

CERTIFICATE

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This Certificate is Awarded to

Blego Sedionoto., S.K.M., M.Kes., Ph.D.

as oral participant at *The 1st Mulawarman International Conference on Tropical Public Health (MICTOPH)*

Rektor of Mulawarman University

 Dr. Abdunnur, M.Si.
 NIP. 196703081992031001

Dean of Faculty of Public Health

 Prof. Dr. Iwan M Ramli S.Kp. M.Kes.
 NIP. 197509072005011004

Chair of The 1st MICTOPH Committee

 Nurul Afiah, S.Gz., M.Kes.
 NIP. 198909262018032001

Schedule of Conference Activities

12th Nov 2022

Time (Central Indonesia Time)	Activity	PIC	Time (Central Indonesia Time)	Activity	PIC
08.00-08.15	Registration (FKM Unmul Video Playback)	Committee		Thailand (11.10 – 11.50)	2. Prof. Sukri Palutturi, S.K.M., M.Kes., M.sc.PH., Ph.D. (Hasanuddin University)
08.15-08.30	Opening • Indonesia Raya anthem • Prayer • Committee Chairman's Report	Committee		5 th Topic: Digitization in the Health Insurance Implementation (11.50 – 12.30)	Moderator: Nur Rohmah, S.K.M., M.Kes., Ph.D.
08.30-08.40	Speech by the Rector of Mulawarman University and Opening Ceremony	Dr. Ir. Abdunnur, M.Si.	12.30-13.00	Discussion (30 minutes)	
08.40-10.25	Keynote Speech 1 1 st Topic: Occupational Health & Safety After COVID-19: Challenges and Opportunities (08.40 – 09.20)	Speakers: 1. Dr. Kelly Johnstone (The University of Queensland, Australia) 2. Asst. Prof. Frederick R. Masangkay, RMT, MSMT, Ph.D. (University of Santo Thomas, Philippines) 3. Prof. dr. Kemal N. Siregar, MA, Ph.D. (The University of Indonesia) Moderator: Dr. Ike Anggraeni, S.K.M., M.Kes.	13.00-13.30	Break	Committee
	2 nd Topic: Environmental Epidemiology of Waterborne Protozoan Parasites: A Potential Epidemic Amidst the Covid-19 Pandemic (09.20 – 10.00)		13.30-15.00	Panel Presentation (16 break out room – 15 oral room and 1 poster room) 1. Biostatistics and Population 2. Environmental Health 3. Health Promotion 4. Nutrition 5. Occupational Health and Safety 6. Health Administration and Policy 7. Epidemiology 8. Child and Maternal Health 9. Poster Presentation	Chair of room
	3 rd Topic: Digital Health for Primary Healthcare on Post-Pandemic Covid-19 (10.00 – 10.40)		15.00 – 15.20	Entertainment (from students) • Traditional dance • Acoustic • FKM Profil	Committee
10.40-11.10	Discussion (30 minutes)		15.20 - 15.25	Announcement of the winner of the oral continue with poster and follow-up to the publication of articles	Committee
11.10-12.30	Keynote Speech 2 4 th Topic: Social Media Data for Exploring Cannabis Usage in	Speakers: 1. Asst. Prof. Francois Rene Lamy, Ph.D. (Mahidol University, Thailand)	15.25 – 15.35	Documentation	Committee
			15.35 – 15.40	Closing	Committee

Essential Risk Factors of Co-infection of Hookworm and *Strongyloides stercoralis* in East Kalimantan Province, Indonesia

¹*Blego Sedionoto, ²Syamsir, ³Witthaya Anamnart

^{1,2}Department of Environmental Health, Faculty of Public Health Mulawarman University, Samarinda, 75123

³Department of Environmental Health, School of Public Health, Walailak University, Thasala, 80160, Thailand

*Corresponding author's Email: blego.kesling@yahoo.com

Abstract.

Hookworm and *strongyloides stercoralis* infections are still challenge in public health problem especially in developing countries where have environmental risk factors that are potential for transmitting of hookworm infection and *strongyloides stercoralis* infection.. In East Kalimantan Province, Indonesia have high risk environmental factors of the prevalence of hookworm infection and strongyloidiasis. In this study would show the infection rates, correlation analysis between environmental risk factors and prevalence of hookworm infection with statistical analysis. We performed a cross-sectional study among 213 participants from rural community of Muarakaman District and Marangkayu Districts, Kutai Kertanegara Regency East Kalimantan Province, Indonesia. In this study used two diagnostic methods: Kato Katz and Koga agar plate culture/KAP culture for diagnosing of hookworm and *Strongyloides* infections. Pearson chi-square analysis was used for study correlation between environmental risk factors with hookworm infection and strongyloidiasis. Hookworm, *strongyloides* and Co-infection were found in this study; 94(44.1%), 35(16.4%), and 33(15.5%) respectively. Environmental risk factors such as; district, organic carbon content in soil, temperature, humidity, elevation from above of sea, number day of rainfall and volume of rainfall have correlated significant with hookworm, *Strongyloides stercoralis* and co-infection (p value < 0.05). The environmental risk factor above have contributed of survival larvae of hookworm and *Strongyloides stercoralis* in environment this research could be contributed for decreasing program of hookworm infection and strongyloidiasis especially in rural community area.

Keywords: Essential, Environmental risk factors, hookworm, Strongyloides stercoralis, Co-infection.

Introduction

The prevalence of hookworm infection and strongyloidiasis is of serious public health concern globally. Hookworm infection and strongyloidiasis are prevalent in poor rural community in tropical and subtropical areas in many developing country (Wardell R et al 2017). They are transmitted through in protected contact with soil are 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. (Pullan, et al, 2014, WHO, 2011 (Bethony et al. 2006).

Hookworm infection and strongyloidiasis are transmitted through in protected contact with soil are endemic in tropical and temperate regions. Human 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 (Forrer et al. 2016).

Generally, hookworm infection and strongyloidiasis are found among poor people with poor environmental sanitation and where the climate is warm and humid (Bannon et al., 1995; Hall et al., 1994). Factors affecting difference in distribution of hookworm

infection and strongyloidiasis may include good hygiene practices among population, availability of sewerage system and the length of rainy season. Environmental factors have contributed for transmission of diseases as well as growth and development of the worms (Anamnart, *et al*, 2013; Prasit *et al*, 2016).

Environmental factors especially long rainy season may affect the decrease in prevalence of *strongyloides stercoralis* infection but not for hookworm infection. Prevalence of strongyloidiasis in south Thailand is lower than other parts of the country, in contrast, prevalence of hookworm infection is still high in the south. It is possibly because the failure in the control of hookworm infection due to 10 months long rainy season in southern Thailand contrasted with 4 months long rainy season in other parts (Anamnart *et al.*, 2015). The study in Cambodia reported the lower prevalence of strongyloidiasis in area with heavy rainfall than in low rainfall area. Moreover, high amount of soil organic carbon content affect to the lower prevalence of strongyloidiasis (Khieu *et al.*, 2014). Epidemiology study of hookworm infection and strongyloidiasis in Southern Laos showed 56.1% and 41% respectively where was heavy rainfall and poor sanitation. In this study Baerman and Kato-Katz techniques were used for detecting them (Vonghachack Y *et al*, 2015).

In rural East Kalimantan province Indonesia has environmental risk factors of prevalence of hookworm infection and strongyloidiasis that important to exploration association both of them. We perform a cross-sectional study in rural community in Muarakiaman and Marangkayu district to analysis of geography, texture of soil, humidity, hookworm and strongyloides in pet, vegetation, elevation, volume rain , amount days of rain yearly, temperature and quality of soil as clay content, organic carbon of soil and pH of soil then was correlated with prevalence of hookworm infection and strongyloidiasis.

Materials and methods

Ethical consideration

Official permission and ethical clearance for collection human fecal samples was obtained from head master and teacher. The study protocol was approved by the Ethical Clearance committee on human right related to research involving human subjects, Walailak University HE: number WUEc-18-034-01.

Study Setting and Population

The study was carried out in rural area of Muarakaman District and Marangkayu District East KalimantanPprovince Indonesia. This research is a community based, was

conducted during July 2018- February 2019. Total of number participant is 426 participant who were joined and sent stool samples.

Field Procedures

For collecting stool samples, the first day were requested to head of house hold and member of house hold for requesting stool sample, second day in the morning would start to collect stool samples, were brought to parasitology laboratory Mulawarman University for diagnosis samples. Others day was done observation environmental condition houses surrounding village.

Laboratory Procedures

Agar plate culture and Kato Katz technique

Agar plate culture will be done as described by Koga et al., 1991. Briefly, a few grams of stool will be placed at the center of nutrient agar and kept at room temperature for five days. Tracks from larva crawling and larvae or adult worms will be observed. If positive, 10 ml of 10% formalin will be added to agar surface for 5-10 minutes and transferred to centrifuged tube. Centrifugation at 2,500 rpm for 5 minutes and supernatant will be discarded. The sediment will be examined for hookworm larvae and *S. stercoralis* larvae or adult worm.

For Kato-katz thick smear, 50 mg of stool will be placed on slide and covered with a cellophane paper soaked in glycerin solution for 24 hours. The stool will be spread out using rubber stick. After 30 minutes will be examined and counted for eggs

Environmental data

Environmental data was collected consist such as vegetation, elevation of soil, kind of pets, kind of soil around houses, length of 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 will be collected by observation form, kind of pet will be collected by questioner and observation, and length of 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>).

Data Analysis

The prevalence of hookworm and *Strongyloides* infection was stratified according to environmental data and reported by descriptive statistic. Statistical analysis was performed by Chi-square using SPSS verse 21. The correlation analysis chi-square to evaluate association of hookworm and *strongyloides* and co-infection with 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%.

Results

Study Sample

A total of 426 individuals participated in this study. The age ranged between 2 and 70 years from 28 villages, with detail 12 villages from Muarakaman District and 16 villages from Marangkayu District, East Kalimantan Province Indonesia.

Parasitological Findings

Prevalence hookworm infection and *strongyloides stercoralis* infection were diagnosed by Kato Katz technique and APC method showed of 426 tested samples from community have 188 (44.1%) cases found positive with hookworm infection and 70 (16.4%) cases found positive with *strongyloides* infection and co-infection 66 (15.5%). Detail data of prevalence of hookworm, *strongyloides stercoralis* and co-infection were explained below:

Table 1. Prevalence of Co-infection Hookworm and *Strongyloides stercoralis* among Communities in East Kalimantan Province

Infections	Muarakaman District		Marangkayu District		Total	
	Positive	Negative	Positive	Negative	Positive	Negative
Co-infection of Hookworm and <i>S. stercoralis</i>	6 (3.2%)	184 (96.8%)	24 (10.2%)	212 (89.8%)	30 (7.0%)	396 (93.0%)

The prevalence of hookworm infection in Muarakaman District is higher than in Marangkayu district was 61.1% and 30.5% respectively, while the prevalence *Strongyloides stercoralis*, Marangkayu District (23.7%) is higher than Muarakaman District (7.4%). Prevalence of co-infection was showed in Marangkayu District (22.0%) where is higher than Muarakaman District (7.4%) .

Characteristics of Participants Included in the analysis

Table 2. Characteristics of the 426 Participants Included in the analysis

Variable	Category	N (%)
Gender	male	260(61.0)
	female	166(39.0)
Age (years)	2-12	228(53.5)
	13 and above	186(46.5)
Main Occupation	Farmer	140(32.9)
	At home	110(25.8)
	At school	162(38.0)
	Others	14(3.3)
Occupation	Non farmer	276(64.8)
	Farmer	150(35.2)
Kinds of Floor covering indoor of house	Sanitair floor (cement, wood, etc)	424(99.5)
	Soil floor	2(0.5)
Yard covering	Not soil	71(16.7)
	Soil	355(83.3)
Water waste treatment	Healty water waste treatment	216(50.7)
	Without water waste treatment	210(49.3)
Water resources for daily activity	Sanitary water resources	184(43.2)
	Un-sanitary water resources	242(56.8)
Drinking Water	Sanitary drinking Water	234(54.9)
	Un sanitary drinking water	192(45.1)
Toilet	Sanitary toilet in home	362(85.0)
	Open defecation (plantation,garden or river	64(15.0)

Table 3. Personal Hygiene of Participants

Variable	Category	N (%)
Frequency using shoes on out-door	Routine	148(34.7)
	Un-routine	278(65.3)
Usual wash foot after soil contact	washing foot after soil contact	52(12.2)
	Not washing foot after soil contact	374(87.8)
Washing fruit/vegetable before eaten	Routine	66(15.5)
	Un-routine	360(84.5)
Usual ate row/un-cook fish/meat/vegetable	no	344(80.8)
	yes	82(19.2)
Pet contact	no	322(75.6)
	yes	104(24.4)
Washing hand after pet contact	Washing hand	8(1.9)
	At home	418(98.1)
Washing hand after soil contact	Washing hand	50(11.7)
	Not washing	376(88.3)
Washing foot before house enter	No	400(93.9)
	Yes	26(6.1)
Usual use toilet at home	Yes	232(54.5)
	No	194(45.5)
Usual use sandals in toilet	Routine	232(54.5)
	Un-routine	194(45.5)

Environmental Risk Factor

Table 4. Environmental Factors

Variable	Category	N (%)
District	Muarakaman	190(44.6)
	Marangkayu	236(55.4)
Organic carbon content in soil	<2.47%	182(42.7)
	2.47-4.04%	244(57.3)
pH soil	<5.85	204(47.9)
	5.85-6.92	222(52.1)
Clay content in soil	<18.5	192(45.1)
	18.5-42.50	234(54.9)
Temperature	<28.6 °C	236(55.4)
	28.6 -29.5°C	190(44.6)
Humidity	<65.4	236(55.4)
	65.4-66	190(44.6)
Number day of rainfall	<164	190(44.6)
	164-174	236(55.4)
Rainfall volume	<3549 mm ³	190(44.6)
	3549-4000 mm ³	236(55.4)
Elevation from above of sea	<41.6m	194(45.5)
	41.6-50m	232(54.5)
Texture of soil	Sandy soil with organic material	278(65.3)
	Non-sandy soil with organic material	148(37.3)
Vegetation	Surrounding palm plantation and/or rubber plantation	334(78.4)
	Surrounding rice field	92(21.6)
Village areas	Buffer river/sea	332(77.9)
	Hill area	94(22.1)
Dry or wet soil surrounding house	Dry soil	338(79.3)
	Wet soil	88(20.7)
Having cat	Not having cat	160(37.6)
	Having cat	266(62.4)
Having dog	Not having dog	8(1.9)

	Having dog	418(98.1)
Strongyloides in cat	Negative	268(62.9)
	Positive	144(37.1)
Strongyloides in dog	Negative	104(24.4)
	Positive	322(75.6)

Risk factors of Hookworm infection in East Kalimantan Province

Characteristic, facilitate Sanitation of Participants and Hookworm infection

Table 6. Characteristic, facilitate Sanitation of Participants and Hookworm infection

Variable	Category	Hookworm infection		P- value
		Negative n(%)	Positive n(%)	
Gender	male	246 (94.6)	14((5.4)	0.094
	female	150(90.4)	16(9.6)	
Age (years)	2-12	210(92,1)	18(7.98)	0.461
	13 and above	186(93.9)	12(6.1)	
Main Occupation	Farmer	134(95.7)	6(4.3)	0.156
	At home	98(89.1)	12(10.9)	
	At school	150(92.6)	12(7.4)	
	Others	14(100)	0(0.0)	
Occupation	Non farmer	252(91.3)	24(8.7)	0.070
	Farmer	144(96.07)	6(4.0)	
Kinds of Floor covering indoor of house	Sanitair floor (cement, wood, etc)	394(92.9)	30(7.1)	0.696
	Soil floor	2(100)	0(0.0)	
Yard covering	Not soil	67((94.4)	4(5.6)	0.611
	Soil	329(92.7)	26(7.3)	
Water waste treatment	Healthy water waste treatment	200(92.6)	16(7.4)	0.765
	Without water waste treatment	196(93.3)	14(6.7)	
Water resources for daily activity	Sanitary water resources	170(92.4)	14(7.6)	0.690
	Un-sanitary water resources	226(93.4)	16(6.6)	
Drinking Water	Sanitary drinking Water	212(90.6)	22(9.4)	0.036
	Un sanitary drinking water	184(95.8)	8(4.2)	
Toilet	Sanitary toilet in home	338(93.4)	24(6.6)	0.429
	Open defecation (plantation,garden or river	58(90.6)	6(9.4)	

Table 7. Personal hygiene and Strongyloidiasis

Variable	Category	Co-infection		P- value
		Negative n(%)	Positive n(%)	
Frequency using shoes on out-door	Routine	140(94.6)	8((5.4)	0.335
	Un-routine	256(92.1)	22(7.9)	
Usual wash foot after soil contact	washing foot after soil contact	44(84.6)	8(15.4)	0.012
	Not washing foot after soil contact	352(94.1)	22(5,9)	
Washing fruit/vegetable before eaten	Routine	62(93.9)	4(6.1)	0.735
	Un-routine	334(92.8)	26(7.2)	
Usual ate row/un-cook fish/meat/vegetable	no	326(94.8)	185.2)	0.003
	yes	70(85.4)	12(14.6)	
Pet contact	no	300(93.2)	22(6.6)	0.766
	yes	96(92.3)	8(7.7)	
Washing hand after pet contact	Washing hand	8(100)	0(0.0)	0.432
	Not washing	388(92.8)	30(7.2)	
Washing hand after soil contact	Washing hand	42(84.0)	8(16.0)	0.008
	Not washing	354(94.1)	22(5.9)	
Washing foot before house enter	No	26(6.6)	0(0.0)	0.148
	Yes	370(92.5)	30(7.5)	
Usual use toilet at home	Yes	216(93.1)	16(6.9)	0.898
	No	180(92.8)	14(7.2)	
Usual use sandals in toilet	Routine	216(93.1)	16(6.9)	0.898
	Un-routine	180(92.8)	14(7.2)	

Environmental Risk Factors of Hookworm infection in East Kalimantan

Environmental risk factors of Hookworm infection in East Kalimantan Province, Indonesia

Table 8. Environmental Factors and Hookworm infection

Variable	Category	S. stercoralis		P value
		Negative n(%)	Positive n(%)	
District	Muarakaman	184(96.8)	6(3.2)	0.005
	Marangkayu	212(89.8)	24(10.2)	
Organic carbon content in soil	<2.47%	160(87.9)	22(12.1)	0.000
	2.47-4.04%	236(96.7)	8(3.3)	
pH soil	<5.85	192(94.1)	12(5.9)	0.370
	5.85-6.92	204(91.9)	18(8.1)	
Clay content in soil	<18.5	180(93.7)	12(6.3)	0.563
	18.5-42.50	216(92.3)	18(7.7)	
Temperature	<28.6 °C	212(89.8)	24(10.2)	0.005
	28.6 -29.5°C	184(96.8)	6(3.2)	
Humidity	<65.4	212(89.8)	24(10.2)	0.005
	65.4-66	184(96.8)	6(3.2)	
Number day of rainfall	<164	184(96.8)	6(3.2)	0.005
	164-174	212(89.8)	24(10.2)	
Rainfall volume	<3549 mm ³	184(96.8)	6(3.2)	0.005
	3549-4000 mm ³	212(89.8)	24(10.2)	
Elevation from above of sea	<41.6m	188(96.9)	6(3.1)	0.004
	41.6-50m	208(89.8)	24(10.2)	
Texture of soil	Sandy soil with organic material	254(91.4)	24(8.6)	0.079
	Non-sandy soil with organic material	142(95.9)	6(4.1)	
Vegetation	Surrounding palm plantation and/or rubber plantation	312(93.4)	22(46.6)	0.484
	Surrounding rice field	84(91.3)	8(8.7)	
Village areas	Buffer river/sea	310(93.4)	22(6.6)	0.529
	Hill area	86(91.5)	6(8.5)	
Dry or wet soil surrounding house	Dry soil	312(92.3)	26(7.7)	0.304
	Wet soil	84(95.5)	4(4.5)	
Having cat	Not having cat	152(95.0)	8(5.0)	0.201
	Having cat	244(91.7)	22(8.3)	
Having dog	Not having dog	8(100)	0(0.0)	0.432
	Having dog	338(92.8)	30(7.2)	
Hookworm in cat	Negative	152(95.0)	8(5.0)	0.201
	Positive	244(91.7)	22(8.3)	
Hookworm in dog	Negative	8(100)	0(0.0)	0.432
	Positive	388(92.8)	30(7.2)	
Strongyloides in cat	Negative	250(93.3)	18(6.7)	0.732
	Positive	146(92.4)	12(7.6)	
Strongyloides in dog	Negative	102(98.1)	2(1.9)	0.019
	Positive	294(91.3)	28(8.7)	

The results statistical analysis between environmental risk factors with hookworm infection showed several of environmental factors have correlated significant with hookworm infection ($p < 0.05$) such as district, organic carbon content in soil, clay content in soil, temperature, humidity, number day of rainfall, rainfall volume, vegetation and

village areas. While pH of soil, clay content in soil, and texture of soil have not significant correlated with prevalence of hookworm infection in East Kalimantan Province Province.

Environmental risk factors which were higher association/correlation *Strongyloides stercoralis* infections were elevation from above of sea, rainfall volume, number day of rainfall, humidity, temperature, organic carbon content in soil, vegetation, village areas and district with p-value 0.000, even though organic carbon content in soil also had significant association with co-infection with p value= 0.042.

The category of environmental risk factors which had percentage of positive hookworm infection more than 44% such as elevation from above sea (<41.6m), volume of rainfall (<3549 mm³), number day of rainfall (<164 days), humidity (<65.4%), temperature(<28.6 0C), organic carbon content in soil(2.47-4.04%), pH of soil (5.85-6.92), clay content in soil (<18.5)texture of soil (sandy soil with organic material), district (Muarakaman District) and vegetation(surrounding palm plantation and/or rubber plantation), village areas (buffer river or sea)

The results statistical analysis between environmental risk factors with *Strongyloides stercoralis* infection showed several of environmental factors have correlated significant with hookworm infection (p<0.05) such as district, organic carbon content in soil, pH soil, clay content in soil, temperature, humidity, number day of rainfall, rainfall volume, elevation from above sea, and texture of soil. While clay content in soil, vegetation and village areas have not correlated with prevalence of *Strongyloides stercoralis* in East Kalimantan Province.

Environmental risk factors which were higher association/correlation *Strongyloides stercoralis* infections were elevation from above of sea, rainfall volume, number day of rainfall, humidity, temperature, organic carbon content in soil and district with p-value 0.000, even though pH of soil and texture of soil also had significant association with co-infection with p value= 0.049 and 0.022 respectively.

The category of environmental risk factors which had percentage of positive *Strongyloides stercoralis* infection more than 23% such as elevation from above sea 41.6-50m, volume of rainfall (3549-4000 mm³), number day of rainfall (164-174 days),humidity (<65.4%), temperature(<28.6 0C), organic carbon content in soil (<2.47%), district (Marangkayu) and vegetation(surrounding palm plantation and/or rubber plantation).

Essential Risk Factors of Hookworm Infection in East Kalimantan Province.

The estimated value of risk factor of hookworm, *Strongyloides stercoralis* and co-infection explained in table 5 below:

Table 9. Essential Risk Factors of Hookworm and *S. stercoralis* Co-infection in East Kalimantan Province

Essential risk factors	Category	S. stercoralis		OR(95%CI)
		Negative n(%)	Positive n(%)	
District	Muarakaman	184(96.8)	6(3.2)	0.67 (0.55-0.82)
	Marangkayu	212(89.8)	24(10.2)	2.32 (1.13-4.79)
Organic carbon content in soil	<2.47%	160(87.9)	22(12.1)	2.23(1.228-4.07)
	2.47-4.04%	236(96.7)	8(3.3)	0.55(0.43-0.71)
Temperature	<28.6 °C	212(89.8)	24(10.2)	2.32 (1.13-4.79)
	28.6 -29.5°C	184(96.8)	6(3.2)	0.67 (0.547-0.82)
Humidity	<65.4	212(89.8)	24(10.2)	2.32 (1.13-4.79)
	65.4-66	184(96.8)	6(3.2)	0.67 (0.547-0.82)
Number day of rainfall	<164	184(96.8)	6(3.2)	0.67 (0.547-0.82)
	164-174	212(89.8)	24(10.2)	2.32 (1.13-4.79)
Rainfall volume	<3549 mm ³	184(96.8)	6(3.2)	0.67 (0.547-0.82)
	3549-4000 mm ³	212(89.8)	24(10.2)	2.32 (1.13-4.79)
Elevation from above of sea	<41.6m	188(96.9)	6(3.1)	0.66 (0.55-0.80)
	41.6-50m	208(89.8)	24(10.2)	2.37 (1,15-4.89)
Strongyloides in dog	Negative	102(98.1)	2(1,9)	0.79 (0.71-0.89)
	Positive	294(91.3)	28(8.7)	3.86 (1.00-14.89)
Drinking Water	Sanitary drinking Water	212(90.6)	22(9.4)	1.73 (0.95-3.18)
	Un sanitary drinking water	184(95.8)	8(4.2)	0.73 (0.58-0.92)
Usual wash foot after soil contact	washing foot after soil contact	44(84.6)	8(15.4)	1.21 (0.97-1.41)
	Not washing foot after soil contact	352(94.1)	22(5,9)	0.42(0.14-0.82)
Usual ate row/un-cook fish/meat/vegetable	no	326(94.8)	18(5.2)	0.44 (0.27-0.72)
	yes	70(85.4)	12(14.6)	1.37 (1.02-1.64)
Washing hand after soil contact	Washing hand	42(84.0)	8(16.0)	1.22 (0.98-1.52)
	Not washing	354(94.1)	22(5.9)	0.35(0.21-0.77)

Result analysis of estimating risk between environmental risk factor with hookworm, *strongyloides stercoralis* and co-infection by chi-square odds ratio analysis had showed several environmental risk factors with OR > 1, but the odds ratio had deferent each others of infection.

Analysis OR in district explained that Marangkayu District high risk for hookworm infection, in contrast Muarakaman District high risk for *strongyloides stercoralis* and co-infection. Village areas had high risk for hookworm, *Strongyloides stercoralis* and co-infection in hill area category . In vegetation with surrounding field rice also high risk for

the all infections, field rice category is highest odd ratio for hookworm infection (OR=2.513).

Temperature in category <28.6 °C become high risk factor for hookworm infection, but *Strongyloides stercoralis* and co-infection high risk in temperature category >28.5°C-29 °C), while humidity category 65.4-66 high risk for *strongyloides stercoralis* and co-infection with OR= 2.472 and OR= 2.305 respectively , but humidity category <65.4 high risk for hookworm infection with OR= 1.799.

Elevation from above sea in category <41.6m is high risk for *strongyloides stercoralis* and co-infection while hookworm infection high risk in elevation< 41.6-50m. Clay content <18.5% was higher risk for *Strongyloides stercoralis* and co-infection, clay content 18.5-42.50% was high risk for hookworm infection. pH of soil with category <5.8 become protective environmental risk factor for *Strongyloides stercoralis* and co-infection.

Rainy season with rainfall in category number day of rainfall <164 days yearly was high risk for *Strongyloides stercoralis* and co-infection but hookworm infection still high risk in rainfall 164-174 days. Volume rainfall in category 3459-4000 was higher risk for hookworm infection and the factor was lower/protective risk for *Strongyloides stercoralis* and co-infection.

Discussion

Environmental factor had contribution for distribution, association and high risk for hookworm, *Strongyloides stercoralis* and co-infection each district in this research. Muarakamn district had dominant for prevalence hookworm infection 116(61.1%) with overall prevalence in East Kalimantan 44.1%. Deference of environmental factor between Muarakaman District and Marangkayu District should be affected the higher hookworm infection in Muarakaman district such as vegetation surrounding area of villages and geographical location where Muarakaman District be located surrounding palm plantation and river area. Similar study in Manufahi District, Timor Leste where is rural area with prevalence of hookworm infection was 62.8%.(Nerry SV, et al 2015)

In contract, the prevalence *strongyloides stercoralis* was higher in Marangkayu District 23.7% , even though the prevalence *Strongyloides stercoralis* was lower than hookworm infection in overall cases. The range prevalence of hookworm infection and *Strongyloides stercoralis* infection in East Kalimantan Province have different with study in Preah Vihear Province Cambodia, where the prevalence was equal hookworm and *strongyloides stercoralis* (49.0% and 48.8%) in East Kalimantan Province, Indonesia the

prevalence hookworm infection was higher than *Strongyloides stercoralis* infection (44.1% and 16.4%). The environmental conditions should effect against increasing or decreasing prevalence of hookworm infection and *Strongyloides stercoralis* infection in rural area. (Forrer et al 2018).

Co-infection was description dominant in Marangkayu District, the prevalence of co-infection was higher than Muarakaman District with deference 22.0% and 7.4% respectively. Overall cases co-infection in this study were 66(15.5%), it is lower than study in combodia where the prevalence co-infection 43.8% that equal with prevalence *Strongyloides stercoralis* and hookworm infection 48.8 % and 49.0%. (Forrer 2018, Khieu V 2014).

Result statistical analysis for association/correlation test showed, in the prevalence *Strongyloides stercoralis* had several environmental variables that had not significant such as clay content in soil, vegetation, and village areas, while hookworm infection had no significant correlation with texture of soil, clay content and pH in soil. In reality number and volume rainy season, elevation organic carbon content in soil have high association with prevalence both of hookworm infection and *Strongyloides stercoralis* infection, impact of environmental factors in level of survival eggs or larvae hookworm and *Strongyloides stercoralis* in environmental condition at Muarakaman dan Marangkayu district. In general condition soil surrounding houses is wet soil that was caused without waste water treatment each houses and behavior communities still not save for protection skin from larvae hookworm or *Strongyloides stercoralis* also in file rice and palm or rubber plantation. Hookworm infection and *Strongyloides stercoralis* are both of neglected tropical diseases (Anamnart, W *et al*, 2010). In poor countries with tropical climate, where have environmental condition favorable for transmission hookworm infection and *Strongyloides stercoralis* infection, the prevalence of parasite still high. (Jongwutiwes s *et al*, 1999).

Furthermore, low socioeconomic status and low hygiene living conditions of the rural population are strongly associated with hookworm infection and *Strongyloides stercoralis* In southeast Asia, a recent work in Cambodia reported a very high infection rate of Takeo Province (Khieu V *et al*, 2014) Furthermore, low socioeconomic status and low hygiene living conditions of the rural population are strongly associated with hookworm infection and strongyloidiasis. In southeast Asia, a recent work in Cambodia reported a very high infection rate of Takeo Province (Khieu V *et al*, 2014)

Supporting environmental factor against survival of hookworm infection and *strongyloides stercoralis*. When communities defecated in rubber or palm plantation could be spread in village or rice field that condition be because elevation plantation is higher than village and rice field elevation, run of water from plantation or forest when rainfall maybe bring the eggs or larvae hookworm or *Strongyloides stercoralis* from hill to village and field rice. Potential infected together via field rice and rubber and palm plantations adult communities also for children when they were playing around houses.

Co-infection of hookworm and *Strongyloides stercoralis* had no significant correlated with clay content, texture, vegetation and village areas although the prevalence co-infection still high in several environmental factor. Collaboration many environmental risk factors could support the survival of larvae the worms. Environmental factors of hookworm and *Strongyloides stercoralis* infections in East Kalimantan has similar with south Thailand including long rainy season, temperature and several geography area, then the prevalence of hookworm infection in East Kalimantan Province (44.1%) is higher than in south Thailand but equal for Strongyloidiasis, that condition was caused other environmental risk factors like quality of soil such as organic carbon of soil, clay content and pH. (Anamnart *et al.*, 2015).

The prevalence hookworm infection in East Kalimantan has similar with study in southern Laos and Cambodia where hookworm still high but more than prevalence of *Strongyloides stercoralis* infection. The study in Cambodia reported the lower prevalence of *Strongyloides stercoralis* in area with heavy rainfall than in low rainfall area. Moreover, high amount of soil organic carbon content affect to the lower prevalence of *Strongyloides stercoralis* infections (Khieu *et al.*, 2014). Epidemiology study of hookworm infection and *Strongyloides stercoralis* in Southern Laos showed 56.1% and 41% respectively where has heavy rainfall and poor sanitation. (Vonghachack Y *et al.*, 2015).

Coonclusions

The prevalence of hookworm and *Strongyloides stercoralis* and co-infection in East Kalimantan Province had correlation with environmental factors especially such as district, organic carbon content in soil, number and volume rainfall and humidity and temperature. Village areas, vegetation, clay content no significant correlation with *Strongyloides* infection. Hookworm infection had not been significant by texture of soil, clay content and pH of soil while Clay content in soil, texture of soil, vegetation and village areas had not significant correlated with co-infection. Environmental factors could became risk of increasing factor or protecting/reducing of hookworm, *Strongyloides stercoralis* and co-

infection. Essential environmental risk factors of the infections should use for preventing program of reduction prevalence hookworm and *Strongyloides stercoralis* infections

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