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Assessment of Knowledge, Attitude, Practice, Preference and Acceptance of Mosquito Larvicidal Measures in George Town, Penang – A Cross Sectional Study

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Authors' contributions

This work was carried out in collaboration between all authors. Authors WLC, SAA and AR designed the study. Author WLC performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors WLC and SAA managed the analyses of the study as well as the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: This study aimed to assess the knowledge, attitude and practice (KAP) on larvicidal measures, and to assess the level of acceptance and preference of larvicidal measures among George Town residents.
Methods: 300 pre-validated questionnaires were administered to residents of three randomly selected dengue-sensitive areas via systematic random sampling proportionate to size, to assess KAP levels, preference and acceptance of mosquito larvicidal measures. Using Stata version 13.0, the KAP components were analyzed separately and categorized into good or poor KAP. Predictors of KAP were determined using multivariate logistic regression models.
Results: One hundred and fifty-five (51.7%) respondents demonstrated good knowledge and 154 (51.3%) respondents had good attitude while 188 (62.7%) respondents showed good practice. Majority (72.7%, 218/300) of the respondents preferred both chemical and biological larvicides. In

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general, less than 9.0% of the respondents had issues of concern regarding the use of chemical and biological larvicides in terms of safety, side-effects and environmental aspects respectively. There was a significant association between preferred choice of larvicides and age groups, race, marital status, education level, residence type and occupation. In multivariate regression analysis, female respondents had significantly (3.6 times) higher odds of having good practice compared to male respondents, while older age, Chinese race, higher education levels, being a housewife and living in medium-cost apartments were significant predictors of knowledge, attitude and practice regarding larvicidal measures in George Town, Penang.

Conclusion: Dengue prevention practices on larvicidal measures were higher compared to knowledge and attitude, and only a very small proportion of respondents preferred biological larvicide.

Keywords: Knowledge; attitude; practice; preference; acceptance; mosquito; larvicide; Aedes; dengue.

ABBREVIATIONS

CI : Confidence Interval
IQR : Interquartile Range
IVM : Integrated Vector Management
KAP : Knowledge, Attitude, Practice
A/OR : Adjusted/Odds Ratio
MOH : Ministry of Health
SD : Standard Deviation
WHO : World Health Organization

1. INTRODUCTION

Dengue fever is a disease of tropical and subtropical countries transmitted by female *Aedes aegypti* and *Aedes albopictus* mosquitoes of genus Flavivirus and family Flaviviridae. Dengue fever is characterized by high fever, rash, muscle and joint pain. Hemorrhage and shock occurs in the severe form called Dengue Shock Syndrome.

A very large number of cases of dengue infection occur worldwide each year with increasing trend [1]. Worldwide, an estimated 50 to 100 million clinically apparent dengue infections occur yearly, with an observed increasing trend over the past 10 years according to the World Health Organization (WHO) in 2012. Dengue is endemic in over 100 countries across Asia, the Pacific, the Americas, Africa and the Caribbean, putting over 40% of the world's population at risk. Fatal dengue epidemics have also been reported more consistently around the world, in recent times [2]. In Malaysia, the average annual incidence of dengue has been consistently in excess of 125 per 100,000 population since 2002 [3], although a 2-3 fold increase in annual incidence was reported since 2014 by the Ministry of Health Malaysia.

Despite extensive vector control measures, combating the dengue menace remains a huge challenge to public health officials. Climate change and development of *Aedes* resistance against insecticides create difficulty in vector control measures [4]. Hence, apart from vector control routines, the fight against dengue requires strong community awareness and participation in the reduction of breeding sites and potential breeding sites as well as prevention and early treatment of infected patients [5]. Various knowledge, attitude, and practice (KAP) studies on dengue prevention and control measures have been done in dengue-endemic areas. In a recent Nepalese study, the knowledge on dengue prevention was found to be low (12%) [6]. A community survey conducted in Colombia reported that despite favorable attitudes regarding dengue control, preventive practices were inadequate [7]. On the other hand, a study conducted in Brazil's urban area, revealed community household attitude was not positive and had insufficient practice in prevention of dengue [8]. Nalongsack et al. [9] found that out of 230 subjects surveyed in a cross-sectional study designed to assess the knowledge, attitude, and practice of people regarding dengue disease in 9 villages of the Pakse district, Nepal from July to September 2006, 163 subjects (70.9%) had a fair knowledge about the vector. Another study by Dhimal et al. [6] on KAP regarding dengue prevention in Nepal found that 83% of the people had good attitude and 37% of the people had good practice. In two studies conducted in Thailand, health education and continuous campaigns had been suggested to prevent and control dengue successfully [10], [11]. Based on a community knowledge and acceptance of larviciding for malaria control in a rural district of east-central Tanzania, Africa, most survey respondents trusted in the safety (73.1%) and efficacy of larviciding, both with regards to mosquito control (92.3%) and to reduce malaria infection risk (91.9%).

Focus group participants and key informants were also receptive to larviciding, but stressed the importance of sensitization before its implementation. Overall, 73.4% of survey respondents expressed a willingness to make a nominal household contribution to a larviciding program, a proportion which decreased as the proposed contribution increased [12].

In Malaysia, a cross-sectional survey was conducted to assess the level of knowledge, attitude and practice concerning dengue and its vector *Aedes* mosquito among selected rural communities in the Kuala Kangsar district in June 2002 [13]. It was found that the knowledge of the community was good. Out of the 200 respondents, 82.0% cited that their main source of information on dengue was from television or radio. The respondents' attitude was found to be good and most of them were supportive of *Aedes* control measures. There was a significant association found between knowledge of dengue and attitude towards *Aedes* control. It was also found that good knowledge does not necessarily lead to good practice. The authors reported that this was most likely due to certain practices like water storage for domestic use, which is deeply ingrained in the community. Mass media remained the important means of conveying health messages to the public even among the rural population, thus research and development of educational strategies designed to improve behavior and practice of effective control measures among the villagers were recommended.

The objective of this study was to assess the knowledge, attitudes, practices, preference and acceptance of mosquito larvicidal measures among residents of George Town, Penang, Malaysia.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was an analytical cross-sectional study in which pre-validated interviewer-administered questionnaires were completed by 300 respondents within the first week of this study in three randomly-selected dengue-sensitive areas using systematic random sampling to survey the respondents' knowledge, attitudes and practices on dengue and vector control, and their preference and acceptance towards larvicidal measures. The list of flats and blocks of residential areas were identified in all the three areas. Based on the sample size required, residences were surveyed using systematic random sampling proportionate to size. The particular household representative who is 16 years old and above and willing to give consent is then surveyed. If the participant was not around, the research team returned to the residence the following week. If the resident was still not available, then it was considered as a non-respondent. A total of 12 surveyors were briefed and trained by the principal investigator on standardization of the ways to ask the questions and collect data.

2.2 Study Procedures

2.2.1 Sample size and sampling design

The current study was conducted simultaneously with a parent study – a field trial comparing the effectiveness of chemical, biological or both larvicides on vector control in three dengue-sensitive areas of George Town, Penang. These three areas A, B and C were randomly selected from a list of 33 sensitive areas and randomized to either receive the chemical larvicide, biological larvicide or both. Areas A, B and C had 612, 1227 and 1008 units respectively, giving a total of 2847 household units. A sample size of 300 participants was estimated from Stata 13.0 (StataCorp, 2013) based on results of a similar study in Tanzania, Africa, where overall, 73.4% of survey respondents expressed support for the larviciding program (12).

Based on the required sample size, the proportionate number of units selected from Areas A, B and C were 65, 129 and 106 units respectively. The residents were surveyed by interviewer-administered questionnaires based on systematic random sampling proportionate to size. A description of the sampling method for the questionnaire-based survey is provided, as follows:

> Locality A – Taman Seri Damai low-cost flats (Area size: approximately 1.2 hectares) – The three blocks of 17-storey low-cost flats at Taman Seri Damai have 12 units each level, giving a total of 3 x 17 x 12 = 612 units. Based on proportionate sampling, 65 units were selected out of 612 units by systematic random sampling. An interval of 9 was calculated by 612/65 = 9.4. A random start was selected from 1 to 10, which was 3. Henceforth, every kth (9^{th}) unit was chosen, which are Units 3, 12, 21, 30, 39… until 65 units were sampled.

Locality B – Taman Free School low-cost flats (Area size: approximately 10.4 hectares) – Since Taman Free School consists of a few low-rise flats and high-rise flats, the units were selected using proportionate sampling to better reflect the population. The total units were 1227. The interval selected was every 9th unit (1227/129 = 9.5). A random start was selected from 1 to 10, which was 2. Henceforth, every 9th unit was chosen, which included Units 2, 11, 20, 29, 38… until 129 units were sampled.

Locality C – Taman Kristal, Lengkok Erskine medium cost apartment (Area size: approximately 3.1 hectares) – The total units were 1008. The interval selected was every 9th unit (1008/106 = 9.5). A random start was selected from 1 to 10, which was 5. Henceforth, every 9th unit was chosen, which included Units 5, 14, 23, 32, 41… until 106 units were sampled.

If more than one eligible resident were present, the head of the household or the individual who could provide the most accurate information was selected to answer the questionnaire. For those who did not respond or consent to participate in the survey, the team went to the next pre-selected unit. The team then returned to the unresponsive unit the following day and if there was still no answer by the resident, then they proceeded to the following unit until enough units were surveyed in that locality.

2.2.2 Validation of study instruments

The questionnaire was constructed and then subjected to content validity by coverage and relevance, which was assessed by qualitative approach (expert opinion) by the researcher and supervisor(s). Areas to cover and points to be included in each component of knowledge, attitude, and practice were determined. Internal consistency reliability was tested. 5 volunteers were selected in the pretesting of the questionnaires, and subsequently 30 participants consisting of a wide range of respondents were selected for piloting via purposive sampling. The internal consistency reliability analysis for numerical data is reflected by the Cronbach's Alpha statistic. In all the components of the questionnaire tested, the Cronbach's Alpha value was 0.9281, reflecting a good internal consistency.

The questionnaire underwent forward translation from English to Malay and back translation by a professional translator from Universiti Sains Malaysia (USM) with a Bachelor of Literature (Hons) in Translation and Interpretation.

2.3 Data Collection

Primary data was collected using interviewer-administered questionnaire to assess the knowledge, attitude, practice, preference and acceptance on dengue and vector control, in addition to socio-demographic characteristics of respondents.

Based on extensive literature search and current coverage of dengue prevention and control measures in George Town, the research team agreed that out of the 25 questions listed in the knowledge section, 18 questions were selected and weighted as "compulsory knowledge" to obtain one mark each for every correct answer for the 18 questions listed. Out of the 10 questions listed in the attitude section, 8 questions were deemed "compulsory attitude" which were important to curtail the spread of dengue and allocated one mark for each correct answer. Out of the 10 questions listed in the practice section, 9 questions were deemed "compulsory practice" to gain one mark for each correct answer.

2.4 Data Analysis

Normality testing was conducted for numerical data using the graphical and statistical methods. The knowledge, attitude and practice scores were not normally distributed; hence they were categorized into good or poor scores based on median cut-off points due to the substantial skewness of the knowledge, attitude and practice variables, which did not respond to data transformation. All values greater than or equal to the median scores based on the three components respectively were defined as good, while all scores below the median were categorized as poor.

Good knowledge was then defined as a score 15 and above out of the total 18 points. Good attitude was defined as a score of 5 and above out of the total 8 points. Good practice was defined as a score of 7 and above out of the total 9 points. Knowledge, attitude and practice categories were then analyzed separately, looking into the relationship with each sociodemographic profile (univariate analysis) and then logistic regression was done to examine the relationship of each outcome with all

the sociodemographic profiles. Respondents who answered "not sure" were categorised as "no" for analysis purposes. For the negatively-worded questions, "not sure" answers were categorised as "yes" while "no" answers were scored accordingly. Using STATA version 13.0, Chi-square tests and Multivariate Binary Logistic Regression analyses were performed to test the study hypotheses. Significance level for statistical tests was set at <0.05.

3. RESULTS

3.1 Response Rate

310 out of the 360 intended respondents (inclusive of adjustment for 20% drop out rate) were reached during the period of the study. Of this number, 300 respondents (original sample size) successfully completed the questionnaires, while the remaining 10 had incomplete information or dropped out, giving an overall response rate of 96.8%.

Table 1. Socio-demographic profile of the respondents (n=300)

Variable	n (%)
Gender	
Male	136 (45.3)
Female	164 (54.7)
Race	
Malay and other bumiputera*	110 (36.7)
Chinese	157 (52.3)
Indian	33 (11.0)
Marital status	
Single**	43 (14.3)
Married	257 (85.7)
Education level	
No formal and primary education	106 (35.3)
Secondary and tertiary education	194 (64.7)
Residence type	
Low-cost flat	200 (66.7)
Medium-cost apartment	100 (33.3)
Occupation	
Employed	122 (40.7)
Unemployed	31 (10.3)
Housewife	112 (37.3)
Retired	35 (11.7)
Age (Mean, 95%CI)	52.8 (50.8, 54.8)

**Other bumiputera include the indigenous tribes of East and West Malaysia.*

***Single includes unmarried, divorced, separated and widowed*

3.2 Socio-demographic Profile of Respondents

Out of the 300 respondents in the sample, males constituted 45.3% whereas female represented 54.7% of the population. Chinese were the majority respondents (52.3%) followed by Malays and other bumiputeras (36.7%) which include indigenous respondents from East and West Malaysia, and Indians (11.0%). Majority (85.7%) of the respondents were married, and 64.7% had completed secondary and tertiary education. About two-thirds (66.7%) of the respondents lived in low-cost flats while the remaining respondents live in medium-cost apartments. 40.7% respondents were employed, 37.3% were housewives, while the proportion of retirees and those unemployed were 11.7% and 10.3% respectively. Almost 95% respondents or their immediate family members in their households were not previously infected by dengue fever as of time of survey. The mean age (95%CI) was 52.8 (50.8, 54.8) and ranged from 16.8 to 90.8 years (Table 1).

3.3 Item-by-item Analysis of Respondents' Knowledge on Dengue Prevention

As highlighted in Table 2 regarding respondents' knowledge of the breeding of mosquitoes, 81.0% of the respondents knew that mosquitoes could breed in stagnant water. 78.3% knew that mosquitoes breed in drains and 72.0% were aware that mosquitoes could breed at construction sites. Interestingly, 70.0% thought that mosquitoes could breed in well-maintained swimming pools which was the wrong answer while only 30.0% answered correctly as 'No' for this question. 74.7% of the respondents knew that discarded pots and tyres were the breeding sources for mosquitoes while 72.7% respondents thought vases with water were the breeding sources for mosquitoes. 57.0% respondents obtained the correct answer as they answered 'No' for vases without water because mosquitoes cannot breed without the presence of water. Majority of the respondents were right when they knew that roof gutters (71.7%), water tanks (67.0%) and toilets (58.3%) were the common places for mosquito breeding. However, only 45% respondents were aware that mosquitoes could breed in uncovered and unmaintained trash cans whereas surprisingly, 76.3% respondents thought mosquitoes could still breed in properly-covered trash cans with regular clean-outs. 64.0% respondents were correct on

the life cycle of the mosquito which is 1 week and 74.3% respondents were spot on that *Aedes* is the species of the mosquito which spreads dengue fever, with 61.0% respondents able to identify the features of the *Aedes* mosquito (black and white markings on its body), while only 29.7% and 27.7% chose *Anopheles* and *Culex* respectively. 78.7% respondents believed that mosquitoes which spread dengue like to breed in dirty water, instead of clean water. The majority of respondents thought that mosquito larvae could be eliminated by eliminating places with stagnant water (75.7%), putting chemical powder (66.0%), and biological control (61.0%), but 87.3% were not sure about other methods used to destroy mosquito larvae. 73.3% respondents thought they could reduce the mosquito nuisance by clearing the undergrowth within their housing compounds and the surroundings. A very high percentage (96.3%) knew that mosquito eggs can survive without water, which is true (Table 2).

Table 2. Distribution of respondents' knowledge on dengue prevention by items

	Question	Yes n (%)	No n (%)
1.	Do you know if mosquitoes can breed in stagnant water?	243 (81.0)	57 (19.0)
2.	Do you know if any of these are common places for mosquito breeding?		
	a) Drains	235 (78.3)	65 (21.7)
	b) Construction sites	216 (72.0)	84 (28.0)
	c) Well maintained swimming pools*	210 (70.0)	90 (30.0)
	d) Discarded pots and tyres	224 (74.7)	76 (25.3)
	e) Vases with water	218 (72.7)	82 (27.3)
	f) Vases without water*	129 (43.0)	171 (57.0)
	g) Water tanks	201 (67.0)	99 (33.0)
	h) Roof gutters	215 (71.7)	85 (28.3)
	i) Trash cans that are not covered and not well maintained	135 (45.0)	165 (55.0)
	j) Trash cans that are covered properly with regular cleanouts*	229 (76.3)	71 (23.7)
	k) Toilets	175 (58.3)	125 (41.7)
3.	Do you know that the life cycle of a mosquito is about 1 week?	192 (64.0)	108 (36.0)
4.	Do you know the name of the mosquito which can spread dengue fever?		
	a) *Anopheles**	89 (29.7)	211 (70.3)
	b) Aedes	223 (74.3)	77 (25.7)
	c) *Culex**	83 (27.7)	217 (72.3)
5.	Does the mosquito which spread dengue like to breed in clean water?	137 (45.7)	163 (54.3)
6.	Does the mosquito which spread dengue like to breed in dirty water?*	236 (78.7)	64 (21.3)
7.	Does the mosquito that carries the dengue virus have black and white markings on its body?	183 (61.0)	117 (39.0)
8.	How can mosquito larvae be eliminated?		
	a) By eliminating places with stagnant water	227 (75.7)	73 (24.3)
	b) By putting chemical powder (Abate)	198 (66.0)	102 (34.0)
	c) Biological control	183 (61.0)	117 (39.0)
	d) Other methods*	38 (12.7)	262 (87.3)
9.	Could you decrease mosquito nuisance by cleaning out bushes inside and outside of your house?	220 (73.3)	80 (26.7)
10.	Do you know if mosquito eggs can survive without water?	289 (96.3)	11 (3.7)

*Questions marked * were not used in the summation of knowledge scores. The rest of the questions are 'must-have' knowledge according to the researcher*

3.4 Item-by-item Analysis of Respondents' Attitude on Dengue Prevention

In terms of attitude, 65.7% respondents considered the mosquito nuisance a public health problem in Georgetown, 63.7% felt the programmes to eliminate the mosquito problem in the city were sufficient, 74.3% felt they have a role to play in reducing the mosquito problem in the city while 64.0% would join any activity for mosquito control when requested by the local health authority (Table 3). 63.7% agreed that a legislation should be created to keep unused containers in properly tied plastic bags in order to prevent stagnant water for mosquito breeding. Only 7.3% respondents were reluctant to use chemical larvicides due to its side effects. Slightly more than half of the respondents (51.7%) preferred biological larvicides because of their lesser side effects while a large proportion of respondents (85.3%) were not willing to spend some amount of money to buy mosquito repellants and use them to protect themselves from being bitten by mosquitoes. Two-thirds of the respondents (66.7%) agreed that dengue is a community health problem rather than an individual disease per se while 89.3% respondents perceived that the reason a person got infected by dengue fever was because he or she did not take care of his or her health (Table 3).

3.5 Item-by-item Analysis of Respondents' Practice on Dengue Prevention

Pertaining to practice, Table 4 showed that 74.0% respondents turned unused, disposed containers upside down to prevent water stagnation, 66.0% of them cleaned water tanks or containers inside and outside of their houses at least once a week, 67.0% cleaned bushes and rubbish inside and outside their houses at least once a week, and 64.0% put chemical powder given by the local health authorities into vases or any other places with stagnant water. 65.0% checked around their houses at least once a week for any disposed container or tyre that could collect water, 74.3% allowed health inspectors to check their houses for mosquito breeding sites, 66.0% co-operated with the local health authorities to conduct 'gotong-royong' (mass community cleaning effort) from time to time, 53.0% warned their family members and neighbors not to allow containers or environment which could breed mosquitoes. Strikingly, only 8.7% read the mass media or online media

Table 3. Distribution of respondents' attitude on dengue prevention by items

	Question	Yes n (%)	No n (%)
1.	Is the mosquito nuisance considered a public health problem in Georgetown?*	197 (65.7)	103 (34.3)
2.	Are the programmes to eliminate the mosquito problem in the city sufficient?*	191 (63.7)	109 (36.3)
3.	Do you have a role to play in reducing the mosquito problem in the city?	223 (74.3)	77 (25.7)
4.	Do you agree that there should be a law to ensure unused containers are kept in properly tied plastic bags to prevent stagnant water for mosquito breeding?	191 (63.7)	109 (36.3)
5.	Will you join any activity for mosquito control when requested by your local health authority?	192 (64.0)	108 (36.0)
6.	Are you reluctant to use chemical larvicides like Abate due to its side effects?	22 (7.3)	278 (92.7)
7.	Do you prefer biological larvicides because of their lesser side effects?	155 (51.7)	145 (48.3)
8.	Are you willing to spend some amount of money to buy mosquito repellants and use them to protect yourself from being bitten by mosquitoes?	44 (14.7)	256 (85.3)
9.	Do you agree that dengue is a community health problem rather than an individual disease per se?	200 (66.7)	100 (33.3)
10.	Do you think that a person who gets dengue fever is because he or she did not take care of his or her health?	268 (89.3)	32 (10.7)

*Questions marked * were not used in the summation of attitude scores. The rest of the questions are 'must-have' attitudes according to the researcher*

regarding new ways to prevent breeding of mosquitoes while 18.3% informed the local authorities had they noticed any potential mosquito breeding sites in the neighborhood or the community (Table 4).

3.6 Distribution of Respondents' Knowledge, Attitude and Practice on Dengue Prevention

A summary of respondents' knowledge, attitude and practice on dengue prevention is presented in Table 5. Out of the 300 respondents, 94.3% of them and/or their immediate family members did not have any previous history of dengue infection. The median knowledge score was 15.0 and 51.7% of the respondents belonged to the good knowledge category while 48.3% fell into the poor knowledge category. The median attitude score was 5.0 where 51.3% respondents had good attitude while 48.7% had poor attitude. The median practice score was 7.0 with 62.7% belonging to good practice category while 37.3% had poor practice in dengue prevention.

3.7 Distribution of Respondents' Preference and Concerns with Larvicidal Measures

As shown in Table 6, majority of the respondents preferred both chemical and biological larvicides (72.7%), followed by 17.0% who disliked both agents, while 9.3% preferred chemical agent only and a mere 1.0% preferred biological agent only. Reasons for choice of larvicides include being cost effective (67.3%), safe (72.0%), effective (62.3%), easily available from local health authorities (33.7%), less harmful to the environment (39.0%), less side effects to humans (32.0%), less side effects to pets or fishes (31.3%) and 61.3% respondents have been using it all along for larvae control. With regards to concern issues, only a handful of respondents voiced their concerns regarding skin problem (allergies) with 3% for chemical and 0.3% for biological; cancer with nil for chemical and 1% for biological; larvae resistance with nil for chemical and 0.3% for biological; breathing difficulties with 0.7% for chemical and 0.3% for biological; environmentally toxic both 0.3% for chemical and biological respectively; not effective with nil for chemical and 4.3% for biological; expensive with nil for chemical and 6.3% for biological. 5.7% of respondents needed to rely on the local authorities to provide Abate while 8.7% of the respondents needed to rely on the local authorities to provide Vectobac as both larvicides were not easily obtained in the markets. Overall, the concern issues studied were only evident in less than 10% of the total respondents surveyed for each of the issues of concern (Table 6).

Table 4. Distribution of respondents' practice on dengue prevention by items

	Question	Yes n (%)	No n (%)
1.	When disposing off unused containers, do you turn it upside down to prevent water stagnation?	222 (74.0)	78 (26.0)
2.	Do you clean water tanks or containers inside and outside of your house at least once a week?	198 (66.0)	102 (34.0)
3.	Do you clean bushes and rubbish inside and outside of your house at least once a week?	201 (67.0)	99 (33.0)
4.	Do you put chemical powder (Abate) given by your local health authority in vases or any other place with stagnant water?	192 (64.0)	108 (36.0)
5.	Do you check around your house at least once a week for any disposed container or tyre that could collect water?	195 (65.0)	105 (35.0)
6.	Do you allow health inspectors to check your house for mosquito breeding sites?	223 (74.3)	77 (25.7)
7.	Do you co-operate with the local health authorities to conduct 'gotong-royong' from time to time?	198 (66.0)	102 (34.0)
8.	Do you warn your family members and neighbours not to allow containers or environment which could breed mosquitoes?*	159 (53.0)	141 (47.0)
9.	Do you inform the local authorities if you notice any potential mosquito breeding sites in the neighbourhood or community?	55 (18.3)	245 (81.7)
10.	Do you read the mass media or online media regarding new ways to prevent breeding of mosquitoes?	26 (8.7)	274 (91.3)

*Questions marked * were not used in the summation of practice scores. The rest of the questions are 'must-have' practices according to the researcher*

Table 5. Distribution of respondents' level of knowledge, attitude and practice (KAP) on dengue prevention

Variable	Median(IQR)	N (%)
Knowledge score	15.0(6.75)	-
Knowledge category		
Good	-	155(51.7)
Poor	-	145(48.3)
Attitude score	5.0(3.0)	-
Attitude category		
Good		154(51.3)
Poor		146(48.7)
Practice score	7.0(5.0)	-
Practice category		
Good	-	188(62.7)
Poor	-	112(37.3)

3.8 Association between Socio-demographic Factors and Preferred Choice of Larvicides

Table 7 demonstrates the association between sociodemographic factors and preference of larvicides, whether the respondents disliked both types, liked chemical only, liked biological only or liked both. 46 (90.2%) respondents in the age category of 50 years old and above dislike both larvicides, followed by age group 30-49 with 4 (7.8%) respondents and age group less than 30 with only 1 respondent (2.0%). A cumulative 26 (92.8%) respondents in age group 30 and above preferred chemical larvicide only while out of only 3 respondents who preferred biological larvicide 2 (66.7%) were of age 30 to 49 and 1 (33.3%) was of age 50 or above. 114 (52.3%) respondents age 50 or above preferred both larvicides, followed by the age 30-49 group with 72 (33.0%) respondents and 32 (14.7%) respondents in the age<30 group. There was a

Table 6. Distribution of respondents' preference and concerns with larvicidal measures

Variable	n (%)	
Choice of larvicide		
Dislike both	51 (17.0)	
Chemical only	28 (9.3)	
Biological only	3 (1.0)	
Both chemical and biological	218 (72.7)	
Reasons for choice		
Cost effective	202 (67.3)	
Safe	216 (72.0)	
Effective	187 (62.3)	
Easily available from local health authorities	101 (33.7)	
Less harmful to the environment	117 (39.0)	
Less side effects to humans	96 (32.0)	
Less side effects to pets/fish	94 (31.3)	
Have been using it all this while for larvae control	184 (61.3)	
Concern issues	**Respondents who think Abate (chemical) is the cause n (%)**	**Respondents who think Vectobac (biological) is the cause n (%)**
Skin problem (allergies)	9 (3.0)	1 (0.3)
Cancer	0 (0)	3 (1.0)
Larvae resistance	0 (0)	1 (0.3)
Breathing difficulties	2 (0.7)	1 (0.3)
Environmentally toxic	1 (0.3)	1 (0.3)
Not effective	0 (0)	13 (4.3)
Expensive	0 (0)	19 (6.3)
Need to rely on local authorities to provide the larvicide as not easily obtained in the markets	17 (5.7)	26 (8.7)

Table 7. Chi-square analysis showing association between socio-demographic factors and preferred choice of larvicides

Variable	Dislike both, n (%)	Chemical only, n (%)	Biological only, n (%)	Chemical and Biological, n (%)	P-value
Age group					<0.001*
<30 years	1 (2.0)	2 (7.2)	0 (0)	32 (14.7)	
30 to 49 years	4 (7.8)	13 (46.4)	2 (66.7)	72 (33.0)	
≥50 years	46 (90.2)	13 (46.4)	1 (33.3)	114 (52.3)	
Gender					0.149*
Male	19 (37.3)	16 (57.1)	0 (0)	101 (46.3)	
Female	32 (62.7)	12 (42.9)	3 (100.0)	117 (53.7)	
Race					<0.001*
Malay and other bumiputera	10 (19.6)	7 (25.0)	1 (33.3)	92 (42.2)	
Chinese	41 (80.4)	17 (60.7)	2 (66.7)	97 (44.5)	
Indian	0 (0)	4 (14.3)	0 (0)	29 (13.3)	
Marital status					0.040*
Single	2 (3.9)	3 (10.7)	1 (33.3)	37 (17.0)	
Married	49 (96.1)	25 (89.3)	2 (66.7)	181 (83.0)	
Education level					<0.001*
No formal and primary	43 (84.3)	2 (7.1)	1 (33.3)	60 (27.5)	
Secondary and tertiary	8 (15.7)	26 (92.9)	2 (66.7)	158 (72.5)	
Residence type					<0.001*
Low-cost flat	46 (90.2)	4 (14.3)	2 (66.7)	148 (67.9)	
Medium-cost apartment	5 (9.8)	24 (85.7)	1 (33.3)	70 (32.1)	
Occupation					<0.001*
Employed	4 (7.8)	14 (50.0)	1 (33.3)	103 (47.3)	
Housewife	31 (60.8)	12 (42.8)	2 (66.7)	67 (30.7)	
Unemployed	7 (13.7)	1 (3.6)	0(0)	23 (10.5)	
Retired	9 (17.7)	1 (3.6)	0(0)	25 (11.5)	

**Calculated based on Fisher's Exact Test*

significant association (p<0.001) between the age categories and preference for types of larvicides. There was no significant association (p=0.149) between gender and preferred choice of larvicides. However, there was significant association between larvicides' preference and race (p<0.001), marital status (p=0.04), education level (p<0.001), residence type (p<0.001) and occupation (p<0.001) (Table 7).

3.9 Multivariate Regression Analysis of the Relationship between Socio-demographic Factors and Knowledge, Attitude and Practice Regarding Dengue Prevention

We fitted three separate multivariate logistic regression models to examine the relationship of all the sociodemographic factors with level of knowledge, attitude and practice on dengue prevention, respectively. All variables that were significantly associated with knowledge, attitude and practice at univariate level were included in the final models. Additionally, we included in the models, variables such as sex and previous history of dengue infection which were hitherto not significant at univariate level based on evidence of potential association from literature. The logistic regression models were all statistically significant (p<0.001). The models explained 20%, 19% and 31% of the variance in knowledge, attitude and practice on dengue prevention, respectively.

3.9.1 Knowledge on dengue prevention

Result of the analysis presented in Table 8 showed statistically significant association

between level of knowledge and age, race (Chinese group), level of education and occupation (housewife group). Chinese respondents had about 44% lower odds of having good knowledge compared to Malays and other bumiputeras (aOR = 0.44, p<0.011). Respondents who attained secondary and tertiary education had about 3.35 times higher odds of having good knowledge compared to those with no formal or primary education (aOR = 3.35, p=0.001). Housewives were found to have 32% lower odds of having good knowledge compared to respondents who were employed (aOR = 0.32, p=0.006). For every one year increase in age, the odds of having good knowledge decreased significantly by 97% (OR = 0.97, p=0.018). No other socio-demographic factors showed any statistically significant association with level of knowledge on dengue prevention.

3.9.2 Attitude towards dengue prevention

We found a statistically significant association between attitude towards dengue prevention and race (Chinese group), level of education and occupation (housewife). Chinese respondents had about 38% lower odds of having good attitude compared to Malays and other bumiputeras (aOR = 0.38, p<0.003). Respondents who attained secondary and tertiary education had almost four times higher odds of having good attitude compared to those with no formal or primary education (aOR = 3.91, p<0.001). Housewives were found to have 32% lower odds of having good knowledge compared to respondents who were employed (aOR = 0.32, p=0.006). No other socio-demographic factors showed any statistically significant association with level of attitude on dengue prevention (Table 8).

3.9.3 Practice on dengue prevention

Results of the analysis presented in Table 8 showed statistical significant association between practice on dengue prevention and age, sex, race (Chinese group), level of education, type of residence and occupation (housewife group). For every one year increase in age, the odds of having good practice decreased significantly by 97% (aOR = 0.97, p=0.012). Female respondents had about 3.6 times higher odds of having good practice compared to male respondents (aOR = 3.62, p = 0.009). Chinese respondents had about 24% lower odds of having good practice compared to Malays and other bumiputeras (aOR = 0.24, p<0.001). Respondents who attained secondary and tertiary education had about 4.6 times higher odds of having good practice compared to those with no formal or primary education (aOR = 4.58, p<0.001). Housewives were found to have 16% lower odds of having good practice compared to respondents who were employed (aOR = 0.16, p<0.001). Respondents who resided in medium-cost apartments had 56% lower odds of having good practice compared to those who lived in low-cost flats (aOR = 0.56, p=0.003). No other socio-demographic factors showed any statistically significant association with level of practice on dengue prevention.

4. DISCUSSION

The survey findings provided a deeper insight and dimension into the knowledge, attitudes, practices, acceptance and preference of larvicidal measures among George Town residents. We gained a deeper understanding of the perception by the respondents who were reflective of the general population in dengue-sensitive areas of George Town. Slightly more than half of the respondents had good knowledge (51.7%) and good attitude (51.3%). More respondents had good practice (62.7%) compared to good knowledge and good attitude. Previous studies have demonstrated good knowledge but poor attitude led to poor practice, predominantly in selected rural communities in the Kuala Kangsar district of the state of Perak, Malaysia [13]. Similar to the findings in our study, a study on knowledge, attitudes and practices regarding dengue infection in Westmoreland, Jamaica showed 54% of the respondents had good knowledge about dengue [14].

According to a study of factors affecting dengue fever knowledge, attitudes and practices among selected urban, semi-urban and rural communities in Malaysia, there was no significant association between knowledge score and socio-demographic factors. Attitudes toward dengue fever were significantly associated with the level of education and employment status ($p < 0.05$). Practice was associated significantly with age, marital status, and geographic area ($p < 0.05$) and knowledge on dengue fever ($p = 0.030$) [13].

Table 8. Logistic regression analysis showing association between socio-demographic factors and knowledge, attitude and practices regarding dengue prevention

Sociodemographic factors	Knowledge on dengue prevention			Attitude towards dengue prevention			Practices on dengue prevention		
	Crude OR (95% CI)	Adjusted OR (95% CI)	P value	Crude OR (95% CI)	Adjusted OR (95% CI)	P value	Crude OR (95% CI)	Adjusted OR (95% CI)	P value
Age	0.96 (0.94, 0.97)	0.97 (0.95, 0.99)	0.018	0.96 (0.94, 0.97)	0.98 (0.96, 1.00)	0.050	0.95 (0.93, 0.97)	0.97 (0.94, 0.99)	0.012
Gender/Sex									
Male	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Female	0.77 (0.49, 1.22)	1.55 (0.72, 3.34)	0.259	0.89 (0.56, 1.40)	2.03 (0.94, 4.36)	0.071	1.01 (0.63, 1.62)	3.62 (1.37, 9.53)	0.009
Race									
Malay & Bumiputera	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Chinese	0.31 (0.18, 0.52)	0.44 (0.23, 0.83)	0.011	0.36 (0.22, 0.59)	0.38 (0.20, 0.72)	0.003	0.18 (0.10, 0.32)	0.24 (0.12, 0.49)	<0.001
Indian	1.01 (0.44, 2.31)	1.26 (0.51, 3.14)	0.618	0.96 (0.43, 2.16)	1.05 (0.43, 2.60)	0.909	1.24 (0.43, 3.62)	1.65 (0.51, 5.40)	0.407
Marital status									
Single	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Married	0.41 (0.20, 0.82)	1.30 (0.52, 3.25)	0.576	0.46 (0.23, 0.91)	1.52 (0.60, 3.83)	0.376	0.46 (0.22, 0.98)	2.06 (0.72, 5.88)	0.178
Education level									
No formal and primary	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Secondary and tertiary	4.92 (2.93, 8.27)	3.35 (1.64, 6.84)	0.001	5.97 (3.50, 10.17)	3.91 (1.91, 8.00)	<0.001	5.69 (3.39, 9.54)	4.58 (2.06, 10.16)	<0.001
Residence type									
Low-cost flat	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Medium-cost apartment	0.84 (0.66, 1.07)	0.73 (0.53, 1.01)	0.059	1.08 (0.85, 1.38)	1.04 (0.76, 1.44)	0.793	0.74 (0.58, 0.94)	0.56 (0.38, 0.81)	0.003
Occupation									
Employed	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Housewife	0.30 (0.18, 0.52)	0.32 (0.14, 0.72)	0.006	0.32 (0.18, 0.54)	0.32 (0.14, 0.71)	0.006	0.30 (0.17, 0.52)	0.16 (0.05, 0.44)	<0.001
Unemployed	0.26 (0.29, 1.42)	0.35 (0.14, 2.98)	0.971	0.56 (0.25, 1.24)	1.17 (0.40, 3.41)	0.769	0.41 (0.18, 0.94)	0.80 (0.24, 2.63)	0.710
Retired	0.50 (0.23, 1.06)	1.40 (0.54, 3.64)	0.491	0.44 (0.21, 0.95)	1.64 (0.63, 4.30)	0.312	0.40 (0.18, 0.88)	1.00 (0.35, 2.87)	0.993
Previous dengue infection									
No	Reference	Reference	-	Reference	Reference	-	Reference	Reference	-
Yes	1.77 (0.64, 4.92)	0.77 (0.24, 2.49)	0.144	1.38 (0.51, 3.72)	0.67 (0.22, 2.06)	0.485	2.92 (0.82, 10.41)	0.93 (0.20. 4.31)	0.924

Our study revealed that although good knowledge and good attitude are of the same level or proportion, good practice had higher levels. This is probably due to respondents living in the urban areas of George Town being aware of the strict enforcement of a mandatory MYR500 penalty which is imposed on any resident whose premise is found to be positive for breeding of mosquito larvae during routine inspection by health officials. Usually, information conveyed to the public will address the knowledge and practice component [15,16] such as the MOH Malaysia's campaign of "Spending 10 minutes of your time to destroy mosquito breeding sites every week at home and surroundings", in line with reinforcement practices from similar study findings [17]. Although KAP scores were not particularly poor in urban areas [18], more efforts needed to be carried out in terms of highlighting the awareness and responsibility of each citizen to ensure "zero *Aedes*" in the battle against dengue [19,20,21,22]. More in-depth studies need to be explored on the mentality and attitude of residents from various demographics strata to understand the civic-consciousness of the society [23], in comparison to developed societies like Japan and Scandinavian countries where upbringing and culture are more emphasized as opposed to strict enforcement in countries like Singapore.

Race (Chinese group), level of education and occupation (housewife group) were the three main socio-demographic factors which were significantly associated with all three KAP components respectively. The effect of the level of education is generally understood, such that the more educated the respondent is, the better their KAP levels [24]. However, it is interesting to note that housewives are not doing well in terms of good KAP levels compared to the employed group. As housewives spend most of their time at home, they would be expected to be more vigilant in identifying and exterminating possible breeding ground for mosquitoes. The Chinese respondents appeared to score poorly on KAP levels compared to the Malays. Based on the layered Chi-square analysis, the poor KAP levels of the Chinese respondents was probably due to majority of them (n=61, 42%) having no formal and primary education, accounting for significant difference between groups.

The impression given by the majority of the respondents choosing both chemical and biological larvicides strengthened the fact that they preferred to use combination of agents for larvae control. The fact that a very small number of the respondents claimed safety and health concerns on the use of both larvicides is a good thing for the vector control team as the usage of such agents will not trigger much opposition or resistance from the community. The results pertaining to reasons of larvicide choice also reflect the various demands and perceptions on the usage of larvae control agents.

5. STRENGTHS

Nested within a field trial which was the first to compare efficacy of various larvicides on vector control in Malaysia, our study is also one of very few studies that analyzed preference, level of acceptance and concerns of Malaysian residents regarding current larvicidal measures. We applied a systematic random sampling proportionate to size which ensured that results can be generalized to the population of all dengue-sensitive areas in George Town, Penang, and limits the possibility of bias in the results. Apart from its good psychometric properties, the design of study instrument used in this survey provided a new, tailored, context-specific approach of determining KAP of respondents on dengue, in such a way that it enables elicitation of deeper understanding of the constructs, and also diminishes the potential to guess correct answers by the respondents.

6. LIMITATIONS

This study has some important limitations. Like all surveys, the potential for social desirability and recall bias in the responses provided cannot be overlooked, hence, guided interpretation of these findings is necessary. It is also possible that some responses provided by the household representatives (majority of whom were the heads) in this study might have been reflective of shared attitudes and practices of other members of the household, and not just the respondent alone. The design of this study did not permit the establishment of any causal associations or deeper meanings that might have further explained the reasons behind poor knowledge and attitudes but better practices on dengue prevention among the respondents.

7. CONCLUSION

Poor attitude of the respondents towards dengue prevention needs to be studied in detail to expose the underlying reasons behind the failure

to address the perception and behavioral change in ensuring a dengue-free Penang. Despite various educational awareness programmes by local health authorities, non-governmental organizations (NGOs), corporate social responsibility (CSR) messages via mass media and social media, only slightly more than half of the respondents had good knowledge (51.7%) and good attitude (51.3%) respectively, while a higher percentage of respondents had good practice (62.7%) possibly due to strict enforcement by the authorities to impose a mandatory MYR500 penalty for positive confirmation of *Aedes* larvae breeding found in their premises. The attitude component is the most important part of all, as a change towards positive attitude will ensure a change in mentality and less influenced by enforcement. It is desired that residents voluntarily take preventive steps to combat dengue and not solely take actions due to fear of punishment or other negative consequences. It is hoped that this study will inspire future vector-borne disease research related to the *Aedes* species of mosquitoes such as the ever-challenging threat of Zika virus, which not only has been proven to spread via *Aedes* vectors but also through sexual transmissions, necessitating WHO to declare it as a global public health emergency recently.

CONSENT

The participant information sheet and informed consent form were distributed to all the participants chosen randomly for the survey. This was a minimal risk study with no name nor identifier recognizable in the data collection and analytical process.

ETHICAL APPROVAL

The Belmont principles of autonomy, beneficence, non-maleficence and justice were upheld at all times in the conduct of the research. Ethical approval was obtained from the Joint Penang Independent Ethics Committee (JPEC) prior to commencement of the study (ethical approval number: JPEC 03-16-0044).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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