
ICOPH-TCD 2022
The 4th International Conference on Public Health
for Tropical and Coastal Development
30th - 31th August 2022
Universitas Diponegoro
ICOPH-TCD
2022

MINISTRY OF EDUCATION, CULTURE, RESEARCH, AND TECHNOLOGY
UNIVERSITAS DIPONEGORO
FACULTY OF PUBLIC HEALTH

CERTIFICATE

OF APPRECIATION

Number : 11/UN7.A/HK/VII/2022

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SKP IAKMI No SK: 719/IAKMIPUSAT/SKP-VII/2022 Peserta : 3 SKP Peserta Oral : 5 SKP Pembicara : 5 SKP Moderator : 3 SKP Panitia : 3 SKP
SKP PERSAKMI No SK: 48/KEP/PP-PERSAKMI/C/V/2022 Peserta : 6 SKP Pembicara : 6 SKP Moderator : 6 SKP Panitia : 6 SKP

PREVALENCE AND RISK FACTORS OF HOOKWORM INFECTION AND STRONGYLOIDIASIS SURROUNDING PALM PLANTATION RURAL KUTAI KERTANEGARA, EAST KALIMANTAN

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Abstract. *The rural area East Kalimantan with humidity tropical rain forest is high risk of hookworm infection and strongyloidiasis. The infection rates, correlation analysis between risk factors and prevalence of hookworm infection, and Strongyloidiasis was explored in this study. In this study was collected one hundred and seven schoolchildren from rural areas of Kutai Kertanegara regency. This study used two diagnostic methods: Kato Katz techtique and agar plate culture that were used in this study for diagnosing hookworm infection and strongyloidiasis We found 31.8% and 10.3% respectively. School location and water resources have been correlated with hookworm infection with p-value 0.006 and 0.002 respectively. Risk factors of strongyloidiasis such as school location, yard covering and waste water treatment have been correlated with strongyloidiasis in school children surrounding palm plantation of rural Kutai Kertanegara Regency, East Kalimantan Province with P-Value: 0.027; 0.010, and 0.010 respectively. Environmental risk factors and facilitate of sanitation have correlated with hookworm infection and strongyloidiasis, and that variables could be used for focuses the palnning program for reducing the soil transmitted-helminthes especially for school children in rural area.*

Keyword : Risk factors, hookworm infection, strongyloidiasis, Schoolchildren, Kutai Kertanegara

Introduction

The prevalence of hookworm infection and strongyloidiasis is of serious public health concern globally. Hookworm infection and strongyloidiasis are prevalent in a poor rural community in tropical and subtropical areas in many developing countries (1). They are transmitted through in protected contact with soil that is endemic in tropical and temperate regions. The prevalence of hookworm infection and strongyloidiasis was estimated in 2010 that 438.9 million people were infected with hookworm and 100 million with strongyloides. Almost 70% of these infections occur in Asia (2-4). Hookworm infection and strongyloidiasis are transmitted through in protected contact with soil are endemic in tropical and temperate regions. Humans acquire the hookworm infection and strongyloidiasis through direct skin contact with infective third stage larvae where the soil was contaminated by human feces penetrate the intact human skin and eventually reach small intestine (5). The epidemiology of hookworm infection depends on three interactive factors which include the following; the mode and extent of fecal pollution of the soil, the suitability of the soil for eggs and larval development, the extent of contact between infected soil and skin, and the presence of abiotic

factors on the viability of the egg. Those risk factors of hookworm infection are environment, facilitates sanitation, human behavior and social economic factors (6).

Prevalence of hookworm infection was showed higher among school-age children by the case study of Chikwawa, Malawi, the study showed hookworm infection diminished with increasing age and increased with fishing and low education (7). Ecological factors have associated with hookworm infection, the result studied on the coast of Kenya where prevalence and intensity of hookworm infection (19.1%) were significantly higher in adults and males, and were associated with environmental conditions, low socioeconomic status, household flooring, individual and household water, sanitation and hygiene (WASH) characteristics and behaviors and shoe-wearing. The study showed altitude and aridity (humid category) have been associated with hookworm infection (8). According to Riess H, et al. (2013) explained five ecological stayed significant in the final multivariable model consist: population density, vegetation density, annual LCT during day and night latrine coverage in the household surrounding (9).

Study hookworm in Cambodia investigated the hookworm infection in humans and dogs with overall hookworm in human 57%. The populations were infected by *N. americanus* 47.6% and *A. Ceylaninum* 52%, while over 90% of dogs infected by *A. ceylanicum*. Studied in the rural area of central Thailand that showed bare foot walking and raising buffaloes around the house were high-risk factors for hookworm infection (10) also the study in Xayaburi Province, Lao PDR explained that working in farms, failure to wear shoes showed a significant correlation with hookworm infection that the prevalence one of soil-transmitted helminth (11). Factors affecting difference in the distribution of hookworm infection may include good hygiene practices among the population, availability of sewerage system and the length of rainy season. Study of hookworm infection in Southern Laos showed 56.1% where were heavy rainfall and poor sanitation (12).

In rural Kutai Kertanegara Regency, Indonesia has risk factors of the prevalence of hookworm infection and strongyloidiasis that important to exploration association both of them. We perform a cross-sectional study among school children in rural Kutai Kertanegara Regency to analysis of characteristics of school children, sanitation facilities of school, personal hygiene and environmental factor then was correlated with the prevalence of hookworm infection and strongyloidiasis.

Main text

Methods and materials

Study design and area

The study was carried out in rural area of Muara Kaman district and Marangkayu district, Kutai Kertanegara regency, Indonesia. Kutai Kertanegara regency is located 0.44019^0S and 116.98139^0E. The everage temperature was 28℃ (26℃-32℃). Muara Kaman district has located surrounding Mahakam river and closed with forest area and palm plantation. While Marangkayu has located in the coastal area and surrounding rubber and palm plantation also rice field. We collected data from two elementary school from the Muara Kaman district and one elementary school from the Marangkayu district. Data would be collected from 100 school children each district. This research is a school children based, was conducted from July 2018 to January 2019. The total of number participant is 107 participants who were joined and sent stool samples (13).

Study population, sample size, and sampling technique

We selected three elementary schools from two districts in Kutai Kertanegara regency, Indonesia to conduct this study: two elementary schools in Muara Kaman district and one elementary school in Marangkayu district where these schools have differences such as quality of soil, day number, and yearly volume of rainfall, temperature, humidity, elevation,

village area and vegetation, These areas were selected based on the potential risk of hookworm infection and strongyloidiasis, consist rural area, poor sanitation and hygiene, agriculture activity and surrounding forest and have not yet data study of hookworm and *S. stercoralis* infection from both areas. The sample size was determined using the single population formula by Stanly Lemeshow technique sampling . It was calculated using a prevalence rate (p) of 37% as detail previous study (14), with 95% confidence interval (z=1.96) and a 10% margin error (d= 0.1). The calculated sample size was 90 participants per district of the school area. We assumed that the final sample size would end up being reduced by around 10% due to subjects being unable to pass stool on the study date. Thus we aimed for a sample size of 100 schoolchildren. A simple random sampling method was used to select the population from the district of the school area. Inclusion criteria were participants who were ≥ 7 years old and studied in both school areas. We randomly selected 100 participants in this research and then gave them instructions and distributed plastic containers for stool collection. According to the following formula applied:

$$n = \frac{Z_{1-\alpha/2}^2 P(1-p)}{d^2}$$

$$= \frac{1.962 \times 0.37(1-0.37)}{0.12}$$

$$= 89.5$$

$$= 90$$

= 90 + 10% for potential reducing sample size

= 90 + 10 = 100 school children participants

Inclusion criteria

The schoolchildren whose guardian or parent signed or head of written informed consent and all schoolchildren who were available and registered in their school during the study period and who gave sample were included in the study.

Exclusion criteria

Schoolchildren who are already used un-helminthic within 2 weeks before data collection and the subjects who were unable to provide a stool specimen at the time of sampling were excluded from the study.

Data collection and processing

Socio-demographic data and rusk factor assessment of study participants

The observational form and the questionnaire were prepared in English and translate to Bahasa (Indonesian language) and checked for fitness. Pre-test was done in 10% of schoolchildren that were not included in the study. The data of sanitation facilities of household of schoolchildren participants also were collected by questionnaire.

Parasitological techniques

We collected two stools sample each schoolchild. For collecting stool samples, the first day were requested to the headmaster of elementary school for requesting stool sample with collected data of questionnaires, second and third day in the morning would start to collect stool samples, were brought to the biomedical laboratory, Faculty of Public Health Mulawarman University for diagnosis samples. Another day was done observation environmental condition houses surrounding school areas include school sanitation facilities village. We used two methods to diagnosis stool samples, agar plate culture and the Kato Katz technique. Agar plate culture was done as described by Koga et al., 1991. Briefly, a few grams of stool was placed at the center of nutrient agar and kept at room temperature for five days. Tracks from larva crawling and larvae or adult worms were observed. If positive, 10 ml of 10% formalin was added to the agar surface for 5-10 minutes and transferred to a

centrifuged tube. Centrifugation at 2,500 rpm for 5 minutes and supernatant was discarded. The sediment will be examined for hookworm and *S. stercoralis* larvae or adult worm. For Kato-Katz thick smear, 50 mg of stool was placed on a slide and covered with a cellophane paper soaked in glycerin solution for 24 hours. The stool was spread out using a rubber stick. After 30 minutes was examined and counted for eggs (15-17).

Data analysis and Interpretation

Demographic data and personal hygiene of participants were collected by questionnaire, and sanitation facilities each house hold of participants were collected by observation, while environmental data was collected consist such as vegetation, elevation of soil, kind of pets, kind of soil around houses, length of the rainy season, humidity and temperature per year. Quality of soil as organic carbon content, clay content, and pH were diagnosed by soil laboratory Mulawarman University. Vegetation and kind of soil around houses were collected by observation form, kind of pet would be collected by questionnaire and observation, and length of the rainy season, humidity and temperature per year will collected from Central Bureau of Statistics (https://www.bps.go.id) and Central Bureau of meteorology, climatology and Geophysical of Indonesia (https://www.bmkg.go.id). The prevalence of hookworm infection and *S. stercoralis* infection was stratified according to demographic data, sanitation facilities and personal hygiene, environmental data, and reported by the descriptive statistic. Statistical analysis was performed by Chi-square using SPSS verse 22. The correlation analysis chi-square to evaluate the association of *S. stercoralis* infection with demographic data, sanitation facilities, personal hygiene, and environmental risk factors and the level of significance was considered as $P<0.05$ and the analysis of risk estimate by odds ratio Chi-Square with confidence interval 95% (13).

Results

A total of 107 schoolchildren participated in this study. The age ranged between 7 and 13 years from 3 elementary school, consist of two schools from Muarakaman district and one school from Marangkayu district, Kutai Kertanegara Regency, Indonesia. Among three elementary schools we had collected stool samples from grade school 3-6 grade of elementary school. The school is Bunga Jadi elementary school, Puan Cepak Elementary school in Muarakaman district and Semangkok elementary school in Marangkayu district. In this study collected 107 schoolchildren participants. Males 59 (55.1%) were dominant in the sample study than females 48 (44.9%). The age distribution of sample was 10 and under 60 (56.1%) and 10 age old above 47(43.9%). Sanitation facilities of school such as covering the floor in the door, covering yard surrounding house, water waste treatment, water sources for daily activity and drinking sources and toilets. All of the sanitation facilities were took the data by observation each school.

The detail distribution quality of sanitation facilities participants showed in table 1. Personal hygiene of participants was explored by questionnaire such as; usual wear shoes in out-door activity, usual wash foot and hand after soil contact, wash fruit or vegetable before eat, usual eat un-cook vegetable, usual wash hand after pet contact, usual use toilet in the home, with detail in table 1.

Table 1. Characteristics and Sanitation facilities and personal hygiene of the 107 schoolchildren in rural areas East Kalimantan

Variable	Category	N (%)
Gender	Male	59 (55.1)
	Female	48 (44.9)
Age (years)	< 10 year old	60 (56.1)

	10 and above	47 (43.9)
	Bunga Jadi elementary school	49 (45.8)
School location	Puan Cepak elementary school	24 (22.4)
	Semangkok elementary school	34 (31.8)
Kinds of Floor covering indoor of school	Sanitair floor (cement, wood, etc)	107 (100)
	Soil floor	-
Yard covering	Not soil	49 (45.8)
	Soil	58 (54.2)
Water waste treatment	Healthy water waste treatment	49 (45.8)
	Without water waste treatment	58 (54.2)
Water sources for daily activity	Sanitary water resources	83(77.6)
	Un-sanitary water resources	24 (22.4)
Drinking water	Sanitary drinking water	106 (99.1)
	Un-sanitary drinking water	1 (0.9)
	Sanitary toilet in home	107 (100)
Toilet	Open defecation (plantation, garden or river	-
Frequency using shoes on out-door	Routine	59 (55.1)
	Un-routine	48 (44.9)
Usual wash foot after soil contact	washing foot after soil contact	30 (28)
	Not washing foot after soil contact	77 (72)
Washing fruit/vegetable before eaten	Routine	47 (43.9)
	Un-routine	60 (56.1)
Usual ate row/un-cook fish/meat/vegetable	No	93 (86.9)
	Yes	14 (13.1)
Pet contact	No	9 (8.4)
	Yes	98 (91.6)
Washing hand after pet contact	Washing hand	44 (41.1)
	At home	63(58.9)
Washing hand after soil contact	Washing hand	44 (41.1)
	Not washing	63 (58.9)
Washing foot before house enter	No	33 (30.8)
	Yes	74 (69.2)
Usual use toilet at home	Yes	28 (26.2)
	No	79 (73.8
Usual use sandals in toilet	Routine	4 (3.7)
	Un-routine	103 (96.3)

Parasitological Findings

Prevalence of hookworm and S. *stercoralis,* infections among school children in East Kalimantan province was diagnosed by Kato Katz technique and APC method showed of 107 tested samples from schoolchildren that would be showed detail below in table 2:

Table 2 Prevalence of Hookworm, and *S. stercoralis* among Schoolchildren **in East Kalimantan Province**

Infections	Kutai Kertanegara Schoolchildren		Total N (%)
	Positive (%)	Negative (%)	
Hookworm	37 (31.8)	73 (68.2)	107 (100)
S. stercoralis	11 (10.3)	96 (89.7)	107 (100)
Co-infection	11 (10.3)	96 (89.7)	107 (100)

The prevalence of hookworm infection, *S. stercoralis* infection, and Co-infection among school children in East Kalimantan province was 37 (31.8%), 11 (10.3%), 11 (10.3%) and respectively.

District and Prevalence hookworm and *S. stercoralis* infections in Schoolchildren

Prevalence of hookworm and *S. stercoralis* among school children in Muarakaman district and Marangkayu district, Kutai Kertanegara Regency would be explained in table 5 below:

Table 3. District and Prevalence hookworm, *S. stercoralis* in Schoolchildren

Infections	Muarakaman district		Marangkayu district		Total	
	Positive (%)	Negative (%)	Positive (%)	Negative (%)	Positive (%)	Negative (%)
Hookworm	27 (37.0)	46 (63.0)	7 (20.6)	27 (79.4)	34 (31.8)	73 (68.2)
S. stercoralis	6 (8.2)	67 (91.8)	5 (14.7)	29 (85.3)	11 (10.3)	96 (89.7)

The table above explained that prevalence of hookworm and *S. stercoralis* among schoolchildren in Muarakaman district was 27 (37.0%) and 6 (8.2%) respectively. The prevalence of hookworm and *S. stercoralis* among school children in Marangkayu was 7 (20.6%) and 5 (14.7%) respectively.

Characteristic, school Sanitation facilities, personal hygiene and hookworm infection and S. stercoralis among schoolchildren in East Kalimantan

Characteristic, facilitate Sanitation of schoolchildren and Hookworm infection

Distribution of characteristic, facilitate sanitation of schoolchildren with detailed below

Table 4. Characteristic, school Sanitation facilities, personal hygiene and hookworm infection and S. stercoralis among schoolchildren in East Kalimantan

Variable	Category	Positive n (%)		P-value	
		Hookworm	*S. stercoralis*	Hookworm	*S. stercoralis*
Gender	male	19 (32.2)	5 (8.5)	0.916	0.495
	female	15 (31.3)	6 (12.5)		
Age (years)	< 10 year old	19 (31.7)	6 (10.0)	0.978	0.914
	10 and above	15 (31.9)	5 (10.5)		
School location	Bunga Jadi elementary school	13 (26.5)	1 (2.0)	0.006	0.027
	Puan Cepak elementary school	14 (58.3)	5 (20.8)		
	Semangkok elementary school	7 (20.6)	5 (14.7)		
Kinds of Floor covering indoor of school	Sanitary floor (cement, wood, etc)	34 (31.8)	11 (10.3)	-	-
	Soil floor	0	0		
Yard covering	Not soil	13 (26.5)	1 (2.0)	0.284	0.010
	Soil	21 (36.2)	10 (17.2)		
Water waste treatment	Healthy water waste treatment	13 (26.5)	1 (2.0)	0.284	0.010
	Without water waste treatment	21 (36.2)	10 (17.2)		
Water resources for daily activity	Sanitary water resources	20 (24.1)	6 (7.2)	0.002	0.053
	Un-sanitary water resources	14 (58.3)	5 (20.8)		
Drinking water	Sanitary drinking water	34 (32.1)	11 (10.4)	0.493	0.734

	Un sanitary drinking water	0	0		
	Sanitary toilet in the home	34 (31.8)	11 (10.3)		
Toilet	Open defecation (plantation, garden, or river	-	-	-	-
Frequency using shoes on out-door	Routine	17 (28.8)	6 (10.2)	0.466	0.967
	Un-routine	17 (35.4)	5 (10.4)		
Usual wash foot after soil contact	washing foot after soil contact	9 (30.0)	3 (10.0)	0.805	0.952
	Not washing foot after soil contact	25 (32.5)	8 (10.4)		
Washing fruit/vegetable before eaten	Routine	15 (31.9)	4 (8.5)	0.978	0.594
	Un-routine	19 (31.7)	7 (11.7)		
Usual ate raw/un-cook fish/meat/vegetable	no	25 (26.9)	9 (9.7)	0.005	0.597
	yes	9 (64.3)	2 (14.3)		
Pet contact	no	5 (55.6)	0	0.109	0.289
	yes	29 (29.6)	11 (11.2)		
Washing hand after pet contact	Washing hand	15 (34.1)	5 (11.4)	0.667	0.758
	Not washing	19 (30.2)	6 (9.5)		
Washing hand after soil contact	Washing hand	15 (34.1)	5 (11.4)	0.667	0.758
	Not washing	19 (30.2)	6 (9.5)		
Washing foot before house enter	No	9 (27.3)	2 (6.1)	0.504	0.337
	Yes	25 (33.8)	9 (12.2)		
Usual use toilet at home	Yes	7 (25.0)	1 (3.6)	0.370	0.174
	No	27 (34.2)	10 (12.7)		
Usual use sandals in toilet	Routine	0	0	0.164	0.490
	Un-routine	34 (33)	11 (10.7)		

Prevalence of hookworm infection was higher in males 19 (32.2%) than in females 15 (31.3%), in contrast for the prevalence of *S. stercoralis* was higher in females 6 (12.5%) than males 5 (8.5%). Age-old group in 10 age-old above was higher for hookworm infection 15 (31.9%) than in the category 7-9 age-old: 19 (31.7%) but for S. stercoralis 2-12 age old; 6 (10.0%) than higher in the category in 10 age-old above 5 (10.5%). was higher than 7-9 age-old; hookworm infection 15 (31.9%) than in category 7-9 age-old: 19 (31.7%) but for s. stercoralis 2-12 age-old; 6 (10.0%). Highest of prevalence of hookworm infection and *S. stercoralis* in school location was Puancepak elementary school 14 (58.3%) and 5 (20.8%) respectively. Hookworm infection was high in participant in the category soil yard covering, without water waste treatment, unsanitary water resources, and unsanitary drinking water with prevalence 21 (36.2%), 21 (36.2%), 14 (58.3%), respectively. While *S. stercoralis* has highest of percentage in participant with school with soil yard covering and without water waste treatment with 10 (17.2%). The result Pearson chi-square analysis characteristic of school children and school sanitation facilities showed that hookworm infection has been correlated significant with school location (p=0.006) and, water resources for daily activity (p=0.002). While *S. stercoralis* infection has correlated significant such as school location (p=0.027), yard covering(p=0.010), and water waste treatment (p=0.010) .

In category un-routine using shoes hookworm infection was higher than routine; 17 (35.4%) and 17 (28.8%) respectively. Hookworm infection in category not washing foot after soil contact was higher than washing foot with prevalence; 25 (32.5%) and 9 (30.0%) respectively. The percentage of hookworm infection in category eat raw vegetable was higher than not routine eat with prevalence; 9 (64.3%) and 25 (26.9%) respectively. Washing foot before house enter has higher hookworm infection that did not wash; 25 (33.8%) and 9 (27.3). Not

usual use toilet at home higer hookworm infection than routine; 27 (34.2%) and 7 (25.0%) Un-routine use sandals in toilet has hornworm infection higher than routine 34 (33%) and 0 respectively. While *S. stercoralis* infection was higher in un-routine using shoes in outside than using shoes; 5 (10.4%) and 6 (10.2%) respectively. Un-routine washing fruit/vegetable before eat has higher of *S. stercoralis* infection than routine; 7 (11.7%) and 4 (8.5%). schoolchildren who usual eat raw vegetable higher of *S. stercoralis* infection than did not usual eat raw vegetable; 2 (14.3%) and 9 (9.7%) respectively. Usual washing foot before house entering has higher S. stercoralis than did not with the prevalence was 9 (12.2) and 2 (6.1) respectively. Un-routine using toilet at home has higher prevalence S stercoralis than routine was 10 (12.7%) and 1 (3.6%) respectively. Un-routine using sandals in toilet has higher S. stercoralis than routine was 11 (10.7%) and 0 (0%) respectively. Personal hygiene of schoolchildren that have significant correlated with hookworm infection were usual ate raw/un-cook vegetables (p=0.005). Personal hygiene has not significant correlated with *S. stercoralis* infection.

Essential risk factors of hookworm *S. stercoralis* infections among school children in Kutai Kertanegara Regency, Indonesia

The estimated value of the risk factor of the high hookworm infection and low *S. stercoralis* in East Kalimantan explained in table 6 below:

Table 5 Essential risk factors of high prevalence of hookworm infection and low prevalence of *S. stercoralis* infection in East Kalimantan province

Variable	Category	n	Positive no (%)		hookworm	*S. stercoralis*
			hookworm	*S. stercoralis*	OR (95%CI)	OR (95%CI)
Gender	male	59	19 (32.2)	5 (8.5)	1.03 (0.65-1.61)	0.80 (0.45-1.44)
	female	48	15 (31.3)	6 (12.5)	0.98 (0.68-1.41)	1.24 (0.63-2.42)
Age (years)	2-12	60	19 (31.7)	6 (10.0)	0.99 (0.63-1.57)	0.96 (0.49-1.91)
	13 and above	47	15 (31.9)	5 (10.5)	1.01 (0.70-1.44	1.03 (0.59-1.82)
Kinds of Floor covering indoor of school	Sanitary floor (cement, wood, etc)	107	34 (31.8)	11 (10.3)	-	-
	Soil floor	-	0	0	-	-
Yard covering	Not soil	49	13 (26.5)	1 (2.0)	0.82 (0.58-1.16)	0.55 (0.42-0.72)
	Soil	58	21 (36.2)	10 (17.2)	1.29 (0.79 - 2.10)	5.50 (0.84-36.02)
Water waste treatment	Healthy water waste treatment	49	13 (26.5)	1 (2.0)	0.82 (0.58-1.16)	0.55 (0.42-0.72)
	Without water waste treatment	58	21 (36.2)	10 (17.2)	1.29 (0.79 - 2.10)	5.50 (0.84-36.02)
Water resources for daily activity	Sanitary water resources	83	20 (24.1)	6 (7.2)	0.33 (0.17-0.67)	0.43 (0.20-0.93)
	Un-sanitary water resources	24	14 (58.3)	5 (20.8)	1.47 (1.09-1.97)	1.47 (0.85-2.55)
	Sanitary	106	34 (32.1)	11 (10.4)	0.99 (0.96-	0.99 (0.96-

Drinking Water	drinking Water				1.01)		1.01)	
	Un sanitary drinking water	1	0	0	-		-	
Toilet	Sanitary toilet in home	107	34 (31.8)	11 (10.3)	-		-	
	Open defecation (plantation,garden or river	-	-	-	-		-	
Frequency using shoes on out-door	Routine	59	17 (28.8)	6 (10.2)	0.85 1.30)	(0.55-	0.99 1.95)	(0.50-
	Un-routine	48	17 (35.4)	5 (10.4)	1.15 1.70)	(0.78-	1.01 1.79)	(0.57-
Usual wash foot after soil contact	washing foot after soil contact	30	9 (30.0)	3 (10.0)	0.97 1.12)	(0.55-	0.99 1.45)	(0.67-
	Not washing foot after soil contact	77	25 (32.5)	8 (10.4)	1.09 2.12)	(0.56-	1.03 2.85)	(0.37-
Washing fruit/vegetable before eaten	Routine	47	15 (31.9)	4 (8.5)	1.01 1.44)	(0.70-	0.87 1.40)	(0.54-
	Un-routine	60	19 (31.7)	7 (11.7)	0.99 1.57)	(0.63-	1.23 2.78)	(0.55-
Usual ate raw/un-cook fish/meat/vegetable	no	93	25 (26.9)	9 (9.7)	0.26 0.71)	(0.09-	0.69 2.68)	(0.18-
	yes	14	9 (64.3)	2 (14.3)	1.27 157)	(1.03-	1.07 1.43)	(0.80-
Pet contact	no	9	5 (55.6)	0	1.11 1.29)	(0.95-	-	
	yes	98	29 (29.6)	11 (11.2)	0.37 1.30)	(0.11-	0.91 0.97)	(0.85-
Washing hand after pet contact	Washing hand	44	15 (34.1)	5 (11.4)	1.08 1.53)	(0.76-	1.09 1.91	(0.62-
	Not washing	63	19 (30.2)	6 (9.5)	0.90 1.44)	(0.56-	0.89 1.78)	(0.45-
Washing hand after soil contact	Washing hand	44	15 (34.1)	5 (11.4)	1.08 1.53)	(0.76-	1.09 1.91	(0.62-
	Not washing	63	19 (30.2)	6 (9.5)	0.90 1.44)	(0.56-	0.91 0.97)	(0.85-
Washing foot before house enter	No	33	9 (27.3)	2 (6.1)	0.91 1.18)	(0.71-	0.83 1.13)	(0.61-
	Yes	74	25 (33.8)	9 (12.2)	1.24 2.38)	(0.65-	1.78 6.43)	(0.49-
Usual use toilet at home	Yes	28	7 (25.0)	1 (3.6)	0.90 1.12)	(0.72-	0.79 0.99)	(0.63-
	No	79	27 (34.2)	10 (12.7)	1.40 2.97)	(0.66-	3.09 20.60)	(0.47-
Usual use sandals in toilet	Routine	4	0	0	-		-	
	Un-routine	103	34 (33)	11 (10.7)	0.95 1.00)	(0.89-	0.96 1.00)	(0.92-

According to univariate analysis characteristics of school children and school sanitation facilities showed that hookworm infection has been correlated significantly with school location and, water resources for daily activity while *S. stercoralis* infection has correlated significantly such as school location (p=0.027), yard covering and water waste treatment .

Muara Kaman district school 1.78 times more likely to be infected with hookworm than Marangkayu district school location (OR: 1.78 (95%CI: 0.87-3.71, p-value=0.006). Un-sanitary water resources for daily activity 1.47 times more likely to be infected with hookworm than sanitary water resources (OR: 1.47 (95%CI: 1.09-1.97, p=0.002). Marangkayu district school 1.28 times more likely to be infected with *S. stercoralis* than Muarakaman district school location OR: 1.28 (95%CI: 0.73-2.23, (p=0.027). Soil yard covering 5.50 times more likely to be infected with S. stercoralis than sanitary yard covering OR: 5.50 (0.84-36.02, p=0.010). Un-sanitary water waste treatment 5.50 times more likely to be infected with *S. stercoralis* than sanitary water waste treatment (OR: 5.50 (95%CI: 0.84-36.02, p= 0.010). Usual eat raw vegetable 1.07 times more likely to be infected with hookworm than did not eat it(OR: 1.07 (95%CI: 0.80-1.43, p= 0.005). The soil with pH >6.61, 1.78 times more likely to be infected with hookworm (OR: 1.78 (95%CI: 0.87-3.71, p= 0.002). Personal hygiene of schoolchildren that have significant correlated with hookworm infection was usual ate raw/un-cook vegetable (p=0.005). Usual ate raw vegetable Personal hygiene has not significantly correlated with *S. stercoralis* infection

Discussion

Prevalence of hookworm infection was higher in male 19 (32.2%) than in female 15 (31.3%), in contrast for prevalence *S. stercoralis* was higher in female 6 (12.5%) than male 5 (8.5%). Age old group in 10 age-old above was higher for hookworm infection 15 (31.9%) than in category 7-9 age old: 19 (31.7%) but for s. stercoralis 2-12 age-old; 6 (10.0%) than higher in category in 10 age-old above 5 (10.5%). was higher than 7-9 age old; hookworm infection 15 (31.9%) than in category 7-9 age old: 19 (31.7%) but for *S. stercoralis* 2-12 age old; 6 (10.0%). The highest of the prevalence of hookworm infection and *S. stercoralis* in school location was Puancepak elementary school 14 (58.3%) and 5 (20.8%) respectively. Hookworm infection was high in participants in category soil yard covering, without water waste treatment, unsanitary water resources, and un sanitary drinking water with prevalence 21 (36.2%), 21 (36.2%), 14 (58.3%), respectively. While *S. stercoralis* has highest of percentage in the participant with school with soil yard covering and without water waste treatment with 10 (17.2%). The result Pearson chi-square analysis characteristic of school children and school sanitation facilities showed that hookworm infection has been correlated significant with school location (p=0.006) and, water resources for daily activity (p=0.002), while *S. stercoralis* infection has correlated significant such as school location (p=0.027), yard covering (p=0.010), and water waste treatment (p=0.010). According to Amor and et al (2016), the prevalence hookworm infection and *S. stercoralis* in schoolchildren probably linked to the poor sanitation conditions in the study area (18).

According to univariate analysis characteristics of school children and school sanitation facilities showed that hookworm infection has been correlated significantly with school location and, water resources for daily activity while *S. stercoralis* infection has correlated significantly such as school location (p=0.027), yard covering, and water waste treatment. Muara Kaman district school 1.78 times more likely to be infected with hookworm than Marangkayu district school location (OR: 1.78 (95%CI: 0.87-3.71, p-value=0.006). Unsanitary water resources for daily activity 1.47 times more likely to be infected with hookworm than sanitary water resources (OR: 1.47 (95%CI: 1.09-1.97, p=0.002). Marangkayu district school 1.28 times more likely to be infected with *S. stercoralis* than Muarakaman district school location (OR: 1.28 (95%CI: 0.73-2.23, (p=0.027). Soil yard covering 5.50 times more likely to be infected with S. stercoralis than sanitary yard covering (OR: 5.50 (0.84-36.02, p=0.010). Unsanitary water waste treatment is 5.50 times more likely to be infected with *S. stercoralis* than sanitary water waste treatment (OR: 5.50 (95%CI: 0.84-36.02, p= 0.010).

In category un-routine using shoes hookworm infection was higher than a routine; 17 (35.4%) and 17 (28.8%) respectively. Hookworm infection in the category not washing foot after soil contact was higher than washing foot with prevalence; 25 (32.5%) and 9 (30.0%)

respectively. The percentage of hookworm infection in the category eat raw vegetables were higher than not routinely eat with prevalence; 9 (64.3%) and 25 (26.9%) respectively. Washing foot before house enter has higher hookworm infection that did not wash; 25 (33.8%) and 9 (27.3). Not usual use toilet at home higher hookworm infection than a routine; 27 (34.2%) and 7 (25.0%) Un-routine use sandals in toilet has hornworm infection higher than routine 34 (33%) and 0 respectively. While *S. stercoralis* infection was higher in un-routine using shoes outside than using shoes; 5 (10.4%) and 6 (10.2%) respectively. Un-routine washing fruit/vegetables before eat has higher of *S. stercoralis* infection than a routine; 7 (11.7%) and 4 (8.5%). Schoolchildren whom usual eat raw vegetable higher of *S. stercoralis* infection than did not usually eat raw vegetable; 2 (14.3%) and 9 (9.7%) respectively. Usual washing foot before house-entering has higher *S. stercoralis* than not washing with the prevalence was 9 (12.2%) and 2 (6.1%) respectively. Un-routine using the toilet at home has higher prevalence of *S stercoralis* than a routine was 10 (12.7%) and 1 (3.6%) respectively. Un-routine using sandals in the toilet has higher *S. stercoralis* than a routine was 11 (10.7%) and 0 (0%) respectively. Usual eat raw vegetables 1.07 times more likely to be infected with hookworm than did not eat it (OR: 1.07 (95%CI: 0.80-1.43, p= 0.005). The soil with pH >6.61, 1.78 times more likely to be infected with hookworm (OR: 1.78 (95%CI: 0.87-3.71, p= 0.002). Personal hygiene of schoolchildren that have significantly correlated with hookworm infection was usual ate raw/un-cook vegetable (p=0.005) (19). Personal hygiene has not significantly correlated with *S. stercoralis* infection. In general condition soil surrounding yard covering of school covering with soil where close the location with plantation and forest that have a high position for contamination from plantation and forest. And besides personal hygiene and sanitation facilities still not save for protecting skin from larvae hookworm and *S. stercoralis* also in file rice and palm or rubber plantation (17). In poor countries with tropical climate, where have environmental condition favorable for transmission hookworm and *S. stercoralis* infection the prevalence still high (20).

Conclusions

Hookworm infection has been correlated significantly with water resources for daily activity While *S. stercoralis* infection has correlated significantly such as schoolyard covering and water waste treatment. Personal hygiene of schoolchildren that have significant correlated with hookworm infection were usual ate raw/un-cook vegetables . Personal hygiene has not significant correlated with *S. stercoralis* infection. This study has explained essence of risk factors and the prevalence of hookworm infection and *S. stercoralis* infections. Essential of risk factors of the infections should be used for preventing program of reduction the prevalence hookworm and *S. stercoralis* infection.

Acknowledgments

We grateful to schoolchildren whom participants in this research, parent, headmaster and teacher of the elementary schools, and Head officer of Bunga Jadi Health Center that they helped in data collecting, also the local authority of Kutai Kertanegara Regency. We deeply thank the Dean of School of Public Health Mulawarman University and the Dean School of Allied Health Walailak University for permitting us to use the laboratory and supporting approval of the letter for this research. This work was supported by Walailak University grant (contract no 17/2561) and the Government of East Kalimantan Province grant for Ph.D. study

Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

Availability of data and materials

Consent for publication
Not applicable

Ethics approval and consent to participate
Official permission and ethical clearance for the collection of human fecal samples were obtained from headmaster of elementary school and the parent of schoolchildren. The study protocol was approved by the Ethical Clearance Committee on human rights related to research involving human subjects, Walailak University HE: NO. WUEc-18-034-01.

Funding
Walailak University grant (contract no 17/2561), and the Government of East Kalimantan.Province grant for Ph.D. study

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