Infection of Soil-Transmitted Helminth among Mining Workers in Southeast Sulawesi

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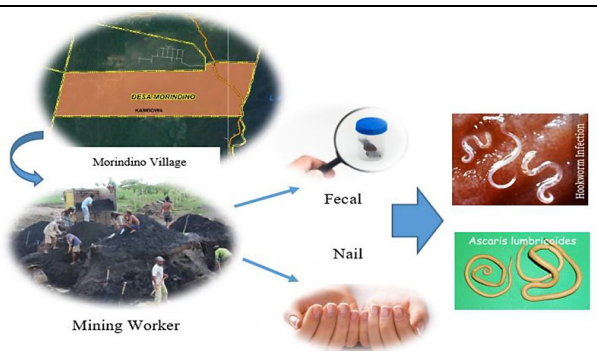
ABSTRACT

Soil-Transmitted Helminth (hereafter STH) is considered as the leading cause of global health problems. This study aims to know the intensity and prevalence of STH infections among mining workers by comparing fecal and nail examinations in Morindino Village, Kambowa District, North Buton Regency Southeast Sulawesi Province. Feces were examined by using a native method, whilst the nails were observed by a sediment method. Additionally, descriptive and inferential analysis with independent t-tests were used to analyze the data. A total of 48 respondents were involved in this study. The observations of fecal respondents indicated that 4 (8.3%) of the respondents were infected with *Ascaris lumbricoides*, 12 (25%) had hookworm eggs, and 32 respondents (66.67%) were not infected. Moreover, the observation of STH worm eggs using nail samples showed that 1 respondent (2%) was infected with *Ascaris lumbricoides*, 4 (8.3%) respondents were infected by hookworm, and 43 respondents (89.58%) were free. The intensity of the attack was still in the mild category for all types of worm eggs; yet the highest attack was on hookworm for both examinations (2.16 and 2.25 eggs/individual). The research site took place around a sand mining land area with loose sandy soil structures that are protected from sunlight and mixed with humus to support the STH life cycle. Some individuals did open defecation habits at the research site leads to the STH contamination of the soil. Thus, the surveillance programs and infections control should be effectively implemented to manage worms incident.

ABSTRAK

Soil-Transmitted Helminth (STH) merupakan penyebab utama masalah kesehatan global. Penelitian ini bertujuan untuk mengetahui intensitas dan prevalensi infeksi STH pada pekerja tambang dengan membandingkan pemeriksaan feses dan kuku di Desa Morindino Kecamatan Kambowa Kabupaten Buton Utara Provinsi Sulawesi Tenggara. Feses diperiksa dengan metode natif, sedangkan paku diamati dengan metode sedimen. Analisis deskriptif dan inferensial dengan uji-t independen digunakan untuk menganalisis data. Sebanyak 48 responden digunakan dalam penelitian ini. Hasil pengamatan tinja responden menunjukkan 4 (8,3%) responden terinfeksi Ascaris lumbricoides, 12 (25%) bertelur cacing tambang, dan 32 responden (66,67%) tidak terinfeksi. Selain itu, pengamatan telur cacing STH menggunakan sampel kuku menunjukkan 1 responden (2%) terinfeksi Ascaris lumbricoides, 4 (8,3%) responden terinfeksi cacing tambang, dan 43 responden (89,58%) bebas. Intensitas serangan masih dalam kadtegori ringan untuk semua jenis telur cacing namun serangan tertinggi pada Cacing tambang untuk kedua pemeriksaan (2,16 dan 2,25 telur/individu). Lokasi penelitian terletak di sekitar lahan penambangan pasir dengan struktur tanah berpasir lepas yang terlindung dari sinar matahari dan bercampur humus untuk mendukung siklus hidup STH. Beberapa individu yang melakukan kebiasaan buang air besar sembarangan di lokasi penelitian menyebabkan pencemaran STH pada tanah. Program surveilans dan pengendalian infeksi harus diterapkan secara efektif untuk mengelola insiden cacingan.

GRAPHICAL ABSTRACT



Keyword
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INTRODUCTION

Soil Transmitted Helminth (STH) is a group of intestinal parasites in the phylum Nematoda and are primarily transmitted through contaminated soil (World Health Organization, 2021). Parasitic worms generally consist of roundworms, whipworms, and hookworms (Centers for Disease Control and Prevention, 2019). STH is among the most common infectious diseases worldwide, affecting low-income communities. According to the World Health Organization (WHO) data for 2021, more than 1.5 billion people, or 24% of the world population, have been infected by STH, with the most considerable prevalence in Sub-Saharan Africa, the Americas, China, and East Asia. More than 267 million preschool and 568 million school-age children live in areas where this parasite life is highly transmitted. Worm infections are common and become a health problem in tropical climates such as Indonesia (Dunn et al., 2016). The prevalence of helminth infections in Indonesia remains relatively high at 60-70% (Ministry of Health of The Republic of Indonesia, 2018). Although worms are rarely lethal, it has been reported that malnutrition can affect the health and productivity of the affected population (Novikov et al., 2008).

People get infected primarily by walking barefoot on soil contaminated with infective larvae or ingesting them (Zeynudin et al., 2022). These worms can inhabit for several years in the gastrointestinal tract of their hosts (Ross et al., 2017). With helminth usually co-infecting the host, infections have been observed to cause more substantial morbidity and disability than death (Novikov et al., 2008). These morbidities include malnutrition, especially in children, iron deficiency anemia, malabsorption syndrome, intestinal obstruction, chronic dysentery, rectal prolapse, respiratory complications, and poor weight gain (Anwar et al., 2018).

The development of worm disease is influenced by multifactor including tropical climate, poor personal hygiene, poor environmental sanitation, and dense and humid settlements. In addition, polluted water, eating with dirty nails, and contaminated objects may contribute to the spread of worms (Khan et al., 2022). Economically vulnerable groups are at increased risk of developing helminthiasis because they cannot maintain hygiene in the sanitation facilities of their living environment. This public health problem remains unsolved (Tadege et al., 2022). Worms can be transmitted in various ways, including food and drink contaminated with worm eggs or soil (Eyayu et al., 2022).

The activities of mining workers have been classified as the highest risk group for helminth infections (Tuuk et al., 2020). Buton Regency, Southeast Sulawesi Province, is a sand mining area with relatively high worm infection. Data from the Health Center in 2021 showed 43 cases of helminth infections in the last three months (Dinas Kesehatan Kabupaten Buton, 2021). A traditional miner's lifestyle of burrowing in the ground day and night with minimal personal protective equipment, poor personal sanitation, and inappropriate defecation habits are risk factors for helminth infections (Ross et al., 2017). According to the preliminary study conducted by the author through interviews with several residents regarding mining, most mining activities in Morondino Village are still carried out traditionally and are processed by the surrounding community. They use personal safety equipment, such as sandals and T-shirts, and some workers do not use gloves. This has the opportunity to be infected with worm eggs which can multiply into adult worms through the body.

Worm infection is due to more activity on land (Hossain & Bhuiyan, 2016). Soil pollution is the leading cause of transmission of helminth eggs from the soil to humans through the hands or fingernails containing worm eggs, then

enter the mouth with food (Idris et al., 2019). Nails can be a place of attachment to various impurities that contain microorganisms, one of which is worm eggs, which can be tucked in and swallowed while eating (Khan et al., 2022). The diagnosis of STH infection can be established with the discovery of worm eggs in fecal examination. Worms can occur when infective eggs enter the human body by ingesting eggs or entering larvae through the skin. The worm will mature in the intestine and lay eggs in the intestine of humans, and then the eggs will come out concurrently with feces and further develop in the soil. Several factors can affect the ingestion of worm eggs related to the habit of not cutting nails, and not washing hands thoroughly when consuming food and after defecation. One factor entry of the larvae into the skin is not wearing shoes as doing outdoor activities (Nasution et al., 2019).

Diagnosis of STH infections can be made by identifying helminth eggs in the fecal examination. The STH worm group generally has an intestinal habitat and lays eggs in the intestine because the worm eggs mix with fecal during food digestion. This fecal examination is the standard gold examination for diagnosing helminthiasis, as the STH worm group with such a life cycle is well suited to provide a supportive diagnosis using fecal examination materials (Mahartina et al., 2020; Steinbaum et al., 2017). However, according to previous studies, worm eggs can also be found in nail clipping examinations (Tuuk et al., 2020; Wikurendra et al., 2021). In addition, identifying a miner's worm parasitic eggs can be used to know if STH has contaminated the environment (Wikurendra et al., 2021). Several studies have examined soil helminth through feces or nails (Eyayu et al., 2022; Khan et al., 2022; Tuuk et al., 2020; Wikurendra et al., 2021), but there is still insufficient data for comparison examination of the two methods. Therefore, this study aimed to detect the prevalence and intensity of infections caused by parasitic worms by comparing nail and fecal examinations among mining workers.

METHODS

The research was observational, with a simple random sampling technique to select the research samples. The research collected nail and faecal samples from 48 respondents of 97 workers in traditional sand mining in Morindino Village, Kambowa District, North Buton Regency, in January 2022.

To respect the respondents, before the research, we provided a consent form for approval of willingness to be involved. In the first stage, nails and feces were collected in dry and clean containers. In the next step, feces and nails were examined separately. Feces were examined using the native method. Sufficient fecal samples were put, emulsified in a 2% eosin solution on the object glass, covered with deck glass, compressed until thin and flat, and examined under an Olympus brand binocular microscope at 40x10 magnification. The examination of nails was done using the sediment method, starting with a 20-minute immersion in 0.9% NaCl in a test tube and centrifugation at 1,500 rpm for 15 minutes. Furthermore, the sediment was pipetted out, placed on an object glass, covered with a deck glass, and examined with the same microscope at a 40x10 magnification.

Data, moreover, were analyzed descriptively, aiming to determine the characteristics and frequency of the number of optimistic respondents by examining feces and nails and the number of worm eggs found based on the species of worms. The prevalence of worms among mining workers was described using frequency distributions and percentages. Moreover, the inferential analysis aims to determine the number of populations based on a sample

Table 1
Respondent characteristics

Characteristics	n=48	Percentage
Age		
<25	2	4,2
26-30	8	16.7
31-35	20	41.7
36-40	17	35.41
>40	1	2.1
Education		
Elementry School	24	50
Junior High School	14	29.2
Senior High School	10	21
Socio Economic Status		
Upper	0	0
Moderate	8	16.7
Lower	40	83.4
Personal Hygiene		
Less	25	52
Sufficient	23	48
Use of Personal Protective Equipment		
Use	20	42
Unuse	28	58

by analyzing data, interpreting it, and drawing conclusions. It all began with hypothesis tests, performed to assess the data distribution within data groups or variables, whether the data were normally distributed and Chi-Square test with comparative analysis techniques based on differences in frequency to determine the difference of STH worm eggs examination between fingernail and fecal examinations among mining workers. The outcome-based determination of the intensity of both examinations was represented using a formula suggesting that the intensity is a parameter that describes the number of individuals of a parasite species in one individual host with a very light intensity category if the value is <1, Mild with a value of 1-5, Moderate with a value of 6-50 and Severe with a value of 51-100 (Bush et al., 1997)

This study had been conducted under the research ethics clearance number 31/EC/UMW.01/XII/2021 issued by the Ethics Committee of Mandala Waluya University. We undisclosed the names and addresses of the respondents in the questionnaire/measuring instruments, and we used coding to the form (the respondent's initials or identity number).

RESULTS

The Characteristic of The Respondents

Most respondents were working-age persons, among whom the highest level of education is Senior High School. The average socio-economic status of mining workers was in the lower economic class. The dominant personal hygiene behavior was low (73%), and the use of personal protective equipment (PPE) in the workplace was down by 48% (Table 1). Most of the population made their living as cattle ranchers, garden farmers, and sand mining workers, and they dominated as a middle to lower economic class. Because soil-transmitted helminth live in the human intestine, eggs could be shed out into the environment through the feces of infected individuals. The survey area around the sand mining was between the gardens and the river, and people's defecation habits were on the ground around the gardens and river. It could be suspected as a risk factor for worm infections. It was evident that only 40% of people have toilets. The presence of worm eggs in the feces of infected individuals who defecated in the open ground increased the likelihood of worm larvae transmitting to the surrounding community.

Table 2
Frequency Distribution of Worm Eggs in Fecal and Nail Examination

Results	n=48	Percentage	Sig.
Feces			
Positive	16	33.34%	0.000
Negative	32	66.67%	
Nails			
Positive	5	10.4%	
Negative	43	89.58%	

The Comparison of Examination Results

The study results, by using 48 samples for fecal examination, indicated that 16 (33.34%) were positively infected with STH and 32 (66.67%) were uninfected. On the other hand, the nail examination showed that 5 (10.4%) samples were positively infected with STH, and 43 (89.58%) samples were uninfected. A significant difference was found when fecal and nail samples from mining workers were examined for worm eggs (Table 2).

Prevalence and Intensity of Soil-transmitted Helminth

The research results (Table 3) revealed that *Ascaris lumbricoides* and hookworm eggs were detected in fecal samples. Prevalence and egg intensity of parasitic worms were found in 48 samples with different amounts. The highest prevalence was found in hookworm (25%) and *Ascaris lumbricoides*, with only 8.3% on stool examination. Similar to nail examination, the highest prevalence was found in hookworm (8.3%) and *Ascaris* only 2%. While the type of Trichuris trichiura was not found on both examination. The intensity of the attack was still in the mild category for all types of worm eggs, but the highest attack was on hookworm for both examinations (2.16 and 2.25 eggs/individual). The research site was located around plantations and paddy fields near mining areas that typically have humus-entrained, sun-protected, loose sandy soil structures supporting the life cycle of hookworms.

DISCUSSION

Parasitic infections are associated with poverty, and the greater the level of poverty, the higher the likelihood of parasitic infection (Dhaka et al., 2020). It relates to personal hygiene and sanitation in the living environment. The previous study found that worm infections were associated with economic conditions and sanitary conditions of the home environment (Kurscheid et al., 2020; Vaz Nery et al., 2019). It indicates that the economic status of the family and the sanitary conditions of the home environment are risk factors for worm infection.

Research has shown a relationship between the use of personal protective equipment and the prevalence of worm infections, confirming the importance of using PPE (Baidowi et al., 2019). It will protect a person or isolate part or all of the body from potential workplace hazards of disease (Wikurendra et al., 2021). Incomplete use of PPE can allow infectious eggs or larvae to enter various body organs such as hands, feet, and mouth. *A. lumbricoides* can be transmitted to mining workers by ingesting the infective eggs on the hands of mining workers who do not wear protective equipment such as gloves. Infectious hookworm larvae can penetrate the skin of a mining worker who is not wearing shoes.

The number of positive samples on fecal examination is higher than nails. Worm larvae can infect the skin or eggs ingested with food (Buchmann & Mehrdana, 2016). Interviews on PPE showed that 58% did not use

Table 3
Prevalence and Intensity Sort of Soil Transmitted Helminths Worm Eggs

Type Of Worm	Frequency	Prevalence	Egg Worm	Intensity (Item/Ind.)
Fecal				
Ascaris lumbricoides	4	8,3%	7	1,75
Hookworm	12	25%	26	2,16
Trichuris trichiura	0	0		-
Nails				
Ascaris lumbricoides	1	2%	1	1
Hookworm	4	8,3%	9	2,25
Trichuris trichiura	0	0		-

PPE such as gloves or boots at work. Infection through the skin of the feet is inevitable, but infection through the hands can still be avoided by workers washing their hands before eating. This is consistent with some of the PPE use asked during the interview, showing that shoes were minimally used with the 89% response, while the use of gloves remained good enough. It makes worm eggs more common in feces than nails. The use of personal protective equipment (PPE) should be well utilized. Many workers wearing imperfect PPE can be easily infected through various body organs, such as hands, feet, and mouth (Muslimah, 2017).

The sand and mining owners in this study said they provided PPE for their sand mining workers but refused to wear PPE due to discomfort and low awareness among the workers. This condition gets support due to the lack of PPE use supervision and the workplace owners' concern. Several factors influence employee attitudes, such as workers' beliefs about the availability of PPE facilities, owner supervision, and the importance of using PPE (Aram et al., 2021).

In addition, they tend not to wash their hands with soap before eating, resulting in the ingestion of Soil-Transmitted Helminth eggs (Ross et al., 2017; Tadege et al., 2022). Personal hygiene is crucial for prevention, so nails should always be kept short to prevent hand-to-mouth transmission of worms. Similarly, consistent footwear use reduces the likelihood of transmission by infective larvae through the skin (Nasution et al., 2019). Some previous studies have shown a relationship between weekly nail clipping, wearing shoes, hand washing before meals, and foot-washing feet and the prevalence of worms (Lim et al., 2018; Novikov et al., 2008)

In this study, most infestations were caused by hookworms (*Necator americanus* and *Ancylostoma duodenale*). It is consistent with the previous research in a study of worm-infected mining workers that 16 out of 86 samples and all samples were positively infected with hookworm (Tuuk et al., 2020). Hookworm infections were caused by workers in direct contact with soil and sand. The study conducted by research showed that many species of hookworm frequently occur in rural areas and infect workers in mining areas who are in direct contact with the soil (Clements & Addis Alene, 2022).

In Indonesia, *Necator americanus* is more common than *Ancylostoma duodenale* (Dunn et al., 2016). Loose, moist, shady, sandy, loamy soils and humus are ideal places for hookworm eggs to develop into larvae (Idris et al., 2019). It corresponds to the hookworm cycle being infected through the skin, while *Ascaris* infects through nails and contaminated food (Centers for Disease Control and Prevention, 2019). Eggs are excreted in feces, and if the condition is favorable, the rhabditis-like larvae will hatch in one to two days. After

5-10 days, they become infective filariform which can penetrate the skin of human feet and enter the lungs by the bloodstream.

Ascaris egg habitats are the same as hookworms in tropical environmental conditions and poor sanitation. Infective eggs can infect from soil to mouth through the hands. Eggs can enter the body of other hosts through drinking water or contaminated food. Clean water supplies are far from the workplace, so hands are rarely washed before consuming food in the workplace (Chapman et al., 2021; Hossain & Bhuiyan, 2016).

The process of hookworm infection in humans is that the eggs come out with feces in the soil within two days and hatch into rabditi-shaped larvae that are not infective. These larvae penetrate the skin, enter the bloodstream, and become adults in the heart, lungs, alveoli, bronchi, trachea, esophagus, stomach, and finally, in the intestines (Idris et al., 2019). Then it molts a second time and becomes slender into infectious filarial-shaped larvae. Active filarial-shaped larvae penetrate the outer skin of the host through hair follicles, pores, or damaged skin (Chapman et al., 2021).

Ascaris lumbricoides worm infection in humans is caused by the introduction of infective worm eggs into food or drink contaminated with soil containing feces of ascariasis sufferers. When swallowed by humans, the eggs will hatch in the small intestine, and the larvae emerge from the small intestine through the walls of the digestive tract into the intestine (Paller & Babia-Abion, 2019). This larval migration lasts about 15 days, and then the larvae spread to the bronchi, trachea, and larynx, then to the pharynx, esophagus, down to the stomach, and finally to the small intestine. Then the larvae molt and develop into adult worms (Lagatie et al., 2020). It takes about 2-3 months from ingestion of mature eggs to laying adult eggs (Cao & Guiton, 2018).

CONCLUSIONS

There was an infection of parasitic worm eggs on fecal and nail examination with *Ascaris* and hookworm types. Worm parasite eggs were found more in the faeces than in the nails, which were dominated by hookworm species. The highest prevalence and intensity were found in hookworm eggs. The limitation of this study is the use of a binocular microscope that has not been connected to a computer system, so the egg size scale cannot be determined. In addition, fecal examination should be carried out repeatedly so that the consistency of worm eggs can be detected. In contrast, the strength of this study is measuring the reliability of two different examination methods. Thus, the consistency of parasite identification can be known. Regular monitoring and surveillance alone were needed for stakeholders to improve and maintain hygiene and use of personal equipment in the communal and workplace. Moreover, mining workers are required to use personal protective equipment and maintain personal hygiene to prevent parasitic helminth infections. Implementation of prevention and control strategies and health education in working areas is essential to decrease the burden of the disease. In addition, future researchers should use other subjects susceptible to infection with parasitic worms, such as farmers or breeders.

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AUTHORS CONTRIBUTIONS
Yunita Amraeni conceived and designed the study, and wrote the manuscript. Muhammad Nirwan enrolled participants, collected data, and analyzed the data. Jumintono Suwardi edited and wrote the manuscript. All authors participated in reviewing the manuscript. The author(s) read and approved the final manuscript.

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COMPETING INTERESTS
The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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