

MOBILE HEALTH INTERVENTIONS FOR VECTOR CONTROL IN DENGUE PRONE AREAS IN MALAYSIA

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Abstract: The rise of dengue fever incidence over the past decade in Malaysia has associated with increased morbidity and mortality but also incurred massive healthcare cost. Apart from continuous physical control efforts and on-going health educational programs using conventional approaches, it seems ineffective in tackling the increasing trend of dengue. The objective of this study was to examine the acceptance and viability of an integrated mobile e-learning approach in educating the community on the prevention and control of dengue. A face-to-face questionnaire were used to collect feedback on the intervention from residential adults in four selected dengue fever prone rural residential areas in Malaysia. Out of the 379 participants, the majority of residents (99.21%) showed a favourable interest towards the use of e-learning approach. The prime reason given for their interest in the e-learning via smartphones was the provided prompt visual knowledge and understanding. The pictorial diagrams contained diversified information in an easy-to-understand layout. Being able to understand the information quickly, being able to share information with others and ease of self-regulated learning are the main advantages of disseminating health information via mobile phone. It will be useful and interesting to produce e-learning modules for future community-based health interventions.

KEYWORDS: Adult community, dengue fever, e-learning, health education, integrated learning

Introduction

The incidence of dengue fever has grown dramatically with a 30-fold increase globally over the past 50 years (Schaffner & Mathis, 2014). The World Health Organization (WHO) reported that the transmission of dengue fever is now endemic in about 125 countries, 75% of which are in the Asia Pacific region. It is estimated the global incidence of dengue fever is between 50 to 200 million cases annually. The transmission of dengue fever is expected to increase due to climate change, ecological disruption and evolution, globalization of trade and travel, and uncertainties in the global socioeconomics and political instability (Institute of Medicine, 2010). Dengue is commonly spread in the tropical and sub-tropical countries, mostly in urban and semi-urban developed areas (World Health Organization, 2012). Malaysia

has been experiencing an unprecedented increase in the number of reported cases of dengue fever over the last 5 years (Khan *et al.*, 2017). From 2012 to 2016, Malaysia recorded 396,137 dengue fever cases with an average of 1,523 cases reported weekly (Crisis Preparedness and Response Centre, Ministry of Health, Malaysia, 2018). The cases were reported from residential communities in the urban and rural settings. Currently, there is no specific medication available for curing dengue fever, but early detection and access to proper medical supportive care lowers the mortality rate to less than 1% (World Health Organization, 2012). Nonetheless, dengue fever is the leading cause of serious illnesses and mortality among children in Asian and Latin American countries, where sudden seasonal outbreaks occur widely (WHO SEARO, 2018).

Given the potentially deleterious impact of dengue fever on health, and the fact that many environmental health risks are both identifiable and preventable, the communities play an important role in the prevention and control of the disease. The 2012–2020 Global strategy for dengue prevention and control, aims to reduce the burden of dengue with at least 50% and 25% respectively reduction in mortality and morbidity (World Health Organization, 2012). Early preventive approaches avert probable dengue fever adversities effectively (Murray *et al.*, 2013). Besides, effective communication continues to play an important role in reversing the trend in dengue fever whereby this approach can improve knowledge and achieve behavioural change outcomes (World Health Organization, 2012).

In Malaysia, dengue control and preventive measures have been undertaken by authorities. Nonetheless, prevention and control activities from authorities itself did not achieve the target to contain the epidemic. For example, only 40% of households were managed to be fogged within the incubation period of the disease (Ministry of Health, Malaysia, 2003). Continued various approaches of educating the public on prevention and control of dengue fever remains to be an integral part in curtailing the menace. Therefore, the main focus of the Malaysian National Strategic Plan for prevention and control of dengue fever are effective case surveillance, early detection and management of cases, and information management (Disease Control Department, Ministry of Health, Malaysia, 2009). Integrated vector management and social mobilization are currently of great importance, prompting self-reliant actions by the community through increased knowledge, attitude and practice towards the elimination of dengue vectors. Social mobilisation and community participation in dengue control efforts have accounted for 80% reduction of cases in dengue prone and sensitive areas (Ministry of Health, Malaysia, 2003). This clearly indicates the need for a better innovative approach to complement existing dengue fever

control activities. Apart from outdoor residual spraying, dissemination of insect control agents, use of insecticidal paint and biocontrol agent and gene-based sterilisation of insect are some innovations on control of dengue vectors in Malaysia (Lee *et al.*, 2015).

Besides, the importance of eliminating dengue mosquito breeding habitats (source reduction) were anticipated through community mobilization (Casas *et al.*, 2017) but did not materialize into sustainable action. This could be primarily due to the unavailability of continuous informative materials coupled with poor understanding and acceptance of the affected communities towards what is intended for dengue prevention and control. Similarly, public awareness in maintaining good sanitation and long-term prevention and control strategies is also important. Generally, health education activities are reinforced with related health information on dengue fever which is disseminated to the affected communities through available mass media, printed pamphlets, local newspaper coverage and through television and radio advertisements (World Health Organization, 2012). Nonetheless, the effectiveness of these health education practices is varied as these approaches have been in place since the advent of endemic dengue fever. Other more effective and appropriate channels of educating the public is needed to further control the ever-increasing incidences and prevalence of dengue fever (Al-Mansoori *et al.*, 2017).

The advancement of digital technology and its peripherals can supplement and strengthen continuous knowledge-based interventions in the communities through e-learning approaches and materials. The Malaysian Communication and Multimedia Commission (MCMC) reported that currently there are more than 20 million smartphone users in the country and this number is growing every year (Malaysian Communications and Multimedia Commission, 2016). Of this, 56.9% of users have secondary education, 92.7% spend time texting messages while 90.1% seek information from their smart gadgets. The majority of them (79.7%) spend

time on the social network weekly. This current trend and standing of the Malaysian population towards information and communication technology serves as a barometer for relevant stakeholders to tap into this potential means to realign dengue fever learning preferences for a more constructive outcome and impact. Hence, this study was aimed to investigate the feasibility of knowledge transfer of dengue fever to the affected communities by innovating integrated e-learning health education approach through the use of the digital technologies and devices (Zhang *et al.*, 2015). It is important to examine available opportunities for promoting health education on dengue fever through different avenues of interest.

Materials and Methods

Study population

A cross-sectional survey was conducted from November 2016 to June 2017 among residents in dengue fever-prone rural areas located in three states of Peninsular Malaysia (Table 1). The respondents were selected through cluster sampling of the housing estates based on the census provided by the respective local district health offices. Ethical approval was granted by the Research Ethics Committee of Universiti of Teknologi MARA (UiTM) (600-RM-5/1/6). All the information obtained from the data collection was kept confidential.

Table 1: Distribution of data collection sites and population.

Location (District, State)	No. of residents	No. of houses
Tapah Garden, Tapah, Perak	806	150
Dusun Raja Village, Baling, Kedah	706	141
Dusun Village, Kulim, Kedah	293	102
Manggis Village, Sungai Puyu, Penang	990	286
Total	2795	979

These rural residential communities had been experiencing an average of 4 to 8 cases of dengue fever over the last 5 years with a number of fatalities. Data for incidence and location of dengue fever cases were taken from the Epidemiological Report by the regional state health offices. The selected locations were classified as dengue-prone areas as there was a tendency for cases to re-occur since the incidence of dengue was reported annually. Importantly, there is a high probability of dengue outbreak in these areas, if proactive and sustainable preventive activities were not carried out. This study was aimed at obtaining information with regards to the use of smartphones for delivering dengue fever prevention and control information, hence the selection of rural dengue prone areas is vital for this study. Compared to urban dwellers who are well versed with mobile technology in their daily routine, it was also crucial to evaluate the acceptance of using mobile phones as an educating tool and its effectiveness of health education among rural

respondents. On the other hand, compared to urban and semi-urban areas with high risk for dengue infection, the residents in these rural areas were not been subjected to regular and continuous dengue control intervention activities from their respective health authorities.

The sample size required for this study was calculated using Raosoft.com (Raosoft Inc., 2004) with 95% confidence level and 5% margin of error. The minimum sample size was 338 respondents and in anticipation of incomplete response, the number of sample size was inflated by 10% to 372 respondents.

Study design

A questionnaire was developed and designed based on discussion among environmental health practitioners, researchers and relevant literatures on dengue fever. The questionnaire consisted of i) demographic data of respondents, ii) preferences towards e-learning. The

questionnaire was pilot-tested prior to its use in the study. The comments and feedback received during the pilot test helped in modifying the required content of the final questionnaire.

The final year students of Diploma in Environmental Health who had undergone data collection training and field visits were recruited as facilitators. The study was conducted via face to face (F2F) interview using Malay language which was then followed by health education on dengue fever to the respective respondents using materials provided from students' smartphones. Each session took approximately 30 to 45 minutes. The digital materials were then transferred via bluetooth to the respective respondents' smartphones for their immediate use and dissemination. The e-learning materials included causes and symptoms of dengue fever, life cycle of *Aedes* mosquitoes, larvae prevention checklist and methods of prevention and control of dengue. After two weeks, the respective respondents were asked to evaluate the e-learning materials and their preferences towards the e-learning. A scale of "preferred", "not sure" to "not preferred" was used to reflect the degree of acceptance of the e-learning approach.

Data analysis

The data were analysed using Statistical Package for the Social Sciences (SPSS), version 17.0 (SPSS Inc., 2008). Descriptive statistics were

employed to further describe the findings. The association between population dynamics and e-learning preferences were assessed by chi-square analysis with a $p < 0.05$, considered as statistical significance.

Results and Discussion

This intervention aimed to disseminate the importance of prevention and vector control especially in rural dengue fever prone areas in order to reduce dengue transmission, thereby decreasing the incidence of the infection and preventing dengue outbreaks.

Participants' sociodemographic factors

A total of 379 residents participated in this study (Table 2). Respondents were mainly Malay (69.1%), Chinese (24.2%) and Indian (6.6%). More than half of them were female (61.7%). The majority of the respondents were 31 years old and above (81.5%). Most of the respondents were housewives (38.8%), self-employed (31.4%), or worked in the private sectors (18.7%). The majority of the respondents had at least secondary education (72.8%). A total of 90.2% of the respondents had an average household income below RM 3000 (approximately equivalent to US\$ 723, US\$ 1 = RM 4.15). More than half (54.4%) had three to five dependants living together (Table 2).

Table 2: Sociodemographic characteristics of participants.

Variables	n (%)
Location	
Tapah	100 (26.4)
Baling	102 (26.9)
Kulim	80 (21.1)
Sungai Puyu	97 (25.6)
Gender	
Male	145 (38.3)
Female	234 (61.7)
Ethnicity	
Malay	262 (69.1)
Chinese	92 (24.3)
Indian	25 (6.6)
Age	
< 21	8 (2.1)
21 – 30	62 (16.4)
31 – 40	77 (20.3)
41 – 50	80 (21.1)
51 – 60	82 (21.6)
> 60	70 (18.5)
Occupation	
Government sector	26 (6.9)
Private sector	71 (18.7)
Self-employed	119 (31.4)
Housewife	147(38.8)
Unemployed	16 (4.2)
Education level	
Tertiary	6 (1.6)
Secondary	276 (72.8)
Primary	86 (22.7)
None	11 (2.9)
Average household income (Malaysian currency, MYR)	
Less than 1,000	113 (29.8)
1,001-3,000	229 (60.4)
3,001-5,000	33 (8.7)
5,001-8,000	4 (1.1)
No. of dependents	
< 3	101 (26.6)
3 to 5	206 (54.4)
> 5	72 (19.0)
MYR 1 = USD 0.24	

Acceptance of e-learning approach for health education on dengue fever

This study provides the important evidence that e-learning health education approach is a viable option to be considered for future continuous disease prevention strategy. Table 3 shows the proposed reasons of preference towards e-learning approach as an alternative to dengue fever prevention and vector control education. Most of respondents (97.6%) agreed that they were able to clear any doubts by asking the facilitators during the initial face to face visual learning, which helped to improve their understanding. This suggests that e-learning could be an alternative or complementary tool to support continuous public health education, rather than for independent self-learning especially for the first-time users among rural

residents. Most respondents understood the pictures shown on their smartphones (89.7%); could identify the visual aids and related them to vector control activities that they could have taken by themselves. Similarly, 77.8% agreed that they could understand the information highlighted in the devices quickly and agreed that they could share this information to others during their online interaction with others. Moreover, it was generally accepted that this approach of learning was time saving (88.9%) and flexible since the education materials can be stored and replayed regularly. At the same time, 73.6% residents were able to share the information with their neighbours, family and friends easily as it could be transferred easily via the mobile phones. Importantly, the learning activity did not affect their daily family chores and commitments.

Table 3: Reasons for adopting e-learning approach.

Reasons for adopting e-learning	n (%)
Able to clear any doubts by asking	370 (97.6)
Visual learning and understanding (pictorial representation)	340 (89.7)
Able to seek further clarification on related matters	337 (88.9)
Time saving and diversified information	337 (88.9)
Able to understand the information quickly	295 (77.8)
Information can be shared with family and friends	279 (73.6)
Allowed self-regulated learning after	218 (57.5)
Less impact on family routine duties	218 (57.5)

*respondents were allowed to choose more than one reason

The majority of the respondents (99.21%) showed favourable interest and apt towards adopting e-learning approaches in public health education. The knowledge and practices imparted during e-learning integration sessions could create a platform applicable by the communities themselves for promoting a positive behavioural change on dengue fever prevention and control through community mobilization. As the community understand the content, they are likely to share the information and accomplishment with family and friends using social media, thus they are potentially more attentive in maintaining good sanitation at home and work place. In line with the

approach of Communication for Behavioural Impact (COMBI) advocated by World Health Organization, this behaviourally-focused communication strategies help to modify behaviours associated with dengue prevention (World Health Organization, 2012).

Continuous enforcement of laws and legislation on dengue vector control are especially common in dengue hotspot areas in Malaysia. Nonetheless, current common practice in epidemic-prone areas is when there are dengue cases, it will be followed by intensive management of the vector in the possible breeding sites where the case are coming from

(Lee *et al.*, 2015). The intervention includes source reduction such as fogging, diagnosis, recognising the symptoms and reporting of dengue cases. Those are vector control measures undertaken after the onset of an epidemic, which could be too late to achieve significant impact. Alternatively, local healthcare authority could assess the problem and implement appropriate control and prevention measures including risk communication, social mobilization and health promotion with sound monitoring and evaluation from time to time. The study basically focused on improving the knowledge of respondents through the exposure of available information on mobile phones which they can review repeatedly and overtime. This was opposed to the conventional method of educating the public via the use of disposable pamphlets and reading materials which were not kept properly or tend to be misplaced. A better understanding of the knowledge and perceptions in the communities can self-identify the appropriate approaches for prevention and control measures (Arellano *et al.* 2015).

Association between population dynamics and health education through e-learning

Table 4 summarizes the population dynamics and residents' responses towards health education through e-learning. There was significant association between ethnicity, age, education level, total household income, number of dependents in a family and the preferences towards health education through e-learning. Of the various social determinants, it was prominent that users' education level influences the ability of self-learning and sharing with others. Similarly, age was significantly associated with the ability of respondents to understand the information quickly. This is in line with the fact that there are age-related differences in cognitive skill learning and functioning (Salthouse, 2009). Thus, the above-mentioned factors should be considered in future educational campaigns. Nonetheless, gender dissimilarity and types of occupation variables had no significant association with the tendency of e-learning.

Table 4: Association between population dynamics and e-learning preferences.

Variable	Yes	No	Not sure	e-learning preferences	χ^2	p-value	
Ethnicity	Malay	245	0	26	Visual learning and understanding	6.62	0.036
	Chinese	16	0	7			
	Indian	77	0	8			
Ethnicity	Malay	240	0	22	Able to seek further clarification on related matters	9.77	0.008
	Chinese	81	0	11			
	Indian	17	0	8			
Ethnicity	Malay	240	0	22	Time saving and diversified information	9.77	0.008
	Chinese	81	0	11			
	Indian	17	0	8			
Ethnicity	Malay	123	139	0	Allowed self-regulated learning after	8.67	0.013
	Chinese	37	55	0			
	Indian	5	20	0			
Ethnicity	Malay	207	0	55	Information can be shared with family and friends	11.89	0.003
	Chinese	59	0	33			
	Indian	13	0	12			

Variable	Yes	No	Not sure	e-learning preferences	χ^2	p-value	
Age	<21	5	0	3	Able to understand the information quickly	18.97	0.041
	21-30	15	0	47			
	31-40	14	0	63			
	41-50	16	0	64			
	51-60	22	0	60			
	>60	11	0	59			
Education	None	4	7	0	Allowed self-regulated learning after	8.88	0.031
	Primary	32	54	0			
	Secondary	123	153	0			
	Tertiary	6	0	0			
	None	4	0	7	Information can be shared with family and friends	10.21	0.017
	Primary	57	0	29			
	Secondary	212	0	64			
	Tertiary	6	0	0			
Household Income (RM)	≤ 1000	94	0	19	Visual learning and understanding	8.54	0.036
	1001-3000	210	0	19			
	3001-5000	32	0	1			
	5001-8000	4	0	0			
	≤ 1000	49	64	0	Less impact on family routine duties	15.83	0.015
	1001-3000	99	130	0			
	3001-5000	14	19	0			
	5001-8000	4	0	0			
No. of dependents	< 2	80	0	21	Visual learning and understanding	25.87	0.002
	3-5	189	0	17			
	>5	71	0	1			
	< 2	64	0	37	Information can be shared with family and friends	29.52	0.001
	3-5	158	0	48			
	>5	57	0	15			

The prevalence of dengue fever disease transmission and related health issues undermine the continuous efforts of relevant authorities to curb the rise of dengue cases in Malaysia (Pang & Loh, 2016). Environmental health practitioners play important roles in

designing and implementing behavioural and social interventions that will guide communities on the useful risk reduction measures. By using educating materials to improve public understanding, it will enhance self-awareness among the population, thus they keep practicing

self-protection methods such as larvae and adults control (Thapa *et al.*, 2017; Lugova & Wallis, 2017; Kajeguka *et al.*, 2017). Our results suggested that the communities can be engaged directly and indirectly on prevention and control of dengue fever through the use of smart digital devices. Furthermore, the vital information can be shared widely among affected communities via social media. Currently people are communicating daily through the use of mobile phones and they have been used successfully in behavioural change interventions (Zhao *et al.*, 2016). Thus, it is apparent that mobile e-learning could be an effective platform in imbuing positive change in prevention and control of dengue fever.

Our findings may serve as groundwork for more detailed meeting with the program stakeholders. The study, nevertheless, had its limitations. The inclusion of study areas and respondents were limited due to budget constraints and only able to cover four sites. Of note, we used cluster sampling method to optimise the generalizability. We also had to exclude survey with some missing data, as some questions were not answered by the respondents. In addition, since the scope of e-learning for disease prevention is very broad, we had omitted less important factors such as history of dengue, factors determining dengue outbreak, and cost of dengue. We also did not use the feedback to modify the materials for people who had no access to a facilitator while using them. The feedback, though, could be used for such purpose in the future study.

Conclusion

Dengue fever continues to be a debilitating menace in the country with annual increases in reported cases. Health authorities have continuously worked closely to curtail the brutal and never-ending epidemic. Cost effective measures like continuous education of the general public, especially those in the affected areas are much needed through community mobilization. This study has provided adequate

indication for an inclusive and active health education approach in rural communities on dengue fever prevention and control. Upon identifying a dengue fever outbreak area, immediate intervention actions include mass cleaning campaign directly at the affected community without much delay. The affected community can then self-regulate to carry out sustainable best practices for continuous preventive and control measures. Since mobile phone is indispensable and feasible tool to enhance and continuously support the public health education, the integrated and innovative e-learning approach in the community could strengthen and sustain the effort in the fight against dengue fever.

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