

# Do Occupational Factors Render Army Service a High-Leptospirosis-Risk Occupation?

Siti Sara Y.<sup>1</sup>, Aziah B. D.<sup>2\*</sup> , Azwany Y. N.<sup>2</sup>, Mohd Nazri S.<sup>2</sup>, Zahiruddin W. M.<sup>2</sup>, Nabilah A.<sup>3</sup>, Siti Asma' H.<sup>3</sup>, Zaliha I.<sup>4</sup>, Fairuz A.<sup>5</sup>

<sup>1</sup>Public Health Division, Selangor State Health Department, Ministry of Health, Selangor, Malaysia

<sup>2</sup>Department of Community Medicine, School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia

<sup>3</sup>Department of Medical Microbiology & Parasitology, School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia

<sup>4</sup>Population Health & Preventive Medicine Discipline, Faculty of Medicine, Universiti Teknologi MARA, Selangor, Malaysia

<sup>5</sup>Institute for Medical Research (IMR), Kuala Lumpur, Malaysia

Email: \*aziahkb@usm.my

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## Abstract

**Objective:** Leptospirosis is a known zoonotic disease which is closely related to certain high-risk occupational group. This study aimed to identify the risk factors associated with seropositive leptospirosis among army personnel. **Methodology:** A cross sectional study was conducted involving 616 army personnel using a self-administered questionnaire. The questionnaire consisted of sociodemographic, occupational and environmental data as well as recreational activities history. Serum sample for leptospirosis was taken for screening with IgM Enzyme-linked Immunosorbent Assay (IgM ELISA) test. Positive tests were confirmed by Microscopic Agglutination Test (MAT). **Results:** All respondents were male, Malays and married with the mean age of 29.28 (7.15) years old. The mean duration of working was 11.50 (7.75). Majority of the respondents were non-officer and riflemen, smokers (455 (73.9%), stayed inside the camp and engaged in recreational activities. The mean duration of employment was 11.50 (7.75) years. The overall seroprevalence of leptospirosis was 16.2% (95% CI: 13.32, 19.15) and the predominant pathogenic serovar identified was Terengganu (38.2%). Those who had lower educational levels were more protective for positive leptospirosis compared to those who have only primary education (OR: 0.32; 95% CI: 0.14, 0.76;  $p = 0.009$ ). **Conclusion:** Despite being named as one of the high-risk occupations for leptospirosis, this study found no significant occupational factors related to leptospirosis seropositivity among army personnel.

## Keywords

Army, Leptospirosis, Seroprevalence, Igm Enzyme-Linked Immunosorbent Assay (ELISA), Microscopic Agglutination Test (MAT)

## 1. Introduction

Leptospirosis is an infectious disease caused by infection of the bacteria belongs to *genus leptospira* that affects human as well as other mammals, birds, amphibians and reptiles. It is known as zoonotic diseases, which can be transmitted directly or indirectly from animal to human [1] [2]. Humans are usually the incidental hosts [3] [4].

Leptospirosis occurs worldwide but it is usually seen in tropical and subtropical areas with high rainfall. A review on the worldwide incidence trends of leptospirosis had listed Malaysia as a country without any available data but probably endemic with leptospirosis [5]. However, based on laboratory surveillance data from the Malaysia Institute for Medical Research (IMR), the estimated incidence has gradually increased from 0.9, 1.18 and 2.13 per 100,000 population in 2003, 2004 and 2005 respectively. Another hospital-based study in Northeastern part of Malaysia revealed that the prevalence of leptospirosis among febrile hospital admissions was 8.4% [6].

El Jalii and Bahaman in 2004 stated that the risk to leptospiral infection was demonstrated with respect to occupation, location, sex, race and age group [7]. Various studies around the world found that many factors associated with seroprevalence of leptospirosis, which include socio-cultural, occupational, behavioural and environmental factors [8]. The determinants for the transmission of *Leptospira* infection include the presence of carrier animals, suitability of the environment for the survival of leptospirae and interaction between man, animals and environment [5] [9]. Leptospirosis is an occupational hazard for many people who work outdoors or with animals, examples farmers, sewage workers, veterinarians, fish workers, dairy farmers, or military personnel [5] [7] [10] [11].

Army is identified as one of the high-risk occupations in leptospirosis infection [12] [13] [14]. Army personnel were regarded as at-risk population for leptospirosis because of their operation and military exercise activities that bring them into contact with zoonotic reservoirs [15] [16] [17]. Few studies around the world also found the risk of infections existed at the training site [14] [18]. Tan and Lopes (1972) reported the seroprevalence of leptospirosis among the military personnel at that point of time was 17.2% [19]. A study done a few years later revealed that the seroprevalence of leptospirosis among healthy army personnel was 12% to 22% [20]. Thus, this study was aimed to identify the possible risk factors which associated with seropositive leptospirosis among army personnel in Northeastern Malaysia.

## 2. Materials and Method

### 2.1. Study Area and Design

A cross sectional study was conducted in four camps in Northeastern Malaysia.

### 2.2. Sample Size and Selection of Participants

Sample size was estimated using PS Software Version 3.0 [21], based on calcula-

tion for two samples proportion for each possible factor at 80% power and alpha 0.05. The sample size estimated for this study was 278 per group based on a study in Laos [22]. After considering 10% non-response rate, the required sample size was 612. Army personnel who had been working for more than six months and involved in the operation and military training were included in the study.

### 2.3. Data Collection

A validated self-administered questionnaire was distributed to respondents. The questionnaire consist of data on socio-demography (age, gender, race, marital status, smoking status), occupational factors (job category, position, duration of employment in years, frequency of operation or training that the respondent took part in a year, duration of latest operation or training, type of latrine used during latest operation or training, cuts or wounds during training or operation, washing hands with soap after work, shower immediately after work, contact with animals during working and sighting of rats at workplace) and environment factors (house ownership, type of house, main source water supply, type of toilet, distance from house to the river and paddy field, household animal ownership, neighbours' animal ownership, presence of rats in house, house area affected by flood, accumulated garbage near the house and garbage disposal). History of recreational activities that predispose the respondents to leptospirosis was also explored.

### 2.4. Serological Evaluation

Five mls of venous blood was taken from each subject for ELISA and microscopic agglutination test (MAT). MAT is a gold standard test for serological diagnosis of leptospirosis due to its high sensitivity and specificity compared to other currently available tests [23] [24].

MAT was performed according to the guideline by WHO [23] to determine the presence of anti-*Leptospira* antibodies with a panel of live leptospire after ELISA was performed. The Indeterminate and positive samples of ELISA test were sent to Institute for Medical Research (IMR). Agglutination was examined by dark field microscopy at a magnification of x100. MAT titre of  $1 \geq 100$  was considered as positive for the evidence of past exposure to leptospirosis [25].

### 2.5. Statistical Analysis

Simple and multiple logistic regressions were performed to determine the risk factors for leptospirosis among the respondents. Model of fitness was tested by Hosmer Lemeshow, classification table and receiver operator characteristics (ROC) curve [26]. Model is considered fit when there was high overall percentage in the classification table and area under the curve towards 1 in ROC curve. The adjusted odds ratio was estimated with 95% confidence interval. The level of significance was set at 5% (0.05 with two-tailed).

### 3. Results

All the eligible army personnel agreed to participate in this study giving the response rate of 100%. A total of 616 subjects were recruited into the study. There were 117 Positive and Indeterminate samples from ELISA and these samples were sent for further confirmation by MAT.

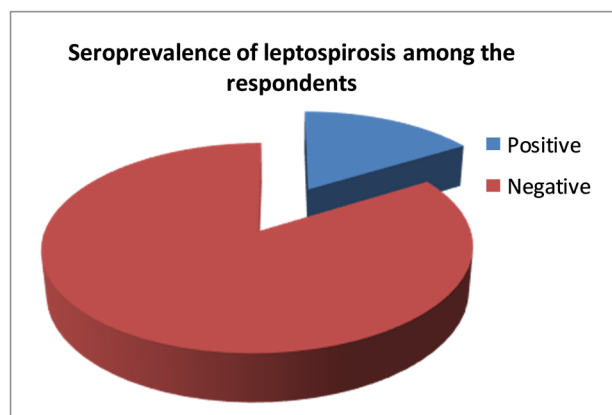
All respondents were male, Malays and married with the mean age of 29.28 (7.15) years old. Majority of the respondents were non officer and riflemen, smokers, stayed inside the camp and engaged in recreational activities. The mean duration of employment was 11.50 (7.75) years. The overall seroprevalence of leptospirosis was 16.2% (95% CI: 13.32, 19.15) (**Figure 1**). Education level of the respondents ( $p = 0.010$ ) and duration of latest operation ( $p = 0.024$ ) were found to be significantly associated with seropositive leptospirosis among army personnel at bivariate level (**Table 1**).

In multivariable analysis, multiple logistic regression analysis showed that only education level of the respondents (OR: 0.32; 95% CI: 0.14, 0.76;  $p = 0.009$ ) had a significant association with seropositivity (**Table 2**) where those who had lower educational level were more protected for positive leptospirosis compared to those who have only primary education.

### 4. Discussions

Leptospirosis is presumed to be the most widespread re-emerging zoonotic disease in the world. Seroprevalence of leptospirosis varies from one profession to the other [7] [10] [27] [28]. In addition, geographical distribution, weather and climate also influenced the seroprevalence of leptospirosis. Findings in this study documented a high prevalence of leptospiral antibody (16.2%) among army personnel.

Education level may influence the personal hygiene of an individual and awareness on diseases. Our study found that the education level was a significant factor for seropositive leptospirosis. The respondents who went to lower secondary school had protective effect against seropositive leptospirosis as compared to the respondents who went to primary school only. However, there was



**Figure 1.** Seroprevalence of leptospirosis among the respondents.

**Table 1.** Univariable analysis of possible risk factors for leptospirosis among 616 army personnel using simple logistic regression.

Variable	Seropositive n = 100	Seronegative n = 516	Crude OR <sup>a</sup>	95% CI <sup>b</sup>	p value <sup>c</sup>
	Freq. (%)	Freq. (%)			
<b>Age</b>	29.36 (6.83)	29.26 (7.22)			0.898
<b>Marital status</b>					
Single/Widower	38 (37.6)	226 (43.9)	1		
Married	63 (62.4)	289 (56.1)	0.75	(0.48, 1.16)	0.197
<b>Income (RM)</b>	1580.97 (964.07)	1506.52 (826.43)			0.423
<b>Level of education</b>					
Primary	11 (11.0)	29 (5.6)	1		
Lower secondary	17 (17.0)	138 (26.7)	0.33	(0.14, 0.77)	0.010
Upper secondary	69 (69.0)	331 (64.1)	0.55	(0.26, 1.15)	0.113
Tertiary	3 (3.0)	18 (3.5)	0.44	(0.11, 1.79)	0.251
<b>Job category</b>					
Riflemen	89 (89.0)	460 (89.1)	0.99	(0.50, 2.0)	0.965
Non riflemen	11 (10.9)	56 (10.9)	1		
<b>Position</b>					
Non officer	87 (87.0)	61 (11.8)	1		
Officer	13 (13.0)	455 (88.2)	1.12	(0.59, 2.12)	0.740
<b>Duration of working (years)</b>	10.65 (7.36)	11.67 (7.82)			0.229
<b>Smoking status</b>					
Smoker	85 (85.0)	432 (83.7)	1		
Never smoke	15 (15.0)	84 (16.3)	0.91	(0.50, 1.65)	0.750
<b>Frequency of operation/training (year)</b>			1.07	(0.85, 1.35)	0.577
<b>Duration of latest operation (days)</b>			0.99	(0.79, 0.99)	0.024
<b>Duration of latest training (days)</b>			1.00	(0.99, 1.01)	0.945
<b>Wound during operation (n = 80)</b>					
Upper limb	5 (41.7)	27(39.7)			
Lower limb	6 (50.0)	33 (48.5)			
Other parts of the body	1 (8.3)	8 (11.8)			
<b>Hand washing with soap after activity (yes)</b>	89 (89.0)	443 (85.9)	0.75	(0.38, 1.47)	0.403
<b>Shower after work (yes)</b>	97 (97.0)	489 (94.8)	0.56	(0.17, 1.88)	0.349
<b>Contact with animals during operation (yes)</b>	68 (13.2)	8 (8.0)	1.75	(0.81, 3.76)	0.154
<b>Sighting rats/rodents at work site (yes)</b>	58 (58.0)	289 (56.0)	0.92	(0.60, 1.42)	0.713
<b>House location</b>					
Outside camp	48 (48.0)	210 (40.7)	1		
Inside camp	52 (52.0)	306 (59.3)	0.74	(0.48, 1.14)	0.176

## Continued

<b>House ownership</b>					
Own	31 (31.0)	120 (23.3)	1		
Rent	22 (22.0)	101 (19.6)	0.84	(0.50, 1.55)	0.582
Quarters	47 (47.0)	295 (57.2)	0.62	(0.37, 1.02)	0.058
<b>Main water source</b>					
Treated water	81 (81.0)	401 (77.7)	1		
Open well	13 (13.0)	48 (9.3)	1.34	(0.70, 2.59)	0.382
Tube well	6 (6.0)	67 (13.0)	0.44	(0.19, 1.06)	0.066
<b>Distance of house to river (n = 258)</b>					
<100 meters	11 (22.9)	36 (17.1)	1		
100 to 200 meters	12 (25.0)	58 (27.6)	0.68	(0.27, 1.70)	0.405
>200 meters or no river nearby	25 (52.1)	116 (55.2)	0.71	(0.32, 1.57)	0.390
<b>Distance of house to paddy field (n = 258)</b>					
<100 meters	8 (16.7)	19 (9.0)	1		
100 to 200 meters	5 (10.8)	28 (13.3)	0.42	(0.12, 1.50)	0.182
>200 meters or no paddy field nearby	35 (72.9)	163 (77.6)	0.51	(0.21, 1.26)	0.144
<b>Animal ownership (n = 217)</b>					
High risk	38 (37.6)	161 (31.3)	1		
Low risk	2 (2.0)	15 (2.9)	0.82	(0.53, 1.28)	0.389
<b>Neighbours' animal ownership (n = 325)</b>					
High risk	50 (50.0)	234 (45.3)	1		
Low risk	8 (8.0)	34 (6.6)	1.10	(0.48, 2.52)	0.820
<b>Presence of rats in house (yes)</b>	51 (51.0)	223 (43.2)	0.73	(0.48, 1.12)	0.153
<b>House area affected by flood</b>	16 (16.0)	68 (13.2)	0.80	(0.44, 1.44)	0.453
<b>Accumulated garbage close by to the house (yes)</b>	24 (23.8)	133 (25.8)	1.10	(0.67, 1.81)	0.709
<b>Garbage disposal</b>					
Local authority	54 (54.0)	299 (57.9)	1		
Other	46 (46.0)	217 (42.1)	1.17	(0.76, 1.81)	0.466

**Table 2.** Risk factors for leptospirosis among 616 army personnel using multiple logistic regression.

Variables	B	Adj OR <sup>a</sup> (95% CI <sup>b</sup> )	Wald (df)	p value
<b>Education level</b>				
Primary		1		
Lower Secondary	-1.14	0.32 (0.14, 0.76)	6.75 (1)	0.009
Upper secondary	-0.63	0.52 (0.24, 1.09)	3.04 (1)	0.081
Tertiary	-0.90	0.41 (0.10, 1.67)	1.56 (1)	0.212

<sup>a</sup>OR = Odds Ratio, <sup>b</sup>CI = Confidence Interval, <sup>c</sup>df = degree of freedom.

no significant different when compared to higher educational level. This finding was consistent with the study done in Salvador, Brazil which reported a positive correlation between seroprevalence of leptospirosis and low education level [29].

Another study that shared a similar finding was in Jamaica. Lower education level was a significant risk factor for having leptospirosis among the butchers, in which almost half of the respondents only completed primary school [30]. The other study in Brazil also found that education was the protective effect against leptospirosis. The researchers suggested that the higher the education level, a better personal hygiene was practiced [31].

Leptospirosis was often regarded as occupational related disease [1] [17]. As shown by a case control study in Singapore, the researchers found that the study subjects (high risk occupation) had six times higher seroprevalence than the control subjects [32]. In epidemiological study done in Hawaii revealed that occupational exposures accounted for 44% of all cases, mostly related to farming, specifically, taro farming [33].

Our study did not find any significant occupational risk factor. In our routine army jungle operation, once the team leader identified based place, the team members will find for the safe drinking water source and proper place to rest. In addition to that, facilities such as proper drinking water (mineral waters) and proper latrine were provided for the team that stayed longer at the military field activities, hence the potential hazards were reduced. This precaution measures might be one of the factors that helps to reduce the risk of infection.

Contact with animals while working especially the reservoirs for leptospires might predispose the workers to leptospirosis as seen by study among seasonal strawberries harvesters in Germany [34] and also in Vietnam [35]. However, in our study, there was no significant association between history contact with animal and the respondents at work with the seropositivity of leptospirosis.

Leptospirosis is a disease of the environment; transmission depends on the interaction between the men and mammalian reservoir hosts [36]. Previous studies found that leptospirosis was associated with environmental factors especially household environmental factors [33] [37] [38] [39]. Studies had reported a significant environmental factors such as distances of house to the river and paddy field [40] [41] [42], living in agricultural areas or on clay soil [31] [43]. However, there were no significant environmental factors found to be associated with seropositivity of leptospirosis among the respondents in our study.

Our study was limited to the fact that our army responders were all male which make us unable to investigate the different of gender related activities with seropositivity. In addition to that, information on personal, occupational, environmental and recreational histories was subjected to the current six months period and was based on self reporting which may lead to recall bias. Misclassification of persons as seronegative and seropositive might be a potential bias due to false negativity in the early course of disease [44].

## 5. Conclusions

Despite being named as one of the high-risk occupations for leptospirosis, this study found no significant occupational factors related to leptospirosis seropositivity among army personnel. This may indicate the importance of safety precaution to overcome the high-risk exposure in occupational activities.

By knowing the possible factors, leptospirosis can be prevented if appropriate control and preventive measures are taken especially for potentially modifiable risk factors. Therefore, it is important to identify the risk factors associated with seroprevalence of leptospirosis among army personnel. In addition to that, identification of the modifiable risk factors that present in the dynamics of the circulation of *Leptospira* among the high risk groups, may contribute to a better preventive and control program, as well as planning for good policies and interventions with the aim to control the emerging health problem.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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