ORIGINAL ARTICLE

Assessment of Knowledge, Attitude and Practice of Urban and Rural School Children in Malaysia towards Insects: Before and After the Implementation of I.N.S.E.C.T. Educational Program

Nurul Azmiera [1], Nur-Aliah Natasha Azmi [1], Chong Chin Heo [1,2], and Tengku Shahrul Anuar [3]*

[1] Department of Medical Microbiology and Parasitology, Faculty of Medicine, Universiti Teknologi MARA, Sungai Buloh Campus, 47000 Sungai Buloh, Selangor, Malaysia
[2] Institute for Pathology, Laboratory and Forensic Medicine (I-PPerForM), Universiti Teknologi MARA, Sungai Buloh Campus, 47000 Sungai Buloh, Selangor, Malaysia
[3] Centre for Medical Laboratory Technology Studies, Faculty of Health Sciences, Universiti Teknologi MARA, Puncak Alam Campus, 42300 Puncak Alam, Selangor, Malaysia

ABSTRACT

Introduction: Insects-related education programs targeting specifically on school children were scarce in Malaysia. Our study developed an educational program called Insect Science Educational Program using Creativity and Technology (I.N.S.E.C.T.) that was intended to educate school children on insects, especially the medically important ones. The aim of this study is to assess and compare Knowledge, Attitude and Practice (KAP) of school children living in urban and rural areas before and after the educational program was introduced. **Methods:** This study was conducted among school children living in urban and rural communities of Selangor, Malaysia. The questionnaires related to general and medical knowledge of insects, common attitude, and practices towards insects were distributed before and after the program. **Results:** Three hundred thirty-nine (n = 389) subjects were able to actively participate in the program and answered both pre and post questionnaires. There was a significant increase in the mean scores of knowledges of school children, especially those from the urban areas (4.40 ± 0.79). However, there were significant drops in the mean scores of attitudes (15.33 ± 3.89) and practice (24.30 ± 5.24) of the school children also from the urban areas. **Conclusion:** In summary, the INSECT program was able to upgrade knowledge significantly, but more modifications were necessary to improve the attitude and practice of the school children related to insects.
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Keywords: Knowledge, Attitude, Practice, Insect, School children

Corresponding Author:
Tengku Shahrul Anuar, PhD
Email: tengku9235@uitm.edu.my
Tel: +603-3258 4425
Fax: +603-3258 4599

INTRODUCTION

Insects are the most populated organism on earth, filling up 73% of the total number of overall faunas (1). Approximately 82% of insects have been identified at species level with Coleoptera, Lepidoptera, Diptera and Hymenoptera being the most described Orders (2). Insects have important roles as pollinators, organic matter decomposers, nutrient cyclers and primary consumers in food webs and indicators for water quality which helps in maintaining the ecosystem (3,4). However, some insects possessed threats to the other organism such as humans and animals because of their ability to transmit diseases.

Insect-borne diseases are infections of bacteria, viruses and parasites to other organisms using insects as vectors. The common terms to describe these types of insects were medically important insects. Among all, flies and mosquitoes are given special attention because of their ability to spread diseases such as leishmaniases, dengue, malaria and zika (5, 6, 7, 8, 9). The prevalence of insect-borne diseases in 100 different countries was 700 million annually where malaria and dengue showed the highest number, 96-600 million annual global cases with 0.02-8 million deaths (10). Most affected countries included were in the tropics and subtropics (11).

Malaysia was affected by insect-borne diseases such as leishmaniases, dengue, malaria, lymphatic filariasis, Japanese encephalitis and Chikungunya (5, 7, 12, 13). Several insect-vector control programmes have been

introduced but the focus remained on controlling disease transmission by mosquitoes (14, 15, 16). These strategies include disease surveillance and control, vector surveillance and control, public education, interagency collaborations and community participation, quality assurance and research and training (14, 16). The implementation of the strategies became an economic burden to Malaysia. For example, in 2010, Packierisamy and colleagues estimated that the cost for national vector control programs in Malaysia to be US$73.5 million. These costs included fogging activities and inspection of mosquitoes breeding sites (15).

Therefore, to reduce the cost of the national vector programs, active participation by the public is necessary (17, 18). A few studies had been conducted in Malaysia to assess the Knowledge, Attitude and Practice (KAP) of the public from various living areas such as dengue hotspots, non-dengue hotspots, islands, forests and rural areas (17, 18, 19). The results showed that public health education was important to improve the KAP of the public. Therefore, for this study, an educational program called Insect National Science Education through Creativity and Technology (I.N.S.E.C.T.) was developed to educate and increase the awareness of school children in Malaysia towards medically important insects. The objective of this study was to evaluate and compare the KAP of the school children living in urban and rural areas of Malaysia before and after the educational program was introduced.

MATERIALS METHODS

Study areas

Selangor, a state in Malaysia occupied a part of the coastal alluvial plain on the Straits of Malacca. The estimated population of the state was reported to be ~7 million people in 2020. Among this number 29.5% were children. For this study, eight primary schools (four were classified as rural and another four were determined as urban by the Ministry of Education Malaysia) were randomly selected from Kuala Langat and Kuala Selangor districts of Selangor state. The classifications for urban and rural depended on the location of the schools from the city and access to facilities such as the internet connection, teaching tools and others.

Study population and respondents

The sample size calculated using Raosoft Inc. (Seattle, USA) indicated that a minimum number of 367 respondents was required for this study. During the initial survey, 401 respondents (210 respondents were from rural schools and 191 respondents from urban schools) agreed to participate. The school children were selected randomly among students by their age ranging from 10 to 12 years old. The students were identified by their teachers based upon the age range. The specific age range was selected due to the exposure towards knowledge related to insects in their formal standardised textbooks used in schools.

Questionnaire to evaluate Knowledge, Attitude and Practice on medically important insects

A validated questionnaire to assess the Knowledge, Attitudes and Practice (KAP) on medically important insects were used in this study (20). The questionnaire was translated from English to Malay language to ensure that it was well understood by the school children. The questionnaire contained 20-items that were further divided into three domains. Each domain was further divided into four dimensions for Knowledge, one dimension for Attitude and two dimensions for Practice (**Fig. 1**). The Knowledge section included the definition of entomology, identification of insects, biology of

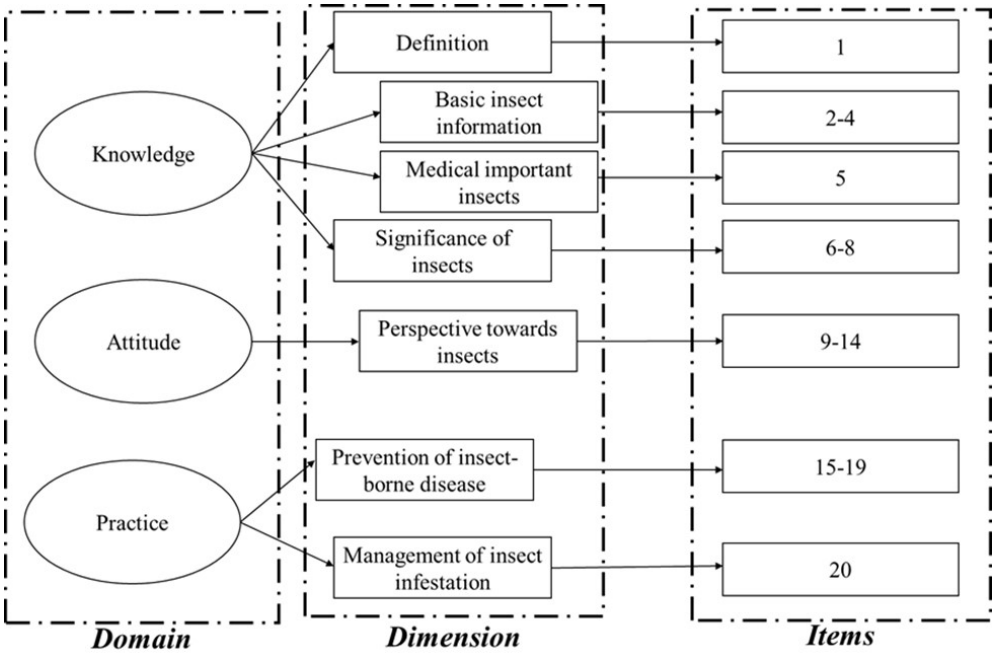

Fig. 1: The division of domain, dimensions and items of the questionnaire to assess the KAP of urban and rural school children in Selangor. Each division is boxed into their individual categories.

insects, classification of insects and roles of insects. The Attitude and Practice sections were intended to assess the general perception of insects as well as the prevention and management of insect's vectors. Multiple-choice answers with only one option for the right answer was given for the Knowledge section. Meanwhile for the Attitude and Practice sections the answers were given in the form of Likert scales.

I.N.S.E.C.T. community program

An educational program called I.N.S.E.C.T. was designed to improve the knowledge of school children on medically important insects. The content of the program included six educational videos produced locally by postgraduate students and experts. The videos covered several topics related to insects such as i) brief introduction of insects; ii) insects and diseases; iii) insect collection and processing; iv) life cycle on an insect; v) craft of insect holographic; vi) insect building craft. Prior to the program, a set of KAP pre-questionnaire made in Google Forms and consent forms for participation in the program was distributed to the school children from the eight schools. Adhering to social distancing and limited face-to-face activities due to COVID-19, the program was conducted online via a Google Meet platform for approximately 4 hours in each school. The effectiveness of the program was evaluated through the reassessment of the KAP questionnaire on medically important insects after the program.

Statistical analysis

Demographic data collected from participants included age, gender and the type of schools. The KAP scores were calculated and evaluated according to the scoring system in Table I. Data errors such as missing values and redundant participants were cleaned prior to the analysis. In the Knowledge section, the scores for the right answer were one (1) while the wrong answer was recorded as zero (0). The attitudes and practice were evaluated by a Likert scale from one (1) = totally disagree, two (2) = disagree, three (3) = not sure, four (4) = agree and five (5) = totally agree. The quantitative values were represented in the forms of means and standard deviation (SD). The data was recorded in Microsoft Excel prior to statistical analysis using IBM SPSS Statistics 28 (Chicago, USA). Paired data with two variables were evaluated by using a McNemar test and paired data with more than two variables were evaluated by the exact test for symmetry. The KAP scores of each school before and after the program was evaluated by using paired t-test.

Ethical approval

The study was approved by Universiti Teknologi MARA Human Ethics Community (REC/07/2020 (MR/159). The participants were provided with consent forms that were required to be written and signed by the school children with the presence of an adult (i.e., teachers or parent) prior to the program and KAP assessment.

Table I: The Knowledge, Attitude and Practice (KAP) scoring system

Domain	Number of Questions	Scores for answers	Score range
Knowledge	5	1 = Correct 0 = Wrong/Don't know	Good = 2.6 – 5.0 Moderate = 2.5 Poor = 0 – 2.4
Attitude	5	1 = Totally disagree 2 = Disagree 3 = Not sure 4 = Agree 5 = Totally agree	Good = 12.6 – 25.0 Moderate = 12.5 Poor = 1 – 12.4
Practice	6	1 = Totally disagree 2 = Disagree 3 = Not sure 4 = Agree 5 = Totally agree	Good = 16.0 – 30.0 Moderate = 15.0 Poor = 1 – 14.0

RESULTS

Demographic information

The total number of students from eight schools located in rural and urban areas of Selangor, Malaysia involved as subjects in the I.N.S.E.C.T. program were originally 401 students. However, due to some unexpected circumstances such as health issues and family matters, only 389 students (97.01%) were able to participate in the program and answer both questionnaires given before and after the program. Even so, the analysis was still conducted as the number of subjects were still within the sample size expected. Details of demographic descriptions of the subjects such as gender (boy and girl), type of schools (urban and rural) and age of the school children (10 years old, 11 years old and 12 years old) were reported in Table II. In this study, it was observed that the number of girls (56.29%) attending the program and the questionnaire were more than boys (43.70%). Also, the age range of students participating in the program were between 12 years olds (70.12%), 11 years olds (24.42%) and 10 years olds (5.40%). Meanwhile for the type of schools, urban areas showed slightly higher participation (51.16%) than the rural areas.

Table II: The demographic descriptions of the students participating in the I.N.S.E.C.T. program

	Total number of subjects (n = 401) (%)	Total number of subjects after program (n = 389) (%)	Total number of lost subjects (n = 12) (%)	p-value
Gender				
Boy	179 (44.64)	170 (43.70)	9	0.943
Girl	222 (55.36)	215 (56.29)	7	
Age				
10 years old	22 (5.48)	21(5.40)	1	0.885
11 years old	95 (23.69)	95 (24.42)	0	
12 years old	284 (70.82)	273 (70.12)	11	
Type of schools				
Urban	210 (52.36)	199 (51.15)	11	0.182
Rural	191 (47.63)	190 (48.84)	1	

*p-value <0.05 is considered significant and was marked in bold in the table. Comparison of the subjects before and after the program were performed using paired t-test.

The analysis of Knowledge, Attitude and Practice from the questionnaire

For KAP analysis, only 389 students that were able to answer the questionnaire before and after the I.N.S.E.C.T. program was included as test subjects. In the Knowledge section, overall results showed that there is an increase in the mean score (Mean ± SD) of children's knowledge on medical important insects before (3.92 ± 1.04) and after

(4.20 ± 0.99) the program (Table III). It was observed that the percentage of students who understood the definition of insects (87.1%) and the basic characteristics of insects (68.6%) improved significantly to 94.1% and 83.3% respectively after the program. Other questions related to the life cycle of insects (72.8%), diseases caused by insects (80.5%) and the significance of insects (79.9%) showed small increments of knowledge from before the program was held.

Table III: The questionnaire (Knowledge section) with the correct and wrong answers from the subjects before and after the I.N.S.E.C.T. program was held regardless of type of schools, gender and ages

Question	Answer	Before Program (n = 389) (%)	After Program (n = 389)	p-value
What is entomology?	Studies related to insects Correct Wrong	339 (87.1) 50 (12.9)	366 (94.1) 23 (5.9)	0.002*
How many legs does an insect has?	Six Correct Wrong	267 (68.6) 122 (31.4)	324 (83.3) 65 (16.7)	<0.001*
Which of these is the correct life cycle for an insect?	Eggs>Larvae>Pupae>Adults Correct Wrong	283 (72.8) 106 (27.2)	294 (75.6) 95 (24.4)	0.406
From the choices below, which one of the diseases were not caused by insects?	Diabetes Correct Wrong	313 (80.5) 76 (19.5)	333 (85.6) 56 (14.4)	0.064
Which one of these insects is important for pollination?	Bees Correct Wrong	311 (79.9) 78 (20.1)	314 (80.7) 75 (19.3)	0.862
Total score (Mean SD)		*3.92 1.04*	*4.20 0.99*	

*p-value <0.05 is considered significant and were marked in bold in the table. Comparison of the subjects before and after the program were performed using McNemar test and the exact symmetry test.

Meanwhile in the Attitude section, the mean score slightly dropped before (19.48 ± 3.48) and after the program (17.14 ± 4.14) (Table IV). Before the program, the students were not sure whether insects were dangerous (40.4%) and able to cause disease (34.4%) but they believe that insects should not be exterminated (35.7%). After the program, the results showed significant shifts in their opinions towards medical important insects where they considered insects to be dangerous (34.7%), able to cause disease (33.2%) and should be exterminated (34.4%). Majority of the students grasped the fatality of mosquito bites (74.6%) and their expression of interest in learning more about insects (73.3%) even before the program was conducted. As a result, there were no significant differences between their answers from before and after the program.

As for the Practice section, the mean scores showed a small decrease before (27.52 ± 3.38) and after the program (25.90 ± 4.75) (Table V). Majority of the students practised proper handling of medical important insects despite there were significant decreases in their answers before and after the program. However, after the program, they still understood the need to throw away stagnant water (67.1%), old tyres (57.3%), and food wastes (77.4%). Moreover, they also knew the importance of cleaning the garbage bin (70.4%) and the house (64.8%).

The total KAP scores were compared between urban and rural areas in Table VI. In the Knowledge section, the mean scores towards medically important insects before and after the program were significantly different between urban and rural schools. Rural schools showed higher mean scores for Knowledge at first (4.07 ± 0.98) while urban schools were (3.75 ± 1.08). However, after the program, urban schools showed better increment (4.40 ± 0.79) than the rural schools. As for the Attitude mean scores, there was no significant difference before the program between urban (19.41 ± 3.57) and rural schools (19.42 ± 3.59). However, after the program, the Attitude scores for urban schools decreased significantly (15.33 ± 3.89) while rural schools remained unchanged (19.27 ± 3.36). The same observation was seen for Practice scores where urban schools (27.39 ± 3.61) and rural schools (27.66 ± 3.59) were originally almost similar. However, after the program, the Practice scores for urban schools were) significantly lower (24.30 ± 5.24) compared to rural schools (27.36 ± 3.62).

DISCUSSION

Medical important insects such as mosquitoes and flies have been recorded as vectors for diseases (21, 22, 23, 24). Current KAP studies in Malaysia were more focused on specific mosquito-vectored diseases such as dengue fever, malaria and Zika (25, 26, 27, 28). To our knowledge, this is the first study in Malaysia that attempted to assess the KAP scores related to insects among school children that live in both urban and rural areas before and after an intervention module called I.N.S.E.C.T. was introduced. In the study, we found that there is an improvement of general and medical knowledge related to insects after the program has been implemented especially for children in urban schools. This diminished the stigma that urban schools' children have better access to information than in rural areas. The United Nations International Children's Emergency Fund (UNICEF) reported that despite living in urban areas, children could be the victims of urban paradox (29). Hence, through the I.N.S.E.C.T. program, it was important to ensure that the knowledge related to medical important insects were disseminated regardless of the children's background. This effort was in parallel with two Sustainable Development Goals (SDGs), which promoted good health and well-being (SDG 3) and quality education (SDG 4).

Regarding the attitude and practice of school children

Table IV: The answers from the Attitude section of the questionnaire before and after the I.N.S.E.C.T. program was held regardless of type of schools, gender and ages

Question	Before program (n = 389) (%)					After program (n = 389) (%)					
	Totally Agree	Agree	Not sure	Disagree	Totally Disagree	Totally Agree	Agree	Not sure	Disagree	Totally Disagree	p-value
Attitude											
1. I am confident that all insects are dangerous.	35 (9.0)	49 (12.6)	157 (40.4)	72 (18.5)	76 (19.5)	135 (34.7)	49 (12.6)	107 (27.5)	56 (14.4)	42 (10.8)	<0.001*
2. I am confident that all insects should be exterminated	34 (8.7)	37 (9.5)	78 (20.1)	101 (26.0)	139 (35.7)	129 (33.2)	42 (10.8)	70 (18.0)	73 (18.8)	75 (19.3)	<0.001*
3. I am confident that all insects can cause diseases	59 (15.2)	29 (7.5)	134 (34.4)	87 (22.4)	80(20.6)	134 (34.4)	58 (14.9)	95 (24.4)	56 (14.4)	46 (11.8)	<0.001*
4. I believe I need to see a doctor if I still have a fever after 3-days if I was bitten by mosquitoes	290 (74.6)	64 (16.5)	23 (5.9)	6 (1.5)	6 (1.5)	288 (74.0)	67 (17.2)	23 (5.9)	5 (1.3)	6 (1.5)	0.452
5. I believe I need to learn more about insects	285 (73.3)	51 (13.1)	32 (8.2)	11 (2.8)	10 (2.6)	301 (77.4)	50 (12.9)	31 (8.0)	5 (1.3)	2 (0.5)	0.247
Total score (Mean ± SD)			19.48 ± 3.48					17.14 ± 4.14			

Table V: The answers from the Practice section of the questionnaire before and after the I.N.S.E.C.T. program was held regardless of type of schools, gender and ages

Question	Before program (n = 389) (%)					After program (n = 389) (%)					
Practice	Totally Agree	Agree	Not sure	Disagree	Totally Disagree	Totally Agree	Agree	Not sure	Disagree	Totally Disagree	p-value
1. I need to throw away stagnant water to prevent mosquitoes' breeding	334 (85.9)	28 (7.2)	12 (3.1)	7 (1.8)	8 (2.1)	261 (67.1)	29 (7.5)	43 (11.1)	18 (4.6)	38 (9.8)	<0.001*
2. I need to throw away old tyres to ensure no mosquito larvae	289 (74.3)	50 (12.9)	24 (6.2)	11 (2.8)	15 (3.9)	223 (57.3)	51 (13.1)	45 (11.6)	23 (5.9)	47 (12.1)	<0.001*
3. I need to clean my house to prevent mosquitoes' breeding	333 (85.6)	31 (8.0)	13 (3.3)	6 (1.5)	6 (1.5)	252 (64.8)	37 (9.5)	45 (11.6)	25 (6.4)	30 (7.7)	<0.001*
4. I need to clean the garbage bin containing leftover food to prevent flies' breeding	315 (81.0)	52 (13.4)	12 (3.1)	6 (1.5)	4 (1.0)	274 (70.4)	54 (13.9)	42 (10.8)	12 (3.1)	7 (1.8)	<0.001*
5. I need to use mosquitoes screening clothes to protect myself from mosquitoes	193 (49.6)	115 (29.6)	56 (14.4)	14 (3.6)	11 (2.8)	243 (62.5)	94 (24.2)	44 (11.3)	5 (1.3)	3 (0.8)	0.011*
6. I need to throw away food that has been infested with flies	294 (75.6)	55 (14.1)	24 (6.2)	7 (1.8)	9 (2.3)	301 (77.4)	50 (12.9)	30 (7.7)	4 (1.0)	4 (1.0)	0.363
Total score (Mean ± SD)			27.52 ± 3.38					25.90 ± 4.75			

Table VI: Comparison of KAP scores before and after the program in urban and rural areas

	Urban (Mean ± SD)	Rural (Mean ± SD)	p-value
Knowledge			
Before program	3.75±1.08	4.07±0.98	0.004*
After program	4.40±0.79	3.96±1.16	<0.001*
Attitude			
Before program	19.41±3.57	19.42±3.59	0.989
After program	15.33±3.89	19.27±3.36	<0.001*
Practice			
Before program	27.39±3.61	27.66±3.59	0.424
After program	24.30±5.24	27.36±3.62	<0.001*

*p-value <0.05 is considered significant and were marked in bold in the table. Comparison of the subjects before and after the program were performed using paired t-test.

towards medical important insects in Malaysia, the KAP scores showed that children have a positive attitude and good practice in both rural and urban areas especially towards medical important insects before the program. Previous research showed that information related to dengue was spread to the public via various methods, including newspapers, television and radio commercials, social media as well as seminars (30). Therefore, it can be assumed that most of the information spread reached the school children involved with the program Selangor successfully. Unfortunately, the scores from urban school children decreased for both sections after the program. We believe that these results could be due to a change in the perspectives of the children. Our program was designed to emphasise on important medical insects. Although there is a drop in mean score of the Attitude section, students were observed to have a shift in their opinions towards insects after the program. Originally, many of them were unsure whether the insects are dangerous or can cause diseases. After the program, they have started to form opinions that important medical insects are dangerous and are able to cause disease. Although this interpretation does not go well with the intention of the question (referring to insects in general). This was probably due to the impact of modules in the I.N.S.E.C.T. program that were highlighting medical importance to insects rather than the important roles of insects in the environment. In future, the I.N.S.E.C.T. modules can be further improved by adding more information and activities related to general information on insects.

CONCLUSION

In summary, this is the first attempt in Malaysia that aimed to educate the children on insects with a special focus on medically important insects in a fun learning environment. Modules in I.N.S.E.C.T. can be further improved to include more hands-on activities related to the general roles of insects. The modules should also emphasise on the attitude and practice of the school children especially in the urban area towards medically important insects. More KAP studies are necessary in the future that involve more school children throughout Malaysia to understand their opinions on insects and the effects of intervention modules like I.N.S.E.C.T. in educating them.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

1. Leandro C, Jay-Robert P. Perceptions and representations of animal diversity: Where did the insects go? Biological Conservation. 2019;237(4):400–8. doi: 10.1016/j.biocon.2019.07.031
2. Stork NE. How many species of insects and other terrestrial arthropods are there on earth? Annual Reviews of Entomology. 2018;63:31–45. doi: 10.1146/annurev-ento-020117-043348
3. Crespo-Pйrez V, Kazakou E, Roubik DW, Cбrdenas RE. The importance of insects on land and in water: a tropical view. Current Opinions in Insect Science. 2020;40: 31–8. doi: 10.1016/j.cois.2020.05.016
4. Pardo A, Borges PAV. Worldwide importance of insect pollination in apple orchards: A review. Agriculture, Ecosystem and Environment. 2020;293(2): 106839. doi: 10.1016/j.agee.2020.106839
5. Ab Rahman AK, Abdullah FH. Visceral leishmaniasis (kala-azar) and malaria coinfection in an immigrant in the state of Terengganu, Malaysia: A case report. Journal of Microbiology, Immunology and Infection. 2011;44(1):72–6. doi: 10.1016/j.jmii.2011.01.014
6. Bouzid M, Colyn-Gonzбlez FJ, Lung T, Lake IR, Hunter PR. Climate change and the emergence of vector-borne diseases in Europe: Case study of dengue fever. BMC Public Health. 2014;14(1):1–12. doi: 10.1186/1471-2458-14-781
7. Tan TK, Yap NJ, Leong KF, Teh CS, Tay ST, Lim YAL. Imported case of Leishmania tropical cutaneous leishmaniasis in a 10-year-old child in Malaysia. Tropical Biomedicine. 2022;39(1):86–8.
8. Tunali M, Radin AA, Başıbьуьk S, Musah A, Borges IVG, Yenigun O, Aldosery A, Kostkova P, dos Santos WP, Massoni T, Dutra LMM, Moreno GMM, de Lima CL, da Silva ACG, Ambrizzi T, da Rocha RP, Jones KE, Campos LC. A review exploring the overarching burden of Zika virus with emphasis on epidemiological case studies from Brazil. Environmental Science and Pollution Research. 2021;40:55952–66. doi: 10.1007/s11356-021-15984-y
9. Yangzom T, Gueye C, Namgay R, Galappaththy GN, Thimasarn K, Gosling R, Murugasampillay S, Dev V. Malaria control in Bhutan: Case study of a country embarking on elimination. Malaria Journal. 2012;11(1):1–11. doi: 10.1186/1475-2875-11-9
10. Nicoletti M. Three scenarios in insect-borne diseases. In: Insect-Borne Diseases in the 21st Century. Massachusetts, United States: Academic

Press. 2020:99–251.
11. World Health Organization. Vector-borne diseases. 2020. Available at: https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases. Accessed 27 February 2024.
12. Abubakar S, Sam I. Reemergence of endemic Chikungunya, Malaysia. Emerging Infectious Diseases. 2007;13(1):147–9. doi: 10.3201/eid1301.060617
13. Vythilingam I, Chiang GL, Lee HL, Singh KI. Bionomics of important mosquito vectors in Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health. 1992;23(4):587–603.
14. Ong SQ. Dengue vector control in Malaysia: A review for current and alternative strategies. Sains Malaysiana. 2016;45(5):777–85.
15. Packierisamy PR, Ng CW, Dahlui M, Inbaraj J, Balan VK, Halasa YA, Shepard DS. Cost of dengue vector control activities in Malaysia. The American Journal of Tropical Medicine and Hygiene. 2015; 93(5):1020–7. doi: 10.4269/ajtmh.14-0667
16. Teng AK, Singh S. Epidemiology and new initiatives in the prevention and control of dengue in Malaysia. Dengue Bulletin. 2001; 25:7–14.
17. Al-Adhroey AH, Nor ZM, Al-Mekhlafi HM, Mahmud R. Opportunities and obstacles to the elimination of malaria from Peninsular Malaysia: Knowledge, attitudes and practices on malaria among aboriginal and rural communities. Malaria Journal. 2010;9(1):1–6. doi: 10.1186/1475-2875-9-137
18. Shafie A, Roslan MA, Ngui R, Lim YAL, Sulaiman WYW. Mosquito biology and mosquito-borne disease awareness among island communities in Malaysia. Journal of American Mosquito Control Association. 2016;32(4):273–81. doi: 10.2987/16-6604.1
19. Ghani NA, Shohaimi S, Hee AKW, Chee HY, Emmanuel O, Ajibola LSA. Comparison of knowledge, attitude, and practice among communities living in hotspot and non-hotspot areas of dengue in Selangor, Malaysia. Tropical Medicine and Infectious Disease. 2019;4(1):1–10. doi: 10.3390/tropicalmed4010037
20. Azmi NAN, Zamri NA, Heo CC, Basri, TSATA. Development and validation of a questionnaire assessing the knowledge, attitude, and practices towards medically important insects among schoolchildren in Malaysia. Journal of Health and Translational Medicine. 2023;247–53. doi: 10.22452/jummec.sp2023no2.27
21. Scott TW, Morrison AC. Vector dynamics and transmission of dengue virus: implications for dengue surveillance and prevention strategies: vector dynamics and dengue prevention. In: Rothman, A. (eds) Dengue Virus. Current Topics in Microbiology and Immunology. Berlin, Germany: Heidelberg. 2010:115–28.
22. Ready PD. Biology of phlebotomine sand flies as vectors of disease agents. Annual Reviews of Entomology. 2013;58:227–50. doi: 10.1146/annurev-ento-120811-153557
23. Medlock JM, Hansford KM, Versteirt V, Cull B, Kampen H, Fontenille D et al. An entomological review of invasive mosquitoes in Europe. Bulletin of Entomological Research. 2015;105(6) 637–63. doi: 10.1017/S0007485315000103
24. Szentiv6nyi T, Christe P, Glaizot O. Bat flies and their microparasites: current knowledge and distribution. Frontiers in Veterinary Science. 2019;6 :115. doi: 10.3389/fvets.2019.00115
25. Selvarajoo S, Liew JWK, Tan W, Lim XY, Refai WF, Zaki RA. Sethi N, Wan Sulaiman WY, Lim YAL, Vadivelu J, Vythilingam I. Knowledge, attitude and practice on dengue prevention and dengue seroprevalence in a dengue hotspot in Malaysia: A cross-sectional study. Scientific Reports. 2020;10(1):1–13. doi: 10.1038/s41598-020-66212-5
26. AhbiRami R, Zuharah WF. School-based health education for dengue control in Kelantan, Malaysia: impact on knowledge, attitude, and practice. PLoS Neglected Tropical Diseases. 2020;14(3):e0008075. doi: 10.1371/journal.pntd.0008075
27. Munajat MB, Rahim MAFA, Wahid W, Seri Rakna MIM, Divis PC, Chuangchaiya S, Lubis IND, Osman E, Mohd Kasri MR, Idris ZM. Perceptions and prevention practices on malaria among the indigenous Orang Asli community in Kelantan, Peninsular Malaysia. Malaria Journal. 2021;20(1):202. doi: 10.1186/s12936-021-03741-y
28. Wong LP, Alias H, Lee HY, AbuBakar S. Has Zika Been Forgotten? Findings from nationwide survey on knowledge, attitudes, and mosquito preventive practices in Malaysia. Disaster Medicine and Public Health Preparedness 2023;17:e131. doi: 10.1017/dmp.2022.40
29. The United Nations International Children's Emergency Fund (2018). Advantage or paradox: The challenge for children and young people of growing up urban. 2018. Available at: https://data.unicef.org/resources/urban-paradox-report/. Accessed 27 February 2024.
30. Guad RM, Wu YS, Aung YN, Sekaran SD, Wilke ABB, Low WY, Sim MS, Carandang RR, Jeffree MS, Taherdoost H, Sunggip C, Lin CLS, Murugaiah C, Subramaniyan V, Azizan N. Different domains of dengue research in Malaysia: a systematic review and meta-analysis of questionnaire-based studies. International Journal of Environmental Research and Public Health. 2021;18(9):4474. doi: 10.3390/ijerph18094474