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Original Research Paper

Personal Hygiene and Soil-Transmitted Helminth Infection Among School Children in Karuwisi Health Centre Area, Makassar

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Abstract

Background: Soil-Transmitted Helminths (STH) infection remains a major public health concern among Indonesian school-aged children, largely influenced by personal hygiene behaviors. **Objective:** To analyze the relationship between personal hygiene practices and STH infection among elementary school children in the Karuwisi Health Centre area, Makassar. **Methods:** This analytical cross-sectional study involved 50 children, using the Kato-Katz method for stool examination and a structured questionnaire to assess hygiene behaviors; data were analyzed using Chi-square and Fisher's exact tests. **Results:** The prevalence of STH infection was 24% (12/50), with all cases identified as *Ascaris lumbricoides* of light intensity. Poor handwashing behavior showed a strong association with STH infection ($p < 0.001$), and inadequate nail hygiene was also significantly related ($p = 0.016$). Conversely, the habit of not wearing footwear was not significantly associated with infection ($p = 0.325$). The findings indicate that transmission occurred primarily via the fecal-oral route rather than skin penetration. These results highlight that improving handwashing and nail hygiene behaviors can substantially reduce infection risk. **Conclusion:** Handwashing and nail cleanliness are key behavioral determinants of STH infection, emphasizing the need for school-based health education focusing on these preventive practices to mitigate STH transmission among children.

Keywords: *Personal Hygiene; Soil-Transmitted Helminths; Kato-Katz; School Aged Children; Handwashing; Neglected Tropical Disease.*

Introduction

Personal hygiene, derived from the Greek words 'personal' (individual) and 'hygiene' (healthy), encompasses the actions and practices an individual performs to maintain cleanliness and preserve health, encompassing both physical and psychological well-being[1]. It includes a wide array of practices such as skin care, oral hygiene, and, critically for infectious disease prevention, hand and nail cleanliness. A lack of adequate personal hygiene is a major contributor to the transmission of preventable diseases, with Soil-Transmitted Helminths (STH) being a prime example. STH are a group of intestinal parasitic nematodes transmitted through contaminated soil, and their infections are among the most prevalent neglected tropical diseases worldwide[2]. The World Health Organization (WHO) estimates that over 1.5 billion people are infected globally, with the highest burden found in sub-Saharan Africa, China, India, and Southeast Asia, including Indonesia[3]. In Indonesia, the national prevalence remains high, with the Ministry of Health reporting that approximately 60% of the population has been infected at some point, and

school-aged children (5-14 years) bearing a significant portion of this burden[4].

The insidious nature of STH infections, often termed "silent diseases", presents a significant public health problem. Chronic infection, even at low intensity, can lead to devastating long-term consequences, including iron-deficiency anemia, malnutrition, growth stunting, impaired cognitive development, and reduced educational achievement[5]. These consequences create a vicious cycle of poverty and disease, hindering national development. While previous studies in Indonesia, such as one by Fattah et al. (2020) in Makassar, have established a general link between poor hygiene and STH, there remains a gap in understanding the specific behavioral determinants within different urban communities[6]. Many studies treat personal hygiene as a single composite variable, potentially obscuring the differential impact of specific behaviors like handwashing after defecation, keeping nails short, or consistently wearing footwear. Furthermore, diagnostic approaches vary, with some studies relying on less sensitive qualitative methods, which may underestimate the true prevalence and fail to provide data on infection intensity, a key metric for public health intervention decisions by the WHO[7].

This research is urgently needed to provide updated, high quality evidence from a specific urban setting in Makassar. The epidemiological landscape of infectious diseases can shift rapidly due to urbanization, changes in sanitation infrastructure, and public health interventions. Relying on older data may lead to misinformed policies. The novelty of this study lies in its methodological rigor and specific focus. First, it employs the Kato-Katz technique, the WHO recommended quantitative method, which not only determines the presence of infection but also measures its intensity in terms of eggs per gram (EPG) of stool[8]. This provides a more nuanced understanding of the disease burden than a simple positive/negative result. Second, the study deconstructs 'personal hygiene' into three distinct, measurable behaviors handwashing, nail hygiene, and footwear use to identify which specific practices are the most significant drivers of infection in this population. This granular approach is novel and highly valuable for designing targeted and efficient health education programs. By focusing on school children in the Karuwisi Health Centre area, this research provides localized data that is directly actionable for local public health officials and school administrators.

The main research question this study aims to answer is: What is the relationship between specific personal hygiene behaviors (handwashing, nail hygiene, and footwear use) and the prevalence of Soil-Transmitted Helminth infection among school-aged children in the Karuwisi Health Centre area? Based on this, the study's specific objectives are: 1) To determine the prevalence of STH infection and its intensity among the study participants. 2) To assess the personal hygiene behaviors regarding handwashing, nail cleanliness, and footwear use among the participants. 3) To analyze the relationship between handwashing behavior and STH infection. 4) To analyze the relationship between nail hygiene and STH infection. 5) To analyze the relationship between footwear use and STH infection.

The findings of this study have significant potential to impact both academia and public health practice. Academically, it contributes to the body of knowledge on STH epidemiology in urban Indonesia by providing recent, quantitative data on both prevalence and intensity. For public health policy and practice, the results are directly translatable into action. By pinpointing the most critical hygiene

behaviors, the local health office and school management can design evidence-based, cost effective health promotion campaigns. For instance, if handwashing and nail hygiene are proven to be the most significant factors, resources can be concentrated on ensuring adequate handwashing facilities in schools and implementing regular "nail-check" programs, rather than on less impactful interventions. This targeted approach maximizes the impact of limited public health resources. Ultimately, this research aims to provide a scientific foundation for interventions that can reduce the prevalence of STH, thereby improving the health, nutritional status, and educational outcomes of children in the community.

Materials and Methods

Studi Design

This research employed an analytical observational study design with a cross-sectional approach. An observational study was chosen because the researcher observed and measured variables without intervening or manipulating them.[9] The analytical component was included to investigate and test the hypothesis of a relationship between the independent variables (personal hygiene behaviors) and the dependent variable (STH infection status). The cross-sectional design was selected because it is the most efficient and appropriate methodology for determining the prevalence of a condition (STH infection) and its associated factors at a single point in time. This design is ideal for generating hypotheses about the etiology of diseases and is widely used in parasitology and epidemiology for snapshot assessments of community health status[10].

Sample

The population in this study was all elementary school children aged 6-12 years residing in the service area of the Karuwisi Health Centre, Makassar City. The sample size was calculated using the Lemeshow formula for cross-sectional studies, which is designed to provide a representative sample for estimating a proportion. The formula is:

$$n = \frac{z^2 \text{ x } p \text{ x } (1-p)}{d^2}$$

Where:

n = minimum sample size
Z = Z-score for the desired confidence level (1.96 for 95% confidence)
p = estimated proportion of the characteristic of interest (0.5, used to maximize the required sample size when the true proportion is unknown)
d = desired margin of error (0.15 or 15%)

The calculation was as follows:

n = $[1.96^2 * 0.5 * (1-0.5)] / 0.15^2$
= [3.8416 * 0.25] / 0.0225
= 0.9604 / 0.0225 ≈ 42.68.

Therefore, the minimum required sample size was 43 participants. To account for potential non-response or inadequate stool samples, the target sample size was increased to 50 participants. The sampling technique used was convenience sampling, a type of non-probability sampling, where children who were present at school on the day of data collection and whose parents provided consent were recruited. The inclusion criteria were: (1) students of the designated elementary schools aged 6-12 years; (2) whose parents/guardians provided written informed consent; and (3) who were willing to provide a stool sample. The exclusion criteria were: (1) children who had received anthelmintic (deworming) medication within the past 4 weeks; and (2) children who were unable to provide a sufficient stool sample for analysis. All eligible participants were briefed on the study's

purpose and procedures to ensure understanding and voluntary participation prior to sample collection.

Data Collection Technique

Data were collected through two primary methods: a structured questionnaire and laboratory stool examination. A validated questionnaire was developed to collect data on the independent variables: personal hygiene behaviors. This included questions about the frequency of handwashing with soap after playing and before eating, the habit of biting nails, and the frequency of keeping nails short, as well as the regularity of wearing footwear outside the home. The questionnaire was administered through face-to-face interviews with the children to ensure comprehension. For the dependent variable, stool samples were collected from each participant. Each child was provided with a clean, labeled stool collection container and instructed on how to provide a sample. The samples were collected in the morning and transported in a cooler box to the Parasitology Laboratory at the Faculty of Medicine, Universitas Muslim Indonesia, on the same day for analysis. The Kato-Katz thick smear technique was used for examination. In this procedure, a template measuring approximately 41.7 mg was used to scoop a small amount of stool, which was then placed on a microscope slide, covered with a piece of cellophane soaked in glycerol-malachite green solution, and cleared for 30-45 minutes before examination under a light microscope by an experienced laboratory technologist. The number of STH eggs was counted and multiplied by 24 to calculate the number of eggs per gram (EPG) of stool[11].

Data Analysis Technique

The collected data were processed and analyzed using SPSS software (version 25.0 for Windows). The analysis was conducted in two stages:

*Univariate Analysis***,** This analysis was performed to describe each variable individually. For categorical variables (age, gender, hygiene behaviors, infection status), frequency (n) and percentage (%) were calculated. For the quantitative variable of infection intensity (EPG), descriptive statistics such as mean and range were calculated. The results were presented in tables to summarize the characteristics of the study population and the prevalence of infection.

Bivariate Analysis, This analysis was performed to test the research hypothesis and determine the relationship between each independent variable (handwashing, nail hygiene, footwear use) and the dependent variable (STH infection status). The Chi-square test was used to analyze the relationship between these categorical variables. The Chi-square test is appropriate for determining whether there is a significant association between two categorical variables. If any cell in the contingency table had an expected count of less than 5, Fisher's exact test was used as an alternative, as it is more accurate for small sample sizes. For all statistical tests, a p-value of less than 0.05 was considered to indicate a statistically significant relationship[12].

Ethical Consideration

This study was conducted in accordance with the ethical principles for research involving human subjects. Prior to commencement, ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Muslim Indonesia (No.2204/KEPK/FK-UMI/2024). Before data collection, written informed consent was obtained from the parents or guardians of all participating children. Additionally, assent was obtained from the children themselves after explaining the study's purpose and procedures

in age appropriate language. Participants were assured of their anonymity and confidentiality; names were replaced with codes on all data forms and laboratory specimens. Participation was entirely voluntary, and children could withdraw at any time without any consequence. All positive cases identified during the study were referred to the Karuwisi Health Centre to receive free anthelmintic treatment, ensuring that the research provided direct health benefits to the participants.

Results

This section provides an overview of the demographic characteristics of the 50 participants, which is essential for understanding the study population. The data were analyzed to determine the distribution across different age groups and between genders, as these factors can sometimes influence exposure to STH.

Data from Table 1 shows that the age group with the highest number of participants was 8 years (40.0%), followed by 10 years (22.0%). In terms of STH infection, the highest number of positive cases was found in the 7-year-old age group (6 cases, 12.0%), followed by the 8 and 10-year-old groups (3 cases each, 6.0%). No infections were found in children aged 6, 9, or 11 years. The overall prevalence of STH infection was 24.0% (12 out of 50 children). Regarding gender, the distribution was relatively balanced, with females constituting 54.0% (27) and males 46.0% (23) of the sample. A slightly higher number of male children were infected (7 cases, 14.0%) compared to female children (5 cases, 10.0%).

Table 1. Characteristics of Respondents Based on Age, Gender, and STH Infection Status

Variable	Category	STH Positive n (%)	STH Negative n (%)	Total n (%)
Age (years)	6	0 (0.0)	2 (4.0)	2 (4.0)
	7	6 (12.0)	4 (8.0)	10 (20.0)
	8	3 (6.0)	17 (34.0)	20 (40.0)
	9	0 (0.0)	5 (10.0)	5 (10.0)
	10	3 (6.0)	8 (16.0)	11 (22.0)
	11	0 (0.0)	2 (4.0)	2 (4.0)
Gender	Male	7 (14.0)	16 (32.0)	23 (46.0)
	Female	5 (10.0)	22 (44.0)	27 (54.0)
Total		12 (24.0)	38 (76.0)	50 (100.0)

***Source:** Primary Data, 2024*

STH Type and Intensity The second paragraph explains the results of the stool examination, detailing the types of STH found and the intensity of infection, which is a unique feature of the quantitative Kato-Katz method.

The results in Table 2 indicate that the only STH species detected in this study was *Ascaris lumbricoides*. All 12 positive cases were infected with this roundworm. No cases of whipworm (*Trichuris trichiura*) or hookworm (*Ancylostoma duodenale* or *Necator americanus*) were found. According to WHO classification criteria, all *Ascaris* infections were classified as light intensity, as the EPG counts were well below the 5,000 EPG threshold for moderate infection.[13] Specifically, 10 cases had an EPG of 33, and 2 cases had an EPG of 66.

Relationships Between Variables The third paragraph presents the results of the statistical tests performed to analyze the relationship

between each personal hygiene behavior and STH infection status.

Table 3 shows a highly significant relationship between handwashing behavior and STH infection ($p < 0.001$). Among children with poor handwashing habits, 10 out of 18 (55.6%) were infected with STH. In stark contrast, among children with good handwashing habits, only 2 out of 32 (6.25%) were infected.

Table 2. Characteristics of STH Infection Type and Intensity

Variable	Category	Number of Eggs per Gram (EPG)	Total n (%)
STH Species	Negative	0	38 (76.0)
	Ascaris lumbricoides	33, 66	12 (24.0)
	Trichuris trichiura	0	0 (0.0)
	Hookworm	0	0 (0.0)
Infection Intensity (WHO)	Negative	-	38 (76.0)
	Light	33, 66	12 (24.0)
	Moderate	0	0 (0.0)
	Heavy	0	0 (0.0)

***Source:** Primary Data, 2024*

Table 3. Relationship Between Handwashing Behavior and STH Infection

Handwashing Behavior	STH Positive n (%)	STH Negative n (%)	Total n (%)	p-value
Poor	10 (20.0)	8 (16.0)	18 (36.0)	**<0.001**
Good	2 (4.0)	30 (60.0)	32 (64.0)	
Total	12 (24.0)	38 (76.0)	50 (100.0)	

***Source:** Primary Data, 2024*

Table 4. Relationship Between Nail Hygiene and STH Infection

Nail Hygiene	STH Positive n (%)	STH Negative n (%)	Total n (%)	p-value
Poor	11 (22.0)	17 (34.0)	28 (56.0)	**0.016**
Good	1 (2.0)	21 (42.0)	22 (44.0)	
Total	12 (24.0)	38 (76.0)	50 (100.0)	

***Source:** Primary Data, 2024*

Table 4 also reveals a significant relationship between nail hygiene and STH infection ($p = 0.016$). A large majority of children with poor nail hygiene (11 out of 28, or 39.3%) were infected. Conversely, only 1 out of 22 children (4.5%) with good nail hygiene was infected.

Table 5. Relationship Between Footwear Use and STH Infection

Footwear Use	STH Positive n (%)	STH Negative n (%)	Total n (%)	p-value
Poor	7 (14.0)	16 (32.0)	23 (46.0)	**0.325**
Good	5 (10.0)	22 (44.0)	27 (54.0)	
Total	12 (24.0)	38 (76.0)	50 (100.0)	

***Source:** Primary Data, 2024*

In contrast, Table 5 shows that there is no statistically significant relationship between the habit of using footwear and STH infection ($p = 0.325$). Among children with poor footwear habits, 7 out of 23 (30.4%) were infected, while among those with good footwear habits, 5 out of 27 (18.5%) were infected. Although the proportion of infection is higher in the poor footwear group, the difference is not statistically significant.

Summary of Key Findings In summary, the research found a 24% prevalence of light-intensity *Ascaris lumbricoides* infection among the studied children. The results clearly demonstrate that poor personal hygiene behaviors are significant risk factors. Specifically, poor handwashing and poor nail hygiene were both significantly associated with a higher likelihood of STH infection. However, the use of footwear was not found to be a significant protective factor against STH infection in this specific study population, a finding that requires careful interpretation in the context of the parasite species identified.

Discussion

Interpretation of Key Findings The primary finding of this study is the 24% prevalence of light-intensity *Ascaris lumbricoides* infection, coupled with the significant associations between poor handwashing and nail hygiene

with STH infection. The 24% prevalence, while lower than some historical reports from other parts of Indonesia, still indicates a significant public health problem that requires attention[14]. The fact that all infections were caused by *Ascaris lumbricoides* and were of light intensity is a crucial observation. *Ascaris* is transmitted through the fecal-oral route, primarily via ingestion of embryonated eggs from contaminated hands, food, or water[15]. This transmission pathway directly explains why handwashing and nail hygiene are so critical. Hands, especially with long or dirty nails, can easily pick up STH eggs from the environment (e.g., contaminated soil). When a child bites their nails or eats with unwashed hands, these eggs are ingested, leading to infection. The strong statistical significance ($p < 0.001$ for handwashing, $p = 0.016$ for nail hygiene) powerfully confirms this well-established biological mechanism in the context of the Karuwisi community.

The non-significant relationship between footwear use and STH infection ($p = 0.325$) is an equally important finding. The most logical explanation for this result lies in the specific STH species identified. Hookworms (*Ancylostoma duodenale* and *Necator americanus*) are primarily transmitted through skin penetration by infective larvae in the soil[16]. For these parasites, wearing footwear is a highly effective protective barrier. However, *Ascaris lumbricoides* is not transmitted through the skin; it is transmitted via ingestion. Since no hookworm infections were found in this study, the protective effect of footwear against STH infection as a whole was not statistically demonstrable. This highlights that the effectiveness of a specific hygiene behavior is entirely dependent on the local epidemiology of the parasite species present.

Our finding of a significant association between handwashing and STH infection is strongly supported by a vast body of literature. A study by Suparni et al. (2023) in North Sumatra also found a significant link between poor handwashing practices and STH infection among school children[17]. Similarly, research by Kause et al. (2020) in East Nusa Tenggara reported that children who did not wash their hands with soap before eating had a higher risk of STH infection[18]. Our study corroborates these findings in an urban Makassar setting, reinforcing the universal importance of this behavior.

The significant link between poor nail hygiene and STH is also consistent with previous research. A study by Yunisyar et al. (2024) in South Sulawesi found that poor nail hygiene was a strong predictor of STH infection[19]. Nails provide a perfect shelter for STH eggs, protecting them from desiccation and making them easy to transport to the mouth. Our findings add to this evidence, demonstrating that even within a single city, the principle holds true.

However, our finding regarding footwear differs from some studies conducted in areas where hookworm is endemic. For example, a study by Al-Muqsith (2016) in Lhokseumawe found a significant association between not wearing footwear and STH infection, likely because hookworm was more prevalent in their study population[20]. This comparison underscores a critical point in public health: interventions must be tailored to the local context. A "one-size-fits-all" approach to hygiene education may not be efficient. In areas dominated by *Ascaris* and *Trichuris*, emphasizing handwashing and nail hygiene may yield greater results than focusing on footwear[21].

The findings of this study have direct and actionable implications for public health practice in Makassar. Clinically, while the infections were of light intensity, they still represent a disease burden and a source of reinfection within the community. Health

workers at the Karuwisi Health Centre should use these findings to strengthen their health education messages.

The primary public health implication is the need for targeted, school-based health promotion programs. These programs should move beyond generic messages and focus specifically on the "how" and "why" of proper handwashing and nail care. For example, schools could implement scheduled handwashing times with soap before meals and after using the toilet. "Nik-nak" or nail-check days could be introduced, where teachers reward children with clean, short nails. Posters depicting the fecal-oral transmission route of *Ascaris* could be placed in classrooms and toilets to provide a visual reminder of the consequences of poor hygiene.

The finding that footwear was not significant should not be interpreted to mean that promoting footwear use is unimportant. Footwear is crucial for preventing other injuries and soil-transmitted diseases, including hookworm, should it be reintroduced into the area. Therefore, the recommendation should be to continue promoting footwear use as part of a comprehensive hygiene package, but to prioritize resources and messaging on handwashing and nail hygiene for STH prevention in this specific context.

The strength of this research lies in its use of the quantitative Kato-Katz method, which provided not just prevalence data but also infection intensity, aligning with WHO guidelines. The clear focus on specific, modifiable hygiene behaviors is another strength, making the results highly practical for intervention design. The study also adhered to strict ethical standards, ensuring participant welfare.

However, the study has several limitations. First, the small sample size (n=50) and the use of convenience sampling limit the generalizability of the findings to all of Makassar or other regions. The results are specific to the schools and children who participated. Second, the use of a single stool sample for Kato-Katz examination is a known limitation. STH egg excretion can be intermittent, and a single sample can result in underestimation of the true prevalence, especially for light infections. The WHO recommends examining multiple stool samples on different days for higher sensitivity[22]. Third, the assessment of hygiene behaviors relied on self-reporting by children, which may be subject to recall or social desirability bias. Children may over-report good behaviors like handwashing because they know it is the expected answer. Finally, the cross-sectional design cannot establish temporality or causality; it can only show associations[23].

Based on the findings and limitations, several recommendations for future research are proposed. First, a larger-scale, multi-site study using a randomized sampling technique is needed to obtain findings that are more representative of the entire city or province. Second, future studies should employ a more sensitive diagnostic approach, such as examining two or three consecutive stool samples per participant, to obtain a more accurate estimate of prevalence. Third, it is recommended to include a qualitative component, such as focus group discussions with children and parents, to explore the sociocultural barriers and facilitators to practicing good hygiene. This would provide invaluable insights for designing culturally resonant health education materials. Finally, an interventional study, such as a cluster-randomized trial, should be conducted to measure the actual impact of a targeted handwashing and nail hygiene education program on reducing STH incidence. This would move the research from observation to implementation and provide the highest level of evidence for public health policy.

Conclusion

In conclusion, this study found a 24% prevalence of light-intensity *Ascaris lumbricoides* infection among school-aged children in the Karuwisi Health Centre area. The most significant finding is the strong, statistically significant relationship between poor personal hygiene behaviors specifically inadequate handwashing and poor nail hygiene and the risk of STH infection. These behaviors directly facilitate the fecal oral transmission of *Ascaris* eggs. In contrast, footwear use was not significantly associated with infection, likely because the only parasite found was *Ascaris*, which is not transmitted through the skin. These results underscore that for STH control, public health interventions must be evidence-based and tailored to the local epidemiological context. For the Karuwisi area, and potentially similar urban settings in Indonesia, prioritizing and intensifying health education on proper handwashing with soap and regular nail cutting is the most critical and effective strategy to reduce the burden of STH and improve the health and well-being of children.

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