

# Risk Factors for *Schistosomiasis* in East Lore District Poso Regency Central of Sulawesi Province, Indonesia

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**Abstract** *Schistosomiasis* is a neglected tropical disease caused by blood trematode worms from the genus *Schistosoma*. The prevalence in East Lore was high.

**Objective:** It's important to comprehend the danger variables. In the Poso Regency East Lore District, a study was conducted to identify the risk factors for the incidence of *Schistosomiasis*. **Method:** This research uses a case control study design and is an analytical observational research project. There were 43 respondents of *Schistosomiasis* cases, and 43 respondents made up the control group, which was chosen at a 1:1 ratio based on respondents age and sex matching the cases. Environmental samples were measured using water quality test. **Result:** The distribution of *Oncomelania hupensis lindoensis* snail habitat was described by measured water temperature and pH was determined in the habitat. According to environmental measurements, rice field irrigation canals and brown plantation streams with water temperatures between 22 °C and 27 °C and pH values between 5.5 and 7.8 were discovered to contain cercariae snails. Bivariate analysis showed that the habit of open

defecation (OR = 6.0; CI (95%) = (2.3 – 15.3), the habit of not using clean water (OR = 7.0; CI (95%) = (1.45 – 34.07), the distance from the house to the snail habitat were risk factor (OR = 28.3; CI (95%) = (8.23 – 97.6), not using PPE (OR = 10.9; CI (95%) = (4.02 – 30.0), and underutilization of *Schistosomiasis* health programs (OR = 11.3; CI (95%) = 4.08 – 31.2) are risk factors. The variable distance between the home and the snail habitat with OR = 40.7; CI (95%) = (5.064 – 328.02) is the most significant risk factor based on the results of multivariate analysis. **Conclusion:** The habit of open defecation, not using clean water, the distance between the house and the snail habitat, not using personal equipment and underutilization of *Schistosomiasis* health programs are risk factors (OR value is > 1) because variables with an OR value > 1 value greater than 1 are risk factors. Meanwhile, the most significant risk factor is the distance between the home and the snail habitat.

**Keywords** Risk Factors, *Schistosomiasis*, Distance from House to Habitat, Indonesia

## 1. Introduction

*Schistosomiasis* is a very complex health problem that affects the lives of a group of people [1]. One illness that falls under the category of neglected tropical diseases is *Schistosomiasis*, which is a significant health issue. The impact is an abnormality in liver function which can disrupt workers' activities and productivity, thus affecting the family economy [2].

*Schistosomiasis*, a disease that has been confirmed to exist globally, is found in tropical areas. It is estimated that 779 million people are at risk of contracting the disease, 250 million people have been infected, and 200,000 fatalities are linked to *Schistosomiasis* annually. Variations in prevalence estimates depend on the focal character of the epidemiology [2,3].

In Central Sulawesi Province, *Schistosomiasis* is an endemic disease that is present in two districts, Sigi Regency and Poso Regency. This is because the disease has always been present in the local population. This disease was first discovered in the Lindu Plateau in 1937, the Napu Plateau in 1974 and the Bada Plateau in 2008 [4].

*Schistosomiasis* cases in East Lore District are still fluctuating and if it is above 1% it is already a public health problem. *Schistosomiasis* can make a person less able to work and in certain situations kill people all ages. In children, *Schistosomiasis* can result in anemia, stunting, and impaired cognitive function [5].

East Lore District is surrounded by mountains and protected forests and there are rice fields and plantations which can be a source of daily life for the community as well as being a habitat for the *Oncomelania hupensis lindoensis* snail. Due to the fact that the snail's body is where *Schistosomiasis* larvae develop from miracidium to cercariae, *Oncomelania hupensis lindoensis* plays a significant role in the epidemiology of the disease. Snails essentially depend on the presence of an appropriate habitat for them to live in [6,7].

Apart from being caused by intermediary snails, *Schistosomiasis* can be influenced by public behavior and awareness which are key factors in efforts to eliminate *Schistosomiasis*. This research was conducted to see a picture of the behavior of the people of East Lore District in preventing the transmission of *Schistosomiasis* and this research will use spatial patterns (mapping) to determine the distribution of positive *Oncomelania hupensis lindoensis* snails in East Lore District, Poso Regency.

## 2. Research Methods

### 2.1. Types of Research

The design of this research is analytical observational using a case control study design, namely an epidemiological design that begins with the selection of

individuals into a case group and a control group whose risk factors will be studied. The two groups were compared in terms of the presence of causes or circumstances/past experiences that may be relevant to the cause of the disease [8]. In this study, we wanted to find out whether certain risk factors influenced the occurrence of the effects studied by comparing the exposure and risk factors in the case group with the control group [9].

### 2.2. Sample Collection

This research was conducted in East Lore District, Poso Regency, Central Sulawesi Province. This study measured physical environmental parameters in 6 habitats of the snail *Oncomelania hupensis lindoensis*. The sample in this study was divided into 2 groups, 43 respondents samples of *Schistosomiasis* cases, and 43 respondents made up the control group, which was chosen at a 1:1 ratio based on respondents age and sex matching the cases.

#### Case Group Inclusion Criteria

1. Willing to participate in the study as a respondent.
2. *Schistosomiasis* sufferers who live in the East Lore District, Poso Regency
3. Patients with *Schistosomiasis* who tested positive in 2023 according to information from stool tests conducted at the North Lore *Schistosomiasis* Laboratory.

#### Control Group Inclusion Criteria

1. Willing to be a respondent in the research.
2. Residents who live in the East Lore District, Poso Regency.
3. Not suffering from (negative) *Schistosomiasis* in 2023 based on data from stool examination results at the North Lore *Schistosomiasis* Laboratory, Poso Regency.
4. It has similar characteristics to the case sample, such as the village where the case is located in the same area as the case sample.
5. Have a *match* between case groups with the same gender criteria and have the same age.

### 2.3. Research of Instrument

The tool for research is made up of; (1) Questionnaire as an interview guide to explore the information expected in accordance with the research objectives, (2) Temperature, (3) pH meter, (4) Global Positioning System, (5) Documentation tools: Photos and video recording of interviews, (6) Writing tools.

### 2.4. Research Ethics

This study was carried out with approval following ethical guidelines and a financial support number: [890/UN4.14/TP.01.02/2024].

### 3. Result

Based on Figure 1, the habitat of rice field irrigation canals in Winowanga Village had the lowest water temperature (23 °C), while the habitat of brown garden waterways had the highest water temperature (27 °C). In Maholo Village, the habitat of rice mill swamps had the lowest water temperature values (22 °C), while the habitat of tomato plantation habitats had the highest water temperature (26 °C).

According to Figure 2, the water habitat of the snail, which was measured at two different locations—plantation ponds and rice field irrigation canals—was found to be neutral (pH 7). The water channel of the tomato plantation and cocoa garden in Maholo Village has a low pH of 6, whereas the rice field irrigation canal in Winowanga Village has the lowest pH of 5.5.

Based on Figure 3, the 9 habitats that have been surveyed, the most common habitat types are found in the waterways of brown plantations as much as 3 (33%) and the least are found in the habitat of plantation ponds 1 (11%),

abandoned rice fields 1 (11%), rice mill swamps 1 (11%), and tomato plantations 1 (11%).

Based on Figure 4, Maholo Village has the highest density of snails in the habitat of the brown garden waterway with 105 snails/m<sup>2</sup>, and Winowanga Village has the lowest density of snails at the point of plantation ponds with 9.7 snails/m<sup>2</sup>.

Figure 5 is the results of a microscopic *Schistosomiasis* laboratory examination, 4 snails positive for cercariae were found in 4 snail foci. The snail *Oncomelania hupensis lindoensis* is amphibious, meaning it can live in water and on land.

Figure 6 is a laboratory examination using a compound microscope with a magnification of 10 x 10 to observe the *O. hupensis lindoensis* snail and the feces of patients with *Schistosomiasis*. Based on the observation results, the snail is tested positive if there is cercaria. Meanwhile, in the feces, the individual is said to be positive if the test results show as shown in the picture of part b, namely the eggs of the *Schistosoma japonicum* worm which are white.

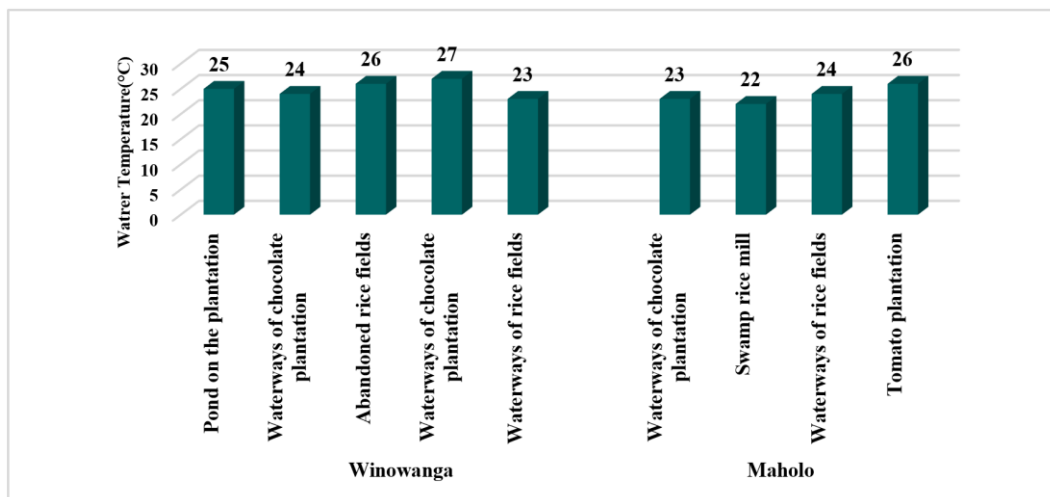


Figure 1. Water temperature habitat of the *Oncomelania hupensis lindoensis*

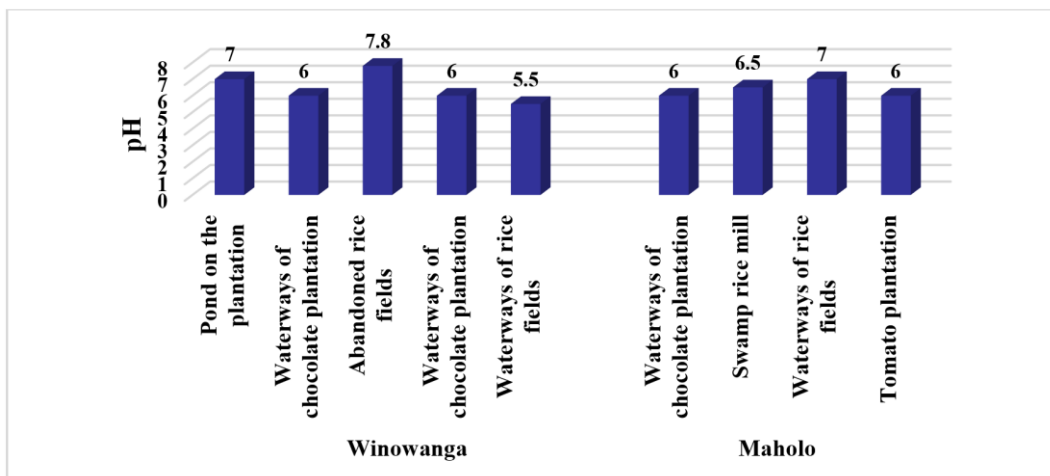


Figure 2. Water pH habitat of the *Oncomelania hupensis lindoensis*

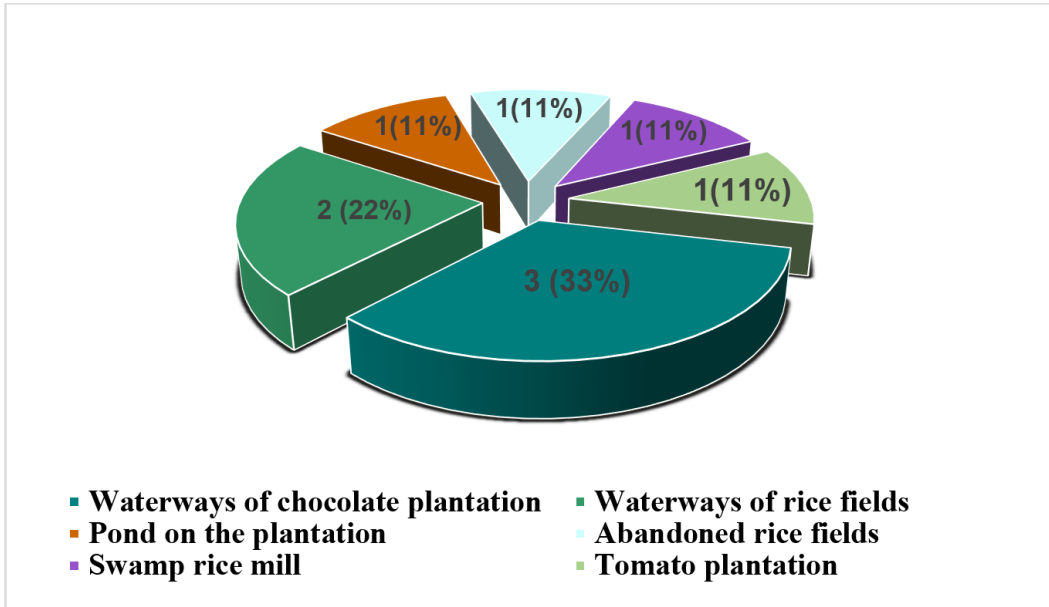


Figure 3. Habitat Type of *Oncomelania hupensis lindoensis*

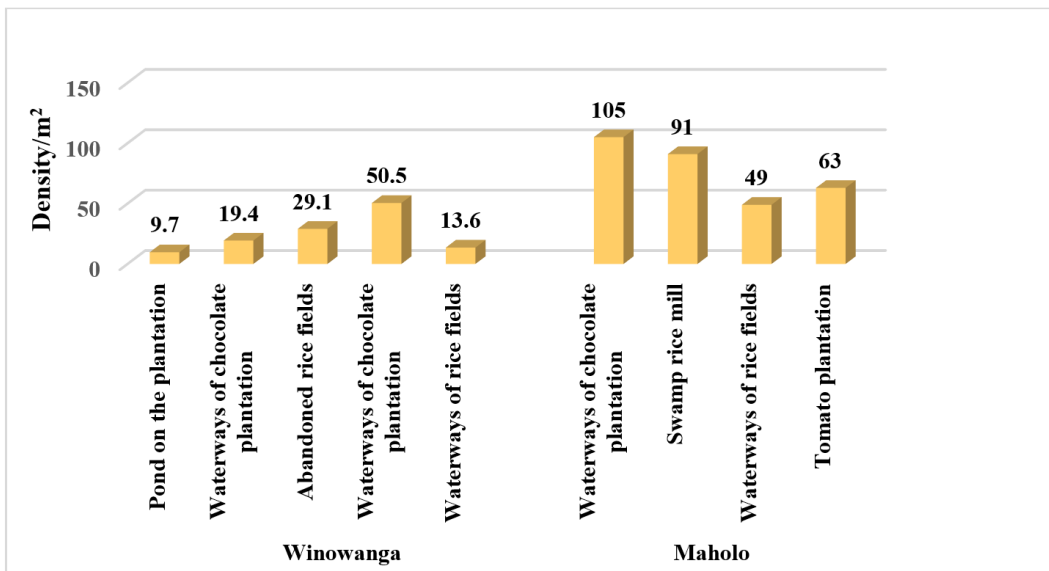


Figure 4. Density of *Oncomelania hupensis lindoensis*

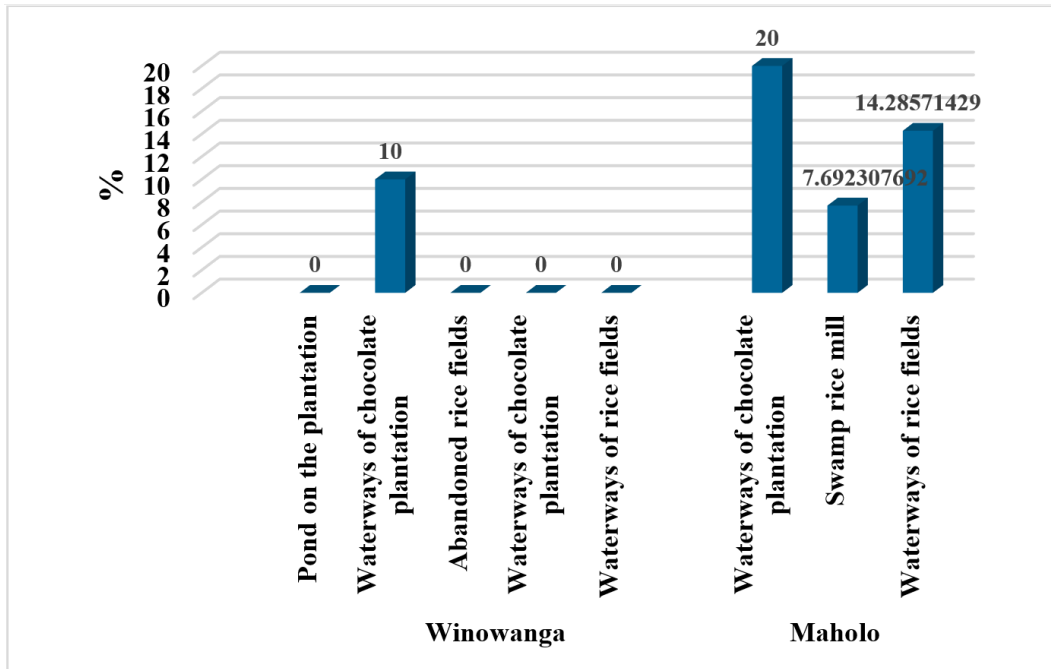
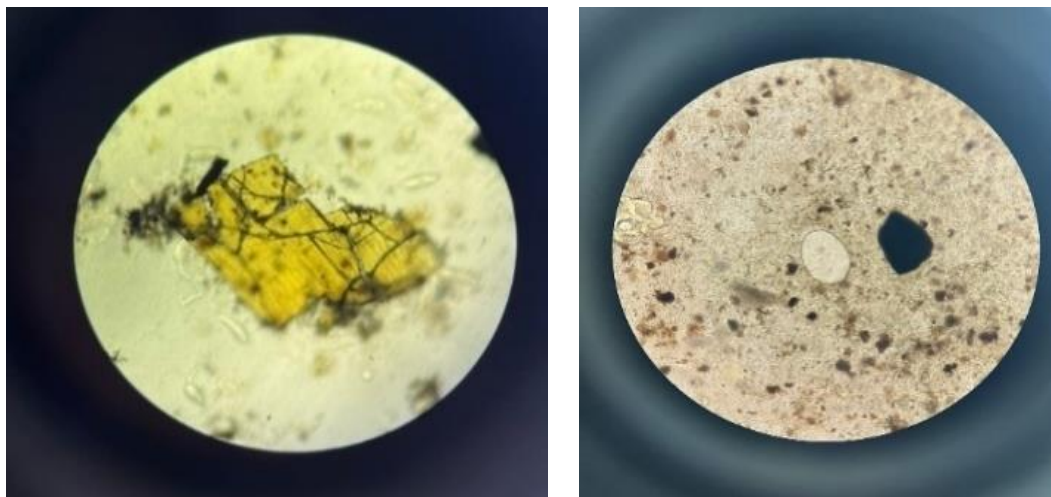


Figure 5. Infection Rate of *Oncomelania hupensis lindoensis*



(a)

(b)

Figure 6. a) Snail *Oncomelania hupensis lindoensis* tested positive for cercariae. b) Feces of *Schistosomiasis* sufferers

Based on Table 1, respondents who did not attend school were primarily young children below school age. In East Lore District, the majority of research respondents were engaged in agriculture, with 47 individuals (54.6%) identifying as farmers. The remaining 23.2% fell into the non-working/other category, which included students, honorary workers, midwives, and teachers.

**Table 1.** Distribution of Respondent Characteristics based on Gender, Occupation, Education

No	Respondent Characteristics	Case		Control	
		n	%	n	%
1	<b>Gender</b>				
	Male	32	74,4	32	74,4
	Female	11	25,5	11	25,5
	Amount	43	100	43	100
	<b>Age (Years)</b>				
	0 - 9	2	4,6	2	4,6
	10 - 19	2	4,6	2	4,6
2	20 - 29	5	11,6	5	11,6
	30 - 39	4	9,3	4	9,3
	40 - 49	17	39,5	17	39,5
	50 - 59	7	16,2	7	16,2
	60 - 69	6	13,9	6	13,9
	Amount	43	100	43	100
	<b>Education</b>				
	No School	1	2,3	1	2,3
	Elementary School	12	27,9	2	4,7
3	Junior High School	18	41,9	15	34,9
	Senior High School	12	27,9	17	39,5
	Diploma	0	0	4	9,3
	S1/S2/S3	0	0	4	9,3
	Amount	43	100	43	100
	<b>Occupation</b>				
	Farmer	38	88,4	9	20,9
4	Civil Servant	0	0	4	9,3
	Self - employed	0	0	15	34,9
	Other	5	11,6	15	34,9
	Amount	43	100	43	100

Source: Data primary, 2024.

Figure 7 illustrates that the initial symptoms experienced by the case group with *Schistosomiasis* were predominantly rashes, affecting 63% of the group. This was followed by fever, characterized by headache and chills, in 18% of the cases. Additionally, 14% of the sufferers reported stomach ache, and 5% experienced a cough. Early-stage symptoms included coughing, nausea, loss of

appetite, and itchy skin due to cercariae penetration.

Table 2 illustrates the analysis's findings, which indicate that those who practice open defecation have 6.0 fold higher chance of contracting *Schistosomiasis* than people who do not. So the habit of open defecation is a risk factor for *Schistosomiasis*, which can be seen from the OR value > 1.

Figure 8 shows the type of latrines used by the case group of 43 people, dominated by cemplung type 15 people (35%) and plengsengan type 15 people (35%). In the control group of 43 people, the gooseneck type latrine was used the most by the respondents, namely 37 people (86%). People who live in East Lore District still have the habit of defecating indiscriminately, and this is supported by data on the percentage of villages stopping BABs from PKM Maholo which noted that the people of East Lore have not reached 100%.

According to Table 3, individuals who do not regularly use clean water have a 7.0 fold higher chance of contracting *Schistosomiasis* than those who do. The OR value > 1 means that the variable habit of not using clean water is a risk factor for the incidence of *Schistosomiasis*.

Figure 9 shows that in the case group of 43 people, there are 11 people (26%) who are still using unclean water sources, namely rivers. Meanwhile, the control group of 43 people consisting of 19 people (44%) used PDAM water.

Based on Table 4, the distance between the house and the snail habitat is a risk factor for the incidence of *Schistosomiasis*, which can be seen from the OR value of 28.3 > 1. This OR value also means that the variable distance between the house and the snail habitat can increase the risk 28.3 times in respondents who have a house distance of ≤ 100 m compared to respondents who have a house distance of > 100 m to the snail habitat.

Table 5 indicates that not using personal protective equipment (PPE) is a practice that increases the risk of contracting *Schistosomiasis*. This can be seen from the OR value of 10.9 > 1. The OR value also means that respondents who do not wear PPE when carrying out activities in the snail focus area (habitat) are at risk of 10.9 times affected by *Schistosomiasis* compared to respondents who wear PPE

Table 6 indicates that respondents who participated in < 2 health programs had a risk of 11.3 times compared to respondents who participated in ≥ 2 health programs. The OR value for this variable is > 1 so it can be said that the habit of following health programs related to *Schistosomiasis* is a risk factor for the incidence of *Schistosomiasis*.

The logistic regression analysis in Table 7 shows that the variable distance from the house to the snail habitat is the variable that has the most influence on the incidence of *Schistosomiasis*. This can be seen based on the smallest significance value (0.000) compared to other variables. Respondents residing less than 100 meters from a snail habitat have a 40.2 times higher likelihood of contracting *Schistosomiasis* compared to those living 100 meters or more away from a snail habitat.

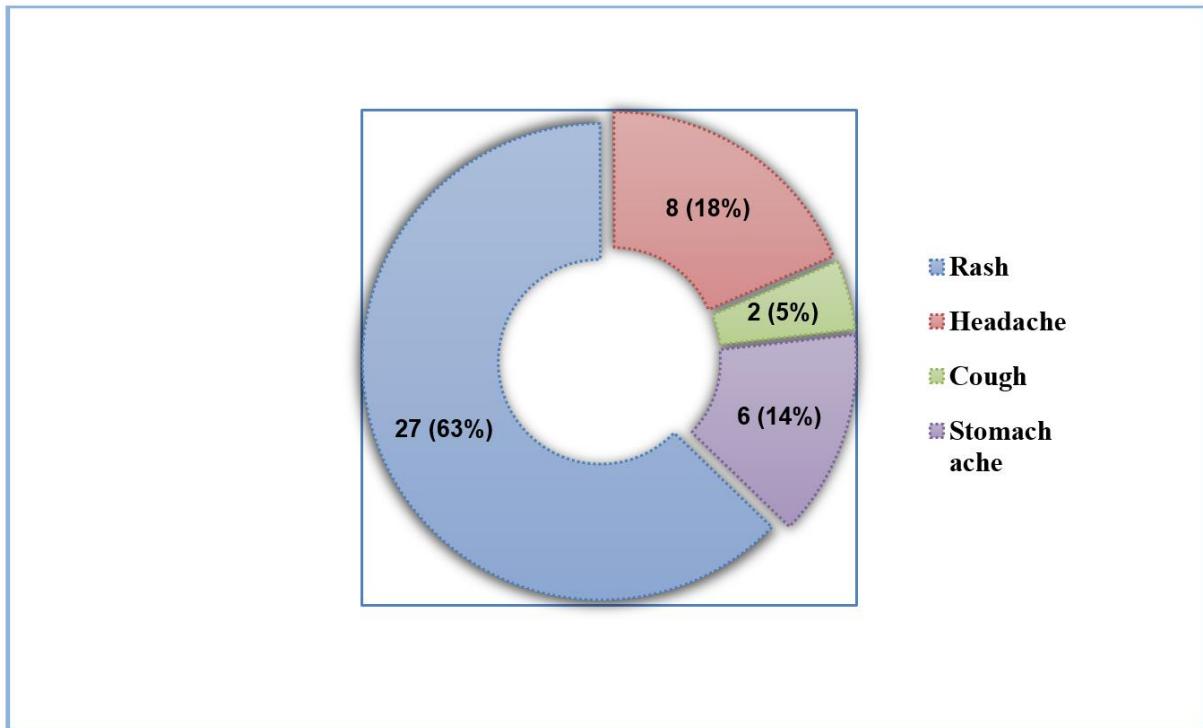


Figure 7. Early symptoms of *Schistosomiasis* at East Lore District, Poso Regency

Table 2. Distribution of control cases and the risk based on open defecation habits

The habit of open defecation	<i>Schistosomiasis</i> Incident						OR (95% CI)	p – value
	Case		Control		Total			
	n	%	n	%	N	%		
Do not use the toilet	29	67.4	11	25.5	40	46.5	6.026 (2.363 – 15.365)	0,000
Use the toilet	14	32.5	32	74.4	46	53.4		
Total	43	100	43	100	86	100		

Source: Primary data, 2024

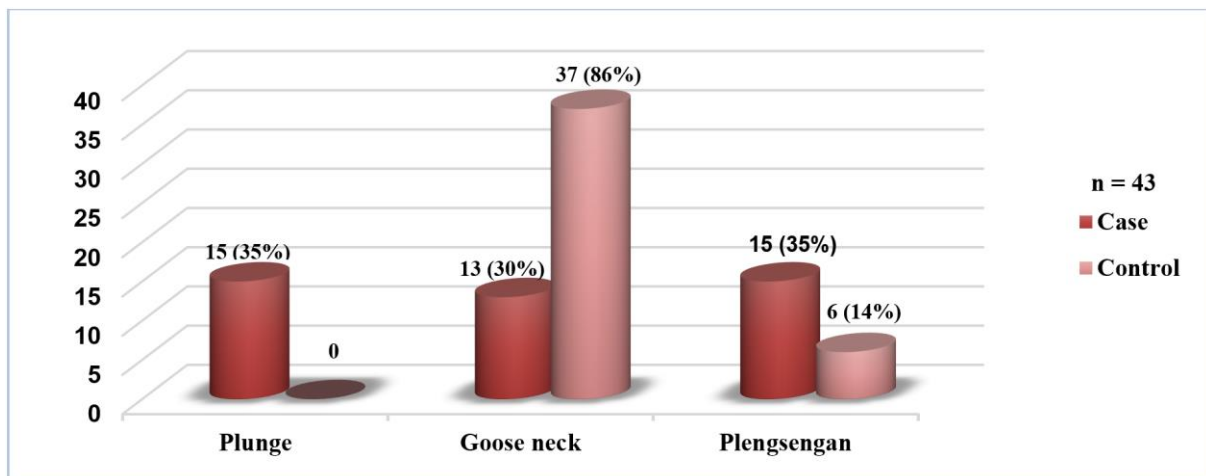
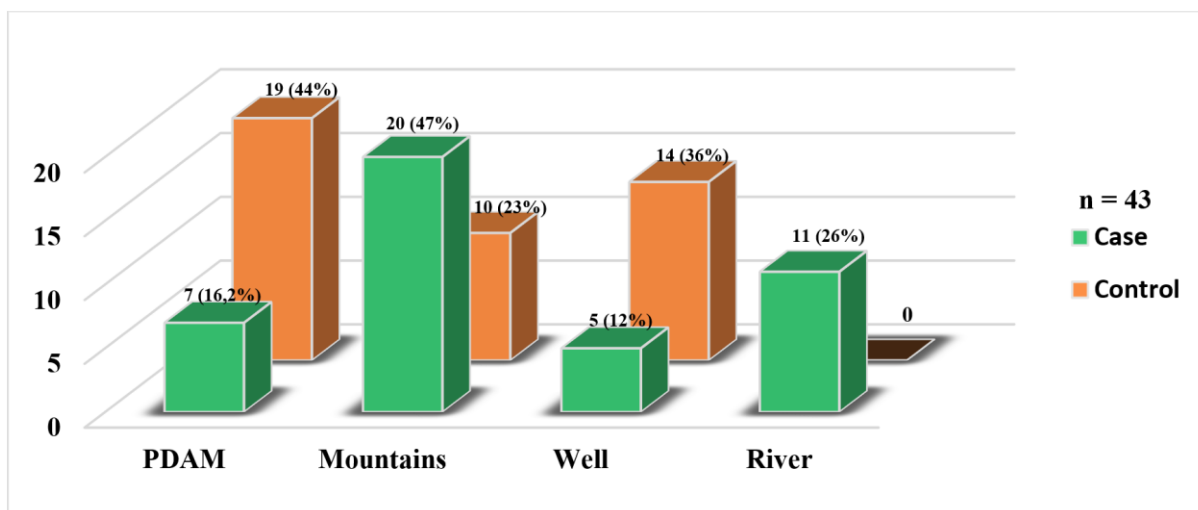


Figure 8. Type Latrines of Case and Control in East Lore District, Poso Regency

**Table 3.** Distribution of control cases and the risk based on the habit of not using clean water

The habit of not using clean water	Schistosomiasis Incident						OR (95% CI)	p – value
	Case		Control		Total			
	n	%	n	%	N	%		
Not use clean water	11	25.5	2	4.65	13	15.1	7.047 (1.457 – 34.075)	0,007
Use clean water	32	74.4	41	95.3	73	84.8		
Amount	43	100	43	100	86	100		

Source: Primary data, 2024.



**Figure 9.** Type Clean Water Sources of Case and Control in East Lore District, Poso Regency

**Table 4.** Distribution of control cases and the risk based on distance from house to snail habitat

Distance from house to snail habitat	Schistosomiasis Incident						OR (95% CI)	p – value
	Case		Control		Total			
	n	%	n	%	N	%		
Risk ≤ 100 m	39	90.6	11	25.5	50	58.1	28.369	0,000
No Risk > 100 m	4	9.30	32	74.4	36	41.8	(8.239 – 97.640)	
Amount	43	100	43	100	86	100		

Source: Primary data, 2024.

**Table 5.** Distribution of control cases and the risk based on the habit of not wearing PPE

The habit of not wearing PPE	Schistosomiasis Incident						OR (95% CI)	p – value
	Case		Control		Total			
	n	%	n	%	N	%		
Not wear PPE	32	74.4	9	20.9	41	47.0	10.990	0,000
Wear PPE	11	25.5	34	79.0	45	53.0	(4.025 – 30.009)	
Amount	43	100	43	100	86	100		

Source: Primary data, 2024.

**Table 6.** Distribution cases control and the risk based on the habit society to following health program *Schistosomiasis*

Health Service	<i>Schistosomiasis</i> Incident						OR (95% CI)	p - value
	Case		Control		Total			
	n	%	n	%	N	%		
Following < 2 health programs	31	72.0	8	19.0	39	45.0	11.302	0,000
Following ≥ 2 health programs	12	28.0	35	8.10	47	55.0	(4.088–	
Amout	43	100	43	100	86	100	31.244)	

Source: Primary data, 2024.

**Table 7.** Multivariable Analysis

No	Variable	β	Sig	Exp β	95% CI		p - value
					Lower	Upper	
1	Distance from home to snail habitat	3.708	0.000	40.758	5.064	328.025	0.000
2	The habit not wearing PPE	3.802	0.001	44.786	5.083	394.607	0.000
3	The habit society to following health program <i>Schistosomiasis</i>	2.756	0.003	15.732	2.488	99.460	0.000
4	Open defecation habits	1.841	0.038	6.304	1.109	35.820	0.000

Source: Primary data, 2024.

## 4. Discussion

### Physical Environmental Characteristics of *O. hupensis lindoensis* Snail Habitat with Snail Density and Infection Rate

#### a. Water temperature

In Indonesia, *Oncomelania hupensis lindoensis* is the intermediary snail for *Schistosomiasis*. The epidemiology *Schistosomiasis* is significantly influenced by this snail. This results from the *Schistosoma* worm larval stage developing from miracidium to sporocyt, cercariae, which are found inside the snail's body [10,11].

Freshwater snail distribution and density are directly influenced by temperature, which has been found to be a significant determinant. Research employing remote sensing models has demonstrated that snails need particular environments, or "niches." Because these factors affect the snail's metabolism and capacity to live in a particular location, *Schistosomiasis* intermediate snails need an aquatic habitat with precise water temperature requirements, appropriate water flow rates, and vegetation cover [12].

Based on findings from studies measuring various aspects of 6 different habitat. of the *Oncomelania hupensis lindoensis* snail, it was found that the water temperature was in the range of 22 °C – 27 °C with the highest density of snails, and the infection rate was found at 23°C.

The results of research conducted by Syukur [13] in Lindu District, the water temperature range in the snail habitat is 22.5 °C - 32.2 °C which affects the average density of snails. This temperature is the ideal temperature for

intermediate snails to reproduce well so that they can hatch their eggs perfectly and produce a greater number of snails in their habitat.

Temperatures between 15 °C and 31 °C are conducive to the survival of snails that spread *Schistosomiasis mansoni*; any higher than this results in a sharp decline in the snail population's ability to live [14]. The growth rate of snails and the production of parasites in their bodies cannot develop well in *Schistosomiasis haematobium* intermediate snails at temperatures below 15.5 °C and above 31.0 °C. The effects of extreme low and high temperatures on snail growth and reproduction can also affect the rate of parasite development [15]. According to research conducted at the Jiangsu Institute of Hong Kong, temperature positively correlated with the development rate of *Schistosoma japonicum* worms in *Oncomelania hupensis lindoensis* snails. The average daily development rate of snails was maintained in the laboratory at 21 °C, 23 °C, 27 °C, and 30 °C [11].

The influence of temperature not only affects the development of snails but also affects the development of cercariae in the snail's body. Research conducted by Yang et al [11]. Hong Kong Jiangsu Institute, stated that the lowest temperature for cercaria development was 15.3 °C. Temperature affects the location and size of snail populations, as well as the rates of egg formation, hatching, and mortality. Infected snails' cercariae maturation is also influenced by temperature [16].

#### b. Water pH

In Indonesia, the trematode worm *Schistosoma japonicum* is the cause of *Schistosomiasis*, while

*Oncomelania hupensis lindoensis* serves as the intermediate host. The snail *Oncomelania hupensis lindoensis* is found throughout the plains in pockets called foci, varying in area from a few square meters to several thousand square meters.

In this study, the pH of the water in 6 habitats where *Oncomelania hupensis lindoensis* snails were found ranged from 5.5 – 7.8. Snail density and infection rates are highest in habitats that have a water pH of 6. Research conducted by Anastasia [10] in endemic areas of Indonesia, found that *Oncomelania hupensis lindoensis* snails live at a normal pH of between 5.5 – 7. Based on research conducted by Syukur [13] in Lindu District, *Oncomelania hupensis lindoensis* snails were found living in an environment with a water pH of 5.4 – 8.4.

Based on research conducted by McCreesh [14], environmental parameters, one of which is water pH, were found to significantly influence the distribution of snails in the habitat. The water pH parameter in this study ranged from 6 - 7, it was found that 54.2% of all snail samples collected were infected.

The density and infection rate of snails are influenced by the water quality in the snail habitat, especially pH. Snails cannot survive at very low pH levels, which can reduce the abundance of freshwater snails. The pH of the water is related to the hatching rate of the miracidium, the maximum miracidium can hatch at a neutral pH level [17].

### Habit of Open Defecation with Occurrence of *Schistosomiasis*

In rural areas, people generally do not have family latrines and still dispose of their feces carelessly, while not all of the people who have latrines meet health requirements. Feces that are thrown carelessly can pollute the surrounding environment, and can be a good space for the transmission of infectious diseases [18].

At the research location, the types of latrines used by the *Schistosomiasis* case group were dominated by cemplung latrines and plengsengan latrines. However, the toilet is not equipped with a septic tank. Based on 2023 PKM Maholo data regarding the percentage of villages stopping defecation, East Lore District is still at 60%, it can be said that East Lore District is still not Open Defecation Free (ODF) because many people are found to have latrines but do not have septic tanks. tank so it can still be said that people practice open defecation [19].

The OR value of 6.0 > 1 indicates that the habit of open defecation is a risk factor based on the analysis's findings. Respondents who practice open defecation face a risk that is 6.0 times higher than those who do not.

Based on previous research conducted by Muslimin [20] in the Lore - Lindu National Park, it shows that open defecation behavior has a significant relationship with the incidence of *Schistosomiasis*. This is indicated by the OR value = 3.0, which means that people do not defecate in latrines have a 3.0 times greater risk of being infected with

*Schistosomiasis*.

Research conducted by Anyolitho [21] in Western Uganda showed that 44 (13.6%) *Schistosomiasis* sufferers defecated carelessly in lakes, bushes or in the open, which was due to the difficulty in building latrines so that there were a limited number of latrines owned by the community. This is a factor that contributes to impeding *Schistosomiasis* prevention and control.

People's behavior of defecating in the open can be caused by the economic status of the community. The economic status of a community can determine the availability of facilities used for certain activities. A person's income level is enough to meet life's needs, if the income level is good then health facilities can be guaranteed. Low income is an obstacle for people who are less able to meet facilities with standards that meet health [22]. Apart from socio-economic factors, this can be triggered because it has become a culture in society to defecate carelessly so that it is difficult to change society to have healthy latrines [23].

### The Habit of Not Using Clean Water with the Incident of *Schistosomiasis*

Water that has been polluted, both organic and inorganic compounds, will very easily become a medium for the development of various diseases. Polluted water can be stagnant (not flowing) water and it can also be flowing water. Infectious diseases due to water pollution can occur due to various reasons because water is a breeding ground for microorganisms, including microbes. There are many pathogenic microbes that breed in polluted water, causing various diseases and all of them are diseases that can be transmitted easily [24].

Based on the research results, there were still 11 respondents in this study from the case group who used water for daily life that came from rivers. *Schistosoma japonicum* worms live in fresh water such as lakes, reservoirs or rivers. These worms can live and develop in the body for weeks or even years. These worms can enter a person's body if they carry out activities such as washing clothes or other activities in water that has been contaminated with *Schistosoma japonicum* worms.

Research conducted by Yusna [25] in the Napu Highlands, Poso Regency, stated that there is an influence of the use of water sources on the incidence of *Schistosomiasis*, someone who uses poor water sources, for example from rivers, is at a much higher risk of contracting *Schistosomiasis* compared to people who use water from better water sources.

The results of this research analysis show that the habit of not using clean water can increase the chance of developing *Schistosomiasis* by 7.0 times more than those regularly use clean water, according to the respondents. This variable is also a risk factor for the incidence of *Schistosomiasis* based on the OR value > 1.

Based on research conducted by Christine [26] in Poso

Regency, it shows that the habitual behavior of not using clean water has a significant relationship with the incidence of *Schistosomiasis*. This is shown by obtaining a value of  $OR = 1.1$ , which means that people do not use clean water have a 1.1 times greater risk of being infected with *Schistosomiasis*.

Research conducted by Masdor [27] in Nigeria shows that 4% of *Schistosomiasis* in children occurs due to poor sanitation, in this case such as limited clean water which causes children's activities such as bathing in river water so that this is the cause of *Schistosomiasis* infection.

### Distance from House to Snail Habitat

The results of the bivariate analysis regarding the distance between the house and the snail habitat show that the OR value is  $28.3 > 1$ , which means that this variable is a risk factor for the incidence of *Schistosomiasis*. The OR value also means that the variable distance between house and snail habitat can increase the chance of risk 28.3 times for respondents who have a house distance of  $\leq 100$  m compared to respondents who have a house distance of  $> 100$  m to snail habitat. Based on field observations, most of the *Schistosomiasis* case groups live close to the snail focus area.

Previous research conducted by Julifent [28] in Lindu District regarding the variable distance to residence obtained an OR value of 5.66, which means that people whose residence is  $\leq 75$  m from the location of the snail habitat have a 5.66 times greater chance of being infected with *Schistosomiasis* compared to people whose residence is  $> 75$  meters from the snail habitat.

Research conducted by Rasyika [29] in Puroo Village shows that 100% of respondents are at high risk, which is because the respondents live around the focus area, and most of the snail focus areas in Puroo Village are rice fields that people automatically pass by or cross area that focus. Meanwhile, respondents have a low risk of 0% if the respondent does not live close to the snail focus area.

In research conducted by Manz [30] multivariable analysis results indicate that there is a higher chance of *Schistosomiasis* infection in Western Tanzania who have a distance to the source of infection (habitat)  $< 1$  km with an OR value = 1.6 which means that this variable has a 1.6 times greater chance of being infected with *Schistosomiasis* compared to residents who are  $> 1$  km from the source of infection.

### The Habit of Not Using PPE with the Incident of *Schistosomiasis*

Based on research conducted by Wartana [31] in Mekarsari Village, it shows that 60% of respondents work in agricultural activities, 62.6% of respondents pass through snail focus areas when going to the fields, and 42.6% do not wear boots when going to the fields. This is an important risk factor for worm infections because most

farmers in their daily activities come into contact with water sources that may be contaminated with *Schistosoma japonicum* worms.

According to the analysis conducted for this study, not using personal protective equipment (PPE) is a habit that increases the chance of contracting schistosomiasis. This can be seen from the OR value of  $10.9 > 1$ . This OR value also means that respondents who do not wear PPE when carrying out activities in the snail focus area (habitat) have a 10.9 times chance of being infected with *Schistosomiasis* compared to respondents who wear PPE.

Based on research conducted by Muslimin [20] in Lindu District, the habit of people not wearing boots when working in snail habitats shows a significant relationship to the incidence of *Schistosomiasis* with an  $OR = 4.6$ , which means that people who do not wear boots when carrying out activities have 4.6 times greater risk of being infected with *Schistosomiasis* compared to those who wear boots when doing work in snail habitat areas.

Research conducted by Nyirenda [32] in Kafue Village, Zambia, showed that 10.6% were infected with *Schistosomiasis*, consisting of 3.7% of girls and 6.9% of boys. The reason why children in Kafue Village are infected is because they carry out activities in water that has been contaminated with worms, they go to graze and water their animals in the river. This activity was carried out by children in Kafue Village without using personal boots or other protective gear that can stop them from contracting *Schistosoma haematobium*.

### Habits of Following the *Schistosomiasis* Health Program with the Occurrence of *Schistosomiasis*

The results of bivariate analysis regarding the habit of following *Schistosomiasis* health programs show that it is a risk factor for the incidence of *Schistosomiasis*, which is based on an OR value of  $11.3 > 1$ . Apart from the OR value, respondents who only follow  $< 2$  health programs have a risk chance of contracting schistosomiasis 11.3 times greater than respondents who attended  $\geq 2$  health programs.

Based on research conducted by Langitan [33] in Wuasa Village, regarding the behavior of respondents in utilizing the *Schistosomiasis* health program, there were 93.3% of the case group who did not utilize health services and 81% of the control group who utilized health services. The OR value is 12.1 which can be concluded that respondents who do not use health services have a greater risk of suffering from *Schistosomiasis*.

The level of public awareness about the dangers of *Schistosomiasis* will influence people's willingness to eradicate the disease, such as environmental sanitation, using personal protective equipment if they want to come into contact with focus areas and eradicating *Schistosomiasis* vectors. Various human activities such as clearing or creating new land can result in environmental changes which have a major influence on the transmission of *Schistosomiasis* [24].

According to research conducted by Diop [34] in Senegal, the Senegalese government's efforts to reduce the number of cases of this disease are by providing regular and appropriate mass medication, in addition to providing education regarding POPM and conducting mapping related to *Schistosomiasis* disease.

### **The Distance between the House and the Snail Habitat is the Most Influential in the Incidence of *Schistosomiasis***

The logistic regression analysis's findings indicate that the separation between the house and the snail habitat is the variable that has the most influence on the incidence of *Schistosomiasis* with the smallest significance value, namely 0.000, and respondents who have a house distance of <100 m from the snail habitat have a 40.2 chance of being infected with *Schistosomiasis* compared to respondents whose house is  $\geq 100$  m from the snail habitat.

Based on the findings of the field observations made by the researcher, most of the houses of the respondents in the case group were located around the snail focus area, such as next to the house or behind the respondent's house, such as cocoa plantations, or rice fields which serve as the *Oncomelania hupensis lindoensis* snail's habitat.

The habitat of the *Oncomelania hupensis lindoensis* snail is located around settlements or where people live, which can influence the incidence of *Schistosomiasis* disease around where people live, this is a very risky factor if village people do not use personal protective equipment Rasyika [29]. Apart from that, people can be infected with the cercariae of the *Schistosoma japonicum* worm that comes out of *Oncomelania hupensis lindoensis* snails when they are in the snail focus area so that residents living around the focus area will certainly be very at risk [35].

According to research conducted by Francis [36] in Temeke Village, Tanzania, differences in *Schistosomiasis* infection between the houses closest to the focus area had a 2.6 times chance of being infected compared to respondents who lived far from the focus area *Oncomelania hupensis lindoensis*.

## **5. Conclusions**

The results of water temperature measurements in snail habitats ranged from 22 °C - 27 °C, water pH ranged from 6 -7, the density of snails in 9 habitats was 9.7 - 105 snail density/m<sup>2</sup> and the infection rate for *Oncomelania hupensis lindoensis* snails ranged from 4.2% - 20%. Based on the OR value > 1, the habit of defecating in the open, the habit of not using clean water, the distance between the house and the snail habitat, the habit of not using PPE and the habit of people participating in health programs related to *Schistosomiasis* are risk factors for the incidence of *Schistosomiasis* in East Lore District, Poso Regency. The variable distance between the house and the snail habitat is

the risk factor that most influences the incidence of *Schistosomiasis* with a risk opportunity (OR) of 40.7 times greater in East Lore District, Poso Regency.

## **6. Suggestions**

Local communities are expected to use PPE when doing activities in the snail habitat, participate in the *Schistosomiasis* health program as an effort to prevent the disease, and the local government can increase cooperation between sectors in carrying out control efforts in the habitat of the *O. hupensis lindoensis* snail. For example, drying the snail habitat area, making water channels in the snail habitat so that water does not stagnate, special handling by providing healthy latrine facilities for the community.

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