One Health 14 (2022) 100399

Contents lists available at ScienceDirect

One Health

journal homepage: www.elsevier.com/locate/onehlt

Factors affecting preventive behavior against leptospirosis among the population at risk in Si Sa Ket, Thailand

Thawatchai Toemjai [a], Pramote Thongkrajai [b], Choosak Nithikathkul [b,*]

[a] Faculty of Medicine, Mahasarakham University, Mahasarakham, Thailand
[b] Tropical and Parasitic Diseases Research Unit, Faculty of Medicine, Mahasarakham University, Mahasarakham, Thailand

ARTICLE INFO

Keywords:
Factors affecting
Preventive behavior
Leptospirosis

ABSTRACT

Leptospirosis is a major public health problem in Si Sa Ket, Thailand. Humans can become infected *via* direct contact with the urine of infected animal reservoir hosts or by indirect contact with contaminated soil and water in the environment. This study examined the factors affecting preventive behavior against leptospirosis among the population at risk in Si Sa Ket, Thailand. A cross-sectional questionnaire was conducted by a representative population survey using a four-stage stratified random sampling to select 350 respondents aged 18–65 years from the fifth districts with the highest morbidity rate in 2010–2019. Data were analyzed by descriptive statistics and stepwise multiple regression. The majority of the respondents were male (53.40%), aged 46–55 years (31.20%), and agricultural workers (76.00%). Their knowledge (M = 10.78, SD = 1.60), perceived severity (M = 2.91, SD = 0.60), perceived probability (M = 2.98, SD = 0.64), self-efficacy expectations (M = 3.18, SD = 0.63), responses-efficacy expectations (M = 3.16, SD = 0.71), social support (M = 3.19, SD = 0.52), and preventive behavior against leptospirosis (M = 3.29, SD = 0.49) were at moderate level. Significant factors affecting leptospirosis preventive behaviors were history of leptospirosis illness (β = 0.312), social support (β = 0.240), perceived probability (β = 0.238), household members with a history of leptospirosis illness (β = 0.158), perceived severity (β = 0.114), self-efficacy expectations (β = 0.094) and knowledge (β = 0.088) regarding leptospirosis. All of these factors could together predict the preventive behavior against leptospirosis up to 42.8% (Adjusted R^2 = 0.428). Public health interventions should be strengthening people's perception and awareness regarding leptospirosis and the promotion of preventive health behavior to prevent potential outbreaks.

1. Introduction

Leptospirosis is a neglected zoonotic disease worldwide. It is of global public health importance with respect to morbidity and mortality in humans. Humans can become infected *via* direct contact with urine from infected animal hosts or by indirect contact with contaminated soil and water in the environment [1]. The main animal reservoir host are rodents, livestock, and dogs. The disease in humans can vary from mild flu-like illness to a serious disease. Some severe complications include kidney damage, liver failure, respiratory distress, meningitis, and death. [2]. Globally, it is estimated that 0.1 to 1 per 100,000 population in temperate climates are affected each year, with the number increasing to 10 or more per 100,000 population in tropical climates. When there is an epidemic, the incidence can soar to 100 or more per 100,000 population. The disease is under-reported for many reasons, including difficulty in distinguishing clinical signs from those of other endemic diseases and a lack of appropriate diagnostic laboratory services [3].

Thailand had an epidemic of leptospirosis in 2000, with a total reported 14,285 cases and 362 deaths, and the disease was reported from 72 of 76 provinces. The morbidity rate was 23.13 per 1000,000 population, with a fatality rate of 2.53%. Most of the cases (85.01%) and most of the deaths (78.18%) were occurred in the Northeastern region. Since then, the number of cases has declined significantly each year until 2005. During 2006–2019, the number of cases was relatively stable. The male to female ratio of leptospirosis in 2019 was 4:1. It was most frequently found in aged 45–54 years (20.33%). Most patients were agricultural workers (45.60%). The highest morbidity rates per 100,000 population were found in the South (4.71) and the Northeast region (2.95), mostly in Ranong (21.97), Phang Nga (18.67), Si Sa Ket (16.71), Yasothon (14.28) and Trang (12.60) [4]. In Si Sa Ket province, the

* Corresponding author at: Tropical and Parasitic Diseases Research Unit, Faculty of Medicine, Mahasarakham University, Muang District, Mahasarakham 44000, Thailand.
E-mail address: nithikethkul2016@gmail.com (C. Nithikathkul).

https://doi.org/10.1016/j.onehlt.2022.100399
Received 9 December 2021; Received in revised form 8 May 2022; Accepted 8 May 2022
Available online 13 May 2022

incidence of leptospirosis cases was 35.95, 29.40, 24.58, 21.48, 17.60, 21.40, 25.40, 52.80, 26.70 and 17.60 per 100,000 population in 2010–2019 respectively. In addition, the fatality rates were 0%, 0.23%, 2.24%, 1.92%, 1.55%, 6.07%, 2.15%, 2.06%, 1.78% and 2.16% in 2010–2019 respectively. The morbidity rate during 2010–2019 was higher than the national level and continues to be so up to the present time. The dramatic phenomenal epidemiological characteristics of leptospirosis in Si Sa Ket include a peak incidence between August to October which is in the rainy season [5]. Although the morbidity rate in Si Sa Ket has decreased, the number of deaths is still high, and annual outbreak of leptospirosis still occur. The goals of control and prevention of leptospirosis according to the National Strategic Plan for 20 years (2018–2037) is to decrease the fatality rate by not more than 1.20%. Important problems and prevention gaps of managing leptospirosis were found to be that people lacked knowledge of the disease, lacked awareness of self-protection from it, not protecting themselves from infection by wearing boots or gloves while working on agricultural activities, and trampling in mud or wet soil or soaking in natural water sources for a long time. These inadequacies were leading to illness. Thus, action is needed to solve these problems to prevent and control leptospirosis more effectively [6]. The purposed of this study was to investigate the factors affecting preventive behavior against leptospirosis among the population at risk in Si Sa Ket, Thailand.

2. Methods

2.1. Ethics statement

This study was reviewed and approved on March 28, 2020 by the Ethics Committee of Mahasarakham University, Thailand (registration number 132/2020). Informed written consent was obtained from all the respondents.

2.2. Study setting and population

A descriptive cross-sectional study was conducted in Si Sa Ket, located in the Northeastern of Thailand. Si Sa Ket province was divided by 22 districts, 206 subdistricts, 2675 villages, and 393,356 households. The population of province aged 18–65 years was 1,003,696 people [7,8]. Sample size was employed multi-stage random sampling. The criteria for eligible respondents was that they were; aged 18–65 years, only persons with at least 12 months of residence in the area, who were involved with occupations or activities that required them to be exposed to wet soil, mud, local natural water for a long time and were living closely to reservoir animals host (Farmer, Fisherman, Livestock, Gardener). Si Sa Ket province was selected based on its high incidence of leptospirosis morbidity rates (Fig. 1). The study location within the province were selected by random sampling using a four-stage stratified technique. The first stage used a purposive random sampling to select the first 5 districts of 22 districts with the highest morbidity rate during 2010–2019 in Si Sa Ket. These were, Phu Sing, Khukhan, Khun Han, Prang Ku and Phrai Bueng districts. The second to the fourth stages used simple random sampling to select subdistricts, villages, and their representative populations respectively. All the samples which fitted into the inclusion criteria were chosen as the respondents. A total of 350 individuals was invited to participate in the study.

2.3. Sampling technique

The sample size was calculated by using a formula to estimate the proportion of the population, which the population size is known $\left[n = \frac{NZ^2_{\alpha/2}P(1-P)}{e^2(N-1)+Z^2_{\alpha/2}P(1-P)}\right]$, where n = sample size, N = the total number of the population aged 18–65 years, Z = *Z*-statistic for a level of confidence at 95%, P = expected prevalence or proportion, which was the mean of incidence with leptospirosis during 2015–2019 in Si Sa Ket in order to obtain the maximum sample size and d = precision of estimation of 5% [9]. The estimated sample size based on the above calculation was 311 individuals. Sample size was increased by 39 individuals to protect drop out, so the sample size that was used in the study was 350 individuals.

2.4. Survey questionnaire and data collection

A self-administered questionnaire was developed based on the protection motivation theory [10], the social support theory [11], literature review of relevant studies, and previous questionnaires. A panel of experts reviewed and checked the tool, including an epidemiologist, infectious disease physician, health educationist and other relevant experts were involved to develop the questionnaire. After modifying some of the questions, internal consistency use a content validity index (CVI) [12]. The questionnaire was reviewed and measured by 7 experts.

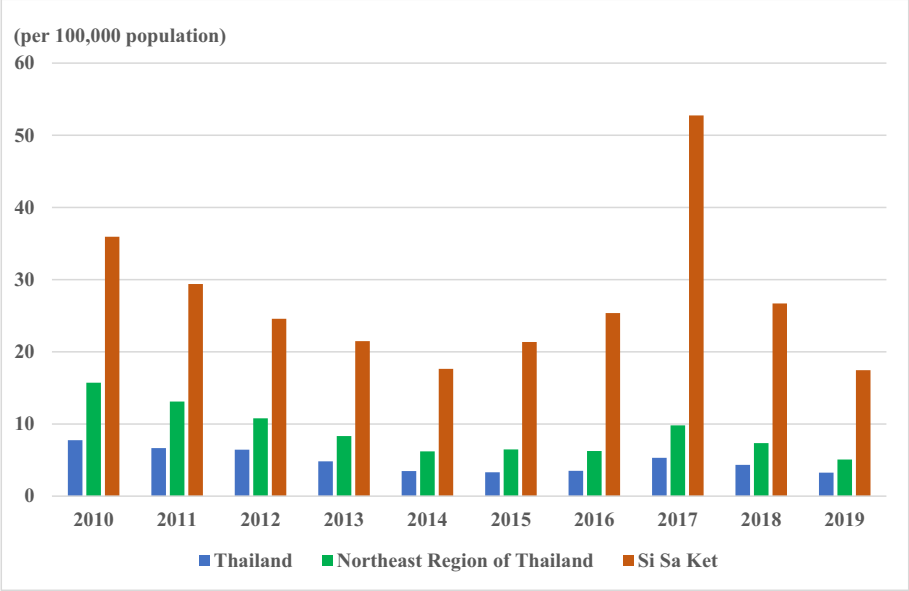

Fig. 1. Incidence of leptospirosis in Si Sa Ket, Northeast Region of Thailand and Thailand, 2010–2019.

Reliability was assured by pre-testing with revision, where the pre-tests were performed with communities having similar characteristics but in different geographical area. A pilot study was conducted among 30 respondents to examine the test-retest reliability and internal consistency of the questionnaire. Cronbach's alpha was analyzed for reliability in terms of internal consistency [13,14].

Survey data were collected during April to May 2020 *via* the questionnaires in the first 5 districts (Phu Sing, Khukhan, Khun Han, Prang Ku and Phrai Bueng) which had the highest morbidity rates during 2010–2019 in Si Sa Ket**.** The questionnaire used to collect data, was composed of positive and negative meaning items. The sociodemographic characteristics included gender, age, marital status, education, occupation, household incomes per year, and history of leptospirosis illness. Social factors included household members with a history of leptospirosis illness, community members with a history of leptospirosis illness, and receiving information regarding leptospirosis. Environmental factors included the residential area experiencing waterlogging, or wet soil or mud, having a cattle or pig stall, having rodents infestation, and having garbage disposal facilities. The knowledge of leptospirosis was based on 15-items that assessed respondents' understanding of leptospirosis. There were measured by nominal scales that were divided into either “true” or “false”. A true answer was given a score as 1 but a false answer was given a score as 0. For evaluation, respondents who obtained scores ≥12 points, 9–11 points, and scores ≤8 points were considered to have good knowledge, moderate knowledge, and poor knowledge respectively [15]. Perceived probability (10-items), perceived severity (10-items), self-efficacy expectations (10-items), and responses-efficacy expectations (10-items) of leptospirosis were measured by ordinal scales that included positive attitude items that were given scores of 5, 4, 3, 2, and 1 for strongly agree, agree, not sure, not agree, and strongly not agree respectively. For negative attitude items, the above scoring system was reversed. For evaluation, respondents who obtained mean scores of 3.68–5.00, 2.34–3.67, and 1.00–2.33 considered to have a perception of leptospirosis at a high, moderate, and low levels respectively. Social support for leptospirosis (10-items) was measured by ordinal scales with positive items that were given scores of 5, 4, 3, 2, and 1 for most, more, moderate, low, and very low respectively. For negative items, the above scoring system was reversed and that assessed the respondents who obtained mean scores 3.68–5.00, 2.34–3.67, and 1.00–2.33 who were considered to have social support for leptospirosis at most, moderate, and low levels respectively. Preventive behaviors against leptospirosis were measured on a 15-items ordinal scale in which positive items were given scores of 5, 4, 3, 2, and 1 for always, often, sometimes, seldom, and never respectively. For negative items, the above scoring system was reversed that assessed the respondents who obtained mean scores 3.68–5.00, 2.34–3.67, and 1.00–2.33 who were considered to have a preventive behavior against leptospirosis good practices, moderate practices, and poor practices respectively. Cronbach's alpha was 0.77, 0.77, 0.77, 0.80, 0.75, 0.80, and 0.78 for knowledge, perceived probability, perceived severity, self-efficacy expectations, responses-efficacy expectations, social support, and preventive behaviors against leptospirosis respectively, indicated good internal consistency.

All interviewers were trained and provided with a field manual for their reference during the face-to-face interview. Before questionnaire administration, the purpose of the study was explained to each respondent, informed consent was gained, and confidentiality of the information assured. The interview was conducted for an average 20–30 min for each respondent. Data were collected on questionnaires completed by the respondents. A total of 350 questionnaires were returned.

2.5. Statistical analysis

Statistical analyses were performed using the IBM Statistical Package for the Social Sciences for windows (SPSS) version 23.0 (SPSS Inc., Chicago, IL, USA). Data were checked and cleaned. Normality of data was checked by histogram, skewness, kurtosis, and Kolmogorov-Smirnov normality test. Data were analyzed with descriptive statistics including frequency and percentages. If the continuous data was of normal distribution, descriptive statistics were presented an average and standard deviation (SD). For the continuous data that was not normally distributed, data were presented as median, maximum, and minimum value. The relationship between determinants and preventive behavior against leptospirosis was investigated by Pearson Correlation Coefficient. Stepwise multiple regression analysis was carried out to determine the predictor of preventive behavior against leptospirosis. The level of statistical significance was set at an alpha level at 0.05.

3. Results

Si Sa Ket province has 22 districts, 206 sub-districts, and 2634 villages. In 2020, incidence of leptospirosis was reported in 18 districts throughout province, with most cases in the province's southwest (Fig. 2).

Of the 350 respondents, 53.4% were male, 62.2% were marital status, and the mean age was 46.99 years (SD = 10.28). The majority 69.4% had completed junior high school and lower, 76.0% were agricultural worker, 60.9% had household income ≤75,000 Baht per year (Mean of Country: 316,452 Baht per year). The median of household income per year was 60,000 Baht (1786.25 USD). Mostly, the respondents had never been sick with leptospirosis (84.0%), the household members had never been sick with leptospirosis (90%), the community members had never been sick with leptospirosis (62.9%), the respondents received information regarding leptospirosis (91.4%), the residential area doesn't have experiencing waterlogging, or wet soil or mud, the residential area doesn't have a cattle or pig stall, the residential area doesn't have rodents infestation, and the residential area has a garbage disposal facilities been 54.9%, 51.7%, 70.0%, and 81.1% respectively (Table 1).

In our study, the respondents had the knowledge (M = 10.78, SD = 1.60), perceived severity (M = 2.91, SD = 0.60), perceived probability (M = 2.98, SD = 0.64), self-efficacy expectations (M = 3.18, SD = 0.63), responses-efficacy expectations (M = 3.16, SD = 0.71), social support (M = 3.19, SD = 0.52), and preventive behavior (M = 3.29, SD = 0.49) regarding leptospirosis were mostly shown a moderate level (Fig. 3).

The high-risk behaviors in this study, were if the respondents were not wearing gloves (M = 2.80, SD = 1.21) and boots (M = 2.94, SD = 0.81) while working in the cattle or pig stall, and wading in flood waters, barefoot trampling in mud or wet soil (M = 3.10, SD = 0.94) (Table 2).

It was found among the respondents that being, agricultural workers ($r = -0.107$, $p < 0.05$), having a history ever being sick with leptospirosis ($r = 0.349$, $p < 0.001$), receiving information regarding leptospirosis ($r = 0.128$, $p < 0.01$), having household members with a history of leptospirosis illness ($r = 0.291$, $p < 0.001$), social support ($r = 0.401$, $p < 0.001$), the residential area has a garbage disposal facilities ($r = 0.130$, $p < 0.01$), knowledge ($r = 0.247$, $p < 0.001$), perceived probability ($r = 0.380$, $p < 0.001$), perceived severity ($r = 0.230$, $p < 0.001$), self-efficacy expectations ($r = 0.256$, $p < 0.001$), and responses-efficacy expectations ($r = 0.217$, $p < 0.001$) were correlated with preventive behaviors against leptospirosis with statistical significance set at an alpha level at 0.05.

The multiple regression analysis indicated that the factors affecting preventive behavior against leptospirosis (Y, Z) with statistically significance (p-value <0.05) were history of leptospirosis illness (X_1), social support (X_2), perceived probability (X_3), household members with a history of leptospirosis illness (X_4), perceived severity (X_5), self-efficacy expectations (X_6), and knowledge regarding leptospirosis (X_7). All of these factors could together predict the preventive behavior against leptospirosis up to 42.8% (Adjusted $R^2 = 0.428$) (Table 3). The predictive equation was as follows:

The predictive equation in raw scores:

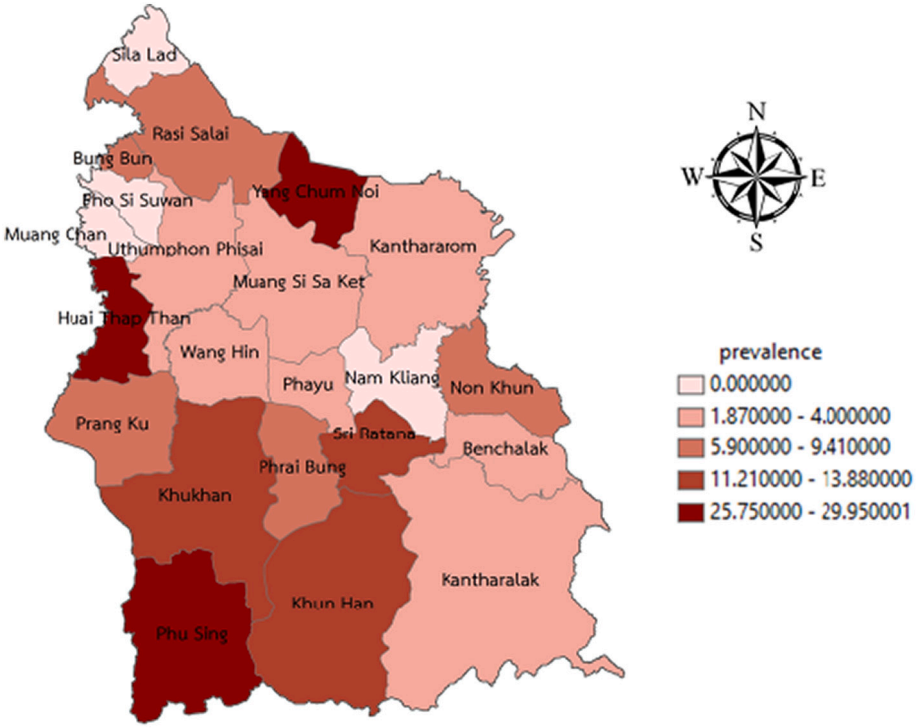

Fig. 2. Incidence of leptospirosis in Si Sa Ket, 2020. (per 100,000 population).

$Y = 17.463$ (Constant) $+ 6.236\ (X_1) + 0.333\ (X_2) + 0.269\ (X_3) + 3.853\ (X_4) + 0.139\ (X_5) + 0.109\ (X_6) + 0.405(X_7)$

The predictive equation in standard scores:

$Z_Y = 0.312\ (ZX_1) + 0.240\ (ZX_2) + 0.238\ (ZX_3) + 0.158\ (ZX_4) + 0.114\ (ZX_5) + 0.094\ (ZX_6) + 0.088(ZX_7)$

4. Discussion

Si Sa Ket is known to experience outbreaks of leptospirosis throughout the year, especially during the rainy season, with the disease affecting some of the population, resulting in significant morbidity and mortality. This study demonstrated that preventive behavior against leptospirosis was at a moderate level. This is consistent with previous studies [16,17]. The high-risk behaviors in this study of the respondents were not wearing gloves and boots while working in the cattle, or pig stall and wading in flood waters, mud or wet soil with bare feet. Most respondents were agricultural workers, who were had risky behavior related to activities or occupations requiring them to contact or soak in natural water sources, canals, swamps, creeks, often wading in flood waters for a long time with bare feet. Most respondents did not wear gloves, boots or personal protective equipment while working in the field, the farm, and the garden. From the preliminary investigation reports and in-depth interviews, these behaviors are also risky behavior and not still resolved at this point of time. This is consistent with a previous study was reported that the habit of taking a bath or washing the clothes in the river, not using personal protection during work were associated the risk of leptospirosis [18]. Bathing in natural bodies of water was significantly associated with an increased risk of severe leptospirosis [19]. A study from Kelantan, Malaysia reported that high risk occupations mostly those of agricultural workers was associated with leptospirosis [20]. Similarly a study from Kandy district, Sri Lanka found that almost all local people worked barefoot in their rice paddies and in other fields wearing rubber slippers or barefoot, and most local home gardeners, rice and other crop cultivators, dairy farmers and construction workers worked bare-handed constituting common local risk factors for leptospirosis [21]. Workers should protect themselves from infection by wearing boots and gloves while trampling in mud or wet soil or wading in flood waters, canals, swamps, and creeks for a long time, but this is sometimes inconvenient [22,23].

The multiple regression analysis indicated that history of leptospirosis illness, household members with a history of leptospirosis illness, social support, knowledge, perceived probability, perceived severity, and self-efficacy expectations were statistically significant factors affecting preventive behavior against leptospirosis (p-value <0.05) and could predict preventive behavior against leptospirosis. This will now be discussed.

History of leptospirosis illness was a significant association with preventive behavior against leptospirosis. This might be for the reason that the respondents had received the knowledge regarding risky behavior, prevention and control of leptospirosis from a public health officer, and with a history of leptospirosis illness. Thus, the respondents had perceived and awareness regarding danger of disease. This consistent with a concept of Rogers (1986) [10], and similar to a previous study, that who get the knowledge and understand, that result a correct and appropriate behavior [24].

Social support for leptospirosis was a significant association with the preventive behavior against leptospirosis. This is consistent with the concept that social support is the interaction between one person and another, comprising love, concern, trust, objects, and information, which results in mutually good feelings for each other. It involves respect and assistance for each other [11,25]. This then resulted in the recipient, acting in the way that the giver wanted. The supporter that may be a family member such as parent, husband, wife, or co-worker, fellow students, health volunteer, and public health officer [26], resulting in support recipients to practice or behave in a way that the supporter wants such as having good preventive behavior of the disease. This affirms previous studies finding that motivation and community participation were associated with leptospirosis prevention behaviors [24], receiving advice from village health volunteers, health officers, and others in the community were associated with preventive behavior against leptospirosis [27]. These results were different from a study of Naksila (2014) who found that individual stimulation was not associated

Table 1
Characteristics of the study population. (n = 350).

Characteristics	Number	%
Gender		
Male	187	53.4
Female	163	46.6
Age (years) (Mean = 46.99, SD = 10.28)		
26–35	56	16.0
36–45	97	27.7
46–55	109	31.2
56–65	88	25.1
Marital status		
Single/ Divorced/widowed	94	37.8
Married	256	62.2
Educational levels		
Junior high school and lower	243	69.4
High school and above	107	30.6
Occupation		
Agricultural	266	76.0
Other	84	24.0
Household income per year (Median = 60,000, max = 800,000, min = 10,000)		
≤75,000 Baht	213	60.9
>75,000 Baht	137	39.1
History of leptospirosis illness		
Never	294	84.0
Ever	56	16.0
Household members with a history of leptospirosis illness		
Never	315	90.0
Ever	35	10.0
Community members with a history of leptospirosis illness		
Never	220	62.9
Ever	130	37.1
Receiving information regarding leptospirosis		
No	30	8.6
Yes	320	91.4
The residential area experiencing waterlogging, or wet soil or mud		
No	192	54.9
Yes	158	45.1
The residential area having a cattle or pig stall		
No	181	51.7
Yes	169	48.3
The residential area having rodents infestation		
No	245	70.0
Yes	105	30.0
The residential area having garbage disposal facilities		
No	66	18.9
Yes	284	81.1

with preventive behavior against leptospirosis [22].

Perceived probability of leptospirosis was a significant association with the preventive behavior against leptospirosis. This was consistent with a previous study showing that factors related to preventive behaviors against leptospirosis among family healthcare core leaders who perceived that perceived probability of leptospirosis was associated with the preventive behavior against leptospirosis [27]. There were differences from a study of Naksila (2014) and Chaengchat (2016) who found that perceived probability of leptospirosis was not associated with the preventive behavior against leptospirosis [22,28], and a study of Wongbutdee et al. (2016) found that perceptions of leptospirosis were not associated with preventive behavior against leptospirosis [29].

Household members with a history of leptospirosis illness was a significant association with the preventive behavior against leptospirosis. This is because people received knowledge regarding preventive behaviors and control of leptospirosis from health officers when household member was sick with leptospirosis. Thus, they had a perception and awareness regarding leptospirosis, that resulted in a good preventive behavior against leptospirosis. This is consistent with a

Table 2
Mean and standard deviation of preventive behavior against leptospirosis. (n = 350).

Preventive behavior against leptospirosis	M	SD	Behavior level
1. You are wading in flood waters, trampling in mud or wet soil with barefoot.*	3.10	0.94	Moderate
2. If you are having a cuts or scratches on your body, you often trampling in mud or wet soil or you bathe or soaking in water sources, canals, swamps and creeks.*	3.33	1.14	Moderate
3. If you have a fever, muscle pain, you often to buy a drug for treatment yourself. *	3.68	1.09	High
4. You wash your hands with clean water and soap after contact with rodents and dead bodies of animals such as rodents, cattle, pigs, dogs.	3.69	1.26	High
5. You keep food completely away from rodents.	3.25	1.16	Moderate
6. You eliminate food scraps.	3.24	1.12	Moderate
7. You eat half-cooked meat or entrails of animals.*	3.42	1.30	Moderate
8. You are wearing boots while trampling in mud, wet soil or soaking in water sources, canals, swamps, and creeks.	3.40	1.46	Moderate
9. You are wearing boots while working in the cattle or pig stall.	2.94	0.81	Moderate
10. You are not wearing gloves while in contact with rodents, dead bodies of animals such as rodents, cattle, pigs, dogs.*	3.51	1.35	Moderate
11. You are not wearing gloves while working in the cattle, or pig stall.*	2.80	1.21	Moderate
12. You bathe with clean water and soap immediately after trampling in mud, wet soil, or soaking in water sources, canals, swamps, and creeks.	3.18	1.46	Moderate
13. Your household has garbage disposal facilities.	3.22	1.13	Moderate
14. You maintain surveillance and eliminate rodents in and around the house area.	3.24	1.07	Moderate
15. You did not participate in the village cleaning campaign to control and prevention of leptospirosis.*	3.38	1.16	Moderate

Remarks: the questions are negatively contrasted.

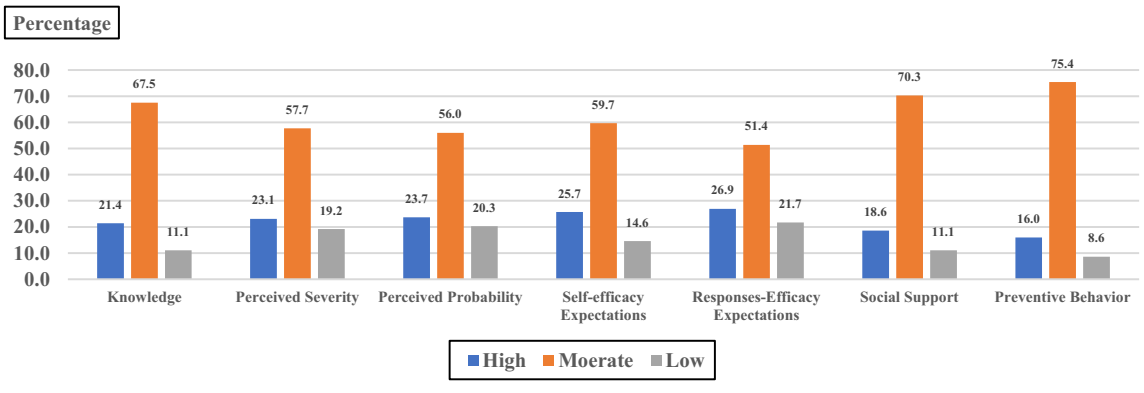

Fig. 3. Level of determinants regarding leptospirosis.

Table 3
Factors affecting preventive behavior against leptospirosis. (n = 350).

Predictive determinants	R	Adjusted R^2	b	SE (b)	Beta	t	p-value
History of leptospirosis illness	0.408	0.164	6.236	0.910	0.312	6.853	0.000***
Social support	0.553	0.301	0.333	0.062	0.240	5.369	0.000***
Perceived probability	0.623	0.383	0.269	0.050	0.238	5.358	0.000***
Household members with a history of leptospirosis illness	0.640	0.402	3.853	1.114	0.158	3.458	0.001**
Perceived severity	0.652	0.417	0.139	0.051	0.114	2.710	0.007**
Self-efficacy expectations	0.658	0.422	0.109	0.051	0.094	2.138	0.033*
Knowledge	0.663	0.428	0.405	0.198	0.088	2.049	0.041*
Constant			17.463	2.820		6.193	0.000***

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

study of Sangwali et al. (2015) was found that a household members with a history of leptospirosis illness was associated with preventive behaviors against leptospirosis [16].

Perceived severity of leptospirosis was a significant association with the preventive behavior against leptospirosis. This perceived severity of disease will lead to changes in attitudes and behaviors. This is consistent with studies of Naksila (2014) and Jinda & Tansakul (2014) reporting that the perceived severity of leptospirosis was associated with the preventive behavior against leptospirosis [22,27]. This is different to the study of Chaengchat (2016) who reported that the perceived severity of leptospirosis was not associated with the preventive behavior against leptospirosis [28].

Self-efficacy expectations of leptospirosis was a significant association with the preventive behavior against leptospirosis. This is consistent with a concept of Wallston & Wallston (1978) that "self-believers are highly self-learning, that results in appropriate health behavior" [30].

Knowledge regarding leptospirosis was a significant association with the preventive behavior against leptospirosis. This is consistent with studies from Thailand [16,24,31], a study from Philippines [32], and a study from Santa Fe, Argentina [33] reporting that knowledge regarding leptospirosis was associated with the preventive behavior against leptospirosis. This affirms a study from Brazil reporting that illiteracy was associated with leptospirosis [34]. A study from South Gujarat region, India reporting that illiteracy increased risk of leptospirosis 1.82 fold [23]. This is a different from Chaengchat (2016) who found that knowledge regarding leptospirosis was not associated with the preventive behavior against leptospirosis [28].

5. Limitations

The respondents may have provided socially desirable responses, especially due to the high perceived and preventive behaviors against leptospirosis. Notwithstanding these limitations, this study is believed the survey conducted among the population at risk, hence, the findings can be used to directly inform the health agency and provide a baseline for evaluating leptospirosis prevention and control in Si Sa Ket province.

6. Conclusions

This study has demonstrated that the levels of knowledge and practices on leptospirosis among the population at risk are still low. Thus, there is an urgent need for the relevant authorities or stakeholders to develop more practicable health education programs or interventions for this group. There is still a gap in knowledge regarding leptospirosis, especially with the perceiving, awareness, and preventive behavior against leptospirosis which were poor, especially regarding the use of PPE. These findings could also provide an insight for health agencies to strengthen their communication, planning for prevention and control of leptospirosis. Health professionals should be encouraged to provide knowledge and develop good action plans or preventive behavior interventions of leptospirosis, particularly in leptospirosis prone areas.

Author contributions

TT, PT and CN had an important role in initiating and designing the study. TT collected and analyzed the data. TT and CN drafted the first version of the manuscript. All authors revised the manuscript critically and contributed to the final version.

Funding

This study is partial fulfillment of requirements for Doctor of Philosophy (Health Sciences) and was supported by the Faculty of Medicine, Mahasarakham University, Thailand.

Author statement

Thank you for giving us the opportunity to submit a revised draft of the manuscript number: ONEHLT-D-21-00460 "Factors Affecting Preventive Behavior against Leptospirosis Among the Population at Risk in Si Sa Ket, Thailand" for publication in the Journal of One Health. We appreciate the time and effort that you and the reviewers dedicated to providing feedback on our manuscript and are grateful for the insightful comments on and valuable improvements to our paper. We have incorporated most of the suggestions made by the reviewers. Those changes are highlighted within the manuscript. Please see below, for a point-by-point response to the reviewers' comments and concerns. All page numbers refer to the revised manuscript file with tracked changes.

Declarations

One Health requires that all authors sign a declaration of conflicting interests. If you have nothing to declare in any of these categories then this should be stated.

Please state any sources of funding for your research
Faculty of Medicine, Mahasarakham University, Thailand.

Declaration of Competing Interest

The authors have no conflicts of interests to declare.

Acknowledgements

The authors would like to thanks the grants from Faculty of Medicine, Mahasarakham University, Tropical and Parasitic Diseases Research Unit, Ph.D in Health Sciences Program, the staff of General Communicable Disease Control Division, Sisaket Provincial Public Health Office, the staff of District-Public Health Office, the staff of Sub-district Health Promotion Hospital in Phu Sing, Khukhan, Prang Ku, Khun Han, and Phrai Bueng district, Si Sa Ket Province, Thailand for supporting and coordinating to collect the data in the study. We also would like to thank all who have helped in the research.

References

[1] Centers for Disease Control and Prevention, Leptospirosis, [Internet] [cited 2022 April 18]. Available from: https://www.cdc.gov/leptospirosis/infection/index.html, 2022.

[2] World Health Organization, A brief guide to emerging infectious diseases and zoonoses, [Internet] [cited 2022 April 18]. Available from: https://apps.who.int/iris/rest/bitstreams/909329/retrieve, 2022.

[3] World Health Organization, Human leptospirosis: guidance for diagnosis, surveillance and control, Malta. (2003) 1–122. https://apps.who.int/iris/handle/10665/42667 (Accessed 13 March 2020).

[4] Department of Disease Control, Ministry of Public Health, Epidemiology of leptospirosis from an annual report of the national disease surveillance system (in Thai), Retrieved from, http://doe.moph.go.th/surdata/disease.php?ds=43, 2020 [Accessed 13 March 2020].

[5] Sisaket Provincial Public Health Office, An annual performance report in 2019, Sisaket Provincial Health Office, 2020.

[6] Department of Disease Control, Ministry of Public Health, Prevention Research Program, Control Disease and Health Hazards 2019–2021, Innovation and Research Division, Department of Disease Control, Ministry of Public Health, 2019.

[7] Sisaket Provincial Statistical Office, Sisaket Province Population Data Report in 2019, Sisaket Provincial Statistical Office, 2020.

[8] Ministry of Interior, Annual Demographic Report in 2019, Office of Registration Administration, Ministry of Interior, 2020.

[9] A. Jirawatkul, Measuring consistency with kappa statistics, J. Public Health 18 (5) (2009) 641–642.

[10] R.W. Rogers, Protection motivation theory, Health Educ. Res. Theory Pract. 1 (3) (1986) 153–161.

[11] J.S. House, Work Stress and Social Support, Addison-Wesley, Reading, MA, 1981.

[12] M.R. Lynn, Determination and quantification of content validity, Nurs. Res. 35 (1986) 382–385.

[13] L.J. Cronbach, Essential of Psychological Testing, Harper and Row, New York, 1970.

[14] P. Suwan, Elements Affecting Behavior, Health Science, Sukhothai Thammathirat Open University, Teaching Documents for Medical Sociology Unit 1-7, Arun Printing, 2007, p. 182.

[15] B.S. Bloom, Handbook on Formative and Summative Evaluation of Study of Learning, David Mackay, New York, 1971.

[16] W. Sangwali, N. Huthaisong, S. Pratumwapi, J. Kuchaphun, W. Kamphaengsri, S. Inthachak, Knowledge and prevention behaviors to the leptospirosis of the people in repetitious flood areas in Warinchamrab District, Ubonratchathani Province, in: The meeting academic and national research papers “create and develop to advance into the community ASEAN” 2nd of the year 2015, Nakhon Ratchasima College, 2015, pp. 122–127.

[17] J. Jittimanee, J. Wongbutdee, Prevention and control of leptospirosis in people and surveillance of the pathogenic Leptospira in rats and in surface water found at villages, J. Infect. Public Health. 12 (5) (2019) 705–711, https://doi.org/10.1016/j.jiph.2019.03.019.

[18] S. Sulistyawati, R. Pradana, S. Sugathan, Human and environmental risk factors of leptospirosis in Gunungkidul, Indonesia: a case-control study, Int. J. Commun. Med. Public Health. 7 (8) (2020) 2967–2971, https://doi.org/10.18203/2394-6040.ijcmph20203371.

[19] S. Hinjoy, S. Kongyu, P. Doung-Ngern, G. Doungchawee, S.D. Colombe, Tsukayama, environmental and behavioral risk factors for severe leptospirosis in Thailand, Trop. Med. Infect. Dis. 4 (2) (2019) 79, https://doi.org/10.3390/tropicalmed4020079.

[20] A.Z. Azimullah, B.D. Aziah, M.N. Fauziah, The rise of leptospirosis in Kelantan 2014: characteristics, geographical pattern and associated factors, Int. J. Public Health Clin. Sci. 3 (2) (2016) 52–62, e-SSN: 2289-7577, http://publichealthmy.org/ejournal/ojs2/index.php/ijphcs/article/view/309.

[21] N. Ehelepola, K. Ariyaratne, W.P. Dissanayake, The correlation between local weather and leptospirosis incidence in Kandy district, Sri Lanka from 2006 to 2015, Glob. Health Action 12 (1) (2019) 1553283, https://doi.org/10.1080/16549716.2018.1553283.

[22] W. Naksila, Factors Related to Preventive behavior against leptospirosis of the Farmers in Chainat Province, Master of Nursing Science Thesis, Burapha University, 2014.

[23] K.T. Desai, F. Patel, P.B. Patel, S. Nayak, N.B. Patel, R.K. Bansal, A case-control study of epidemiological factors associated with leptospirosis in South Gujarat region, J. Postgrad. Med. 62 (4) (2016) 223–227, https://doi.org/10.4103/0022-3859. 188551.

[24] T. Kamsopa, A Model of Leptospirosis Disease Prevention and Control for Risk People in Sisaket Province, Doctor of Philosophy Thesis, Rajabhat Maha Sarakham University, 2014.

[25] R.L. Kahn, Aging and social support, in: M.W. Riley (Ed.), Aging from Birth to Death: Interdisciplinary Perspectives, Westview Press, Boulder, 1979, pp. 77–91.

[26] A. Abbey, D.J. Abramis, R.D. Caplan, Effects of different sources of social support and social conflict on emotional well-being, Basic Appl. Soc. Psychol. 6 (2) (1985) 111–129, https://doi.org/10.1207/s15324834basp0602_2. Submitted for publication.

[27] S. Jinda, C. Tansakul, Factors related to leptospirosis preventive behaviors among family healthcare core leaders in Keb-Nga sub-district, Meuangchan District, Sisaket Province, Chalermkanchana Acad. J. 2 (1) (2014) 25–37.

[28] W. Chaengchat, Factors Related to Leptospirosis Preventive Behaviors of People in Nam Phut Sub-District, Muang District, Trang Province, Sirindhorn College of Public Health, Trang Province, 2016.

[29] J. Wongbutdee, W. Saengnill, J. Jittimanee, S. Daendee, Perceptions and risky behaviors associated with leptospirosis in an endemic area in a village of Ubon Ratchathani Province, Thailand, Afric. Health Sci. 16 (1) (2016) 170–176. https://www.ajol.info//index.php/ahs/article/view/135194.

[30] B.S. Wallston, K.A. Wallston, Locus of control and health: a review of the literature, Health Educ. Monogr. Spring. 6 (2) (1978) 107–117, https://doi.org/10.1177/109019817800600102.

[31] W. Rukwicha, Behaviors Related to Prevention and Control of Leptospirosis in Si Bun Rueang District, Nong Bua Lam Phu Province, Thailand, Master of Science an Independent Study Report in Community Medicine, Faculty of Medicine, Khon Kaen University, 2014.

[32] J. Arbiol, P.M. Orencio, N. Romena, H. Nomura, Y. Takahashi, M. Yabe, Knowledge, attitude and practices towards leptospirosis among lakeshore communities of Calamba and Los Baños, Laguna, Philippines, Agriculture. 6 (2) (2016) 18–29, https://doi.org/10.3390/agriculture6020018.

[33] T. Ricardo, L.C. Bergero, E.P. Bulgarella, M.A. Previtali, Knowledge, attitudes and practices (KAP) regarding leptospirosis among residents of riverside settlements of Santa Fe, Argentina, PLoS Negl. Trop. Dis. 12 (5) (2018), e0006470, https://doi.org/10.1371/journal.pntd.0006470.

[34] J.E. Hagan, P. Moraga, F. Costa, N. Capian, G.S. Ribeiro, E.A. Wunder, Spatiotemporal determinants of urban leptospirosis transmission: four-year prospective cohort study of slum residents in Brazil, PLoS Negl. Trop. Dis. 10 (1) (2016), e0004275, https://doi.org/10.1371/journal.pntd.0004275.