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USE OF INSECTICIDE-TREATED NETS AMONG PIG OWNERS LIVING IN JAPANESE ENCEPHALITIS ENDEMIC AREAS OF NORTHERN MYANMAR

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ABSTRACT: Japanese encephalitis (JE) virus is the leading cause of vaccine-preventable encephalitis in Asia and the Western Pacific region. This study was carried out to explore the use of insecticide-treated nets (ITNs) to prevent JE among pig owners in the high endemic area of Kachin State, Myanmar. A total of 420 pig owners were interviewed by trained research assistants between March and May 2016. The majority of the respondents were farmers with low family income, living in poor housing conditions. Pig-raising by respondents was mainly categorized as closed-type (75%), those pigs were kept in sties close to the house at night. Analysis indicated that less than a quarter (21%) of family members slept under insecticide-treated nets at night. Households with five or fewer members, owning more than two ITNs were more likely to use them at night (AOR: 3.71; 95% CI: 2.07–6.62) (AOR: 5.47; 95% CI: 3.20–9.33). This study highlighted the capability to provide ITNs for all family members as a critical issue to prevent the JE virus. Initiation of strategies to expand interdisciplinary collaborations and communication in all aspects of health care for humans, animals and the environment should take place. Availability of vaccines must be reconsidered as they are important in prevention and control of JE.

Keywords: Insecticide-Treated Nets, Japanese Encephalitis, Pig Owner, Myanmar

1. INTRODUCTION

Japanese encephalitis (JE) is the most important cause of viral encephalitis in Asia and the Western Pacific [1,2]. JE virus is transmitted to humans through the bite of an infected mosquito, primarily the *Culex* species. Humans are incidental or dead-end hosts because they usually do not develop a level or duration of viremia sufficient to infect mosquitoes. *Culex tritaeniorhynchus*, the major mosquito vector, breeds by laying eggs in rice fields, and the pig is considered the most common amplifying host of the JE virus[3]. An estimated 67,900 JE cases typically occur annually, of which only 10% are reported to the World Health Organization [4]. Transmission mainly occurs in rural agricultural areas, often associated with rice cultivation and flood irrigation [2,3,5].

Myanmar has had one of the highest increases in irrigated rice areas over the past 15 years [1]. Data on JE incidence in Myanmar is limited, and it can be assumed that few cases are reported. According to available data, between 2007 and 2012 there were 74 JE cases in Myanmar, with the highest mortality and morbidity reported in 2012 [6]. There were 113 reported cases in 2015. A report on vaccine-preventable disease surveillance from 2006–2011 indicated that the number of reported cases fluctuated [7].

There is no specific treatment for JE, therefore, prevention and control are critically important [1,6]. The World Health Organization recommends having strong JE prevention and control activities, which include ITNs, personal protective equipment, and integrated vector management. Although JE vaccines are available and cost-effective in preventing the disease [8], Myanmar has limited resources and cannot make JE vaccination available through the public sector [9]. There is also no established surveillance system in place [8]. Therefore, insecticide-treated bed-nets (ITNs) are one of the most effective methods to prevent mosquito-borne zoonotic disease including JE [10–13] in this country. Previous research studies identified several factors related to the use of ITNs: these include socio-demographic factors, availability of bed nets, knowledge, and attitudes towards mosquito-borne diseases [14–17]. There is a lack of information on the use of ITNs and their influencing factor in preventing JE in Myanmar. This study aims to examine the use of ITNs and to identify factors associated with their use among pig owners in the endemic area of Myanmar.

2. METHODOLOGY

2.1 Study Design and Subjects

This cross-sectional descriptive study was conducted in Moemauk Township, Kachin State, Myanmar, which borders the People's Republic of China. In 2015, the total population was 62,914 within 1,068.95 square metres. It has lowland areas in the west and south with a warm temperate climate. The

majority of residents are poor and use agriculture as their main source of family income. There were Japanese encephalitis outbreaks in this area in 2013, 2015 and 2016. In a sample of 420 households (required for 5% precision) around 54% of community, residents reported sleeping under an ITN the previous night, with 95% confidence interval and assuming a 95% response rate. Simple random sampling was employed to identify pig owners in selected villages of three JE endemic areas. Pig owners responsible for feeding pigs in sampling areas were interviewed from March to May 2016. Interviewers introduced the topic, objectives, and type of questions. Oral informed consent was obtained prior to the interview. Household environmental observation was also conducted during each interview.

2.2 Research Instrument

A questionnaire was developed based on the literature and local context. It was first drafted in English, then translated into the local language, reviewed by a panel of experts and pretested in a village with comparable proximity and demographic distribution to the target sample. The observation was used to assess environmental factors related to a JE outbreak during data collection time. The questionnaire consisted of four topics: 1) respondents' characteristics; 2) knowledge regarding signs and symptoms of JE and attitude toward the use of ITNs; 3) animals raised and the environment surrounding the house; 4) use of ITNs by family members – whether they had slept under a net the previous night. Approximately 20 to 30 minutes were needed to survey each respondent.

2.3 Data Analysis

Descriptive statistics were employed to determine central distribution and frequency of the study variables. Bivariate and multivariate logistic regressions were conducted to identify the significance of the use of ITNs. Use of ITNs refers to whether all family members slept under an ITN on the night prior to being surveyed. A *P value <0.05* was considered statistically significant.

2.4 Ethical Considerations

The study was reviewed and approved by the committee for research ethics of the university (COA No.2016/123.2903). The research study collaborated with the Ministry of Health, Myanmar, and Department of Health. Personal data of respondents were coded and kept as confidential information.

3. RESULTS

Four hundred and twenty pig owners participated in this study. Over three-quarters of respondents (76.9%) were female. The median age was 38 years (QD 11). Most participants are Shan, Buddhist. Over half completed primary school and lower, and earn a low level of income. Most respondents (73.3%) were raising pigs for sale, and over half owned at least five pigs. Closed type (74.8%) was the most common type of pig farming, while half of the pig farms (51.2%) were located only 6 meters from the pig owner's house. For the closed type, pigs were kept in sites close to the house at night (Picture 1), while free-range, the pig would find the food itself (Picture 2). About one-quarter of respondents also owned cows or buffalos. According to environmental observations, rice fields and wild birds were commonly found in the study area (Table 1).

Table 1 Distribution of respondents by demographic characteristics, and environmental factors (n=420)

Respondents' characteristics and housing	n (%)
Sex: Female	328 (78.1)
Age in years *Median 40, QD.11, Min. 18, Max. 74*	
Ethnicity: Shan	315 (75.0)
Religion: Buddhism	304 (95.0)
Education: Primary school and below	214 (50.9)
Occupation: Farmer	318 (75.7)
Family income (Kyats per month)* *Median 100,000, QD. 45,000, Min 50,000, Max 500,000*	
Purpose of pig raising	
Selling	308 (73.3)
Consumption	98 (23.3)
Debt	14 (3.3)
Number of pigs: *Median 4, QD. 2.5, Min. 1, Max. 60*	
Type of pig farm	
Closed type	314 (74.8)
Free range	106 (25.2)
Other animals raised	
Own and feed ducks: Yes	11 (2.6)
Own and feed cows: Yes	114 (27.1)
Own and feed buffalo: Yes	101 (24.0)
Keep large animals under the house: Yes	6 (1.4)
Environment surrounding household (within 5 km)	
Rice field: Yes	256 (61.0)
Wild birds: Yes	144 (43.3)
Vegetable field: Yes	80 (19.0)

*1 USD = 1,200 Kyats (As of 18 July 2016)

Fig.1 Closed type of pig farming

Fig. 2 Free range

The majority (88%) of the respondents owned ITNs and approximately one-fifth reported sleeping under the ITNs on the night prior to being surveyed. Nearly one-third (30.5%) had a poor level of knowledge regarding the signs and symptoms of JE (Table 2).

Table 2 Use of ITNs, level of knowledge and attitude of respondents

Use of ITNs, knowledge, and attitude	n (%)
Own ITNs	370 (88.1)
Use ITNs previous night	
Yes	88 (21.0)
No	332 (79.0)
Knowledge related to JE signs and symptoms	
Poor	128 (30.5)
Good	292 (69.5)
Attitude toward the use of ITNs	
Negative	122 (29.0)
Fair	130 (31.0)
Positive	168 (40.0)

Over half of the respondents were aware of JE transmission; they knew that its transmission is seasonal and that the pig is an amplifying host of JE. The majority knew that water pits on the ground, stagnant water in either vegetation or rice field are the breeding site. However, they had a lack of knowledge regarding the active time of JE –carrying mosquitoes (Table 3).

Table 3 Frequency and percentage distribution by Knowledge score about signs and symptoms, transmission, the common places for mosquitoes to lay eggs

Statements	Correct answers
Signs & symptoms	
Vomiting of coffee ground vomitus*	229 (54.5)
High fever	283 (67.4)
Seizures	250 (59.5)
A headache	329 (78.3)
Disorientation	269 (64.0)
Passing of black tarry stool*	251 (59.8)
Jaundice*	214 (51.0)
Transmission	
Seasonal transmission of JE	286 (68.1)
JE mosquitoes' active time	60 (14.3)
Amplifying host of JE	302 (71.9)
Commonplace for laying eggs	
Flower leaves*	122 (29.0)
Water pits on the ground	387 (92.1)
In abandoned tyres*	68 (16.2)
In the roof gutter*	142 (33.8)
Stagnant water in the vegetation fields	275 (65.5)
Stagnant water in the rice fields	256 (61.0)

* indicate the negative statement

Bivariate analysis indicated that the level of family income, family size, number of ITNs owned and presence of rice fields near the house were associated with the use of ITNs (Table 4).

Multiple logistic regression revealed that pig owners with low family income are twice as likely to use ITNs compared to those in high income (adjusted odds ratio 2.04, 95%CI: 1.13–3.70). Pig owners with less than five members of their family are nearly four times more likely to use ITNs (AOR 3.71, 95%CI: 2.07–6.62). In addition, respondents who own more than two nets are five times more likely to use ITNs compared to respondents who own only two nets or less(AOR 5.47, 95%CI: 3.20–9.33) (Table 5).

Table 4 Association between independent variables and use of ITNs

Independent variables	Use of ITNs Yes (%)	No (%)	OR(95%CI)
Sex			
Male	23.9	76.1	1.25(0.72–2.16)
Female	20.1	79.9	1
Age in years			
Under 31	15.7	84.3	1
31–45	23.9	76.1	1.69(0.90–3.15)
Over 45	22.3	77.7	1.54(0.83–2.85)
Ethnicity			
Shan	20.0	80.0	1
Kachin and others	23.8	76.2	1.25(0.74–2.12)
Religion			
Buddhism	20.1	79.9	1
Christianity	23.5	76.5	1.22(0.72–2.08)
Education level			
Primary school and below	24.3	75.7	1.50(0.94–2.44)
High school and higher	17.5	82.5	1
Occupation			
Farmer	20.3	79.7	1
Others	23.7	76.3	1.21(0.67–2.19)
Family income			
High (>100,000 Kyats)	14.5	85.5	1
Low (≤100,000 Kyats)	24.1	75.9	1.87(1.08–3.24)
Number of family member			
More than five	12.6	87.4	1
Five or less	27.3	72.7	2.59(1.54–4.38)
Knowledge level			
Poor(< median)	16.4	83.6	1
Good(≥ median)	22.9	77.1	1.51(0.88–2.60)
Attitude			
Negative	20.3	79.7	1
Positive	21.5	78.5	1.07(0.67-1.72)
Number of ITNs owned			
Two or less	12.7	87.3	1
More than two	36.8	63.2	4.01(2.45–6.54)
Own and feed cow			
No	20.6	79.4	1
Yes	21.9	78.1	1.08(0.64-1.82)
Own and feed buffalos			
No	21.3	78.7	1
Yes	19.8	80.2	0.91(0.52–1.59)

Table 4 Association between independent variables and use of ITNs (Cont.)

Independent variables	Use of ITNs Yes (%)	No (%)	OR(95%CI)
Rice field near the house			
No	15.2	84.8	1
Yes	24.6	75.4	1.81(1.08–3.02)
Wild bird near the house			
No	21.7	78.3	1
Yes	19.4	80.6	0.86(0.52–1.43)
Vegetable field near the house			
No	20.3	79.7	1
Yes	23.8	76.3	1.22(0.68–2.18)

Table 5 Multiple logistic regression analysis for predictive factors of use of ITNs among pig owners

Independent variables	Adjusted OR (95% CI)	*p-value*
Family income		
High	1	
Low	2.04 (1.13–3.70)	0.018
Number of family member		
More than five	1	
Five or less	3.71 (2.07–6.62)	<0.001
Knowledge level		
Poor	1	
Good	1.75 (0.97–3.17)	0.062
Number of ITNs owned		
Two or less	1	
More than two	5.47 (3.20–9.33)	<0.001

Hosmer and Lemeshow Test=8.527, p-value=0.384

4. DISCUSSION

In rural areas of Myanmar, the majority of residents work in agriculture as their main source of income. Approximately over half of the households in Moemauk township, Kachin state own at least one pig, while the median ownership is four pigs. This study identified the majority of subjects as farmers, with nearly three-quarters (74%) raising pigs as property that they could sell if financially constrained. In addition, pork is considered an essential luxury food for social and cultural activities, such as wedding ceremonies, religious and harvest festivals. The literature indicated that pigs play a central role in the transmission of both the Japanese encephalitis virus and cysticercosis [18]. Expansion of the JE virus-endemic area depends on irrigated rice farming and pig rearing [3]. A higher proportion of rice planting could, therefore, predict a higher risk of JE [19].

This study found that the majority of pigs (74.8%) are reared in open or unroofed pig pens, close to human dwellings, which hence governs the spread of the JE virus. Lindahl, J. (2012) indicated that closed pig pens were associated with the number of vectors to the human dwelling [20]. Furthermore, one-quarter of pigs were raised as free-range and allowed to freely scavenge food from garbage dumps, markets, rice fields, and paddy fields, which could lead to a higher likelihood of disease transmission. Most JE cases were found in rural areas, especially in rice-planting and pig-rearing areas. In Kachin state, a less-developed area of Myanmar, a greater proportion of the rural population was often short of funds for JE prevention and control, a finding similar to a study in China [21].

As indicated in the results, the respondents who had good knowledge were 1.7 times more likely to use ITNs. The package of knowledge related to the transmission, prevention and control of JE or vector-borne disease still needs to be disseminated in this area. This information should also address and focus on the active time of JE infected mosquitoes since the findings of this study show a low level of knowledge in this regard. In addition, integrated vector management should be encouraged to reduce the mosquitoes' breeding sites.

Those also have to address and focusing the active time of JE mosquitoes, since the findings show a low level of knowledge. In addition, the integration of the integrated vector management to reduce the mosquitoes' breeding sites should be promoted.

The systematic review and meta-analysis identified clear evidence that ITNs have the potential to reduce pathogen transmission and morbidity from a vector-borne disease where vectors enter a house [12]. However, the use of ITNs is related to many factors. A study of the use and maintenance of bed nets and related influencing factors in Kachin Special Region in 2015 revealed that residents consist of poor families, living under thatched roofing, with limited knowledge of how to prevent disease transmission [14]. The Ministry of Health, Myanmar began distributing ITNs to families in rural endemic areas to prevent vector-borne disease such as Malaria, dengue fever, JE, etc. [14]. Free distribution of ITNs resulted in a higher rate of ownership among the poor. As found in this study, though a high number own ITNs, only 21% use them regularly. The low use of ITNs might be due to the issue of inadequacy. Our study found that families consisting of less than five members are more likely to use ITNs (AOR 3.71, 95%CI 2.07–6.62). However, we found that low-income families are more likely to use ITNs compared to high-income families, similar to what a previous study found in eastern Myanmar [17]. This could be explained by the fact that poorer residents were more aware of their risk of being infected by JE due to their work. Most farmers in this area had to sleep on their farm during the harvesting period. They recognized that they could be infected either by JE or malaria at any time due to the unsafe environment.

Study limitations include the disparity in demographics. More females (78.1%) were interviewed than males, due to the fact that male heads are working on the farm, while females had the role of caring for children, feeding animals and doing household work. Another limitation is that residents in this area consist of different ethnic groups, thus the language barrier could introduce information bias.

5. CONCLUSION

In the union of Myanmar, especially in high JE endemic areas, an effective surveillance system should be established, along with the adequate provision of ITNs for all family members. Introduction of immunization coverage for the prevention and control of JE should be set as a high priority agenda, beginning in a rural setting. Moreover, mosquito-control efforts emphasizing improved knowledge related to prevention and control should continue, especially before the onset of the rainy season. Community awareness of these issues should be raised by the effective use of available resources that all community members can access, in different local languages. In addition, management of household environments could be further targeted to reduce the breeding sites of vectors close to households.

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