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Research Article
Factors Associated with Helminthiasis among Vegetable Farmers in Barito Kuala District

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Abstract

Background and Objective: Infections caused by soil-transmitted helminth (STH) are one of the global health problems. Farmers were one group that has a high risk infected by helminth. This study aimed to determine the association of the use of personal protective equipment (PPE) and other factors with helminthiasis among vegetable farmers in Barito Kuala District, South Kalimantan Province. **Materials and Methods:** Population and sample in this study were vegetable farmers and these samples were taken randomly. This study was an analytical study with a case-control design. Chi-square, binary logistic regression and SPSS was used for statistical analysis. **Results:** This study showed male farmers, elementary educated farmers and these farmers do not have hands washing habit. Farmers who have to consume of raw foods habit more than once per week have a greater risk of getting infected by helminth. This study showed more helminth infections occur in farmers who do not use personal protective equipment. **Conclusion:** Current study found that helminthiasis was significantly associated with the use of complete personal protective equipment, gender, education level, hand washing habit and habit of consuming raw foods. It was advisable for vegetable farmers to always use personal protective equipment when farmed and to keep good personal hygiene.

Key words: Helminthiasis, soil-transmitted helminth, vegetable farmers, *Ascaris lumbricoides*, PPE

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Soil-transmitted helminth infections occurred worldwide, more than 1 million people have been infected by one types of helminth[1]. Around 438.9 million people have been infected by hookworm, 819 million by *Ascaris lumbricoides* and 464.6 million by *Trichuris trichiura*[2].

According to data from the World Health Organization (WHO) in 2016, more than 1.5 billion people or about 24% of the world's population is infected with STH. The largest incidence rates are in sub-Saharan Africa, America, China and East Asia[3].

Indonesia is a tropical country and has high humidity. This situation is very supportive for soil transmitted helminths to be well developed. According to the Ministry of Health of the Republic of Indonesia in 2015, the prevalence of helminthiasis in Indonesia reached 28%. The economic and social level of Indonesian society is not evenly distributed so that the knowledge and awareness of the community to maintain personal hygiene and environment is still not good. This is what causes the helminth infection easier in Indonesia so that people can get helminth disease[4].

Helminth infections can lead to declining health conditions, lowering nutritional status, lowering intelligence skill and productivity, causing loss of carbohydrates, protein and blood, lowering the quality of human resources, so many causes economic losses and much more[5,6].

The number of helminth infections was many in Southeast Asia, including Indonesia. Bad personal hygiene and poor environmental sanitation are determinant factors[7,8].

Most of the Indonesian people are still often consuming raw food, especially vegetables. The habit of eating raw vegetables was already a tradition in certain tribes in Indonesia. However, in terms of security, raw vegetables containing pesticide contamination risk or helminth eggs[9]. Farmers also often use organic fertilizers such as manure to improve soil fertility. This, of course, does not make fertilizers free of helminth eggs infection[10]. According to Kaliappan *et al.*[11] the risk of helminth eggs infection will increase when working in direct contact with the soil. Vegetable farmers are one type of job that is in direct contact with the soil[11].

Barito Kuala District is one of the areas that most of the people are farmers. Agriculture is a potential sector in Barito Kuala District, with tidal rice fields reaching 101.424 Ha. From the area of rice fields yield 317,605 t of dry unhulled rice in 2009. This makes Barito Kuala the largest rice producer in South Kalimantan province by contributing approximately 16.23% of total production in South Kalimantan province. This shows that farmers have high productivity in producing rice there. However, based on the preliminary survey conducted by the authors, in general, farmers use manure, a majority of farmers use manure to fertilize crops[12]. In the daily activities, they did not use PPE when worked. This condition can cause infection by the helminth on fertilizer or soil. The purpose of this study is to determine the association of the use of PPE, age, gender, education level, marital status, period of working, hand washing habit, clipping nails, consuming of raw food habit, latrine ownership, type of floor and availability of clean water with helminthiasis among vegetable farmers in Barito Kuala District, South Kalimantan Province.

MATERIALS AND METHODS

Study design: This study was an analytical study with a case control design to assesses the association between exposure and disease. The study knows the relationship between the use of PPE and other factors with helminthiasis. This study collects data on a number of vegetable farmers. After the approval of participant, authors set a date and time to retrieve socio-demographic data of each participant and ask them to collect stool samples for examination. The study was conducted from October-December, 2016.

Sample size: In this study, samples were taken randomly. The study population was all of the vegetable farmers in Barito Kuala District, South Kalimantan Province. The sample of the study was divided into two case samples and control samples, case samples were obtained from data of farmers who suffered from helminthiasis based on stool examination by health officers of a public health center, hospital and private practice. Based on the results of the examination obtained 98 positive farmers experienced helminthiasis and 368 farmers did not experience helminthiasis. The sample in this study was 466 vegetable farmers. We recruited 118 vegetable farmers that use complete PPE and 348 vegetable farmers that did not use complete PPE. Authors went one by one vegetable farmers when they farmed in the garden or goes to vegetable farmers home.

Questionnaire: The instrument used in this study is a questionnaire to obtained data on the use of hand gloves, footwear, mask and a long shirt, hands washing habit, clipping nails habit, latrines ownership, types of floor, consuming raw foods habit and availability of clean water among vegetable farmers. Answer from the questionnaire was confirmed by interviewing their relatives or family. The questionnaire was filled out by each participant. To make sure all of the participants were honest in their answers, participants were

told about the confidentiality of their answers, there will be no identity mentioned in the study and nothing will harm of participants of the moral and material. A questionnaire was given to participants prior to the sampling stool. The questionnaire contains a description of socio-demographic by participants. Demographic information including gender, age, educational level, marital status and period of working.

Stool examination: As for knowing a helminth infection used a tools and stool examination with Kato-Katz method. Helminth eggs calculated within 1 h of Kato preparation for helminth. Tools and materials in this study are aquadest, glycerin, malachite green, object glass, cellophane tape 2.5 cm wide and perforated with perforator. It is also used filter wire, plastic size 10-15 cc, stick, oil paper, filter paper, waterproof marker, rubber bottle cap, metal scissors, small plastic basin, soap, small towel, rubber gloves, formalin 5- 10%, microscope, form, bucket, counter and faces.

The method of distribution and collection of stool: (1) Before giving plastic stool to the respondent, the explanation of sampling purpose is given first, (2) This study was approved by the farmer. Before being asked to collect stool samples given informed consent to the respondent, (3) After giving explanation, pot/plastic stool given according to respondent code, (4) The amount of stool inserted into pots/plastic about 100 mg (as big as marbles or thumb) and (5) The specimen should be checked immediately on the same day, because the helminth eggs will be damaged or hatch into larvae. If examination on the same day can't be done stool sample will be given 5-10% formalin until submerged.

Method to make Kato solution: (1) To make Kato solution required mixture with comparison: Aquadest 100 parts, glycerin 100 parts and 3% malachite green solution as much as 1 part, (2) Weigh malachite green as much as 3 g, insert into glass bottle/beaker glass and add 100 cc aquadest little by little and stir/shake so homogeneous, it will get 3% malachite green solution, (3) Insert 100 cc aqua dest into small plastic basin, then add 100 cc glycerin bit by bit and add 1 cc malachite green solution 3%, then stir until homogeneous. Then will get 201 cc Kato solution. Procedure to immerse or tape the cellophane: (1) Make a rectangular wood frame according to the size of a small plastic basin, (2) Wrap the cellophane on the frame, (3) Soak for +18 h in Kato solution and (4) At the time will be used, cut out the soaked cellophane along 3 cm.

Method to make preparations: (1) Wear hand gloves to reduce the possibility of infection of various diseases, (2) Write the code number on the object glass with the marker according to the one written in the pot/plastic stool, (3) Take the stool with a stick as big as green beans and place it on top of the object glass, (4) Cover with a cellophane that has been soaked in Kato solution and smooth the stool under the cellophane with a rubber bottle cap or glass of the object, (5) Leave the preparation for 20-30 min, (6) Check with weak magnification 100×(objective 10× and ocular 10×), if needed can be raised 400×(objective 40× and ocular 10×) and (7) The results of stool examination in the form of positive or negative of each type of helminth eggs.

Statistical analysis: Completed questionnaires and the results of stool examination input in excel program. Data obtained from the study will be treated with the help of computers and SPSS software (version 21.0 for windows; Armonk, NY; IBM Corp, USA). Data were analyzed by univariate to determine the frequency and proportion of each variable studied. Bivariate analysis was performed to see the association and cross tabulation between the independent and dependent variables, the chi-square test with CI (confident interval) 95%. $p<0.05$ was deemed statistically significant. Binary logistic regression analysis was used to determine which variables have the most influence on the dependent variable.

RESULTS

Socio-demographic characteristics of the study sample are reported in Table 1. From Table 1 it can suggest that most of the farmers using PPE are between 15 and 30 years old, most of the farmers who use PPE are women, most of the farmers who use PPE are high-educated. This study can also suggest that most of the farmers who use PPE did not have helminthiasis. In contrast, farmers who did not use PPE are between 46 and 60 years old. Most of the farmers are middle-educated and elementary-educated.

There were 98 farmers in this study positively infected by helminth, 90 of them did not use complete PPE. Group of farmers that did not use completely is older, more male, more educated elementary school graduates and more of them did not wash hands after farming. Some of them have a habit of consuming raw foods. Among farmers who use complete PPE and did not use complete PPE on marital status, the period of working, clipping nails, latrine ownership, type of floor, availability of clean water and helminth infection comparison is the same. There is no significant association between farmers using complete PPE and did not use complete PPE regarding age, marital status, the period of working, clipping nails, latrine ownership, type of floor and availability of clean water.

Table 1: Description of socio-demographic and independent variable with the use of PPE among farmers (N = 466)

	PPE (Yes) (N = 118)		PPE (No) (N = 348)		
Characteristics	N	%	N	%	Total (100%)
Age (years)					
15-30	45	38.1	58	16.7	103
31-45	39	33.1	112	32.1	151
46-60	22	18.6	122	35.1	144
>60	12	10.2	56	16.1	68
Gender					
Male	46	39.0	194	55.7	240
Female	72	61.0	154	44.3	226
Education level					
Elementary	17	14.4	100	28.7	117
Middle	48	40.7	208	59.8	256
High	53	44.9	40	11.5	93
Marital status					
Married	69	58.5	176	50.6	245
Single	20	17.0	94	27.0	114
Widowed/divorced	29	24.5	78	22.4	107
Period of working					
≤5 years	79	66.9	102	29.3	181
>5 years	39	33.1	246	70.7	285
Hands washing habit					
Yes (every time after farmed)	80	67.8	203	58.3	283
No (didn't after farmed)	38	32.2	145	41.7	183
Clipping nails					
Yes (1-2 times a week)	82	69.5	183	52.6	265
More than one week	36	30.5	165	47.4	201
Consuming of raw foods habit					
More than once a week	9	7.6	75	21.6	84
Once a week	10	8.5	26	7.5	36
1-3 times a month	12	10.2	40	11.5	52
Once a month	11	9.3	55	15.8	66
No	76	64.4	152	43.6	228
Latrine ownership					
Yes (at home)	73	61.9	251	72.1	324
No	45	38.1	97	27.9	142
Type of floor					
Good (not easy absorb water and dirt)	95	80.5	261	75.0	356
Bad	23	19.5	87	25.0	110
Availability of clean water					
Yes	105	89.0	220	63.2	325
No	13	11.0	128	36.8	141
Helminth infection					
Positive (helminth egg such as *Ascaris lumbricoides*, *Trichuris Trichiura*, *Ancylostoma duodenale*, *Necator americanus*)	8	6.8	90	25.9	98
Negative (No helminth eggs)	110	93.2	258	74.1	368

Source: Primary Data, PPE (Yes) refers to farmers who use complete PPE. PPE (No) refers to farmers who did not use complete PPE (hand gloves, footwear, mask and long shirt. p-value based on chi-squared tests

In the logistic regression model adjusted in Table 2, male farmers were significantly more likely to be infected by helminth, in the group of farmers use complete PPE (87.5%) and in the group of farmers did not use complete PPE (85.6%) with p = 0.001. Male farmers did not use complete PPE have a greater risk of getting infected by a helminth (OR = 1.23). Elementary educated farmers were significantly more likely to be infected by helminth, in the group of farmers use complete PPE (62.5%) and in the group of farmers did not use complete PPE (80%) with p = 0.02. Elementary educated farmers did not use complete PPE have a greater risk of getting infected by a helminth (OR = 3.12). Did not have hand washing habit was significantly more likely to be infected by helminth, in the group of farmers use complete PPE (87.5%) and in the group of farmers did not use complete PPE (74.4%) with p = 0.001. Farmers who have no habit of washing hands

Table 2: Association of socio-demographic and characteristics with the use of PPE on farmers by helminth infection status (N = 466)

	Helminth infection (Yes)					Helminth infection (No)					
	PPE (Yes)		PPE (No)			PPE (Yes)		PPE (No)			
Characteristics	N	%	N	%	p-value	N	%	N	%	Non-Adjusted OR 95% CI	Adjusted OR 95% CI
Age (years)											
15-30	1	12.5	8	8.9	0.44	44	40.0	50	19.3	1.73 (1.19-2.48)	2.12 (1.45-2.33)
31-45	1	12.5	12	13.3		38	34.5	100	38.8	1.80 (1.52-2.14)	1.69 (1.36-1.94)
46-60	4	50.0	54	60.0		18	16.4	68	26.4	2.19 (1.43-3.12)	3.15 (2.45-3.43)
>60	2	25.0	16	17.8		10	9.1	40	15.5	2.23 (1.76-2.81)	1.27 (0.79-1.64)
Gender											
Male	7	87.5	77	85.6	0.001	39	35.4	117	45.3	1.78 (1.67-2.15)	1.23 (0.67-1.62)
Female	1	12.5	13	14.4		71	64.6	141	54.7	1.04 (0.81-1.56)	1.15 (0.87-1.72)
Education level											
Elementary	5	62.5	72	80.0	0.02	12	10.9	28	10.9	2.55 (1.94-2.82)	3.12 (2.67-3.98)
Middle	2	25.0	14	15.6		46	41.8	194	75.2	0.96 (0.64-1.38)	1.24 (0.92-1.74)
High	1	12.5	4	4.4		52	47.3	36	13.9	2.80 (1.32-4.68)	2.47 (1.11-3.45)
Marital status											
Married	1	12.5	8	8.9	0.70	68	61.8	168	65.1	1.42 (0.88-2.23)	1.19 (0.81-1.46)
Single	4	50.0	54	60.0		16	14.6	40	15.5	1.86 (1.15-2.27)	2.57 (1.67-2.83)
Widowed/divorced	3	37.5	28	31.1		26	23.6	50	19.4	2.54 (1.97-2.96)	1.45 (0.95-1.90)
Period of working											
≤5 years	5	62.5	22	24.4	0.46	74	67.3	80	31	0.71 (0.42-1.13)	1.29 (0.74-1.75)
>5 years	3	37.5	68	75.6		36	32.7	178	69	1.46 (0.84-2.43)	3.20 (1.61-4.12)
Hands washing habit											
Yes (every time after work)	1	12.5	23	25.6	0.001	79	71.8	180	69.8	1.65 (1.71-2.31)	1.45 (1.04-1.53)
No (didn't after work)	7	87.5	67	74.4		31	28.2	78	30.2	3.13 (2.46-3.65)	2.40 (2.14-2.91)
Clipping nails											
Yes (1-2 times a week)	1	12.5	25	27.8	0.59	81	73.6	158	61.2	1.02 (0.65-1.61)	1.46 (1.08-2.10)
More than one week	7	87.5	65	72.2		29	26.4	100	38.8	1.77 (0.92-2.71)	1.47 (0.86-2.15)
Consuming of raw food habit											
More than once a week	4	50.0	59	65.6	0.004	5	4.5	16	6.2	2.01 (1.58-2.39)	3.80 (2.33-4.20)
Once a week	2	25.0	5	5.6		8	7.3	21	8.1	1.22 (0.61-2.32)	2.10 (0.89-2.40)
1-3 times a month	1	12.5	10	11.1		11	10	30	11.6	2.18 (2.12-4.53)	1.84 (1.24-3.54)
Once a month	1	12.5	14	15.5		10	9.1	41	15.9	2.30 (1.32-3.11)	1.75 (1.17-2.19)
No	0	0.0	2	2.2		76	69.1	150	58.2	3.11 (1.80-3.87)	2.10 (1.12-2.24)
Latrine ownership											
Yes (at home)	1	12.5	65	72.2	0.10	72	65.5	186	72.1	1.83 (1.14-2.85)	1.57 (0.96-2.13)
No	7	87.5	25	27.8		38	34.5	72	28.9	0.84 (0.57-1.24)	1.39 (1.01-2.13)
Type of floor											
Good (not easy absorb water and dirt)	2	25.0	46	51.1	0.34	93	84.5	215	83.3	1.33 (0.64-1.83)	1.68 (1.15-2.40)
Bad	6	75.0	44	48.9		17	15.5	43	16.7	2.14 (0.92-2.20)	1.44 (0.92-2.03)
Availability of clean water											
Yes	3	37.5	50	55.6	0.50	102	92.7	170	65.9	3.18 (2.14-4.65)	2.25 (1.87-3.03)
No	5	62.5	40	44.4		8	7.3	88	34.1	1.61 (1.11-2.14)	2.41 (1.99-3.10)

PPE: Personal protective equipment. PPE (Yes) refers to participants who use complete PPE. PPE (No) refers to participants did not use complete PPE (hand gloves, footwear, mask and long shirt), p-value based on chi-squared tests. OR: Odds ratio, CI: Confidence interval, PPE: Personal protective equipment. Significant at 0.05%

after farmed did not use complete PPE have a greater risk of getting infected by a helminth (OR = 2.40). The habit of consuming raw foods more than 1 time/week was significantly more likely to be infected by helminth, in the group of farmers use complete PPE (50%) and in the group of farmers did not use complete PPE (65.6%) with p = 0.004. Farmers who consumed raw food more than 1 time/week and did not use complete PPE had a greater risk of getting infected by a helminth (OR = 3.80).

Furthermore, multivariate analysis was done by choosing the candidate variable by choosing the result of bivariate selection on the variable having p<0.25. The result of the analysis showed that candidates entering multivariate were gender variable, education level, hands washing habit and consuming of raw food habit. The making of helminthiasis determinant factor model in vegetable farmers. In modeling predictors of these helminthiasis factors, all variables are analyzed simultaneously. Model making is done by entering all the eligible independent variables (Table 3). From the analysis results can be seen that the hands washing habit is the strongest predictor of helminthiasis with risk 3.26 times.

Table 3: Multivariate analysis of binary logistic regression between independent variables and dependent variables

Variable	B	p-value	OR	95% CI
Gender	0.79	0.24	2.35	0.64-9.14
Education level	0.16	0.74	1.21	0.44-5.49
Hands washing habit	1.73	0.02	3.26	0.73-6.80
Consuming of raw food	1.06	0.01	2.84	0.85-10.54

DISCUSSION

In this study showed farmers who did not use complete PPE are more at risk of infection by helminth eggs than farmers use complete PPE. Farmers who did not use footwear or hand gloves may increase the risk of helminth egg infections through fingernails. In addition, the use of long shirts and mask can also reduce the risk of helminth egg infection through the skin pores or swallowed through the mouth. These findings indicate that the use of complete PPE can reduce the risk of helminth egg transmission among vegetable farmers.

Examination of vegetable farmers stool found *Ascaris lumbricoides*, *Ancylostoma duodenale* and *Trichuris trichiura*. The type of hookworm infect the workers on the plantation in direct contact with the soil[13]. According to Fuhrimann *et al.*[14] there is an association between the use of PPE and prevalence of helminth infections, most participants were not infected by the helminth have the habit of using PPE when farmed.

The PPE should be used routinely for the majority of farmers' activity related to land. Besides routinely used, the use of PPE must also complete because not completely use of PPE ease the entry of helminth eggs through various organs of the body such as the hands, feet and mouth[15].

According to Mahmud *et al.*[16] farmers use organic fertilizer in the form of human waste and animal manure to improve soil fertility so that contamination of helminth easily happen. According to Seo *et al.*[17], most of the farmers use cattle dung to make fertilizer and some of them showed positive results against helminth infection[17].

This is also consistent with the results of Agyei *et al.*[18], there was a significant association between habitual use of PPE such as hand gloves, shoes and helminth infection. Helminth eggs attached to the hands can be swallowed by farmers who did not use hand gloves[19].

The existence of a significant association between the use of PPE and the prevalence of helminth infections confirmed that PPE is very important. The use of PPE intended to protect a person or isolating a part or the whole body of the potential hazards in the workplace that can cause disease or accident[20].

The use of incomplete PPE enables helminth infection through various organs of the body such as the hands, feet and mouth[21,22]. According to the Paige *et al.*[23] study the use of footwear can reduce the risk of helminth infections. The use of footwear will protect the feet from helminth infections that can penetrate the skin.

According to Bird *et al.*[24], although the use of footwear is not always effective in preventing infection of helminth, the use of footwear can protect a person from helminth. Inconsistent use of footwear will also increase the prevalence of helminth infections[25,26]. Added by Alum *et al.*[8] the use of footwear is one of the factors that could cause parasitic infections including helminth, other than open defecation habits and dirty fingernails.

In this study showed a significant $p<0.05$ association between hand washing habit and helminth infection (Table 2). Farmers have a high risk of getting infected by helminth, most of them using hands to eat. Helminth eggs out with feces in a humid place and not exposed to sunlight, the egg grows into infective. Helminth infection occurs when infective eggs enter through the mouth with food or beverages and through dirty hands[27].

Washing hands are a process that removes dirty and debris leather from hands with plain soap and water. The purpose of washing hands is one element of the prevention of transmission of infection. Hands washing with soap has an enormous influence on the prevention of helminth infection, because of the helminth eggs can enter the body through dirty hands and then the eggs that stick in hands through the food ingested or touched by dirty hands[28].

In the clipping nails variable, farmers who had more than one week of nailing were at greater risk of getting infected by helminth, in a group of farmers use complete PPE (87.5%) and a group of farmers did not use complete PPE (72.2%) (Table 2). It can be concluded that farmers cut nails 1-2 times/week and use complete PPE have a lower risk getting infected by helminth[29]. Some farmers let their nails long because, in their perception, it was convenient to attach or open something.

The habit of consuming of raw foods will increase helminth infection risk. For example, the habit of eating half-cooked fish, half-cooked meat and vegetables. When these foods are cysts or larvae of the helminth, the helminth's life cycle to be complete, resulting infection in humans[30]. In this study, some of the farmers have the habit of consuming raw food, especially vegetables. In fact, sometimes they eat them without washing first. They did it because they thought that raw vegetable nutrition for more. It is indeed true, but it would be dangerous to health if hygiene is not guaranteed.

In the latrine ownership variable, farmers who did not have latrine have a higher risk of getting infected by helminth, in the group of farmers use complete PPE (87.5%) and in the group of farmers did not use complete PPE (27.8%) (Table 2). Latrines are building for a place to defecate and urinate. In the latrine should be provided clean water and soap for hands washing[31]. Some of the participants in the study did not have their own latrines.

The terms of a healthy home is a home building should be strong enough, the floor is easy to clean. The home floor can be made of tile or material that is waterproof or compacted soil[32]. Table 2 showed farmers who have bad floors have a higher risk of getting infected by helminth, in the group of farmers use complete PPE (75%) and a group of farmers did not use complete PPE (48.9%).

The study also showed that there is no significant association between availability of clean water and helminth infection (Table 2). However, farmers who did not have a source of clean water have a higher risk of getting infected by helminth, in a group of farmers use complete PPE (62.5%) and group of farmers did not use complete PPE (44.4%) than farmers with clean water sources, group of farmers use complete PPE (37.5%) and in the group of farmers did not use complete PPE (55.6%) (Table 2).

CONCLUSION

It was concluded that the results showed that most farmers did not use complete PPE. They think that PPE will make them inflexible. In addition, the lack of knowledge of farmers about the risk of helminth infections is the reason why they did not use PPE. Use of PPE on vegetable farmers is highly recommended to avoid the risk of helminth infection.

SIGNIFICANCE STATEMENTS

This study discovered that the use of personal protective equipment reducing the risk of helminth infection. This study will help the researcher to uncover the critical point of helminthiasis incidence which shows that the use of PPE among vegetable farmers has not been explored previously.

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