Hygiene and Sanitation Factors Affecting Contamination of Soil-Transmitted Helminths in Household Water Sources in Jember, Indonesia

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Abstract

Background: Water sources used by households are at risk of contamination by soil-transmitted helminths (STH). Hygiene and sanitation have an essential role in the transmission and contamination of STH. The objective of this study was to analyze whether there was an association between hygiene and sanitation factors with STH contamination in household water sources in Jember Regency, East Java Province, Indonesia.

Methods: This cross-sectional analytic study was carried out from December 2020 to March 2021, including 46 samples from 23 respondents in Sukowono District and 23 respondents in Sukorambi District, Jember Regency, selected using a purposive sampling technique. Primary data on hygiene and sanitation risk factors were obtained from questionnaire interviews. The STH contamination in household water sources was examined by sedimentation and flotation methods. Data were analyzed using Fisher Exact test.

Results: The identification of STH contamination in household water sources using microscope examination found hookworm species contaminated 9% (n=4) of water sources. There was a significant association between the type of human sewage disposal with STH contamination in household water sources (p=0.037). There was no association between hygiene and other sanitation factors with STH contamination in household water sources (p>0.05).

Conclusion: Human sewage disposal that goes directly to sewers and rivers can cause contamination of water sources by STH. Therefore, it is important to dispose of human waste in septic tanks that comply with health requirements to prevent the transmission of STH to humans through water sources.

Keywords: Dug well, hookworm, household water, human sewage disposal

Introduction

Water is one of the basic needs of humans. Water sources used by households have a risk of being contaminated by soil-transmitted helminth (STH).[1] Soil-transmitted helminth infestation is still one of the health problems in Indonesia. The prevalence of STH infestation in Indonesia is still relatively high, varying between 2.5% to 62%.[2] Several studies have proven that water sources can be contaminated by STH. A study in Iraq[3] found that from 104 samples examined, 4.8% of water sources were contaminated by hookworms and 1.9% by *Ascaris lumbricoides*. Another study conducted in Bandung, Indonesia[4] detected *Ascaris lumbricoides* egg in dug wells used by the community.

Hygiene and sanitation have an essential role in the transmission and contamination of STH in the environment. Transmission of STH occurs through the fecal-oral route and skin penetration which is associated with hygiene and sanitation factors.[2,5] These hygiene and sanitation factors are hand washing habits, nail cutting habits, defecation sites, pit latrine facilities, and water source facilities.[6,7]

Jember Regency is one of the regencies in

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East Java Province, where most of the population lives in rural areas. Some households in Jember Regency have not practiced hygiene well, with 31.85% of households have not practiced good hygiene habits. The population of Sukowono District and Sukorambi District who do not have access to improved pit latrines is 70.45% and 53.49%, respectively.[8] The objective of this study was to analyze whether there was an association between hygiene and sanitation factors with STH contamination in household water sources in Sukowono and Sukorambi, Jember Regency, East Java Province, Indonesia.

Methods

This research design was a cross-sectional analytic study. The study was conducted from December 2020 to March 2021 in Sukokerto Village, Sukowono District, and Dukuh Mencek Village, Sukorambi District, Jember Regency, East Java Province. The sample of this study was the people in Sukokerto Village, Sukowono District, and Dukuh Mencek Village, Sukorambi District, Jember Regency. The sample size of this study was 46 people, with 23 samples from Sukokerto Village, Sukowono District, and 23 samples from Dukuh Mencek Village, Sukorambi District. The sampling technique used in this study was purposive sampling. The inclusion criteria for this study were respondents aged ≥18 years old, who could communicate well and had household water sources such as a dug well, artesian well, or tap water. Respondents who used rivers as water sources were excluded from this study.

The hygiene and sanitation factors were identified through questionnaire interviews. The questionnaire consisted of demographic information and questions about handwashing habits, defecation sites, nail cutting habits, pit latrine ownership, human sewage disposal type, household water source type, and distance between the water source and human sewage disposal. Water samples were taken from household water sources such as artesian wells, dug wells, and tap waters. Each source was taken as much as 2 liters of water and deposited for 5–7 days. Water deposit was examined using sedimentation and flotation methods at the Parasitology Laboratory, Faculty of Medicine, University of Jember. Sedimentation was conducted by centrifuge with 2000 RPM for 15–20 minutes. The flotation was done using saturated sucrose solution to float STH eggs. Soil-transmitted helminths in water samples were identified through a microscope examination with 100x

Table 1 Respondents' characteristics

Characteristics	n	%
Gender		
Male	17	37
Female	29	63
Age (years)		
18–45	26	57
45–59	13	28
≥60	7	15
Education level		
No education	2	4
Elementary school	21	46
Junior high school	18	39
Senior high school	1	2
College	4	9
Occupation		
Farmer	12	26
Housewife	17	37
Private sector worker	5	11
Teacher	1	2
Laborer	7	15
Student	2	4
Unemployed	2	4

Table 2 Findings for Soil-Transmitted Helminth Contamination in Water Sources

Species	Household Water Source			n	%
	Dug well	Artesian well	Tap water		
Positive					
Ascaris lumbricoides	-	-	-	-	-
Hookworm	4	-	-	4	9
Trichuris trichiura	-	-	-	-	-
Negative	31	2	9	42	91
Total	35	2	9	46	100

and 400x magnification and according to the World Health Organization's (WHO) Bench Aids for the Diagnosis of Intestinal Parasites guidance.[9] This study was approved by the Ethics Committee of the Faculty of Medicine, University of Jember No: 1541/H25.1.11/KE/2021. Data were analyzed using Fisher Exact test and odds ratio.

Results

Characteristics of respondents based on gender, age, education level, and occupation were presented in Table 1. More than half of the respondents in this study were female (63%) compared to male respondents. Most of the respondents were aged 18–45 years or adults (57%), had elementary school education level (46%) and had jobs as housewives (37%) and farmers (26%).

Water sources contaminated by STH in this study were 4 dug wells (9%). The STH species that contaminated the water sources were hookworms and the distribution of STH contamination was shown in Table 2.

There was no association between hygiene factors and STH contamination in household water sources based on the Fisher Exact test (Table 3). There was also no association between some of the sanitation factors, such as pit latrine ownership, household water source type, and the distance of the water source from the human sewage disposal, with STH contamination in household water sources. There was a significant association between the human sewage disposal type and STH contamination in water sources (p-value=0.037) (Table 4).

Discussion

In this study, the majority of the respondents was female who generally had a role in managing hygiene and sanitation conditions in their homes. However, STH infection is not affected by gender. STH infection is more affected by socioeconomic status, population density, hygiene habits, and sanitation in the individual's environment.[10] The respondents of this study were primarily adults with a range of 18–45 years. Those results were similar to the study conducted in Kediri District, Jawa Timur Province, the majority of the respondents were female and adults.

Table 3 Hygiene Factors with STH Contamination in Water Sources

Hygiene	Negative		Positive		p-value
	n	%	n	%	
Handwashing habit					
Yes	40	87	4	9	1.000
No	2	4	-	-	
Defecation site					
Pit latrine	36	78	4	9	1.000
River/ground	6	13	-	-	
Nail cutting habit					
Regularly (once/week)	27	59	3	6	1.000
Irregularly (not once/week)	15	33	1	2	

Table 4 Sanitation Factors with STH Contamination in Water Sources

Sanitation	Negative		Positive		p-value	Odds ratio
	n	%	n	%		
Pit latrine ownership						
Yes	38	83	4	9	1.000	-
No	4	9	-	-		
Human sewage disposal*						
Septic tank	34	74	1	2.2	0.037	12.750
River/sewer	8	17	3	6.5		
Household water source						
Tap water & Artesian well	10	22	-	-	0.562	-
Dug well	32	70	4	9		
Distance between the water source and human sewage disposal >10 m					1.000	-
Yes	23	50	2	4		
No	19	41	2	4		

Studies on STH were generally more focused on children, although STH can infect people of all ages.[11] Housewife and farmer jobs are common in rural communities. Farmers have a higher risk of STH infection due to frequent contact with the soil, while housewives are at risk of STH infection when doing housework related to the soil, such as cleaning the yard. Those findings were similar to the study conducted in Palembang, that showed the majority of the parents were elementary education levels and worked as housewives and farmers.[10] The low level of education and certain professions, such as farmers, are some of the risk factors for STH infection.[10,12]

Water sources contaminated by STH were dug into wells with a total of 4 samples (8.7%). The low percentage of STH contamination was supported by a study conducted in Iraq[3] which found a low percentage of STH contamination (6.7%). Contamination of water sources by STH is caused by several factors, such as poor hygiene and sanitation, contamination from the environment or agriculture activities, climate, and socio-economics.[1,13,14] The majority of the respondents in this study had good hygiene habits and adequate sanitation facilities. Good hygiene habits and adequate sanitation could be some factors that caused the low percentage of contamination.

The soil-transmitted helminth species which contaminated water sources in this study was hookworm. This study was similar to a study in Nigeria, which detected contamination of water sources by hookworm species. In the study conducted in Nigeria, an inadequate human sewage disposal system caused hookworm contamination.[1] Similar to some of the respondents in this study, some of the households in the Nigeria study had a human sewage disposal system directly discharged into the environment, which caused hookworm contamination in water sources.[1]

This study discovered no significant association between hygiene factors with STH contamination in household water sources. Most of the respondents have applied these hygiene habits, showing that other factors caused the contamination. Some possible factors causing the contamination were agricultural and environmental activities, such as using human feces as fertilizer and the accumulation of residential fecal waste.[12,14,15] Besides being supported by these factors, the water sources in this study were also only contaminated by hookworm species. Hookworms are transmitted through larvae penetrating the skin, and they do not always need dirty hands and nails to transmit like *A. lumbricoides* and T. trichiura eggs. These results were supported by studies in Southern Ethiopia[16] and Bangladesh[17], which stated that regular hand washing and nail cutting habits did not reduce the infection of hookworm.

This study showed a significant association between human sewage disposal type with STH contamination (p=0.037), but there was no association between pit latrine ownership and STH contamination. A study in Ethiopia[18] also found that there was no association between pit latrine ownership with STH

prevalence. Other factors that support the prevalence and contamination of STH are pit latrine construction and conditions. Apart from having pit latrine facilities, a household needs to have a pit latrine with well-maintained construction such as adequate human sewage disposal. Study in another part of Ethiopia[6] stated that STH infestation and contamination were associated with indiscriminate disposal of human feces. Damaged or inadequate human sewage disposal facility results in human feces being wasted in the environment and causes parasitic contamination.[6,18] In this study respondents who had human sewage disposal to a river or sewer were 12.75 times more likely to have STH-contaminated water sources in their homes than respondents who had human sewage disposal to a septic tank (OR=12.750). Liquid waste and human feces must be disposed of in a closed and protected place such as a septic tank. Disposing of human feces in sewers or rivers causes parasites, infective eggs, and STH larvae to contaminate the surrounding environment, such as water sources.[6]

There is no association between the household water source type and STH contamination. This result indicated that several other factors caused the contamination. A study in Bangladesh[15] stated that water sources could be contaminated by pathogens when there was damage or malfunction in the construction of water sources. Water sources that already had a protected construction are still at risk of contamination when they experience damage or malfunction in protective barriers such as walls, pipes, or wellheads. Malfunctions of water source construction cause microorganisms to easily enter water sources from the outside environment.[15] We also did not find any association between the distance of water source from human sewage disposal with STH contamination. A study about parasitic contamination in wells in Iran[19] also stated that there was no association between the distance of the water source from sources of contamination with parasite contamination. One of the factors that determine pathogen contamination is the position of the water source with human sewage disposal. The position of the water source higher on the ground reduces the flow of waste from the septic tank or other pollutant source to the water source.[19,20]

The limitation of the study are the measurement of hygiene and sanitation factors only using questionnaire interviews. There was potential for bias because there was a possibility that some respondents tended to choose answers that were not necessarily following reality. Ideally, the data collection on hygiene and sanitation should be performed by observation.

In conclusion, there is an association between the type of human sewage disposal and STH contamination in water sources. Human sewage disposal that goes directly to sewers and rivers can cause contamination of water sources by STH. Therefore, it is important to dispose of human waste in septic tanks that comply with health requirements to prevent the transmission of STH to humans through water sources.

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