Knowledge and Practices Regarding *Aedes* Control Amongst Residents of Dengue Hotspot Areas in Selangor: A Cross-Sectional Study

(Pengetahuan dan Amalan Kawalan *Aedes* dalam Kalangan Penduduk Kawasan Khas Denggi di Selangor: Suatu Kajian Keratan Lintang)

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ABSTRACT

Dengue fever is endemic and remains a public health concern in Malaysia. The highest number of dengue cases occurred in Selangor in 2015. The majority of hotspot and outbreak areas in Malaysia were located in residential areas. Despite the high number of dengue prevalence in Malaysia, evidence for the level of community knowledge and practice of methods for Aedes *control and prevention in the country remains scant. This cross-sectional study aimed to assess the demographic factors associated with the knowledge and practice of Aedes control and prevention methods. It also aimed to assess the associations and relationships between the public knowledge and practice of* Aedes *control and preventive activities involving* Aedes *larvae ovitraps (ALOTs), Mousticide, Denguard and other methods. Two residential areas that were considered as dengue hotspots were selected for the introduction of* Aedes *control and prevention programs. A sample size was calculated using G*power and a total of 152 residents who attended the dengue awareness events held at Section 3 and Section 8, Bandar Baru Bangi, Selangor, were recruited. A purposive sampling approach was adopted, and data were collected by using a pretested questionnaire with three subsections on sociodemographic information and on the knowledge and practice of* Aedes *control and prevention methods. No statistically significant* (p>0.05) *relationship between demographic factors and knowledge and practice scores was found. The results of* χ^2 *square test showed a strong* (ϕ-coefficient = 0.605) *and significant* (p<0.001) *association between knowledge and practice scores. In addition, a strong and significant positive correlation* (r=0.648, p<0.001) *existed between knowledge and practice scores. In conclusion, health promotion programs that focus on educating the public regarding the use of Aedes larvae ovitraps (ALOTs), Mousticide, Denguard and other methods to prevent and control Aedes mosquitoes and that involve multiple stakeholders, such as government officials and responsible authorities, and the active participation of communities are crucial in the war against* Aedes.

Keywords: Aedes *larvae ovitraps (ALOTs); Denguard; knowledge; Mousticide; practices*

ABSTRAK

Demam denggi adalah penyakit endemik yang berterusan menjadi masalah kesihatan awam di Malaysia. Negeri Selangor mencatatkan jumlah kes tertinggi pada tahun 2015 dan kebanyakan kawasan wabak dan kawasan khas yang berlaku di Malaysia adalah di kawasan perumahan. Walaupun dengan prevalens kes denggi yang tinggi, namun begitu masih terdapat kekurangan maklumat berkenaan tahap pengetahuan dan amalan komuniti terhadap langkah pengawalan dan pencegahan nyamuk Aedes. *Kajian keratan rentas dijalankan bagi mengenal pasti faktor demografi yang mempengaruhi tahap pengetahuan dan amalan berkenaan langkah pengawalan dan pencegahan nyamuk* Aedes. *Kajian juga bertujuan mengenal pasti hubungan antara pengetahuan masyarakat dan amalan berkenaan langkah pengawalan dan pencegahan yang melibatkan* Aedes *larvae ovitraps (ALOTs), Mousticide, Denguard dan langkah-langkah yang lain. Dua kawasan perumahan berstatus kawasan khas telah dipilih dan diperkenalkan dengan program pengawalan dan pencegahan nyamuk* Aedes *menggunakan* Aedes *larvae ovitraps (ALOTs), Mousticide, Denguard dan langkah-langkah pengawalan dan pencegahan yang lain. Pengiraan sampel adalah menggunakan perisian G*power dan sebanyak 152 orang penduduk yang hadir semasa program kesedaran demam denggi di Seksyen 3 dan Seksyen 8, Bandar Baru Bangi, Selangor dipilih sebagai sampel. Kaedah pensampelan bertujuan digunakan dan data kajian dikumpul menggunakan borang soal selidik yang telah diuji yang mengandungi tiga bahagian iaitu bahagian sosio demografi, bahagian pengetahuan dan bahagian amalan bagi pengawalan dan pencegahan untuk pengumpulan data. Tiada faktor demografi yang signifikan* (p>0.05) *dalam mempengaruhi pengetahuan dan amalan. Ujian* χ^2 *kuasa dua menunjukkan hubungan signifikan* (p<0.001) *yang kuat* (ϕ-coefficient = 0.605) *antara skor bagi pengetahuan dan amalan. Terdapat signifikan korelasi positif yang kuat* (r = 0.648, p<0.001) *antara skor bagi pengetahuan dan amalan. Kesimpulannya, program promosi kesihatan yang melibatkan pelbagai pihak seperti badan kerajaan, pihak yang berwajib dan penglibatan aktif daripada masyarakat yang memfokuskan dalam mendidik masyarakat berkenaan penggunaan* Aedes *larvae ovitraps (ALOTs), Mousticide, Denguard dan langkah-langkah pengawalan dan pencegahan nyamuk* Aedes *adalah penting dalam memerangi nyamuk* Aedes.

Kata kunci: Aedes *larvae ovitraps (ALOTs); amalan; Denguard; pengetahuan; Mousticide*

INTRODUCTION

The *Aedes* spp. mosquito is responsible for transmitting four vector-borne viruses: dengue, chikungunya, yellow fever and Zika. *Aedes aegypti* were abundant in domestic area whereas *Aedes albopictus* usually prefer suburban areas (Gratz 2004; Rozita et al. 2013). Dengue fever is one of the fastest growing infectious diseases cases worldwide and has become a global public health problem in recent decades (Norli & Azmi 2008; Palanivel et al. 2012). The World Health Organization (WHO) estimates that 390 million cases of dengue occur each year and that as many as 2.5 billion people are at risk of this disease (Centres for Disease Control and Prevention (CDC) 2018; WHO 2018, 2016). Dengue is not only a public health concern, there is a major impact towards economic and social in those countries where large epidemics occur (Hidayatulfathi et al. 2017).

The number of dengue cases has gradually increased worldwide over the last decade. Dengue in Asia bore 70% of the burden of dengue cases and has been reported since 1770 (Mazrura et al. 2010). The Asian continent is characterised by large swathes of densely populated regions that are highly suitable for disease transmission (Samir et al. 2013). The Southeast Asian region accounts for 52% of the global burden of dengue fever (Palanivel et al. 2012). A large number of dengue outbreaks occurred worldwide in 2015. Relative to that in the previous year, in 2015, the number of dengue cases in the Philippines increased by more 64.8% to 200,415 cases and that in Malaysia increased by 16% to exceed 111,000 (WHO 2016) which it remains the highest reported mosquito borne disease in Malaysia (Aishah et al. 2018).

Since vaccine for dengue infection is still not available, control of vector population and prevention from mosquito bites are the main strategies in preventing dengue (Aishah et al. 2018; Hidayatulfathi et al. 2017). The cleanliness of unattended environments that are potential *Aedes* breeding grounds is one of the factors that contribute to the increase in the number of identified dengue cases in Malaysia. Examples of these environments include construction sites, abandoned apartment projects and playgrounds. *Aedes* prevention and control methods include the use of *Aedes* larvae ovitraps (ALOTs), Mousticide, and Denguard. Nevertheless, despite the magnitude of the problem of dengue, evidence for the knowledge and practice of *Aedes* prevention and control methods amongst the adult population in the worst-hit or hotspot areas remains undocumented.

Given this gap, our study aimed to assess the factors associated with the knowledge and practice of methods for the control and prevention of *Aedes* mosquitoes. It also aimed to assess the association between the knowledge and practice of methods for the control and prevention of *Aedes* mosquitoes amongst the population of Bandar Baru Bangi, a township that was worst hit by dengue outbreaks during the end of 2014. Members of the community were given home kits as preventive tools against *Aedes*. The home kits consisted of ALOTs, Mousticide and Denguard.

MATERIALS AND METHODS

STUDY DURATION AND LOCATION

A cross-sectional study survey was conducted in January 2016 at Bandar Baru Bangi, Selangor, Malaysia. The survey specifically focused on Section 8 (Bangi Prima) and Section 3 (Bangi Perdana). Section 8 has a total area of 28 ha and comprised 640 double-storey houses. Section 3 (Bangi Perdana) covers 18 ha and 600 double-storey houses. The distance between these two locations is approximately 3.13 km. These two locations have similar facilities, including playgrounds and commercial buildings, and were identified as dengue hotspots by the authorities (Idengue 2015). Bandar Baru Bangi has a tropical climate with a distinct monsoon season (April-October) and a dry season (November-March).

Temperatures in the area increased because of the El Niño phenomena that occurred at the end of 2015 and lasted until early 2016. A total of 11, 42 and 17 dengue cases were reported in Section 8 in 2014, 2015 and January-February 2016, respectively. A total of 98, 147 and 17 dengue cases were reported in Section 3 in 2014, 2015 and January-February 2016, respectively. The use of ALOT, Mousticide and Denguard was introduced to the members of the two communities 3 months prior to data collection.

SAMPLING PROCEDURE AND SURVEY

A purposive sampling method was used to select a sample of participants to represent the general community of Sections 8 and 3, Bandar Baru Bangi. Dengue awareness events were held at both localities separately. By using G*power software for sample size calculation, the details input parameters of 0.5 effect size f, 5% margin of error, power 0.8, 128 respondents were required to achieve minimum recommended sample size. The survey was conducted with 152 respondents (72 respondents from Section 3 and 80 respondents from Section 8).

A structured questionnaire on the knowledge and practice of activities for the control and prevention of *Aedes* mosquitoes was prepared. The questionnaire was printed in local language because it is the mother tongue of the respondents. The questionnaire was divided into three sections. The first section covered the sociodemographic information of the respondents. The second part consisted of 18 questions on the respondents' knowledge of *Aedes* control and prevention activities. The final section, which contained 13 questions, focused on the practice of *Aedes* control and prevention activities.

This study was approved by the Ethical Review Committee for Faculty of Health Sciences Department, National University of Malaysia (Ethical code number UKM PPI/111/8/JEP-2016-393).

DATA ANALYSIS

Data collected from the questionnaire were entered and subjected to nonparametric tests by using Statistical

Package for Social Sciences version 23.0. All of the questions were analysed and assessed individually by using a scoring system. Each correct answer was given a point. The total score for each section was calculated. Knowledge was assessed as 'sufficient' or 'insufficient' on the basis of an arbitrary cut-off point. Respondents who obtained median scores and above for knowledge were considered 'sufficient', whereas others were categorised as 'insufficient'. The same principle was applied for scoring the section on the use of preventive home kits.

RESULTS

SOCIODEMOGRAPHIC CHARACTERISTICS

A total of 152 individuals were involved in the study with the response rate of 100%. Table 1 shows the characteristics of the respondents. Approximately 75.0% of the respondents were males, and 38 respondents were females. The majority or 79.6% of the respondents were aged 41 years old or above. The elderly constituted the second largest group or 32.2% of the respondents, and only 5.2% of the total respondents were less than 30 years of age. Almost all of the respondents were married or married once, and only eight (5.3%) were single. All of the respondents were literate with a minimum secondary school background. Approximately 89.5% of the respondents owned houses in the study area. Nearly 30.0% of the participants had a history of dengue infection.

TABLE 1. Sociodemographic characteristics of the respondents ($n = 152$)

Sociodemographic	Frequency (n)	Percentage (%)
Gender		
Male	114	75.0
Female	38	25.0
Age		
18-20 years old	4	2.6
21-30 years old	4	2.6
31-40 years old	23	15.1
41-50 years old	72	47.4
51 years old and above	49	32.2
Marital status		
Single	8	5.3
Married	141	92.8
Widow/widower	3	2.0
Educational level		
Secondary	21	13.8
Diploma	34	22.4
Degree	78	51.3
Others	19	12.5
Home ownership		
Owner	136	89.5
Renter	16	10.5
History of dengue infection		
Infected	45	29.6
Never been infected	107	70.4

AWARENESS OF THE PURPOSE OF PREVENTIVE HOME KITS

Figure 1 shows that 85.5% of the respondents obtained information about the preventive home kits from a website. Telephone application represented the second most common source of information. Specifically, 79.6% of the respondents stated that they acquired information from this source. Seminars were the third most common source of information (77.6%). Approximately 73% and 65.8% of

the respondents obtained information from social media and friends, respectively. Only 47.4% claimed that they learned about preventive home kits from the event staff.

Figure 2 shows the three references used by the respondents for the operation of the preventive home kits. Almost 60% of the respondents used the manual to obtain guidance and information on the use of the preventive home kits. Less than 15% of the respondents opted to use a compact disc (14.5%) or a website (13.2%).
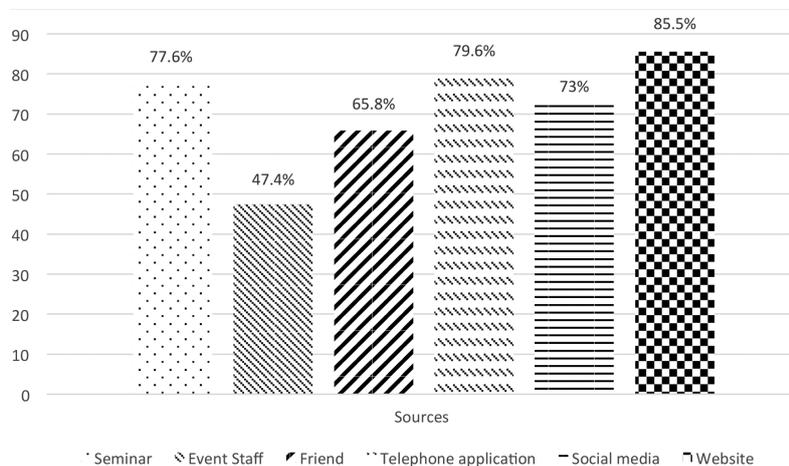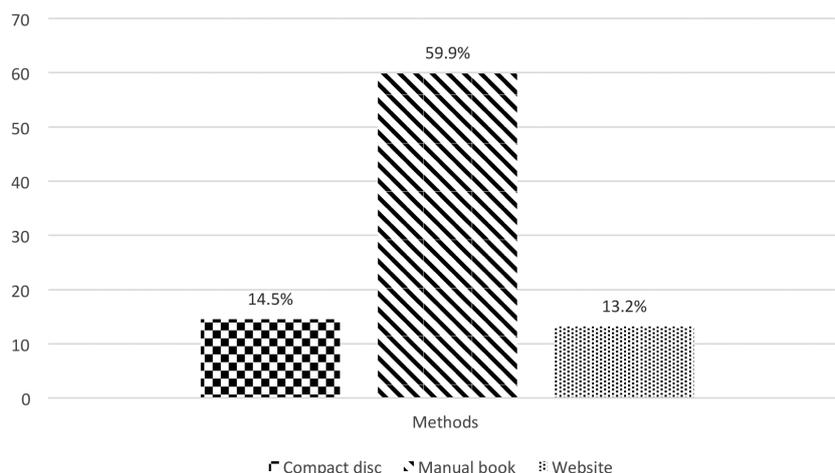

FIGURE 1. Sources of information

FIGURE 2. References used for the operation of the preventive home kit ($n = 152$)

KNOWLEDGE ON THE USE OF PREVENTIVE HOME KITS

The data presented in Table 2 illustrated the extent of the knowledge of the respondents regarding the functions and the operations of ALOTs, Mousticide and Denguard to control and prevent *Aedes* mosquitoes. A total of 67.8% of the respondents stated that their most advanced knowledge regarding the use of ALOTs was the frequency of replacing the water in the trap. Less than 60% of the respondents knew of other information regarding the use of ALOTs. Only 38.8% of the respondents understood the purpose of using ALOTs. Knowledge regarding the function of the preventive kits is the most basic and vital knowledge.

Approximately 48% of the respondents did not know that Mousticide functions as a larvicide, and 35.5% of the respondents knew that Mousticide also contains adult mosquitoes as an active ingredient. Only 19.7% of the respondents understood that Mousticide causes adult mosquitoes to starve and perforates larval intestines. Respondents were also queried about the characteristics of Mousticide. A total of 90% of the respondents knew of only two characteristics of Mousticide. Specifically, 95.4% of the respondents knew that the effects of Mousticide can last for a month, and 92.8% of the respondents knew that Mousticide is nontoxic towards humans. Another important but poorly known characteristic of Mousticide is that it can kill the larvae of other mosquito species (55.9%). A total of 46.7% and 44.1% of the respondents knew that Mousticide is biodegradable and is not dangerous to animals, respectively. Amongst the respondents, 105 understood that rice husk is the main component of Mousticide and that raw rice husk cannot act as a larvicide.

Table 2 presents the knowledge of the respondents regarding Denguard as a skin lotion that repels *Aedes* mosquitoes. Among the 152 respondents, 119 (78.3%) understood that the lotion must be applied to exposed skin and 57.2% knew that that the lotion can remain effective for 5 h. However, not more than a quarter (19.1%) of the respondents knew that Denguard functions to protect skin from *Aedes* mosquito bites.

PRACTICAL APPLICATION OF PREVENTIVE HOME KITS

Table 3 shows 13 statements regarding the use of ALOT, Mousticide, Denguard and other control and preventive measures. Approximately 110 (72.4%) of all respondents claimed that they used any type of larvicide. However, only 48.7% (74) of the respondents used Mousticide as a larvicide. Not more than 60% of the respondents used ALOTs correctly. Specifically, only 59.2% of the respondents filled the ALOT with water correctly and 58.6% placed the device in a shady area. Then, 54.6% of the respondents correctly added one packet of Mousticide to the ALOT. Approximately 53.3% of the respondents correctly serviced the ALOT every 4 weeks and stored the trap upside down in a dry place when not in use. A total of 63.8% of the respondents claimed they used any type of mosquito repellent lotion, such as Denguard.

However, less than 40% of the respondents correctly used Denguard. Approximately 39.5% applied Denguard on exposed skin areas whenever they went outdoors and the same percentage applied Denguard every time they were indoors. Among the respondents, 30.3% applied Denguard on the exposed skin areas of their family members every time they stayed indoors. Only 25.0% of respondents claimed to apply Denguard on mosquito bites on the exposed skin areas of their family members every time they went outdoors.

COMPARISONS OF KNOWLEDGE AND PRACTICE MEAN SCORES

The mean knowledge score of the respondents was 9.36 ± 4.66 out of a total score of 18. The mean practice score of the respondents for the use of ALOT, Mousticide, Denguard and other *Aedes* control and preventive activities was 6.55 ± 5.01 out of a total score of 13. The descriptive statistics of mean scores by gender, age, marital status, educational level, house ownership and dengue history are shown in Table 4. Males have higher mean scores (mean knowledge score: 9.48 ± 4.70; mean practice score: 6.60 ± 4.98) than females (mean knowledge score: 8.97 ± 4.61; mean practice score: 6.34 ± 5.16).

TABLE 2. Knowledge on ALOT, Mousticide and Denguard (*n* = 152)

Item	Frequency (n)	Percentage (%)
Knowledge on ALOTs		
ALOTs function in mosquito control and surveillance	59	38.8
Correct method to open ALOTs	77	50.7
Small perforations on the walls of the ALOT kit are used to mark water level	66	43.4
Correct rice husk quantity	83	54.6
Frequency of water change	103	67.8
Gravid female mosquitoes are attracted to oviposit on the black plastic cover	91	59.9
Knowledge on Mousticide		
Mousticide functions as a larvicide	79	52.0
One of the active ingredients of the Mousticide is derived from adult mosquitoes	54	35.5
Mousticide acts as larvicide by causing adult mosquitoes to starve and by perforating larval intestines	30	19.7
Characteristics of Mousticide:		
• Biodegradable	71	46.7
• Kills larvae from all mosquito species	85	55.9
• Nontoxic to humans	141	92.8
• Not dangerous to animals	67	44.1
• Can last for a month	145	95.4
Raw rice husk cannot kill mosquito larvae	105	69.1
Knowledge on Denguard skin lotion		
Protects skin from *Aedes* mosquito bites	29	19.1
Skin protective effects can last for 5 h	87	57.2
Must be applied to exposed skin	119	78.3

TABLE 3. Use of ALOT, Mousticide, Denguard and other *Aedes* control and prevention activities (*n* = 152)

Statement	Frequency, *n*	Percentage,%
I filled the ALOT container with water in accordance with the marked water level	90	59.2
I replaced the water in the ALOT every 4 weeks	81	53.3
I stored the ALOT upside down in a dry place when not in use	81	53.3
I covered the ALOT with a black plastic jacket	87	57.2
I placed the ALOT in a shady area	89	58.6
I added one packet of Mousticide to the ALOT	83	54.6
I placed Mousticide in potential mosquito breeding areas	74	48.7
I applied Denguard on skin areas that were exposed to mosquitoes every time I went outdoors	60	39.5
I applied Denguard on skin areas that were exposed to mosquitoes every time I stayed indoors	60	39.5
I applied Denguard on the skin areas of my family members that were exposed to mosquitoes every time they went outdoors.	38	25.0
I applied Denguard on the skin areas of my family members that were exposed to mosquitoes every time they stayed indoors	46	30.3
I used a larvicide	110	72.4
I used lotion to prevent mosquito bites	97	63.8

Young respondents aged 18-20 years old had high knowledge mean scores of 11.00 ± 0.82 but the lowest mean practice scores of 5.00 ± 5.23 amongst all age groups. Respondents aged 21-30 years old had the lowest knowledge mean scores of 8.50 ± 6.41. Respondents aged 31-40 years old had the highest practice scores of 6.74 ± 5.20. Widows and widowers had higher mean knowledge and practice scores than single and married respondents. Respondents who had received tertiary education showed a high mean knowledge score. The knowledge scores of respondents who had received diplomas and degrees were 8.91 ± 4.68 and 9.92 ± 4.74, respectively. The mean knowledge scores of respondents with other levels of education were 9.89 ± 4.04. The mean practice scores

TABLE 4. Descriptive statistics of the mean knowledge and practice scores
based on sociodemographic status

Score	Mean ± standard deviation	
	Knowledge	Practice
Gender		
Male (*n* = 114)	9.48 ± 4.70	6.60 ± 4.98
Female (*n* = 38)	8.97 ± 4.61	6.34 ± 5.16
Age		
18-20 years old (*n* = 4)	11.00 ± 0.82	5.00 ± 5.23
21-30 years old (*n* = 4)	8.50 ± 6.41	6.50 ± 6.95
31-40 years old (*n* = 23)	9.70 ± 5.00	6.74 ± 5.20
41-50 years old (*n* = 72)	9.47 ± 4.24	6.72 ± 4.96
51 years old and above (*n* = 49)	8.96 ± 5.22	6.36 ± 5.01
Marriage status		
Single (*n* = 8)	9.38 ± 3.93	6.25 ± 5.12
Married (*n* = 141)	9.30 ± 4.75	6.54 ± 5.02
Widow/widower (*n* = 3)	12.00 ± 1.00	8.00 ± 5.57
Educational level		
Secondary (*n* = 21)	7.48 ± 4.60	5.86 ± 5.03
Diploma (*n* = 34)	8.91 ± 4.68	6.29 ± 4.94
Degree (*n* = 78)	9.92 ± 4.74	6.79 ± 5.05
Others (*n* = 19)	9.89 ± 4.04	6.79 ± 5.24
House ownership		
Owner (*n* = 136)	9.52 ± 4.68	6.46 ± 4.92
Rent (*n* = 16)	8.00 ± 4.65	7.31 ± 5.79
History of dengue infection		
Infected (*n* = 45)	10.11 ± 4.32	6.71 ± 4.88
Never been infected (*n* = 107)	9.04 ± 4.66	6.49 ± 5.08

of respondents who had received diplomas and degrees were 6.29 ± 4.94 and 6.79 ± 5.05, respectively. The mean practice scores of respondents with other educational backgrounds were 6.79 ± 5.24. The mean knowledge and practice scores of respondents who had received secondary education were 7.48 ± 4.60 and 5.86 ± 5.03, respectively. The mean knowledge scores of house owners (9.52 ± 4.68) were higher than those of renters (8.00 ± 4.65). However, the mean practice scores of house owners (6.46 ± 4.92) were lower than those of renters (7.31 ± 5.79). Respondents who had experienced dengue infection had better knowledge (10.11 ± 4.32) and practice (6.71 ± 4.88) scores than those who had never experienced dengue infection.

Normality test (Shapiro-Wilk test) was conducted prior to analytical test and the results conclude that the data was not normally distributed ($p<0.05$) and nonparametric statistics were opted based on violated assumption. Mann-Whitney and Kruskal-Wallis tests, were applied to compare the differences in total scores for the knowledge and practice of ALOT, Mousticide, Denguard and *Aedes* control and preventive activities on the basis of sociodemographic characteristics. The results are shown in Table 5. In the analyses, $p<0.005$ was considered significant. All analyses showed that no statistically significant differences existed in knowledge and practice scores across gender, house ownership status, dengue infection history, age group, marital status and educational level.

ASSOCIATION BETWEEN KNOWLEDGE AND PRACTICES

The χ^2 test was applied and showed a significant ($p<0.001$) association between knowledge and practice scores. The ϕ coefficient (0.605) indicates that a strong association existed between the knowledge and practice of methods for the control and prevention of *Aedes* mosquitoes based on ALOT, Mousticide, Denguard and other approaches.

CORRELATION ANALYSIS

A strongly and significantly positive correlation ($r = 0.648$, $p<0.001$) existed between the knowledge and practice of ALOT, Mousticide, Denguard and other approaches for the control and prevention of *Aedes* mosquitoes.

DISCUSSION

Websites are examples of mass media. In the present study, we identified websites as the most common sources of information used by the respondents. Studies by Hairi et al. (2003), Su et al. (2016) and Wan Rozita et al. (2006)

TABLE 5. Comparison of the total scores for knowledge and practices based on sociodemographic characteristics

Sociodemographic characteristics	p-value	
	Knowledge	Practices
Mann-Whitney Test		
Gender	0.650	0.817
House ownership status	0.261	0.498
Dengue infection history	0.343	0.932
Kruskal-Wallis Test		
Age	0.950	0.948
Marital status	0.607	0.755
Educational level	0.135	0.858

found that the other types of media, such as television, have become the most important sources of information. Mass media plays a vital role in the dissemination of information to create and increase the public awareness and knowledge of *Aedes* control and prevention.

Sociodemographic factors are limited not only to gender, house ownership and dengue infection history. Wong et al. (2015) stated that age, marital status and educational level will influence the behaviours of respondents in the prevention and control of dengue. A similar finding to this study done by Al-Dubai et al. (2013) showed that individuals aged 31-40 years were more involved in *Aedes* control and prevention than respondents aged 18-30 years old and those aged 41 years old and above.

We found that widows or widowers had higher knowledge and practice scores than other respondents. By contrast, Al-Dubai et al. (2013) found that married couples had higher scores for dengue prevention practices than single individuals (Pérez-Guerra et al. 2009). Similar to the studies by Itrat et al. (2008) and Wong et al. (2015), our study suggested that respondents with an educational attainment of tertiary education had higher knowledge scores than those with low education attainment. Hence, engagement with individuals with low educational attainment must be intensified.

Respondents who had been previously infected with dengue showed higher knowledge and practice scores than residents who had never been infected with dengue. Personal experience may improve the understanding of the disease and its preventive measures (Wan Rozita et al. 2006). It causes individuals to seek information on the disease and take all possible action to prevent reinfection. Similarly, Wan Rozita et al. (2006) and Wong et al. (2015) found that individuals who had been previously diagnosed with dengue were more knowledgeable on dengue prevention than those who had not been diagnosed with dengue.

In this study, most of the respondents had average knowledge and practice scores. Health education is important for creating and increasing the public awareness and knowledge of *Aedes* mosquitoes and dengue and for preparing the public to instate *Aedes* control and prevention activities.

The high knowledge scores obtained in this study showed a strong and statistically significant association with practice scores. Studies by Al-Dubai et al. (2013) in Selangor and Kuala Lumpur and by Castro et al. (2013) in Cuba showed that good practice is related with good knowledge level (Mariam et al. 2014). Wong et al. (2015) also suggested that knowledge and awareness factors are associated with effective *Aedes* preventive actions.

However, as found by Thakolwiboon et al. (2013) in Thailand and Hairi et al. (2003), good knowledge is not necessarily correlated with practice. Given that we found a strong relationship between knowledge and practices, we recommend that dengue prevention education programs should focus on increasing public knowledge on *Aedes* control and prevention practices based on the use of ALOTs, Mousticide, Denguard and methods.

LIMITATIONS

We did not characterise the behaviour and perception of the respondents regarding the recommended control and preventive activities. Given that this study is a cross-sectional study, we were unable to ascertain the sustainability of the use of ALOT, Mousticide, Denguard and methods to prevent and control *Aedes* mosquitoes.

CONCLUSION

Health promotion programs that involve multiple stakeholders, such as government officials and responsible authorities, and the active participation of communities are crucial in the war against *Aedes*. Relevant programs must be planned with clear objectives and should focus on educating the public on the use of ALOTs, Mousticide, Denguard and other approaches to control and prevent *Aedes* mosquitoes. Public awareness and knowledge must be increased and strengthened to encourage the adoption of *Aedes* control and prevention activities.

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