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Effectiveness of educational interventions for improving rabies prevention in children: A systematic review and meta-analysis

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Abstract:

Rabies poses a significant global health threat, particularly to school-age children through dog bites. This systematic review aimed to investigate the effectiveness of educational interventions for improving rabies prevention among children. In this review, a comprehensive search was conducted across several electronic databases (PubMed, SCOPUS, EBSCO, Google Scholar, and Thai Citation Index) to identify relevant articles published between 2014 and 2023, following PRISMA guidelines. Data on intervention characteristics, outcomes measures, and findings were extracted. The Joanna Briggs Institute appraisal tool was used to assess the quality of the included studies. Of 788 articles, 11 met inclusion criteria. Results demonstrated the efficacy of educational interventions in increasing rabies knowledge, perceived vulnerability to rabies, and rabies preventive behaviors. Additionally, there was evidence suggesting that educational interventions related to rabies and safety information around dogs may be more effective in improving rabies knowledge and perceived vulnerability to rabies among experimental groups compared with control groups. However, this did not significantly improve rabies prevention behaviors. These findings highlighted the imperative for targeted, well-designed educational strategies, collaboratively delivered with educators, to ensure a sustained impact, especially among vulnerable populations such as school-age children.

Keywords:

Health education, meta-analysis, rabies prevention, school children, systematic review

Introduction

Rabies is a highly feared and widely known disease worldwide, a viral-zoonotic disease primarily affecting the central nervous system. Transmission to humans occurs through contact with infected mammals, including both domestic and wild animals. This virus can be transmitted to humans through various means, such as saliva, bites, scratches, direct contact with wounds, or exposure to open mucosa.[1] The global impact of rabies is significant, with thousands of human deaths occurring annually. The mortality rate stands at approximately 59,000 individuals each year, equating to one rabies-related death every 9 minutes. Notably, around 40% of these deaths occur in Asia and Africa.[2]This distribution accentuates the disproportionate burden borne by specific geographic areas, magnifying the urgency of addressing rabies on a global scale. Beyond the sheer magnitude of human lives lost, rabies imposes a profound societal and economic burden.[3] The impact reverberates through communities, affecting not only individuals but also straining healthcare systems and impeding socioeconomic

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development. Understanding the pervasive nature of rabies and its disproportionate toll on certain regions is imperative for fostering targeted interventions, global collaboration, and public health initiatives to mitigate the devastating consequences of this often-neglected disease.

The primary source of rabies virus transmission in domestic settings is typically through dog bites.[4] However, dogs also play a significant role in human life for various purposes, leading to inevitable situations where individuals may be bitten by domestic dogs, resulting in physical and psychological harm.[5-7] Among vulnerable groups, such as school-age children, the risk of dog bites is particularly high.[8-10] Interactions with dogs are integral to children's daily lives, occurring in various contexts such as homes, neighborhoods, and public spaces.[11,12] Previous research highlights this concern, revealing a substantial increase in the hospitalization of children aged 0–14 years due to dog bites.[6] Recognizing the specific risk encountered by school-age children is crucial in developing targeted interventions and educational programs, empowering them with the knowledge and skills to prevent dog bites.

Rabies prevention in children involves a multifaceted approach aimed at equipping them with the knowledge, skills, and resources to avoid exposure to rabies and effectively respond in case of potential encounters with rabid animals.[13,14] Children should be taught how to recognize signs of aggression or unusual behavior in animals and how to safely interact with dogs and other animals to minimize the risk of bites.[15] By empowering children with the knowledge and skills to prevent rabies transmission, it can effectively protect their health and well-being and contribute to the global efforts to eliminate rabies as a public health threat.

Rabies education proves to be an effective strategy in equipping children with the knowledge necessary to protect themselves from dog bites and mitigate the associated risks of rabies transmission.[16] This approach strategically aligns with the "Zero by 30" global plan by World Health Organization (WHO), which emphasizes the commitment to eliminate human deaths caused by dog-mediated rabies by 2030.[2] While previous studies have demonstrated the success of school-based rabies awareness programs, there remains a notable gap in research concerning the sustainability and long-term impact of these initiatives.[17-20] A comprehensive systematic review synthesizing evidence on school-based educational interventions for rabies prevention in children is lacking. Addressing this gap is crucial for developing informed and evidence-based strategies that extend beyond short-term gains and contribute to enduring rabies prevention efforts. Therefore, this systematic review and meta-analysis aimed to evaluate the effectiveness of educational interventions for school-age children, providing valuable insights into sustained impacts, identifying areas for improvement, and informing the development of enduring programs. Finally, the results of this study hold practical significance for public health policymakers, educators, and healthcare professionals involved in designing and implementing interventions to protect children from rabies, thereby contributing to the development of more effective and sustainable prevention programs.

Materials and Methods

Search strategy

Following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA),[21] we conducted a comprehensive search to identify relevant articles published from January 2014 to December 2023 using PRISMA guidelines. Systematic searches were performed on the databases (PubMed, SCOPUS, EBSCO, Google Scholar, and Thai Citation Index) using specific keywords. The search terms included (school education) AND (children OR students) AND (education OR intervention OR program OR curriculum) AND (rabies). The search was restricted to peer-reviewed articles published in English and Thai.

Eligibility criteria and study selection

The inclusion criteria were as follows: (1) studies involving students enrolled in preschool, elementary school, or secondary school; (2) studies focusing on school-based rabies educational intervention; and (3) studies reporting outcomes related to rabies prevention. Studies that focused on children who were not part of the education system were excluded. Two independent reviewers assessed articles for eligibility, with disagreements resolved through discussion.

Data extraction and quality assessment

The extracted data were organized using a Microsoft Excel sheet. Authors collected relevant data and resolved disagreements through discussion. The extraction table included author (year), participant characteristics, key intervention characteristics, educational strategies, guidelines, outcome measures, main findings, and quality assessment. The quality of the included studies was evaluated using the JBI Critical Appraisal Checklist for quasi experimental studies and randomized controlled trials.[22,23] Each criterion was assessed using a Y/N/U (Yes/No/Unclear) rating system. A score of 1 was assigned for each "Yes" response, while a score of 0 was given for "No" or "Unclear" responses. Based on the overall score, represented as a percentage, the studies were then categorized into three groups: high quality (above 80%), moderate quality (between 60-80%), or low quality (below 60%). Two reviewers

independently evaluated the research, with their scores combined. A higher score indicated a higher methodological quality.

Statistical analysis

Data were entered into RStudio software (v. 4.3.1), and the packages 'metafor'[24] were utilized. All included studies provided both continuous and dichotomous data. We calculated the standardized mean difference (SMD) and 95% confidence intervals (CIs) for continuous data. To handle dichotomous data, we transformed the effect sizes to SMDs using methods described by Sánchez-Meca *et al*.[25] Heterogeneity across studies was assessed using Cochrane's Q test and I^2 statistics.[26] A meta-analysis was considered heterogeneous if I^2 was greater than 25%, in which case a random-effects model was used. Due to the limited number of studies eligible for inclusion in the meta-analysis, it was not possible to perform subgroup analysis based on key intervention features, educational strategies, and quality assessment. To assess publication bias, Egger's test was employed. The presence of a statistically significant result in Egger's test would suggest the existence of publication bias.[27] In cases where publication bias is absent, the anticipated distribution of observed studies around the pooled effects size is symmetrical. If asymmetry is detected, the Trim and Fill method is utilized to adjust the pooled effect size to account for the outcomes of any missing studies.[28]

Results

In this systematic review, we conducted searches across databases and identified a total of 788 articles. After evaluating the eligibility of 20 full-text articles, 9 studies were excluded for reasons such as focusing on medical students, being duplicates, being observational study, and lacking sufficient statistical information. Finally, 11 studies met the inclusion criteria, providing ample statistical data for incorporation into the meta-analysis [Figure 1].

The characteristics of the studies included are outlined in Table 1. Of these studies, 10 studies employed a quasi-experimental design, while one study adopted a randomized controlled trial design. These studies were conducted in various countries, including India (n = 2), Thailand (n = 2), Bhutan (n = 1), China (n = 1), Malaysia (n = 1), Nigeria (n = 1), the Philippines (n = 1), Sri Lanka (n = 1), and Turkey (n = 1). The pooled sample size across these studies was 2101, with ages ranging from 3 to 17 years. The studies were carried out in elementary, primary, secondary, and high schools. Six studies exclusively utilized an intervention group, while

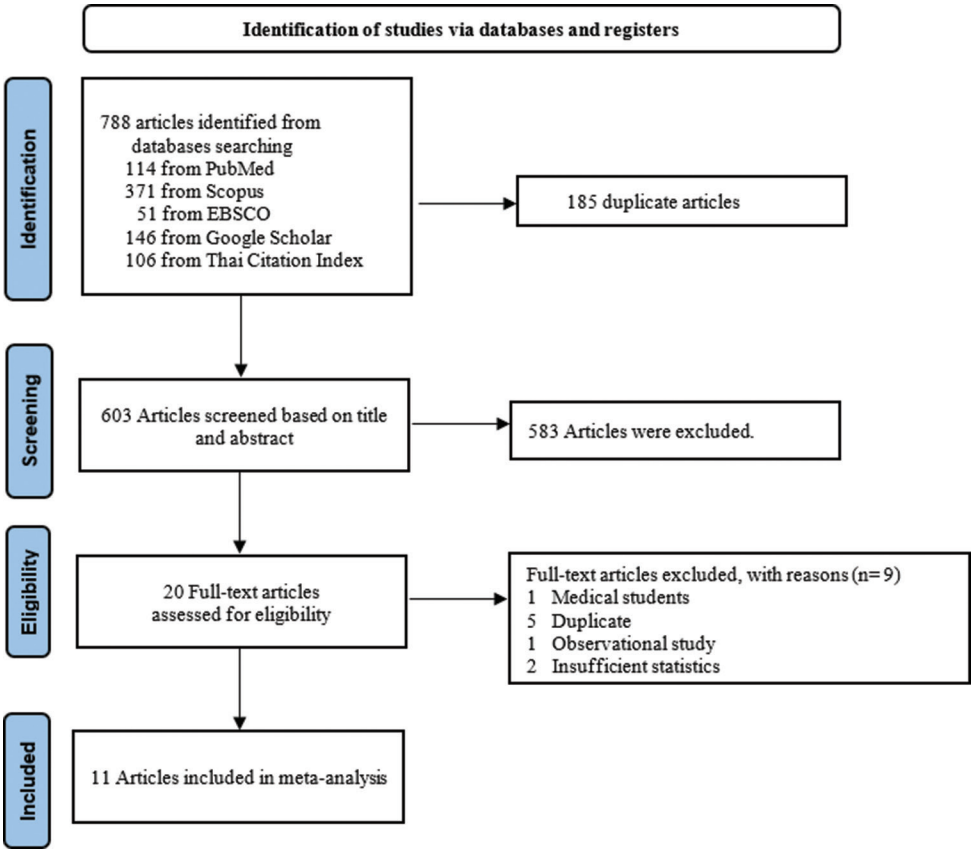

Figure 1: PRISMA flow diagram

Table 1: Characteristics of included studies

Author (Year)	Participant characteristics	Key intervention characteristics	Educational strategies	Guidelines	Outcome	Main findings	Study Quality
Halim *et al*. (2021)[29]	• Intervention: *n*=222 • Control: *n*=188 • Age range: 13-14 yrs.	• Rabies hunter game application • Content: safety knowledge in recognizing dog's behavior, perceived vulnerability toward dog, precautionary behavior around dog, and help-seeking behavior following dog bite • Duration: 4 weeks	The interactive 3D game application	One Health approach	Safety knowledge, perceived vulnerability, precautionary behavior, help-seeking behavior	Significance in safety knowledge, perceived vulnerability, and help-seeking behavior	High
Dzikwi *et al*. (2015)[30]	• Intervention: *n*=228 • Age range: 8-15 yrs.	• Rabies educational materials • Content: basic information on rabies, mode of transmissions, prevention and control of rabies • Duration: 2 weeks	Pamphlets	-	Rabies knowledge	Significance in rabies knowledge	Low
Sancheti and Mangulikar (2016)[31]	• Intervention: *n*=140 • Age range: 13-15 yrs.	• Rabies health education • Content: source, agent, host, environmental factors, mode of transmission, myths, prevention and control of rabies • Duration: 10 days	Audio-visual	-	Rabies knowledge	Significance in rabies knowledge	Moderate
Auplish *et al*. (2017)[32]	• Intervention: *n*=261 • Age range: 10-17 yrs.	• A community-based rabies health education and dog-bite prevention program • Content: ability to interpret dog behavior, level of awareness of rabies, and knowledge of appropriate preventive measures • Duration: 1 day	Written educational materials	GARC	Rabies knowledge	The proportion of students who provided correct responses increased compared to the pretraining proportion	High
Lungten *et al*. (2022)[33]	• Intervention: *n*=94 • Control: *n*=35 • Mean age=16.4	• Rabies awareness education • Content: causes of rabies, rabies transmission routes, rabies symptoms, rabies preventive and first aid measures, and how to behave with dogs • Duration: 3 months	Power point presentation	GARC, WHO and WOAH	Rabies knowledge, perception of rabies, and dog bites safety behavior	The mean knowledge scores, perception scores, and dog bites safety behavior all significantly increased after the intervention	High
Amparo *et al*. (2019)[34]	• Intervention: *n*=335 • Age range: 5-11 yrs.	• A Rabies Prevention Program Manual for Grade School Curriculum Integration and Instruction • Content: rabies, animal bite prevention, bite management, and responsible pet ownership • Duration: 12 months	Curriculum manual	GARC with local authorities	Rabies and dog safety knowledge	The proportion of students that correctly answered in rabies knowledge in all areas except the rabies disease prevention knowledge	Moderate
Kanda *et al*. (2015)[35]	Intervention: *n*=73 Control: *n*=52	Rabies Edutainment 4 Kids campaign Content: rabies prevention lessons Duration: 4 weeks	Lecture, class observation, leaflet, poster, and photocapture contest	-	Rabies knowledge	The score of rabies knowledge showed a significant improvement among the study groups after the intervention	High

Contd...

Table 1: Contd...

Author (Year)	Participant characteristics	Key intervention characteristics	Educational strategies	Guidelines	Outcome	Main findings	Study Quality
Isparta *et al*. (2021)[36]	• Intervention: *n*=117 • Age range: 3-6 yrs • Mean Age=5.3	• A dog bite prevention program • Content: greeting the dog, correct interaction, inappropriate contexts for approaching a dog, and the "Being a Tree" drama • Duration: 1 week	Interactive presentation and performed a drama	-	Dog safety knowledge	The time and age of the participants showed statistically significant associations with the score related to dog-human interaction and the context for approaching dogs	Moderate
Shen *et al*. (2016)[37]	• Intervention: *n*=143 • Control: *n*=137 • Mean age=10.03	• A video-based testimonial intervention • Content: dog safety lesson • Duration: 3 weeks	Video scripted testimonials	-	Dog safety knowledge, perceived vulnerability to dog bites, risky simulated behaviors	The intervention group demonstrated greater dog safety knowledge compared to the comparison group	High
Laorujisawat *et al*. (2022)[38]	• Intervention: *n*=23 • Control: *n*=22 • Age range: 8-10 yrs.	• A rabies prevention activity model • Content: rabies perceived severity, rabies perceived vulnerability, rabies response efficacy, and rabies self-efficacy • Duration: 4 weeks	Animation	-	Perceived severity, perceived vulnerability, response efficacy, and self-efficacy	The intervention group demonstrated greater rabies perceived severity compared to the comparison group	High
Thuybungchim *et al*. (2021)[39]	• Intervention: *n*=31 • Age range: 9-10 yrs.	• A rabies prevention and control model in school • Content: rabies knowledge, how to act when bitten by a dog, rabies preventive behaviors, and rabies vaccination • Duration: 8 months	Curriculum manual	Local authorities	Rabies knowledge,	The score of rabies knowledge showed a significant improvement among the study groups after the intervention	Moderate

GARC, Global Alliance for Rabies Control; WHO, World Health Organization; WOAH, World Organization for Animal Health

five studies compared a rabies educational intervention with a control group. Predominantly, the studies assessed rabies knowledge as outcomes (n = 10), followed by rabies perceived vulnerability (n = 4) and rabies preventive behaviors (n = 4). Teaching materials, such as curriculum manuals integrated into school subjects, leaflets, pamphlets, and videos, were used in six studies, whereas the remaining five incorporated interactive class activities and sessions, including presentations, interactive lessons, and question-and-answer sessions. The educational material covered in these studies encompassed information on rabies, addressing aspects such as the causes of rabies, routes of transmission, symptoms, and methods for preventing and controlling rabies (n = 4). Additionally, some studies incorporated safety knowledge related to dogs, including proper behavior around dogs, correct interaction with them, the ability to interpret dog behavior, and knowledge of suitable prevention measures (n = 2). Furthermore, others integrated rabies knowledge with safety information around dogs (n = 5). Most studies did not adhere to specific guidelines (n = 6), while some followed the global alliance for rabies control (GARC) guidelines, and others followed guidelines developed by local authorities for their educational intervention. Intensity varied significantly across studies, ranging from a brief 1-day educational session (n = 1) to more extended interventions lasting more than 1 week to 1 month (n = 7) and very intensive interventions lasting more than 3 months (n = 3). All included studies underwent peer review, and their quality was evaluated using the JBI Critical Appraisal Checklist tool. Rating indicated high quality for six studies, moderate for four studies, and low for one study.

Educational interventions with pre/post-test groups

Table 2 illustrates the educational interventions with pre/post-test groups were effective in improving rabies knowledge (SMD = 2.29, 95% CI = 1.17–3.41, $P < 0.001$) [Figure 2], perceived vulnerability to rabies (SMD = 1.06, 95% CI = 0.33–1.79, $P < 0.01$) [Figure 3],

and rabies preventive behaviors (SMD = 0.95, 95% CI = 0.14–1.76, $P < 0.05$) [Figure 4]. The random-effects meta-analysis indicated a substantial improvement in rabies knowledge, perceived vulnerability, and preventive behaviors following the intervention. A high level of heterogeneity (I^2) among studies, ranging from 93.8% to 98.2%, suggested variation in the true effect size across different studies. To assess significant publication bias, Egger's regression was employed. Egger's regression test suggested the presence of publication bias for rabies

Table 2: Pooled effect of educational interventions with pre/post-test groups

Outcome	*n*	SMD (95% CI)	*Z*	*P*	Heterogeneity			
					Q	df	*P*	I^2
Rabies knowledge	17	2.29 (1.17, 3.41)	4.00	<0.001	876.26	16	<0.001	98.2%
Rabies perceived vulnerability	4	1.06 (0.33, 1.79)	2.86	0.004	48.24	3	<0.001	93.8%
Rabies preventive behavior	4	0.95 (0.14, 1.76)	2.30	0.022	102.96	3	<0.001	97.1%

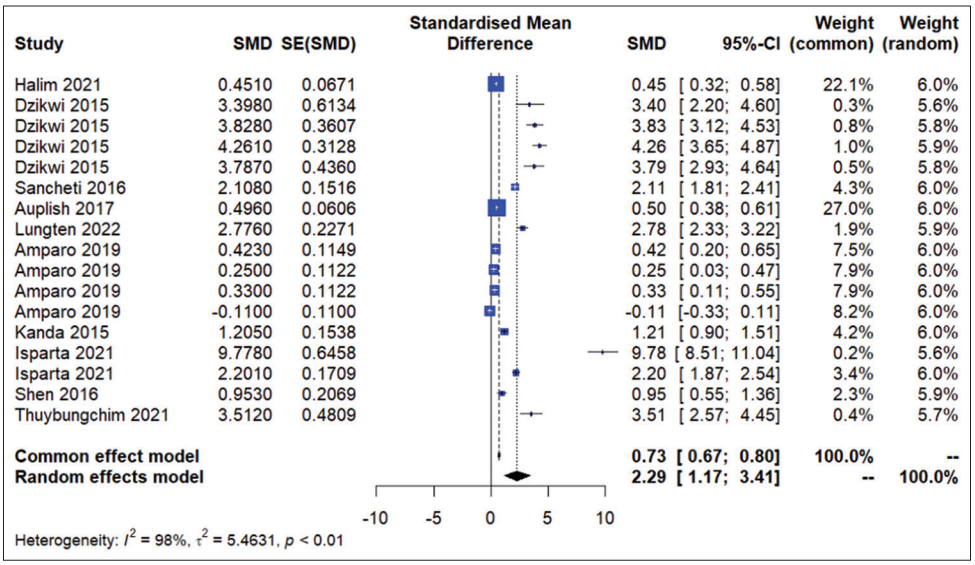

Figure 2: Forest plot for the effect of educational intervention on rabies knowledge with pre/post-test groups

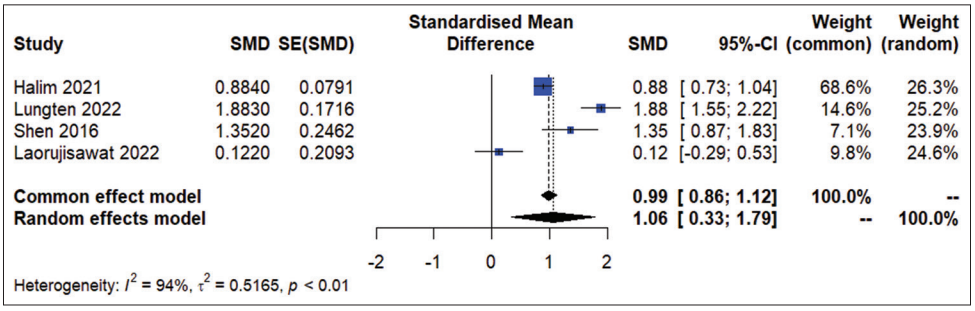

Figure 3: Forest plot for the effect of educational intervention on rabies perceived vulnerability with pre/post-test groups

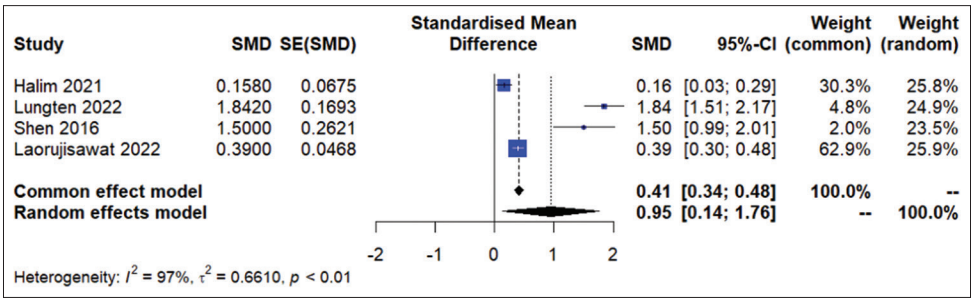

Figure 4: Forest plot for the effect of educational intervention on rabies preventive behavior with pre/post-test groups

knowledge (t = 5.45, df = 15, P < 0.001) but not for perceived vulnerability to rabies (t = 0.29, df = 2, P = 0.8) and rabies preventive behaviors (t = 1.81, df = 2, P = 0.2). The recalculated mean effect size of rabies knowledge using the Trim and Fill method to impute missing studies involved six studies and resulted in a decreased overall estimated effect size, rendering the main effect nonsignificant (SMD = 0.80, 95% CI = -0.63–2.23, P = 0.3).

Educational interventions with controlled groups at postintervention

Table 3 illustrates the overall pooled estimate of change in rabies knowledge (SMD = 0.92, 95% CI = 0.12–1.73, P < 0.05) [Figure 5] and rabies perceived vulnerability (SMD = 1.00, 95% CI = 0.21–1.80, P < 0.05) [Figure 6] within the educational intervention group, compared to the control group, showed a significant difference. However, there was no significant change observed in rabies preventive behaviors (SMD = 0.94, 95% CI = -0.13–2.00, P = 0.1) [Figure 7]. The studies exhibited a high level of heterogeneity (I^2) ranging from 92.6% to 96.7%, indicating variation in the true effect size across different studies. Sensitivity analyses were conducted for total rabies preventive behaviors, and after the removal of an outlier, the results showed that the effect on total rabies preventive behavior remained consistent in the meta-analysis (SMD = 1.25, 95% CI = -0.00–2.50, P = 0.0501). To assess significant publication bias, Egger's

Table 3: Pooled effect of educational interventions with controlled groups at postintervention

Outcome	*n*	SMD (95% CI)	*Z*	*P*	Heterogeneity			
					Q	df	*P*	I^2
Rabies knowledge	4	0.92 (0.12, 1.73)	2.25	0.025	68.36	3	<0.001	95.6%
Rabies perceived vulnerability	4	1.00 (0.21, 1.80)	2.48	0.013	40.43	3	<0.001	92.6%
Rabies preventive behavior	4	0.94 (-0.13, 2.00)	1.72	0.085	89.97	3	<0.001	96.7%

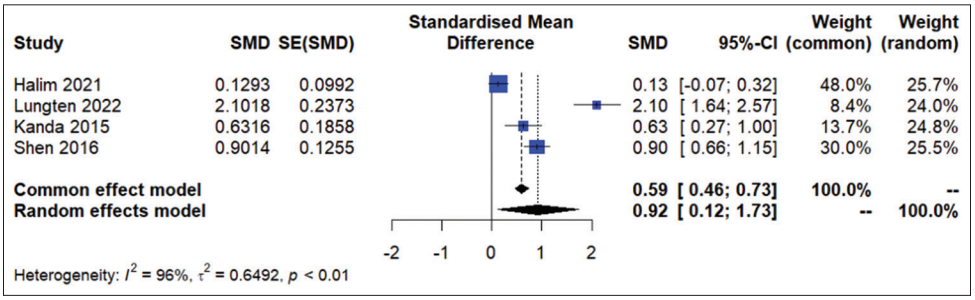

Figure 5: Forest plot for the effect of educational intervention on rabies knowledge with controlled groups at postintervention

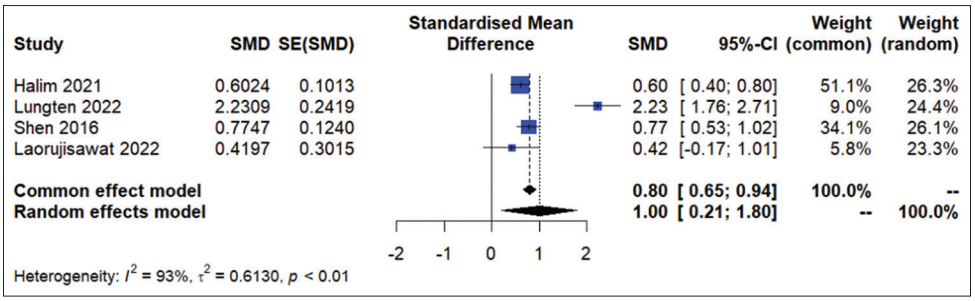

Figure 6: Forest plot for the effect of educational intervention on rabies perceived vulnerability with controlled groups at postintervention

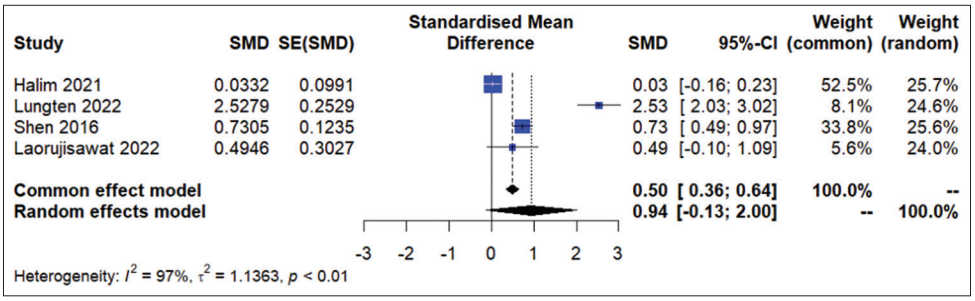

Figure 7: Forest plot for the effect of educational intervention on rabies preventive behavior with controlled groups at postintervention

regression was applied. The results of Egger's regression test suggested an absence of publication bias for rabies knowledge (t = 2.11, df = 2, P = 0.2), rabies perceived vulnerability (t = 0.85, df = 2, P = 0.5), and rabies preventive behaviors (t = 1.32, df = 2, P = 0.3).

Discussion

In this systematic review, we conducted a comprehensive search across various databases to identify articles on educational interventions for improving rabies prevention among children. The initial search yielded a total of 788 articles. After carefully assessing the eligibility of these articles based on predetermined criteria, we identified a final set of 11 studies that met the eligible criteria for inclusion in this review, with findings suggesting that educational interventions are effective for increasing rabies knowledge, perceived vulnerability to rabies, and rabies preventive behaviors. Further, there was evidence suggesting that educational interventions focusing on rabies and safety guidelines related to dogs could more effectively improve rabies knowledge and the perceived vulnerability to rabies compared to control groups. However, no observed improvement was noted in rabies prevention behaviors.

Overall, this review found a substantial and statistically significant impact associated with educational interventions designed to elevate rabies knowledge, heighten perceived vulnerability to rabies, and promote rabies preventive behaviors, which is consistent with the results of studies.[40,41] Notably, the effectiveness of these interventions was prominently observed when they were delivered through collaboration between researchers and school teachers or when teachers underwent specialized training to seamlessly integrate rabies lessons into existing subjects. This indicates that while school-based interventions are commonly facilitated by school staff, the pivotal inclusion of appropriate training or collaborative efforts with researchers and teachers before the intervention is paramount. Such a collaboration approach not only supports the effective delivery of the intervention but also enhances its reception and uptake within the educational framework.[42,43] These findings align with prior research,[44] reinforcing the notion that health education and targeted training act as instrumental tools in fostering improved understandings, perception, and the adoption of rabies prevention practices. This collaborative model, supported by existing literature, emphasizes the importance of strategic partnerships between health education specialists and educators to optimize interventions for enhanced public health outcomes related to rabies prevention.

Meanwhile, the meta-analysis unveiled a noteworthy and statistically significant impact of educational intervention on rabies knowledge, particularly when compared to control groups. For instance, the multifaceted nature of educational strategies emerged as a key facilitator in empowering children to enhance their understanding of rabies and safety protocols during interactions with dogs.[33] Furthermore, educational techniques play a pivotal role in this context, acting as a dynamic intervention tool that holds substantial promise for bolstering knowledge about rabies, especially among school-age children.[35,37] The incorporation of diverse educational methodologies, including curriculum manuals, game applications, pamphlets, audio-visual aids, PowerPoint presentations, and videos, proved instrumental in fostering a comprehensive understanding of both rabies and safety information related to interactions with dogs.[29-39] The utilization of diverse educational methodologies contributed significantly to the promotion of knowledge and comprehension surrounding rabies. These varied approaches not only disseminate information but also actively engage individuals in the learning process. The cost-effective nature of educational interventions, coupled with their varied approaches, positions them as powerful tools in the realm of health education. This effectiveness extends to promoting awareness and understanding of topics such as rabies among diverse and extensive populations.

Furthermore, the meta-analysis revealed a noteworthy enhancement in rabies perceived vulnerability among children through educational interventions, particularly when compared to control groups. These findings align with the results of Al-Mustapha *et al*.,[45] suggesting that educational strategies integrated into the curriculum have potential to elevate rabies awareness. This effectiveness is attributed to the consideration and collaboration of these rabies lessons with international, national, and local authorities, including educational bodies. One plausible explanation for this impact is that the structured rabies lesson, developed in collaboration with various authorities, addresses the fear and severity associated with rabies, thereby contributing to an increased perception of vulnerability among children. These lessons play a crucial role in disseminating rabies and safety information around dogs, aiming to alleviate concerns and enhance awareness of the potential risks posed by rabies. Additionally, the targeted approach of these lessons is particularly relevant in middle-lower-income countries where the prevalence of street or stray dogs is higher. In these regions, these animals are perceived as both threats and valued cohabitants in people's daily lives.[46-48] Educational interventions take into account the unique context of these countries, focusing on aspects such as rabies knowledge, including transmissions methods, symptoms in both dogs and humans, and guidance on appropriate behavior and interpretation of dog behavior.

By providing comprehensive information, educational interventions effectively contribute to shaping the perceived vulnerability of individuals toward rabies, fostering a better understanding of the associated risks and preventive measures.[29,37]

Surprisingly, the findings from the meta-analysis indicate that the educational interventions for rabies prevention assessed in several studies within this review did not yield a significant impact on rabies prevention behavior. This finding contrasts with the results of a previous meta-analytic review,[49] where cognitive/behavioral interventions demonstrated a significant and substantial positive effect on children's behaviors with dogs in live or simulated environments. The apparent discrepancy between these outcomes prompts a critical examination of the potential factors contributing to the observed lack of significance in terms of rabies preventive behavior. One plausible explanation for this inconsistency may lie in the variations in the content and focus of the educational interventions across different studies. The effectiveness of interventions can be contingent on the specific skills and knowledge they aim to impart.[50,51] In the context of rabies preventive behavior, it is conceivable that the content of the educational programs included in the current meta-analysis did not adequately address the development of essential skills or competencies needed to influence prevention behaviors substantially.

Rabies preventive behavior encompasses a range of actions, including proper interaction with dogs, recognizing and responding to potential rabies threats, and adopting precautionary measures.[52,53] If educational interventions primarily focused on imparting knowledge without emphasizing the acquisition of practical skills, it may explain the limited impact on actual preventive behaviors. Successful behavior change often necessitates a combination of knowledge acquisition and skill development, and interventions integrating both aspects tend to be more effective.[54,55] Moreover, the nature of the interventions, such as the duration and intensity of educational sessions, could influence the depth and retention of acquired knowledge and skills. Short-term interventions may not provide sufficient reinforcement to instill lasting changes in behavior.[56-58] Additionally, the quality of the instructional materials, the engagement of participants, and the cultural relevance of the content may all contribute to the overall effectiveness of the intervention.[59,60] It is also worth considering the potential role of individual factors, such as age, cognitive development, and pre-existing attitudes toward dogs and rabies, in influencing the effectiveness of educational interventions. Tailoring interventions to the specific needs and characteristics of the target audience, in this case, school-age children, is essential for achieving meaningful and sustained behavior change.

However, this study had several limitations. First, a significant proportion of the studies adopted a quasi-experimental design without a control group, resulting in reduced internal validity. For a more effective assessment of educational interventions on rabies prevention among students, randomized controlled trials would have been a preferable choice. Second, the meta-analyses of these interventions revealed substantial heterogeneity, signifying notable variation in effect size across studies. This heterogeneity likely stems from differences in study design, participant demographics, intervention approaches, and outcome measurements. It limits the generalizability of findings and warrants caution in interpreting the pooled results. Third, the limited number of eligible studies prevented subgroup analyses based on intervention features, educational strategies, and quality assessment, impeding a more nuanced understanding of differential effects. Fourth, significant variability in the intensity and duration of educational interventions, ranging from brief 1-day sessions to extended programs lasting weeks, may contribute to observed heterogeneity and present challenges in identifying the most effective elements for sustained outcomes. Finally, the sustainability of intervention effects was insufficiently explored due to a scarcity of studies providing extended follow-up data, leaving uncertainties about enduring impacts on rabies knowledge, perceived vulnerability, and preventive behaviors beyond the immediate postintervention period.

Conclusion

In conclusion, rabies poses a significant global threat, resulting in a considerable number of human deaths annually, with certain regions being particularly affected. School-age children, due to their frequent interactions with dogs, emerge as a vulnerable group. This systematic review and meta-analysis, involving 11 studies, emphasizes the positive impact of these educational interventions on rabies knowledge and perceived vulnerability. However, the effectiveness of these interventions in promoting rabies preventive behaviors remains uncertain. These findings highlight the necessity for focused, well-designed educational strategies to be delivered in collaboration with educators to ensure a lasting impact. Despite promising outcomes, the study has limitations, including the prevalence of quasi-experimental designs and heterogeneity among studies. Future research should prioritize randomized controlled trials and investigate the sustained effects of interventions, contributing to the global initiative to eliminate dog-mediated rabies by 2030.

Compliance with ethical guidelines

This article is a systematic review and meta-analysis with no human or animal samples. No ethical considerations are taken into account.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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