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Original Article

Risk Factor Analysis of Soil-Transmitted Helminth Infections among Scavengers at the Denpasar City Landfill – Bali

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ABSTRACT
Background: Soil-transmitted helminth (STH) infection is a public health concern, particularly in developing countries, including Indonesia. Scavengers are a high-risk group due to their direct contact with garbage that is potentially contaminated with worm eggs. This study aims to determine the prevalence of STH infection and risk factors associated with STH infection among scavengers at a landfill in Denpasar, Bali. **Methods:** This research approach was an observational study with a cross-sectional design involving 101 scavengers as respondents. Data were collected through interviews using questionnaires, observation of personal hygiene behavior, and nail clipping examination to detect the sedimentation concentration method. **Results:** The results showed that the prevalence of STH infection was 37.6%. Factors significantly associated with STH infection were knowledge and nail hygiene. Meanwhile, hand washing habits, footwear use, personal hygiene, environmental sanitation, and deworming medication did not show a significant association. **Conclusion:** These results emphasize the importance of enhancing knowledge and nail hygiene practices as a means of preventing STH infections. Continuous health education as a means of promoting clean and healthy living habits among scavengers need to be improved as a preventive measure to reduce the risk of STH transmission

INTRODUCTION

Soil-Transmitted Helminth (STH) infection is one of the diseases that still remains a public health issue, particularly in developed countries, including Indonesia. Globally, more than 1.5 billion people or around 24% world's population were infected by STH, with the highest distribution is in tropical and subtropical regions, such as Sub-Saharan Africa, America, China, East Asia, and South East Asia. Even though it was asymptomatic, STH infection can cause long-term effects as nutritional state disorder, productivity decline, and human resources qualities as well (World Health Organization, 2020; Nyanda, et all, 2024).

In Indonesia, the STH infection prevalence was still high. It was between 2,5% until 62% Kementerian Kesehatan RI, 2017). STH infection cases tend to increase in the lower social levels of society and poor sanitation conditions. The increasing prevalence reached 80% in poor sanitation areas (Aemiro, 2022; Dunn, 2016). The general STH types worm in humans infection are *Trichuris trichiura, Ascaris lumbricoides, Necator americanus*, and *Ancylostoma duodenale.* STH infection is included in the neglected tropical diseases group and still remains a health challenge in many developing countries (Alex, 2021).

Infection contamination is not only impacted by the environment, but also related to individual behavior. The poor knowledge level contributed to the lack of awareness in applying healthy life and cleanliness, such as handwashing habits, maintaining personal hygiene, and trimming nails regularly (Martila, 2016). Long and dirty nails can serve as a medium for the helminth eggs. Thus, it played an important role in the transmission of STH infection from hand to mouth, especially among individuals who are exposed to a contaminated environment (Darlan, 2019; Alydrus, 2025).

Scavengers are a social group that is at high risk of STH infection because of their daily routine. The scavengers that make direct contact with garbage that is tainted by feces and worm eggs. Scattered and decomposing waste on the soil can facilitate the eggs' growth and STH worm larvae (Kouamé, 2025; Duwita, 2018). Instead of high-risk exposure, generally scavengers have limited access to health education, proper sanitation facilitation, and optimal personal hygiene practice, thus will lead to high-risk STH infection case (Kementerian Kesehatan RI, 2017; Azmy, 2018).

Mostly, previous research tends to emphasize that the environmental factor and sanitation as the STH infection determination, meanwhile, studies that specifically discuss the role of knowledge and personal hygiene in scavenger groups is limited (Eviana, 2024). Moreover, the behavior factor is an aspect that may be modified through promotion and preventive intervention. Thus, it is important to discuss as it is a blueprint STH infection control program (Barbara, 2020).

Thus, the study aims to find out the Soil Transmitted Helminth prevalence and also analyze the correlation between knowledge level and personal hygiene through STH infection cases in scavengers at Denpasar city's landfill, Bali.

METHODS

The research is an analytic observational study with a cross-sectional design. It aims to analyze the correlation between behavioral factors and Soil-Transmitted Helminth (STH) infection cases. The research has been done in every landfill in Denpasar, Bali. The research was conducted from May to September 2022. The sample check has been analyzed at Poltekkes Kemenkes Denpasar Medical Laboratory Science's laboratory. The research has been ethically approved by the Ethical Research Commissioner under number 2174/UN14.2.2.VII.14/LT/2022

The Population in this research is every scavenger who works in the landfill in Denpasar, Bali. The research sample consisted of scavengers who met the inclusion criteria and were willing to participate in the research by signing an informed consent sheet. The sampling technique was non-probability sampling with accidental sampling. The respondents were found in the research location and met with research standards. Inclusion criteria in the research were scavengers who actively work in the landfill, with a range of ages ≥15 years old, and willing to participate as respondents. Exclusion criteria were scavengers who were in the parasite treatment when the research was conducted or refused to provide nails sample. The total sample size in the research was 101 respondents.

The dependent variable in the research is STH infection cases, that determined by the finding of STH eggs in the respondent's nail clipping examination. The independent variables were the knowledge level about STH infection, handwashing habits, nail hygiene, footwear usage, personal hygiene, environmental sanitation, and anthelmintic drug consumption. The knowledge level is measured by using a structured questionnaire and categorized as good, moderate, and poor, according to the score gained. Nail hygiene was measured by direct observation and categorized as good, moderate, and poor according to the length of the nail, footwear usage, environmental sanitation, and anthelmintic drug consumption, also categorized according to objective criteria that have been stated in the observation and questionnaire sheet.

Data collection was conducted through interviews, observation, and laboratory checks. Interviews were conducted using a structured questionnaire to gain respondents' characteristics data, knowledge level, and hygiene habits. Observations were conducted by checking nail hygiene, personal hygiene, and safety tools, such as footwear (Prabhusaran, et all, 2018). The questionnaire instrument used in the research was compiled based on a literature review and has undergone

content validity testing by expert lecturers in environmental health and parasitology. Reliability testing was conducted by an internal consistency test, and the obtained reliability coefficient indicated that the questionnaire was suitable for use as a data collection instrument (Teresa, et all., 2017).

Collection and Examination Nail Clipping Procedures

Nail clipping sample collection was conducted after respondents completed the interview and observation process. Respondents were given instructions to clip their nails using sterile nail clippers. Then, nail clippings were placed in a sterile container labeled with identification information. Furthermore, it has been added with NaOH 0,25% to soften the nail tissue and release any helminth eggs that might be attached (Chiara, et all., 2025).

Nail samples were examined using a simple sedimentation concentration method. Nail clipping samples had been added with NaOH 0,25% were centrifuged at 3,000rpm for 2 minutes. Then, the supernatant was discarded. The next step was collecting a drop of sediment using a dropper pipette. The sediment was placed onto object glass, added with a drop of logul, then homogenized using an applicator stick until suspension was formed. It was then covered with cover glass and examined under a microscope at 40x and 10x magnification, each with its 20x visual field. This method is selected because it is simple, economical, and effective to detect the presence of helminth eggs in non-fecal specimens, such as nail clipping (Mirabeau, et all., 2020).

Data Analysis

The data gained were analyzed using univariate and bivariate analyses. Univariate analyses were conducted to describe the respondent characteristics and distribution of each research variable. Bivariate analysis was conducted to determine the correlation between the independent variable in STH infection cases using the Chi-square test or Fisher's Exact Test in accordance with the statistical test. Furthermore, multivariate analysis was performed to determine the most influential factor in STH infection cases using the Hosmer and Lemeshow goodness-of-fit test. The test is used to examine the model fit and the strength of correlation between the independent and dependent variables. The level of significance was set at $p < 0,05$ (Nikola and Thomas, 2023).

RESULTS

1) Respondent's Characteristic

A total of scavengers at the Denpasar city landfill participated in the research were 101. Characteristics of respondents based on gender, age, and knowledge level are presented in Table 1. Most respondents were male (62.4%), with the largest age group being 46-60 years old. The knowledge level of respondents about Soil-Transmitted Helminth infection varied, with the biggest proportion in the poor knowledge classification (39.6%).

Table 1. Scavengers' Respondent's Characteristic at Denpasar City Landfill

Characteristics	n	%
Gender		
Male	63	62.4
Female	38	37.6
Age Group (Years old)		
15-30	15	14.8
31-45	36	35.6
46-60	44	43.6
61-75	6	6.0
Knowledge Level		
Good	33	32.7
Moderate	28	27.7
Poor	40	39.6

2) Hygiene and Sanitation Behavior

The personal hygiene behavior and sanitation respondents' condition distribution are presented in Table 2. Most of the respondents reported good handwashing habits (85.1%) and used footwear while working (96.0%). However, more than half respondents showed poor personal hygiene (53.5%), and most of the respondents were in a poor sanitation environment (68.3%). Respondents' nail hygiene was generally good, although some respondents had moderately clean and poorly maintained nails.

Table 2. Respondent's Hygiene and Sanitation Behavior

Variables	Category	n	%
Handwashing	Good	86	85.1
	Moderate	7	6.9
	Poor	8	7.9
Nail Hygiene	Good	80	79.2
	Moderate	18	17.8
	Poor	3	3.0
Footwear	Yes	97	96.0
	No	4	4.0
Personal Hygiene	Good	27	26.7
	Moderate	20	19.8
	Poor	54	53.5
Environment Sanitation	Good	6	5.9
	Moderate	26	25.7
	Poor	69	68.3
Anthelmintic Drug Consumption	Yes	28	27.7
	No	73	72.3

3) STH Infection Prevalence

The results of nail examinations showed that 38 of 101 respondents (37.6%) were positively infected with Soil-Transmitted Helminth, meanwhile, 63 respondents (62.4%) were negatively infected (Table 3). According to the STH infection prevalence classification established by the Indonesian Ministry of Health, this prevalence falls into the moderate category (≥20%–50%). The STH infection prevalence in the study was relatively higher than previous research in scavenger groups or landfill workers in other regions of Indonesia, which reported prevalence rates that ranged from 7% to 24%. However, it was comparable to studies conducted in populations with high environmental exposure.

Table 3. Frequency Distribution according to STH Infection at Denpasar City Landfill's Scavengers

STH Infection	N (person)	%
Positive	38	37.6
Negative	63	62.4
Total	101	100.0

4) Correlation between Risk Factor and STH Infection Case

The results of the correlation analysis between risk factors and STH infection cases are presented in Table 4. The analysis reported that knowledge level and nail hygiene significantly correlated with STH infection ($p < 0.05$). Respondents with poor knowledge and poor nail hygiene showed that STH infection is higher than in other groups.

In contrast, handwashing habit variable, footwear use, personal hygiene, environment sanitation, and anthelmintic drug consumption didn't show significant correlation with the STH infection case ($p > 0,05$). The lack of significant correlation in the variables may be explained descriptively through respondent data distribution, in which most respondents exhibit relatively homogeneous behaviors, such as high rates of using footwear and good handwashing habits; thus, both groups did not show any differences.

Besides, even though most of the respondents showed poor personal hygiene and sanitation condition, the factor did not represent direct exposure to helminth eggs to nail hygiene, which

plays a direct role in the transmission mechanism from hand to mouth. All respondents were found to have good skin hygiene; therefore, this variable could not be further analyzed statistically.

Table 4. Correlation between Risk Factor and STH Infection Case

Variables	Category	Positive n (%)	Negative n (%)	*P value*
Knowledge	Good	6 (18.2)	27 (81.8)	
	Moderate	14 (50)	14 (50)	0.018
	Poor	18 (45)	22 (55)	
Handwashing	Good	31 (36)	55 (64)	
	Moderate	3 (42.9)	4 (57.1)	0.629
	Poor	4 (50)	4 (50)	
Nail Hygiene	Good	24 (30)	56 (70)	
	Moderate	11 (61.1)	7 (38.9)	0.004
	Poor	3 (100)	0 (0)	
Footwear Usage	Good	35 (36.1)	62 (63.9)	0.148
	Poor	3 (75)	1 (25)	
Personal Hygiene	Good	6 (22.2)	21 (77.8)	
	Moderate	7 (35)	13 (65)	0.104
	Poor	25 (46.3)	29 (53.7)	
Environment Sanitation	Good	1 (16.7)	5 (83.3)	
	Moderate	6 (23.1)	20 (76.9)	0.104
	Poor	31 (44.9)	38 (55.1)	
Anthelmintic Drug	Yes	11 (39.3)	17 (60.7)	0.948
	No	27 (37)	46 (63)	

DISCUSSION

The result showed that STH infection prevalence among scavengers at Denpasar city landfill is 37.6%. This finding indicates that scavengers remain a high-risk group to STH infection, consistent with their work characteristics, which involved direct contact with waste and the environment that is potentially helminth egg-contaminated. The prevalence was relatively higher than in the general population. However, it was consistent among groups with high environmental exposure, such as scavenger and waste management workers (World Health Organization, 2020; Darlan, 2019; Parul , et all., 2022).

Analysis demonstrated that the knowledge level significantly correlated with the STH infection cases. Respondents with a poor knowledge level tend to have a high risk of infection. It was determined that knowledge serves as a fundamental factor that influences preventive behavior, particularly in understanding the transmission mechanism and the importance of personal hygiene. The result is consistent with a previous study, which reported that poor knowledge is associated with a higher prevalence of helminth cases in risk groups (Daniel, et all., 2024; Kusmi, et all., 2015; Gurmassa, et all., 2024).

In addition to knowledge level, nail hygiene also significantly correlated with STH infection cases. Long and dirty nails may possibly be a place for helminth eggs to attach and serve as a direct transmission from hands to mouth. Among scavengers, this factor is particularly important. As it is, according to the high intensity of hand contact with waste and contaminated soil. This finding is associated with a previous study which stated that nail hygiene is one of STH infection main determinants, even when other hygiene habits have been applied well (Apriyanthi, et all, 2023; Yahya, et all., 2020).

In contrast, handwashing habits, footwear usage, personal hygiene, environmental sanitation, and anthelmintic drug consumption variables were not statistically significantly correlated with STH infection cases. The insignificant variable may be critically evaluated. One of the possibilities that might occur is homogeneous respondents' habits, especially in handwashing habits and footwear usage, in which most of the respondents have applied it well, thereby limiting group variety (Azmy, 2018). Furthermore, the insignificant personal hygiene variable and

environmental sanitation may be influenced by other external factors that were not measured in this research, such as duration and intensity of waste contamination, consistency of safety kits, and working environment characteristic in the landfill as well. Several studies have shown that the groups or workers with highly exposure, the risk of STH infection is more strongly determined by the frequency of direct contact with contaminated medium than by general sanitation condition (Firjoun, 2024). It showed that the general personal hygiene indicator may not be sufficiently sensitive to accurately reflect infection risk in the scavenger population.

Therefore, the findings described that preventive efforts should not focus solely on improving environmental sanitation, but also direct effort to improve knowledge and hygiene practices related to direct transmission, especially nail hygiene and proper hand cleaning after making contact with waste. Previous research reported that health's education intervention, combined with a simple behavioral change, could reduce STH infection risk significantly (Kusmi, et all., 2015; Idayani, et all., 2022)

The government's role and landfill management were strongly important to support STH infection prevention efforts by providing handwash facilities with clean water and soap, nail clippers, and proper safety kits. Moreover, the anthelmintic drug distribution program should be given regularly, not only curatively, but also integrated with educational habits to ensure effective and sustainable control of STH infection.

This research showed limitations such as a limited sample and the use of non-random sampling may affect to the generalization of result. Besides, the measurement of behavioral variables using questionnaires may have introduced any bias. Therefore, the next researches are recommended to involve a larger sample, random sampling, and include additional variable such as work duration, consistency of safety kits usage, and landfill characteristics to comprehensively asses STH infection risk.

CONCLUSION

The study demonstrated that STH infection prevalence in scavengers at Denpasar city landfill is 37.6%, which indicates that scavengers are a group at a high-risk of STH infection groups. The knowledge level and nail hygiene were proven to be significantly correlated in STH infection cases; meanwhile, handwashing habits, footwear usage, personal hygiene, environmental sanitation, and anthelmintic drug consumption were not statistically significantly correlated. This indicates that specific behavior factor that has direct contact with transmission lines have played a more dominant role than general prevention behaviors. Based on the findings, local health department official and landfill management suggested improving prevention effort through targeted and sustainable health education for scavengers, focusing on improving knowledge of STH transmission mechanisms, promoting regular nail clipping, and correct handwashing practices after direct contact with waste. These efforts should be supported by handwashing facilities provision, nail clippers, safety kits, and anthelmintic drug consumption integrated program, and behavioral changes education. This study has limitations in the limited total sampling and the use of a non-probability sampling technique, and potentially biased information due to the questionnaire. Therefore, future research is recommended to involve a larger total sampling, using probability sampling, and also add another supported variable to obtain bigger picture of STH infection risk factor comprehensively.

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