be removed with the patient's stool or can also cause autoinfection because it takes place in the host's body (Ludington & Ward, 2015). In its development, *Cryptosporidium* examination uses several types of dyes. Giemsa's dye and Jenner's stain were the earliest dyes that could be used to identify oocysts, but these dyes had the disadvantage that "ghost" cells could be found that interfered with the examination process. The development of the Ziehl-Neelsen (ZN) dye in 1981 also identified oocysts better, and until recently its use was more widespread for screening for *Cryptosporidium* infections. Identification is usually done to pediatric patients who have diarrhea but those who have decreased immune status can also be examined. Examination samples commonly used are feces but can be used for small intestine aspiration, tissue samples, or biopsy if available (Khurana & Chaudhary, 2018).

Cryptosporidiosis can be examined by several methods, namely microscopic methods, immunological methods, antigen detection methods, histology, and molecular methods. Microscopically it can be examined through wet preparations or staining and electron microscopy. The sample used in this examination can use samples preserved with 10% formalin (Khurana & Chaudhary, 2018). Table 3 shows the results of sample examination with Zn and PCR modification methods showing 100% negative samples of *Cryptosporidium sp.* infection. The samples used for Zn modification method examination are fecal samples using Zn modification preservatives and samples for PCR method examination are samples with potassium dichromate preservatives. The use of preservatives in fecal specimens is adjusted to the laboratory examination method.

Microscopic examination is widely used but has several disadvantages, including low sensitivity so that re-examination must be done (*duplo*), the examination time for each specimen is approximately ten minutes so it is not efficient for examination in large quantities and the difficulties encountered if the stool sample used in the examination

contains a lot of fiber (Destura *et al.*, 2015). In addition, another disadvantage is that it requires specially trained personnel and the sample used should be fresh because preserved samples can result in non-optimal examination (Mergen *et al.*, 2020). *Cryptosporidium sp* becomes a protozoan that causes diarrhea. The immune status of the patient determines the prognosis of the disease. Transmission of this parasite occurs through the fecal-oral route of either infection to humans or animals. Innate immunity and acquired immunity play a role in cryptosporidiosis infection. Sporozoites that enter intestinal epithelial cells will cause damage or death to intestinal epithelial cells. As a result of the occurrence of inflammatory processes in the intestine and the occurrence of cryptic hyperplasia and liquid diarrhea may occur. Patients who have good endurance generally do not cause clinical symptoms or real complaints, but patients with low immunity or immune system disorders such as HIV/AIDS will experience severe clinical symptoms (Borad & Ward, 2010).

Natural immune responses suggest dendritic cells, natural killer (NK) cells, and mast cells play a role in clearing parasite infections but the exact mechanism for *cryptosporidium* infection is unknown. The adaptive immune response involving T cells has been studied in many AIDS cryptosporidiosis patients, but it is also unclear (Ludington & Ward, 2015). Dendritic cells play a role in the immune response to *cryptosporidium sp* infection. Dendritic cells recognize parasites and initiate natural immune responses and adaptive immune responses. Dendritic cells stimulate *Toll-Like Receptors (TLRs)* and *Pattern Recognition Receptors (PRRs)* producing proinflammatory cytokines and chemokines. Dendritic cells also present *cryptosporidium sp* antigens to T cells thereby activating adaptive immune responses (Saraav & Sibley, 2023). Until now there is no specific vaccine to protect children and immunocompromised patients against *cryptosporidium sp* infection (Zaph *et al.*, 2014). *Cryptosporidium sp* infection, malnutrition, and immune deficiency are related to one another. Malnutrition can weaken the immune system so that it is more susceptible to *cryptosporidium sp* infection, and



result in prolonged diarrhea (Mahdavi Poor *et al.*, 2022).

The results of statistical testing did not show a significant relationship between clean and healthy living behavior with the incidence of STH infection but of the 13 respondents infected with STH, 8 respondents had the habit of playing soil. The application of clean and healthy living behaviors is a risk factor for helminthic infections because the life cycle of STH worm species is related to soil being infective. STH worm eggs in the soil will develop into a stage of infection and if accidentally entered the body through food or live behavior, it will develop in the intestine. Elementary school children generally do not have awareness about cleanliness and hygiene, so they still have the habit of playing in the dirt, eating back food that has fallen, sucking their fingers, and not washing their hands. Accidentally, worm eggs or infective larvae found in soil or unclean hands can enter the patient's body, develop, and then the patient can be a source of transmission for others. The results of the STH examination found that 6% of respondents were infected with *Ascaris lumbricoides*, 1% of respondents were infected with *Hookworm*, 1% of respondents were infected with *Trichuris trichiura* and 1% had mixed infections of *Ascaris lumbricoides* and *Hookworm*. This STH species is a species that commonly infects elementary school children

because its transmission is related to the application of clean and healthy living behaviors because there is a relationship between the incidence and poor hygiene behavior (Widiarti *et al.*, 2020).

Access to clean water, standardized sanitation facilities, and the implementation of clean living behavior are generally associated with a reduction in soil-borne worm infections. The use of water treated by filtering or boiling shows a relationship with a lower incidence of STH infection, whereas using piped water does not show this relationship (Strunz *et al.*, 2014). Support for water availability, sanitation, and environmental cleanliness supports reducing the incidence of STH infections in addition to mass treatment programs (Garn *et al.*, 2022); access to water, sanitation, and the implementation of clean and healthy living behavior are also related to children's growth and development (Cumming & Cairncross, 2016). However, several studies conducted show that the use of toilets for defecation for children does not have a direct effect, but children are still expected to be directed to carry out defecation activities in the toilet (Majorin *et al.*, 2019).

The results of measuring the nutritional status of respondents, 86% of respondents have normal nutritional status, 5% of respondents are united in malnutrition, 6% of respondents are well nourished and 2% of respondents are obese. In patients with cryptosporidiosis

**Table 3.** The Relationship between PHBS and STH Infection of Elementary School Children in Wori District in 2023

PHBS	Inspection Results (n)		Total	R
	Positive	Negative		
Hand washing				
Yes	10	126	136	0,416
No	3	21	24	
Sucking Fingers				
Yes	8	67	75	0,386
No	5	80	85	
Eating Food Dropped on the Ground				
Yes	5	46	51	0,757
No	8	101	109	
Playing Land				
Yes	8	56	64	0,139
No	5	91	96	

**Table 4.** Cross-Table of Nutritional Status and STH Infection of Elementary School Children in Wori Sub-district in 2023

Status Gizi	Examination Results					Total
	Negative	<i>Ascaris lumbricoides</i>	Hookworm	Mix infection ( <i>Ascaris lumbricoides</i> + Hookworm)	<i>Trichuris trichiura</i>	
Normal	129	7	1	0	1	138
Malnutrition	7	1	0	1	0	9
Nourished	9	1	0	0	0	10
Obese	2	1	0	0	0	3
<b>Total</b>	<b>147</b>	<b>10</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>160</b>

infection can lead to dehydration, malnutrition, and weight loss. Children with low immune status and malnutrition may develop more severe conditions and prolonged infections (Destura *et al.*, 2015). Children with cryptosporidiosis are 2.7 times more likely to be malnourished resulting in chronic diarrhea and malabsorption (Quihui-Cota *et al.*, 2015). Research conducted by Al-Ani and Al-Warid on 43 children diagnosed with *Cryptosporidium sp* infection showed no association between infection and nutritional status (Al-Ani & Al-Warid, 2023). Table 4. shows that most respondents who experience STH infection are respondents who have normal nutritional status. This shows that STH infection is not related to nutritional status but it is necessary to implement clean and healthy living behaviors to prevent the incidence of STH infection because STH infections that are not treated properly will affect the child's health (Djuardi *et al.*, 2021). Research conducted by Bia (2022) shows that nail hygiene is at five times the risk of being infected with STH worms (Bia *et al.*, 2022).

STH infection and nutritional status are related to each other, where STH infection can cause a decrease in nutritional status or poor nutrition can make it easier to become infected with STH (Muslim *et al.*, 2021). Several other studies statistically do not show a weak relationship between STH infection and the incidence of stunting, but prevention and control strategies need to be carried out to prevent ongoing impacts (Campbell *et al.*, 2017).

Fulfilling children's nutrition starts from their nutrition in the womb, the nutritional

intake of pregnant women before and during pregnancy is one of the factors determining the nutritional status of children born (Aguayo & Menon, 2016). Children's growth, immune function, and cognitive development are also influenced by nutritional adequacy (Davies-Kershaw *et al.*, 2024). One of the stunting prevention programs is monitoring the development of nutritional status in the first 1000 days of birth, known as 1000 HPK; Currently, an application is being developed to facilitate monitoring that can be accessed by parents, midwives, and other health workers (Hijrawati *et al.*, 2021). The cleanliness of the house as a place to live and the cleanliness of the food consumed are also factors in the incidence of stunting in children (Dominguez-Salas *et al.*, 2024).

## CONCLUSION

From the results of the study, it was concluded that 100% of respondents were not infected with *cryptosporidium sp* parasites, 8% of respondents were infected with Soil-Transmitted Helminth with no relationship to the nutritional status of respondents where 87% of respondents had normal nutritional status, 5% of respondents were united in malnutrition, 6% of respondents were well nourished and 2% of respondents were obese.

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