Review Article

# School-based Prevention of Mosquito-borne Diseases: A Systematic Review

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## ABSTRACT

**Background:** Mosquito-borne diseases (MBDs) are among the important and highly complex issues in public health. School age children have been encouraged to participate in ongoing household MBDs control activities such as source reduction, as part of MBDs control efforts. Numerous school-based health education studies have been conducted worldwide on the interventions to prevent MBDs. However, the results are still varied and uncertain. This systematic review aims to answer the question of:" Are school-based educational programs able to improve students' knowledge, attitudes, and practices about mosquito-borne diseases?".

**Methods:** This systematic review was conducted using the Preferred Reporting Items for systematic reviews and meta-analyses (PRISMA) statement. A systematic literature search was performed using Sciencedirect, Cochrane library, PubMed, ProQuest, and the Wiley Online Library in the time period of 2000 to 2021. Eligibility criteria was determined according to PICOS guidelines. Quality and risk of bias of the studies were assessed by the effective public health practice project tool (EPHPP) and Cochrane risk-of-bias tool (RoB-2), respectively. Data were analyzed qualitatively, by looking at the number of participants, study design, and the main results obtained in each of the included studies.

**Results:** In the initial search, 1,424 studies were found. Duplicates, those not relevant to students and MBDs, review articles, case reports, dissertations and non-English articles were eliminated. Twenty-three studies fulfilling the inclusion criteria were analyzed. Overall, there was an increase in knowledge, attitude, and practice regarding MBSs. However, knowledge appears to be the most important variable targeted by the included studies. All studies stated a significant increase in knowledge.

**Conclusion:** The effect of the educational interventions on knowledge was more prominent. Future studies need more specialized educational interventions to have a stronger impact on students' attitudes and performance. Further research is also needed to generate stronger evidence and evaluate the long-term impact of these interventions on students' knowledge, attitudes, and practice. The results of this review can be a guide to carry out appropriate interventions in elementary schools.

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## Highlights

• Educational interventions that target school students' knowledge, attitudes, and practices about mosquito-borne diseases (MBDs) are important.

• School-based educational interventions in the reviewed studies had a positive effect on students' knowledge, attitude and practice about MBDs.

• Educational programs to eradicate MBDs in schools had a stronger impact on students' knowledge.

## Plain Language Summary

Targeting school students in the mosquito-borne diseases (MBDs) training programs is very important, given that the school environment is a vulnerable place for the development of the vector. Students are considered good agents for change in the school environment and society. Improving the knowledge, attitude and performance of students about Mosquito-borne diseases can be a solid foundation for preventing these diseases in the future. The present study concludes that the education programs used in the reviewed studies strongly influences students' prior knowledge. However, there is no evidence of long-term sustainability of changes in student practice.

## 1. Introduction

Mosquito-borne diseases (MBDs) are among the important and highly complex issues in public health. Several important factors, such as biological, ecological, and socioeconomic factors, greatly influence the incidence of MBDs in a particular area of a community (Lee, Halverson, & Ezinwa, 2018; Nayyar et al., 2012). Various diseases are categorized as MBDs, such as malaria, dengue fever, typhoid, chikungunya, lymphatic filariasis, and Japanese encephalitis. These diseases have contributed significantly to the morbidity and mortality rates since they were first discovered. The prevalence of MBDs is common in areas with poor environmental sanitation conditions (Arimaswati et al., 2020). Vulnerable populations that lack knowledge, have low incomes, receive irregular water services, have overcrowded housing, and local rural communities whose water source is lakes are all susceptible to increased risk of dengue (Rodrigues et al., 2018; Suwanbamrung et al., 2013). Meanwhile, all risk factors are closely related to management based on multiple interventions in the community (Nigusie et al., 2021). The larval indices are a classical index of dengue which decreases when using an education program (Suwanbamrung et al., 2021). Engaging school-aged children in these programs effectively advances community exposure to messages related to malaria and other MBDs and also improves their perception and behaviors (Kebede et al., 2020). School-based health education is one of the effective methods that can help to control malaria and dengue (Dsouza et al., 2022).

School-based health education is a commendable tool to enhance knowledge, attitude, and practice and creates awareness among school children about the seriousness of MBDs since this disease is particularly prevalent among them (Sam et al., 2013; Midzi et al., 2014). School age children have been encouraged to participate in ongoing household MBDs control activities, such as source reduction, as part of MBDs control efforts (Khun & Manderson, 2007; Kebede et al., 2020). For the prevention of vector-borne diseases, the usefulness of educational interventions (e.g., audiovisual material) that improve knowledge, attitude, and practice about the prevention of disease transmission is pointed out, with the school being an educational space to improving knowledge about health prevention (Kolbe, 2019; Roja et al., 2022).

The studies which have been conducted worldwide reveal that interventional school-based health education programs utilizing interactive lecture methods and audiovisual aids (videos) have helped students to improve their knowledge regarding selected mosquito-borne diseases. Students in these programs showed interest in learning about vectors and their role in disease transmission (Wilson et al., 2020). Health education could be an effective medium in promoting health and possibly behavioral changes in the community (Raghupathi & Raghupathi, 2020) and imparting health education to school students is the starting point for ensuring community participation (Pulimeno et al., 2020). Although many school-based studies have been conducted on MBDs prevention training, it is not clear whether the impact of these educational interventions on the knowledge, attitude and practice of

students in this field has been significant or not. In addition, wide differences can be seen in determining the variable that has been affected by these trainings more than other variables. Based on this, the need to conduct systematic review studies was felt in order to reach a conclusion about the effectiveness of school-based education programs on students' knowledge, attitude and practice about MBDs prevention. The aim of this review is to answer the question of "Are school-based educational programs able to improve students' knowledge, attitudes, and practices about mosquito-borne diseases"? For this purpose, the evidence of the last twenty years (2000 to 2021) available in peer review journals was considered.

## 2. Materials and Methods

### Review protocol

This systematic review was conducted using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement (Moher et al., 2009). The current study tries to answer the question of "Are school-based educational programs able to improve students' knowledge, attitudes, and practices about mosquito-borne diseases" from articles that have been published in the period 2000-2021.

### Search strategy

Relevant articles were searched and collected using Sciencedirect, Cochrane library, PubMed, ProQuest, and the Wiley Online Library, with a publication time between 2000-2021. We also conducted a reference search of articles that met the inclusion criteria. The search keywords were adjusted according to the Mesh terms for health research. The keywords used vary, depending on the search engine used. In general, the keywords focus on Health education OR Educational intervention OR Health promotion OR Health information AND Mosquito Borne Diseases OR Dengue AND malaria AND School based OR Students.

### Eligibility criteria

To propose a well-formulated question and selection of studies for inclusion in this review (PICOS) criteria including participants, intervention, comparison, outcome, and study design were used. PICOS criteria for this study are summarized in Table 1. Other inclusion criteria were time frame between 2000 to 2021, number of participants>30, and articles limited to English language. Review articles, editorials, comments, not full texts, case reports and dissertations were excluded.

### Study quality

Two reviewers assessed the quality of the studies using the critical appraisal tool of the effective public health practice project (EPHPP) (Thomas et al., 2004). This tool provides an organized approach to rating several sections and then the overall article. Interventions are rated as "strong" (4 strong ratings with no weak ratings), "moderate" (less than four strong ratings and one weak rating) and "weak" (two or more weak ratings). The EPHPP tool was chosen as it has established effectiveness in evaluating public health questions and because it can be applied to studies with or without a control group (Thomas et al., 2004).

To assess the risk of bias, we used the revised Cochrane Collaboration tool (RoB 2) (Sterne et al., 2019). To do this, the risk of bias was assessed independently by two reviewers and the third reviewer was consulted to resolve disagreements. The results were classified as "low risk of bias", "some concerns", and "high risk of bias".

**Table 1.** Studies criteria based on PICOS

| Criteria | Inclusion Criteria |
|---|---|
| Participants | Students in primary to high school |
| Intervention | Health education or promotion regarding mosquito borne diseases |
| Comparisons | Single-arm and multi-arm interventions (with a comparison intervention or nonintervention control group) |
| Outcomes | Knowledge, attitude, practice, behavior, awareness |
| Study design | Experimental studies (e.g., randomized controlled trials, quasi-experimental, pre- and post-test study with no control), mixed-method studies |

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**Table 2.** Characteristics of the included studies

| Author, Year, Country | Participant | Study Design | Outcomes | Interventions | Evaluation Strategy | Findings | Study Quality |
|---|---|---|---|---|---|---|---|
| Subramaniam et al., 2020. Malaysia | 50 children aged five to six years old | Before-after pilot study | Knowledge practice | The activity-based program (Theatre and Games) | Questionnaire (one-week after) | Significant increase in knowledge and practice. (P<0.001) | Moderate |
| Sureshbabu, Vasudevan & Raj 2017, India | 508 students | Pre-test-post-test study | Knowledge | 40 minutes of a power point presentation and videos | Questionnaire (three-months after) | Improved knowledge (P< 0.001) | Strong |
| Ibrahim et al., 2009, Saudi Arabia | 2693 female students, 356 teachers, and 115 supervisors | Pre-test-post-test study | Knowledge practice attitude | 20-minute lecture (audiovisual) | Questionnaire (one-week after) | Improved knowledge (P<0.001) Attitude (P<0.001) Practice (P<0.001) | Moderate |
| Amelia, Setyawan, Sukihananto, 2018, Indonesia | 92 children aged 10-12 year old | Quasi-experimental | Attitude | Board game (4 sessions, 40 minutes each session) | Questionnaire (two-weeks after) | Improved attitude (P<0.001) | Moderate |
| Madeira et al., 2002, Brazil | 314 students | Quasi-experimental before-after study with control group | Knowledge | Teaching centered on activities and discussions 45 minutes didactic activities in two weeks | Questionnaire with open question (immediately after intervention) | Increased knowledge (P<0.001) | Moderate |
| Kosasih et al., 2021. Indonesia | 323 children grades 4-6 | Quasi-experimental | Knowledge attitude | Two-way question and answer lecture ( accompanied by posters and educational videos | Questionnaire (Immediately after) | Increased Knowledge (P <0.001) and improved attitude (P<0.001) | Moderate |
| Usman et al., 2018. Saudia Arabia | 593 students in grade 10 to 12 | Quasi-experimental pre-post-test design | Knowledge attitude practice | Lectures with the help of visual aids like flip charts and life cycle specimens followed by small group discussions | Questionnaire (two to three weeks after) | Knowledge (P<0.038) attitude (P<0.14) practice (P<0.022) | Strong |
| Hermida et al., 2021, Argentina | 142 fourth graders (10 years old) and 97 parents | RCT | Knowledge | Tutoring and booklet for 15 minutes | Questionnaire (Immediately after and followed up to 1 month) | Improved knowledge (p<0.000 at 95% level of confidence) | Moderate |
| Radhika et al., 2019, Srilanka | 2194 students | Before-after study | Awareness | Lectures using Microsoft PowerPoint, videos, and discussions for 2 hours | Questionnaire (2 months after) | Increased Knowledge and awareness (p<0.05 at 95% level of confidence) | Strong |
| Ahbirami & Zuharah, 2020, Malaysia | 203 students 13 to 17 years old | Pre-and post-tests design | KAP | Health education using booklet | Questionnaire (one week after) | Increased knowledge (P< 0.05) Not significance in attitude and practice (P> 0.05) | Moderate |
| Kurniawan et al., 2021, Indonesia | 334 elementary students in grade IV-VI | Mixed-method design | KAP | OH-SMART workshop for two days | Questionnaire (immediately after) | Increased KAP (P<0.001) | Moderate |
| Beinner et al., 2015, Brazil | Intervention=75, Control=79, between the ages of 10 to 13 years (fifth grade) | RCT | Knowledge perception | The educational intervention : board game (50 minutes session) | Questionnaire (One week after) | Significant positive impact on attitudes, knowledge and potential behavior changes (P=0,001, CI 95%) | Strong |
| Lennon & Coombs, 2006, Philippines | 168 students in grades 5 and 6 | RCT pre-test/post-test controlled design | Knowledge | "Goodbye-to-Dengue Game" consisted of a playing board and cards in 35 minutes | Questionnaire (three days after) | Increased knowledge and self-efficacy (P<0.0001) | Strong |

| Author, Year, Country | Participant | Study Design | Outcomes | Interventions | Evaluation Strategy | Findings | Study Quality |
|---|---|---|---|---|---|---|---|
| Swain S., Pati S., Pati S., 2019, India | 1098 students (intervention=696, control=402) | RCT | Knowledge practice | Audio-visual lecturers, role playvactivities, demonstration of vectors and larvae (180 minutes) | Questionnaire (Immediately after) | Improved knowledge and practice (P<0.001) | Strong |
| Abamecha et al., 2021, Ethiopia | 404 students grade 6th through 8th | Process evaluation/ mixed method study | Acceptability of the program KAP | The peer learning and educational approach on malaria vprevention (PLEA-malaria) using flip charts, leaflets, and posters with persuasive messages, social dramas, campaigns, and role-plays | Questionnaire and in-depth interviews | Highly acceptability<br>Improved KAP (P<0.001)<br>Qualitative: Students stated that they have got adequate knowledge on Malaria. The program was very easy to implement | Strong |
| Clarke et al., 2017, Mali | Control=954, intervention=937 students, grade 4 and 5 (typically aged 10–12 years) | RCT | Cognitive | Teacher-led participatory malaria prevention education, intermittent parasite clearance in schools (IPCs) | the TEACh (Test of Everyday Attention for Children) by listening, writing | Improved cognitive performance (P<0.001) | Strong |
| Farea et al., 2020, Yemen | 1065 students grade 6, 7, 8 | RCT community-based trial (pre-post intervention study) | KAP | Health education | Arabic questionnaire (Immediately after) | Improved KAP (P<0.001) | Moderate |
| Chukwuocha et al., 2020, Nigeria | 206 children of primary 5 and 6 classes | Quasi-experimental | Awareness practice | Malaria classroom corner (MCC) using simple posters, messages and drawings about malaria | Questionnaire (Immediately after) | Increased awareness(p = 0.0003) and practice(p = 0.0202) | Moderate |
| Nonaka et al., 2007, Japan | 130 school children in grades 3–5 at two primary schools | Quasi-experimental | KAP | Malaria flip chart and 1-day anti-malaria campaign | Questionnaire-based interviews (Immediately after) | Significant increase in knowledge (P<0.001)<br>Attitude (P<0.001)<br>Practice (P<0.001) | Moderate |
| Deepthi et al., 2014, India | 200 students grade 8th, 9th and 10th | Quasi-experimental | Knowledge | Health education through Role play, prepared chart, and demonstration | Questionnaire (Immediately after) | Improved knowledge (P<0.001) | Moderate |
| Ayi et al., 2010, Ghana | the intervention group (105 children, 250 community adults) and the control group (81 children, 133 community adults) | Quasi-experimental participatory health education | Knowledge, practices, and parasite prevalence | Health education using picture charts and posters | Questionnaire-based interviews and parasitological surveys (Immediately after) | Improved knowledge on cause and prevention and bed net impregnation practices. | Moderate |
| Kasthuri, 2018, India | 34 Students of 6th and 7th | Quasi-experimental | Practice | Structured teaching program | Self-reported questionnaire (two-weeks after) | Improved practices on mosquito control (P<0.00001) | Moderate |
| del Carpio-Toia et al., 2019, Peru | 300 school children | Quasi-experimental | KAP | Health education using multimedia audiovisual product | Questionnaire (Immediately after) | Improved KAP | Moderate |

### Data synthesis and data Extraction

The data were synthesized qualitatively in order to understand the effectiveness of school-based prevention interventions of MBDs. Two of the authors independently extracted data from studies that met the inclusion criteria. In order to analyze the data, research design and intervention strategies were first classified. Then, the findings of each study were qualitatively analyzed according to the applied design and intervention and other characteristics. Any disagreement was resolved through mutual discussion.

The data extracted for each study included design, sample size, outcomes, intervention, evaluation strategy, and findings. Data were extracted by the second author and independently double checked by another reviewer. Any disagreements were resolved by the first author. No meta-analysis was done because of the heterogeneity of the data. Characteristics of the included studies are shown in Table 2.

## 3. Results

The literature search produced 1,424 results, including duplicates generated by the search tools (Mendeley). After the first screening (reading only the abstracts and titles and applying the exclusion criteria), 486 studies were found to be potentially relevant for meeting the objectives of our review. Then, a second screening procedure was carried out (reading each publication and applying the inclusion criteria), the final number of studies included was 55 (Figure 1). From these studies published from 2000 to 2021, 23 articles were written in English.

### Characteristics of the included studies

From 1,424 articles obtained from the five databases, 23 articles met the inclusion criteria (Table 1). The articles included in this review were carried out in several countries with high and lower middle income, including Indonesia (Amelia et al., 2018; Kosasih et al., 2021; Kurniawan et al., 2020), India (Deepthi et al., 2014; Kasthuri, 2018; Sureshbabu et al., 2017; Swain et al., 2019), Brazil (Beinner et al., 2015; Madeira et al., 2002), Malaysia (AhbiRami & Zuharah, 2020; Subramaniam et al., 2020), Saudi Arabia (Ibrahim et al., 2009; Usman et al., 2018), Sri Lanka (Radhika et al., 2019), Argentina (Hermida et al., 2021), Philippines (Lennon & Coombs, 2007), Ethiopia (Abamecha et al., 2021), Mali (Clarke et al., 2017), Yemen (Farea et al., 2020), Nigeria (Chukwuocha et al., 2020), Japan (Nonaka et al., 2008), Ghana (Ayi et al., 2010), and Peru (del Carpio-Toia et al., 2019). The study designs used varied, including Before-after (Subramaniam et al., 2020; Radhika et al., 2019), pre-test-post-test study (Ibrahim et al., 2009; Sureshbabu et al., 2017; AhbiRami & Zuharah, 2020; Lennon & Coombs, 2007), mixed methods (Kurniawan et al., 2020; Abamecha et al., 2021), Quasi-experimental (Amelia, Setyawan & Sukihananto, 2018; Ayi et al., 2010; Deepthi et al., 2014; del Carpio-Toia et al., 2019; Kasthuri, 2018; Kosasih et al., 2021; Madeira et al., 2002; Nonaka et al., 2008; Usman et al., 2018; Chukwuocha et al., 2020), and Randomized Controlled Trials (RCTs) (Beinner et al., 2015; Clarke et al., 2017; Farea et al., 2020; Hermida et al., 2021; Swain et al., 2019). The number of samples used is at least 34 students (Kasthuri, 2018) and at most 2693 students (Ibrahim et al., 2009).

### Outcomes of the included studies

In general, the outcome determined in the included studies are knowledge, attitude, and practice (KAP). However, several studies also analyzed other outcomes such as awareness (Chukwuocha et al., 2020; Radhika et al., 2019), behavior changes (Beinner et al., 2015), cognitive performances (Clarke et al., 2017), self-efficacy (Lennon & Coombs, 2007), and acceptability (Abamecha et al., 2021) of a program developed by researchers.

In general, the data of the studies included in this review were collected using questionnaires that were completed before and after the intervention. The outcomes of the interventions were measured in different time periods; including immediately after the intervention (Ayi et al., 2010; Chukwuocha et al., 2020; Deepthi et al., 2014; del Carpio-Toia et al., 2019; Farea et al., 2020; Hermida et al., 2021; Kosasih et al., 2021; Kurniawan et al., 2020; Madeira et al., 2002; Nonaka et al., 2008; Swain et al., 2019), three days after the intervention (Lennon & Coombs, 2007), one-to-three weeks after (AhbiRami & Zuharah, 2020; Amelia et al., 2018; Beinner et al., 2015; Ibrahim et al., 2009; Kasthuri, 2018; Subramaniam et al., 2020; Usman et al., 2018), and one to 3 months after the intervention (Radhika et al., 2019; Sureshbabu et al., 2017). Some studies did not specify the timing of outcome assessment (Abamecha et al., 2021; Clarke et al., 2017).

### Educational interventions

The primary target population for the health education programs in the included studies are students because they are expected to become representatives of the family and community. Besides that, school age is the right moment to shape their character re-

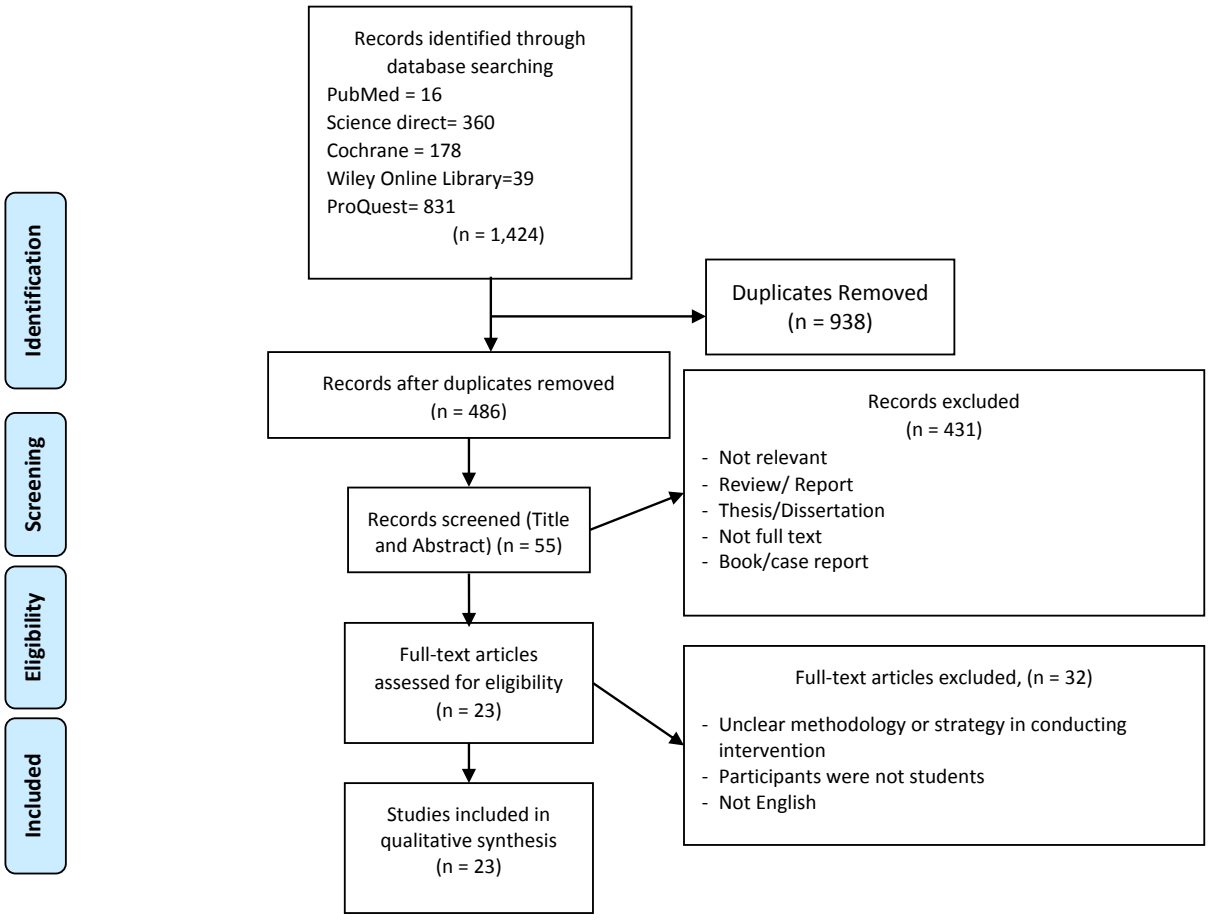


**Figure 1.** PRISMA flow diagram for literature search

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lated to environmental cleanliness. To achieve this, the educational interventions have been performed in schools, where children and teens gather and spend a considerable part of the day. Several methods and materials used in the included studies that match the inclusion criteria of this review; including theatre (Subramaniam et al., 2020), lecture (Abamecha et al., 2021; del Carpio-Toia et al., 2019; Farea et al., 2020; Ibrahim et al., 2009; Kosasih et al., 2021; Madeira et al., 2002; Radhika et al., 2019; Sureshbabu et al., 2017; Swain et al., 2019; Usman et al., 2018), games (Amelia et al., 2018; Beinner et al., 2015; Lennon & Coombs, 2007; Subramaniam et al., 2020), discussions (Madeira et al., 2002; Radhika et al., 2019; Usman et al., 2018), tutoring (Hermida et al., 2021), booklet (AhbiRami & Zuharah, 2020; Hermida et al., 2021), workshop (Kurniawan et al., 2020), role play (Abamecha et al., 2021; Deepthi et al., 2014; Kurniawan et al., 2020; Swain et al., 2019), demonstration (Deepthi et al., 2014; Swain et al., 2019), and campaigns (Abamecha et al., 2021; Nonaka et al., 2008).

### Quality of the included studies

Based on the EPHPP tools, as many as nine studies that were included in this review are in the strong category (Abamecha et al., 2021; Beinner et al., 2015; Clarke et al., 2017; Ibrahim et al., 2009; Lennon & Coombs, 2007; Radhika et al., 2019; Sureshbabu et al., 2017; Swain et al., 2019; Usman et al., 2018), and for the moderate category there were 14 studies (Ahbi-Rami & Zuharah, 2020; Amelia et al., 2018; Ayi et al., 2010; Chukwuocha et al., 2020; Deepthi et al., 2014; del Carpio-Toia et al., 2019; Farea et al., 2020; Hermida et al., 2021; Kasthuri, 2018; Kosasih et al., 2021; Kurniawan et al., 2020; Madeira et al., 2002; Nonaka et al., 2008; Subramaniam et al., 2020).

## 4. Discussion

The most relevant findings of the interventions used in included studies are mentioned in general terms. First, most of the mentioned school-based interventions showed good effectiveness in terms of increased

knowledge and good practices (e.g., cleaning and eliminating breeding sites of mosquito) and reducing the levels of larval indices (the house index, container index and Breteau index). The main role of schools in many of these studies was to serve as a meeting point for children, teens and adults, where educative workshops were offered. Additionally, students were recruited and trained to carry out home visits in their communities for health promotion and larviciding activities. The more reliable results were shown in the RCTs because the randomization offers the best experimental design and reduces sources of bias.

This review reveals various learning methods that may be useful for some health practitioners in other countries concerning improving student KAP. Traditional educative strategies such as lectures, doing manual exercises and sharing printed educative material help to increase students' knowledge of MBDs and improve their attitudes; however, students are more interested in lucid strategies and practical activities, which are demonstrated in the significantly higher KAP scores in the studies from India (Sureshbabu et al., 2017; Kasthuri, 2018; Swain et al., 2019), Saudi Arabia (Ibrahim et al., 2009; Usman et al., 2018), Brazil (Madeira et al., 2002), Indonesia (Kosasih et al., 2021), Sri Lanka (Radhika et al., 2019), Yemen (Farea et al., 2020), Ghana (Ayi et al., 2010), and Peru (del Carpio-Toia et al., 2019). Nonetheless, four studies from Malaysia (Subramaniam et al., 2020), Indonesia (Amelia et al., 2018), Brazil (Beinner et al., 2015), and Philippines (Lennon & Coombs, 2007) revealed higher KAP scores using games, where it was efficient without the guide of a teacher.

Previous review studies stated that educational interventions can increase knowledge about arboviral diseases and the adoption of protective behaviors among students (Paixão et al., 2019). The message in educational interventions needs to be adequate for the level of literacy of the population group. In theory, as a country's literacy level increases, the potential gain from education could increase (Paixão et al., 2019). Schools and teachers should give preference to community-oriented problems and educate the students about them with the involvement of all stakeholders. Information, Education and Communication (IEC) materials may be provided among the school's students, also it should be easily accessible to the community. Information about dengue, vectors and modes of disease transmission may be incorporated into the school curriculum, especially in areas where dengue is highly prevalent (Sureshbabu et al., 2017).

The main goal of any health education program is real behavioral change and not just an increase in knowledge and improvement of attitudes towards disease and control of MBDs. This change in behavior should be maintained over time with the support of health care staff, teachers, and trainers in MBDs control. Scholars and other societies need an ecological model for research into health behavior in MBDs (Richard et al., 2011). These models recommend individual, social, and environmental factors to ensure actual behavior change, which many of the studies cited in this review did not consider.

## 5. Conclusion

This review concludes the importance of the effect of health education on students' knowledge, attitudes and practices as an additional effort besides direct vector control in schools. In the future, it is important to focus more on intervention methods that can guarantee a permanent change in the practice of students in MBDs prevention. Accordingly, conducting prospective cohort school-based studies on MBDs prevention is recommended. It seems that if educational interventions are more personal and instead of just distributing printed materials, they use more active methods that take place with the participation of students, it will have a greater impact on learning and behavioral change. Understanding the role mobile apps can play in MBD prevention is another recommendation that follows a similar logic: personalized and adequately timed warnings might be more successful in leading people to adopt preventive measures than general advice for the whole of the disease transmission season.

### Limitations

In general, the evidence included in this review was not very strong as classified by the EPHPP tool. A component of the rating by this tool refers to the blinding of both assessors of the outcome and participants, which sometimes in public health interventions might not be possible. Another limitation of this review is the exclusion of studies in languages other than English. We would also state another issue regarding our limitation of accessibility on some databases.

## Ethical Considerations

### Compliance with ethical guidelines

The authors of this systematic review have all contributed to the process of conducting the study and the final version has been approved by all authors. All duplicate

publications were removed. Data were extracted independently by two authors, and any discrepancies were resolved by the other authors. Data inclusion was done with the agreement of all authors.

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## Authors' contributions

Contributed to the conception and designing the research: Emilia Chandra; Searched the related literature; Sukmal Fahri and Asni Johari; Analyzed and interpreted the data: Emilia Chandra and Asni Johari; Contributed to the paper's conceptualization, critical revision, edit and overall improvement; Syaiful Syaiful; Contributed to drafting the manuscript and also read and approved the final submitted paper: All authors.

## Conflict of interest

The authors declare no conflict of interest.

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