Dengue Prevention Behaviour from a Social Ecological Model Perspective: A Systematic Review

Abstract

Aims: Dengue remains a major public health problem in endemic regions. Its prevention is influenced by a complex interaction of behavioral, social, environmental, institutional, and policy factors. However, previous studies have often examined these factors separately, limiting a comprehensive understanding of their interrelationships. This systematic review aims to synthesize recent evidence on determinants of dengue prevention behavior using the Social Ecological Model (SEM) as an integrated analytical framework.

Information & Methods: This systematic review was conducted through literature searches in Scopus, ScienceDirect, and PubMed, supplemented by manual searching of relevant studies published between 2013 and 2025. The findings were synthesized descriptively across five SEM levels, including intrapersonal, interpersonal, community, institutional, and policy domains.

Findings: Results show that dengue prevention behavior is shaped by interacting determinants across all SEM levels. At the intrapersonal level, knowledge, attitudes, risk perception, and self-efficacy play key roles. At the interpersonal level, social support and the involvement of community health workers strengthen preventive practices. At the community and institutional levels, environmental conditions, mosquito density, access to information, health system capacity, and communication strategies significantly influence prevention efforts. At the policy level, weak coordination and limited enforcement remain major barriers. In conclusion, dengue prevention requires integrated multi-level approaches.

Conclusion: The findings support strengthening strategic intervention programs aligned with Sustainable Development Goal 3, emphasizing coordinated action across individual, social, environmental, institutional, and policy levels to achieve sustainable dengue control.

Keywords

Dengue [https://www.ncbi.nlm.nih.gov/mesh/68003715];
Social Ecological Model [MeSH Link?];
Health Behavior [https://www.ncbi.nlm.nih.gov/mesh/68015438];
Systematic Review [https://www.ncbi.nlm.nih.gov/mesh/2028176];
Vector Control [MeSH Link?]

Introduction

Dengue Hemorrhagic Fever (DHF) is a contagious disease caused by the dengue virus and transmitted through the bite of the Aedes aegypti mosquito [1]. DHF can lead to serious complications, including hemorrhagic fever and shock syndrome, which can result in death if not treated promptly and appropriately [2]. Dengue remains a major global public health challenge, contributing substantially to morbidity, mortality, and economic burden. According to the World Health Organization (WHO), more than 7.6 million dengue cases, including over 16,000 severe cases and more than 3,000 deaths, were reported globally as of April 2024, with active transmission documented in at least 90 countries [3].

To reduce the risk of dengue infection, several preventive measures, including the dengue vaccine (QDenga), are available and approved in several countries. However, it is only recommended for children aged 6 to 16 who live in areas with high transmission rates, while several other vaccines are still under evaluation. Furthermore, prevention of dengue transmission focuses on dengue prevention practices by protecting oneself from mosquito bites and preventing mosquito breeding [4].

Dengue prevention practice refers to the combination of strategies implemented at the community, governmental, and individual levels to reduce the risk of dengue transmission. These practices include activities such as eliminating mosquito breeding sites through environmental management, vector control interventions (chemical, biological, or integrated methods), public health education campaigns, and community mobilization efforts designed to improve knowledge and ensure sustained behavioral changes [5-12].

The Social Ecological Model (SEM) was initially developed by Urie Bronfenbrenner [13] and later adapted by McLeroy and colleagues [14]. This framework, widely used in public health and social sciences, aims to comprehend the various factors influencing human behavior and health outcomes [13, 14]. The socio-ecological model (SEM) provides a valuable framework for understanding health behaviors by considering influences at multiple levels, including intrapersonal, interpersonal, community, societal/institution and policy factors [15]. For a clearer understanding, the framework model can be seen in Figure 1.

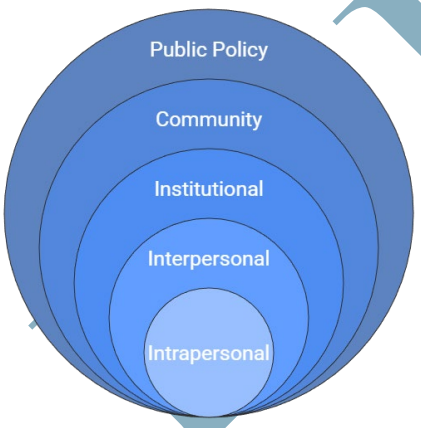

Figure 1. Social Ecological Model (SEM) framework adapted from Kilanowski [13] and McLeroy *et al.* [15]

Dengue prevention behavior is influenced not only by individual knowledge and attitudes but also by family support, community participation, environmental conditions, institutional capacity, and public policies. Therefore, SEM is particularly relevant for understanding dengue prevention because it enables the examination of interacting determinants across multiple levels rather than focusing solely on individual factors. This broader perspective is important because effective dengue prevention requires coordinated actions involving individuals, communities, institutions, and policymakers. The five levels in the Social Ecological Model (SEM) are explained as follows. The first level is the intrapersonal level, which includes individual characteristics such as behavior, knowledge, attitudes, and demographics. The second level is the interpersonal level, which involves social networks or support systems, both formal and informal, such as family, friends, and neighbors. The third level is the institutional level, referring to organizational settings that exist outside the home, such as schools, universities, and workplaces. The fourth level is the community level, which

encompasses groups or areas based on various factors, including geography, psychology, patterns of social interaction, and politics [13, 15].

This systematic review fills the gap by identifying, synthesizing, and narrating the factors related to dengue prevention practices, not only at one or two levels but across various levels to examine the factors influencing dengue prevention in a broader context based on the Social Ecological Model (SEM), which includes intrapersonal, interpersonal, community, institutional, and policy factors. The aim of this review is to provide an overview of the factors related to dengue prevention practices from the SEM perspective. By utilizing the SEM framework, this review not only identifies the key determinants but also emphasizes the need for multi-level interventions that address these diverse factors holistically, providing actionable strategies for more effective dengue prevention practice at the household and community level.

Information and Methods

Review design

This systematic review was developed using the Social Ecological Model (SEM) as a guiding framework to explore the various factors influencing dengue prevention practices. To ensure a comprehensive synthesis of the literature, a structured literature search was conducted across multiple databases. The PRISMA 2020 guidelines was used to enhance the transparency and reporting of the literature identification, screening, and selection processes [16].

Search strategy

We used the online databases Scopus, ScienceDirect, and PubMed, as well as manual searching, as sources for our studies. We limited the search to studies published between January 1, 2013, and December 31, 2025. This timeframe was selected to capture contemporary evidence on factors influencing dengue prevention behaviour across the multiple levels of the Social Ecological Model. Given that behavioural determinants, community engagement approaches, institutional support systems, and public health policies have evolved considerably over the past decade, focusing on more recent studies was considered appropriate to ensure that the review findings remain relevant to current public health contexts. The literature search was conducted using relevant English keywords and Boolean operators “AND” and “OR”, with keywords such as “dengue fever prevention practices”, “dengue fever prevention behavior”, “knowledge, attitudes, and practices (KAP)”, and “dengue fever prevention”. The literature search strategy is presented in Table 1.

Table 1. Literature search strategy used to identify studies on dengue prevention behaviour based on the Social Ecological Model from January 2013 to December 2025

Database	Search string	Number of articles
PubMed	("Dengue Prevention Practice"[All Fields] OR "Dengue Prevention Behaviour"[All Fields] OR "Dengue Preventive Practices"[All Fields] OR "Knowledge Attitude and Practice KAP"[All Fields]) AND "Dengue Prevention"[All Fields]	16
Scopus	(TITLE-ABS-KEY ("Dengue Prevention Practice") OR TITLE-ABS-KEY ("Dengue Prevention Behaviour") OR TITLE-ABS-KEY ("Dengue Preventive Practices") OR TITLE-ABS-KEY ("Knowledge Attitude and Practice KAP") AND TITLE-ABS-KEY ("Dengue Prevention"))	60
Sciendirect	("Dengue Prevention Practice" OR "Dengue Prevention Behaviour" OR "Dengue Preventive Practices" OR "Knowledge Attitude and Practice KAP") AND ("Dengue Prevention")	29
Manual Search	“Dengue Prevention Practice”, “Dengue Prevention Behaviour”, “Dengue Preventive Practices”, “Knowledge, Attitude, and Practice (KAP)”, and “Dengue Prevention”	2

Study eligibility

For the feasibility of the articles included in the review, specific inclusion and exclusion criteria were established. First, the date criterion was designed to include only studies published between January 1, 2013, and December 31, 2025. Second, the articles should discuss factors related to dengue fever prevention practices at the household or community level, or align with the research objectives. Third, the articles should be open access and published in English. The exclusion criteria include review articles or those focused on medical interventions.

Data collection process

The articles obtained from the database search were exported to Zotero software, which allowed for the removal of duplicate studies. Afterward, two authors (IA and AY) independently screened the titles and abstracts of the collected articles to identify those that were aligned with the review's objectives. Prior to the screening process, both authors reviewed and agreed upon the inclusion and

exclusion criteria to ensure consistency in study selection. Studies that passed the screening stage were then evaluated by carefully reading the full manuscripts, referring to the remaining feasibility criteria. Studies that met the feasibility criteria were subsequently included in the data extraction and synthesis process. All study selection processes were conducted using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) diagram, as shown in Figure 2. Ultimately, twenty-seven articles (n=27) were selected after screening the titles, abstracts, and thorough in-depth reading.

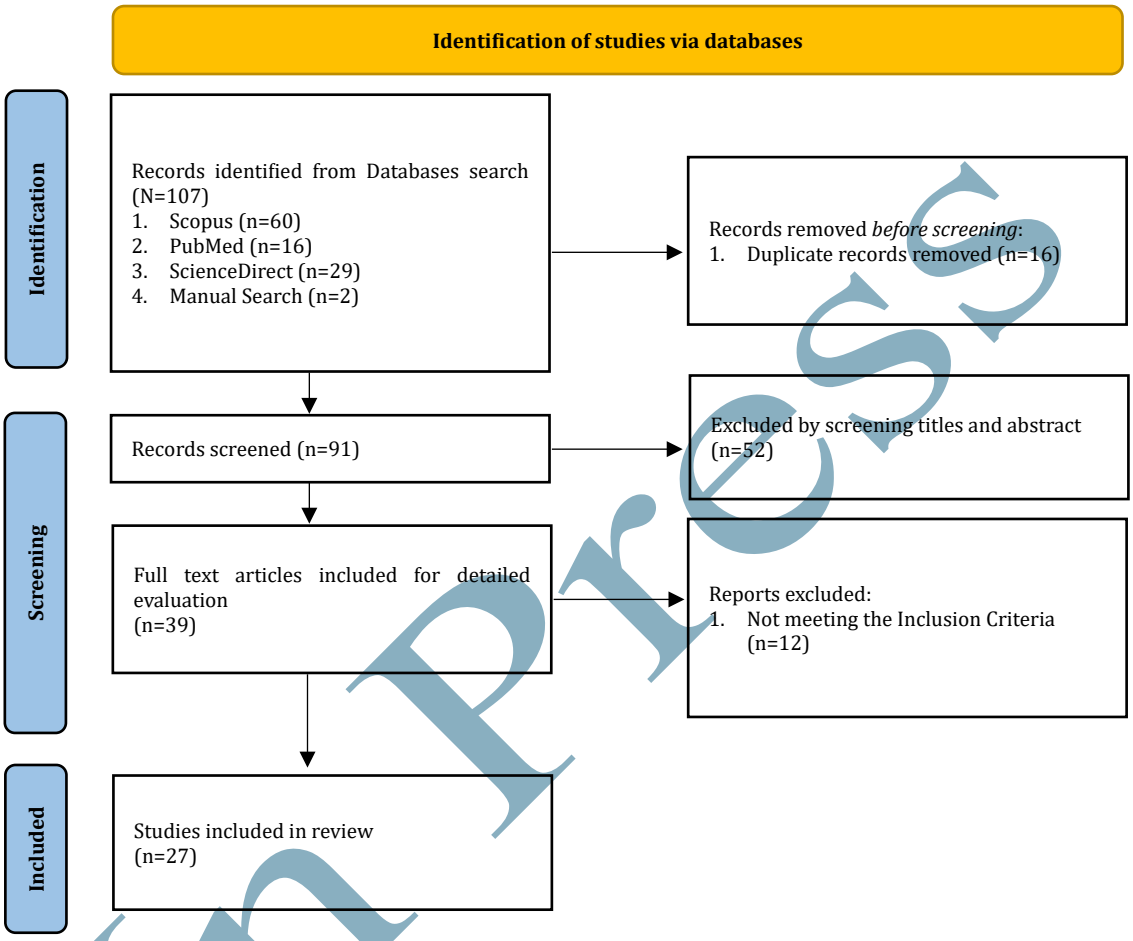

Figure 2. PRISMA flow diagram illustrating the study selection process for the systematic review of dengue prevention behaviour based on the Social Ecological Model (January 2013-December 2025; N=107 records identified)

Quality appraisal

The researcher independently assesses the methodological quality of the included research articles using the Joanna Briggs Institute (JBI) Critical Appraisal Tools for qualitative studies, quasi-experimental, and cross-sectional (https://jbi.global/critical-appraisal-tools). Each item on the checklist is scored "1" for Yes and "0" for No or Unclear. The total score for each study is expressed as a percentage of the maximum possible score to facilitate a descriptive comparison of methodological quality. Studies with scores above 70% are considered to demonstrate stronger methodological rigor. The quality assessment is used to identify potential sources of bias and to describe the overall strengths and limitations of the included evidence. In Table 2, the abbreviations used are Y=Yes, N=No, U=Unclear, and NA=Not Applicable, indicating the JBI assessment results for each criterion.

Table 2. Critical appraisal

Author	Study design	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Score
Wong & AbuBakar (2013) [17]	Qualitative research	Y	Y	Y	Y	Y	N	U	Y	Y	Y	80%
Siddiqui *et al.* (2016) [18]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Harapan *et al.* (2018) [19]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Rakhmani *et al.* (2018) [20]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Makrufardi *et al.* (2021) [21]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%

Mashudi *et al.* (2022) [22]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Khan *et al.* (2022) [23]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Banik *et al.* (2023) [24]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Samsudin *et al.* (2024) [25]	Qualitative research	U	Y	Y	Y	Y	U	Y	Y	Y	Y	80%
Oo *et al.* (2025) [26]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Rahman *et al.* (2021) [27]	Cross-sectional	x	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Bashar *et al.* (2020) [28]	Cross-sectional	x	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Thongkham *et al.* (2025) [29]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Saghir *et al.* (2025) [30]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Samsudin *et al.* (2025) [31]	Cross-sectional	Y	Y	Y	Y	U	U	Y	Y	NA	NA	75%
Huang *et al.* (2025) [32]	Cross-sectional	Y	Y	Y	Y	U	U	Y	Y	NA	NA	75%
Prue *et al.* (2025) [33]	Cross-sectional	Y	Y	Y	Y	U	N	Y	Y	NA	NA	75%
Rajapaksha *et al.* (2023) [34]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Arfan *et al.* (2022) [35]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Klaythong *et al.* (2022) [36]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Perera *et al.* (2021) [37]	Cross-sectional	Y	Y	U	Y	Y	Y	U	Y	NA	NA	75%
Al-Sahafi *et al.* (2021) [38]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Selvarajoo *et al.* (2020) [39]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Wong *et al.* (2015) [40]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Chandren *et al.* (2015) [41]	Cross-sectional	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	100%
Ridha *et al.* (2024) [42]	Quasi-experimental	Y	Y	Y	Y	Y	Y	Y	U	Y	NA	89%
Ridha *et al.* (2023) [43]	Quasi-experimental	Y	Y	U	Y	Y	Y	Y	Y	Y	NA	89%

Synthesis of the study

The selected articles that met the feasibility criteria were extracted using EXCEL software. The extracted data from the selected studies were based on the author and year of publication, study type or research design used, participants, study aim, and primary findings. The extracted data were then synthesized to summarize the factors influencing dengue prevention practices based on the perspective of the Social Ecological Model framework. To facilitate synthesis, the identified factors from each study were reviewed and categorized according to the corresponding levels of the Social Ecological Model (intrapersonal, interpersonal, institutional, community, and policy) based on the definitions of each SEM level. All authors reviewed the extracted findings and discussed the categorization process to ensure consistency. Any differences in interpretation were resolved through discussion until consensus was reached.

Findings

Characteristics of included studies

The included studies were published between 2013 and 2025. Twenty-five studies (92.6%) used quantitative research designs, while two studies (7.4%) employed qualitative approaches. The studies were conducted in a variety of community and household settings and examined determinants of dengue prevention behaviour across multiple levels of the Social Ecological Model. Detailed characteristics of the included studies, including type of study, participants, and study aim, are presented in Table 3.

Table 3. Characteristics of final studies

No.	Authors	Type of study	Participants	Study aim
1	Wong & AbuBakar (2013) [17]	Qualitative (focus group discussion)	84 participants from different ethnic groups in Malaysia	To explore health beliefs and practices related to dengue prevention using the Health Belief Model (HBM)
2	Siddiqui *et al.* (2016) [18]	Cross-sectional	608 residents of Karachi	To assess dengue knowledge, health beliefs, and preventive practices using the Health Belief Model
3	Harapan *et al.* (2018) [19]	Cross-sectional	609 inhabitants of Aceh	To evaluate knowledge, attitudes, and practices (KAP) regarding dengue
4	Rakhmani *et al.* (2018) [20]	Cross-sectional	220 respondents from Lowokwaru, Malang	To identify factors associated with dengue prevention behavior
5	Makrufardi *et al.* (2021) [21]	Cross-sectional	89 respondents from Sendowo, Yogyakarta	To identify factors influencing dengue prevention behavior in a riverbank area
6	Mashudi *et al.* (2022) [22]	Cross-sectional	303 residents of a Johor residential area	To assess dengue preventive practices during COVID-19
7	Khan *et al.* (2022) [23]	Cross-sectional	14,745 participants from 8 districts in KP province	To assess knowledge, attitudes, and practices regarding dengue prevention
8	Banik *et al.* (2023) [24]	Cross-sectional	401 rural Bangladesh participants	To assess knowledge, beliefs, and preventive practices regarding dengue

9	Samsudin *et al.* (2024) [25]	Qualitative	Health authorities, local authorities, community members, patients (n=37)	To explore community behavior and stakeholder challenges in dengue prevention
10	Oo *et al.* (2025) [26]	Cross-sectional	415 Myanmar migrants in Samut Sakhon	To examine socio-ecological factors affecting dengue prevention practices
11	Rahman *et al.* (2021) [27]	Cross-sectional	719 households (360 from Laos and 359 from Thailand)	To assess knowledge, attitudes, and practices (KAP) on climate change and dengue
12	Bashar *et al.* (2020) [28]	Cross-sectional	415 rural Bangladesh participants	To assess knowledge, beliefs, and preventive practices regarding dengue
13	Thongkham *et al.* (2025) [29]	Cross-sectional	279 household heads in northern Thailand	To explore perceptions of dengue fever and identify factors influencing dengue prevention practices
14	Saghir *et al.* (2025) [30]	Cross-sectional	415 participants in Seiyun, Yemen	To assess KAP on dengue and the association with sociodemographic factors
15	Samsudin *et al.* (2025) [31]	Cross-sectional	146 residents of Hulu Langat, Selangor	To evaluate the KAP of the community towards dengue in an urban area
16	Huang *et al.* (2025) [32]	Cross-sectional & quasi-experimental	3,571 Guangzhou residents, 150 in the intervention group	Evaluate KAP levels and the impact of mHealth intervention
17	Prue *et al.* (2025) [33]	Cross-sectional	484 rural residents of Cox's Bazar	Assess knowledge, attitudes, and practices (KAP) regarding dengue infection
18	Rajapaksha *et al.* (2023) [34]	Cross-sectional	532 households from the highest dengue endemic area in Kurunegala, Sri Lanka	Evaluate factors influencing health-seeking behavior (HSB), dengue-prevention behavior (DPB), and community capacity (CC)
19	Arfan *et al.* (2022) [35]	Cross-sectional	379 households in Kubu Raya, West Kalimantan	Determine factors associated with dengue fever prevention practices
20	Klaythong *et al.* (2022) [36]	Cross-sectional	199 residents from Makok Na Bua Village, Lampang Province, Thailand	Assess KAP regarding dengue prevention and control
21	Perera *et al.* (2021) [37]	Cross-sectional	510 residents from Ja-Ela MOH area	Assess knowledge, attitudes, and practices (KAP) towards dengue prevention
22	Al-Sahafi *et al.* (2021) [38]	Cross-sectional	241 residents from three districts in Jeddah	Evaluate knowledge, attitudes, and practices towards dengue fever
23	Selvarajoo *et al.* (2020) [39]	Cross-sectional	500 participants in a dengue hotspot in Malaysia	Assess KAP and seroprevalence of dengue in a community-based study
24	Wong *et al.* (2015) [40]	Cross-sectional	2512 Malaysian public	Study the factors affecting dengue prevention practices among the Malaysian population
25	Chandren *et al.* (2015) [41]	Cross-sectional	505 Orang Asli participants from 16 villages in Malaysia	Investigate factors affecting dengue prevention practices among Orang Asli communities
26	Ridha *et al.* (2024) [42]	Quasi-experimental	Community members from Sidodadi Village, Samarinda	To implement G1R1J through participatory action research and evaluate its impact on dengue prevention
27	Ridha *et al.* (2023) [43]	Quasi-experimental	300 respondents in Sidodadi (intervention) and Dadimulia (control) villages	To evaluate the impact of mentoring by health cadres on community knowledge, attitudes, and actions regarding G1R1J

Factors associated with dengue prevention behaviour based on the social ecological model

The findings from the included studies were categorized according to the levels of the Social Ecological Model (SEM), including intrapersonal, interpersonal, community, institutional, and policy levels. A summary of the main findings across the included studies is presented in Figure 3.

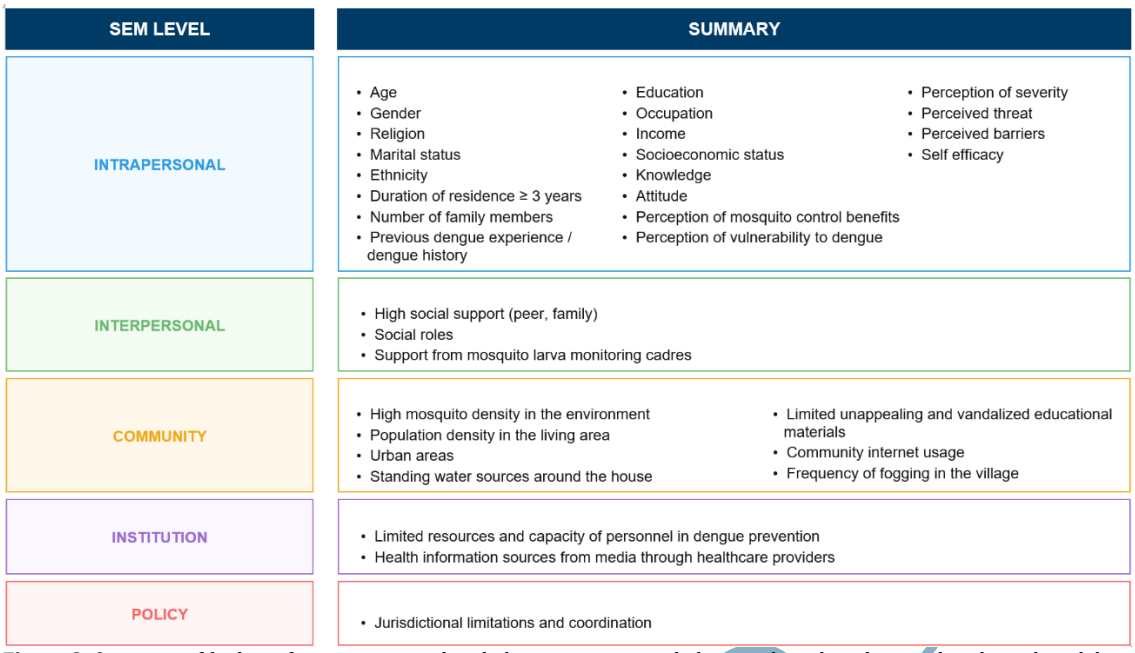

Figure 3. Overview of findings factors associated with dengue prevention behaviour based on the social ecological model

Intrapersonal level

Intrapersonal/individual factors refer to the internal characteristics of individuals that influence behavior and health, such as demographic factors (age, gender, ethnicity), psychological factors (attitudes, beliefs), as well as personal experiences and perceptions [15, 44, 45]. In the context of dengue prevention, various studies have shown that intrapersonal factors play an important role in shaping prevention practices at the household level. Demographically, age is one of the factors frequently associated with dengue prevention behavior. Most studies show that older individuals tend to have better prevention practices compared to younger age groups [21, 24, 32, 34], although some findings suggest the opposite in younger age groups [33]. In terms of gender, females are reported to be more involved in dengue prevention practices [24, 30, 32], although some studies also found a significant relationship in males [23, 31]. Furthermore, social factors such as marital status and religion also play a role, with married individuals or widows and respondents who are Muslim tending to show better prevention practices [23, 31, 33]. Other factors such as ethnicity, socioeconomic status, duration of residence ≥3 years, and smaller family size are also associated with better dengue prevention practices [22, 23, 26, 27, 31, 32, 34, 39].

Socioeconomic factors such as education, occupation, and income show varying results. Most studies report that higher education levels are associated with better prevention practices [19, 23, 24, 27, 28, 32, 33, 35], although some findings suggest that higher education does not always directly correlate with preventive actions [31], and in some cases, lower education is actually linked to better practices [33]. Occupational status also shows inconsistent results, with individuals working primarily in the formal sector being more involved in preventive practices [19, 24, 28, 34], while other studies show that homemakers or individuals who do not work are more active in these practices [21, 23, 33, 37, 40]. Meanwhile, households with lower incomes have been reported to have higher prevention practices [35, 40], although higher income is related to specific practices like recycling items [21]. In addition to demographic and socioeconomic characteristics, cognitive and psychological factors play a significant role. High levels of dengue knowledge are consistently associated with better prevention practices [18, 26, 35, 40, 41], as are positive attitudes toward prevention [26, 33, 36].

Furthermore, various components of perception within the health behavior model also play a role in shaping dengue prevention practices. Individuals with high perceptions of the benefits of mosquito control, high vulnerability perceptions, and high severity perceptions tend to have better prevention practices [17, 24, 25, 38, 40, 41]. High perceived threat even increases the likelihood of individuals engaging in adequate prevention practices by 2.3 times [18]. On the other hand, high perceived barriers and low self-efficacy are hindering factors in carrying out dengue prevention behavior [17, 18, 22, 24, 29, 41].

Interpersonal level

Interpersonal factors/relationships with others: This includes interactions and relationships with others or close formal and informal social relationships such as family, friends, and coworkers. Examples of factors include social support from close individuals, social influences (peer pressure, group norms, family dynamics), communication (how health information is communicated and shared), and others [15, 44, 45].

Social support is one of the main determinants associated with dengue prevention practices. Individuals who receive high levels of social support from family, friends, or their surrounding environment tend to have better prevention practices [19, 26]. This support can be in the form of emotional assistance, information, or direct involvement in prevention activities, which ultimately encourages individuals to be more active in maintaining the environment and applying preventive behaviors.

In addition, social roles also contribute to improving dengue prevention practices. Individuals who hold certain social roles, such as village health volunteers or community leaders, tend to exhibit better preventive behaviors compared to those who do not hold such roles. This can be due to social responsibility, better access to information, and active involvement in public health activities [29]. Furthermore, guidance from larval surveillance cadres has also significantly improved knowledge, attitudes, and dengue prevention practices in households [42, 46]. Overall, interpersonal factors related to household dengue prevention practices include social support from family or friends, high social roles or engagement of households or communities in the social environment, and the presence of support from health cadres or larval surveillance cadres, which encourage households and communities in their dengue prevention behaviors.

Community level

Community factors include the social characteristics as well as the physical environment where individuals live, including infrastructure, environmental conditions, social networks, and the norms that develop within the community. These factors play a role in shaping health behavior through environmental exposure and interactions within the community [15, 44, 45]. Physical environmental conditions, particularly those related to the presence of vectors, have a significant relationship with preventive behavior. Environments with high mosquito density tend to encourage individuals to be more active in implementing dengue prevention practices [40]. Similarly, individuals living in areas with high population density exhibit better prevention practices compared to those living in low-density areas [32]. Furthermore, communities residing in urban areas have been reported to be more active in prevention efforts compared to those in rural areas [19, 23].

Environmental factors around the home also contribute to prevention behavior. Individuals exposed to more sources of stagnant water around their homes are more likely to implement effective prevention practices, with a likelihood up to 2.7 times higher than those with lower exposure [26]. This suggests that direct exposure to environmental risk factors can increase awareness and preventive actions.

Additionally, social factors within the community, such as access to information and education, also influence behavior. Limited educational media, such as the lack of banners or unattractive materials, as well as vandalism like theft or damage to educational media, can hinder the dissemination of dengue prevention information [25]. On the other hand, internet use within the community is associated with better prevention practices as it facilitates access to health information [27].

Community-level control efforts, such as fogging activities, also play a role in shaping community behavior. Villages that rarely or never conduct fogging tend to have lower prevention practices compared to those that regularly perform fogging [41]. Overall, community factors show that the interaction between physical and social environmental conditions at the community level significantly influences dengue prevention behavior.

Institutional level

Organizational or institutional factors include the structure, policies, and capacity of the organizations or institutions where individuals interact, such as healthcare facilities, workplaces, and government agencies. These factors encompass the availability of resources, service quality, and the role of institutions in supporting or hindering health behaviors [15, 44, 45]. In the context of dengue prevention, the role of institutions is crucial in supporting the implementation of programs and influencing community behavior.

The involvement of authorities is a key factor in promoting dengue prevention practices. However, limited resources and institutional capacity present challenges in program implementation. A lack of funding, healthcare personnel, and the high workload on staff can hinder the effectiveness of the

programs being carried out [25]. This condition may reduce the reach and quality of interventions provided to the community. Moreover, the role of institutions in providing and disseminating health information is also critical. The sources of information individuals obtain through media, particularly those delivered by healthcare providers, contribute to enhancing knowledge, awareness, and motivating the community to adopt dengue prevention practices [30, 35].

Policy level

Policy factors encompass laws, regulations, and policies at the local, national, or international levels that influence health and behavior. Examples of health regulations (mandatory vaccination policies), government programs (healthy food subsidies), environmental policies (waste management, pollution control), and others [15, 44, 45]. In the context of dengue prevention, the effectiveness of policies is greatly influenced by inter-agency coordination as well as the clarity of role and responsibility distribution. One of the main challenges at the policy level is the limitation of jurisdiction and coordination among institutions. Inconsistent division of responsibilities among agencies can lead to difficulties in enforcing regulations and implementing dengue control programs effectively [25]. A prominent challenge is the lack of authority for law enforcement and inconsistent penalties for non-compliance. For example, areas under the jurisdiction of Agency A may not be subject to law enforcement actions, while another government body may have the authority to enforce such actions. This inconsistent law enforcement can create a sense of injustice and weaken the effectiveness of dengue control efforts. When authorities identify numerous mosquito breeding sites but fail to impose fines or take appropriate actions, it creates the perception that non-compliance is not punished. This can reduce community motivation to actively participate in dengue prevention measures and jeopardize the overall effectiveness of the prevention program [25].

Discussion

This systematic review aimed to synthesize evidence on factors associated with dengue prevention behavior using the Social Ecological Model (SEM). The findings highlight that dengue prevention is influenced by a complex interaction of determinants across multiple levels, including intrapersonal, interpersonal, community, institutional, and policy levels. This multi-level perspective is important, as it emphasizes that individual behavior cannot be effectively addressed in isolation without considering broader social and environmental contexts.

At the intrapersonal level, findings show that socio-demographic factors, socio-economic factors, cognitive, and psychological factors play a central role in shaping dengue prevention behaviors. Some of these factors are consistent with previous literature, such as psychological factors that align with the Health Belief Model theory, where perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy are part of shaping an individual's behavior [18, 47]. Although some of these factors sometimes reinforce each other, such as cognitive factors like knowledge, knowledge is one of the variables influencing dengue prevention practices in households. However, increased knowledge does not always lead to better practices [48-51]. This suggests that knowledge alone is not enough to drive sustainable behavioral change. Other factors in the social-ecological model are inseparable in shaping household dengue prevention behaviors. Therefore, interventions should not only focus on the intrapersonal/individual level but also on other levels, such as the intrapersonal, community, institutional, and policy levels.

At the interpersonal level, social support from friends or family, having a social role, and the presence of guidance from larval surveillance cadres are identified as important influences on the improvement of community dengue prevention behaviors [19, 26, 29, 42, 46]. Regarding social support, it can affect dengue prevention practices because social support can enhance high self-efficacy in individuals and provide various forms of assistance, such as information, instrumental support, and more. Several studies reveal that individuals with high self-efficacy (feeling capable of preventing dengue) are more likely to engage in dengue prevention actions, and this self-efficacy is strengthened by social support and cooperation [18, 22]. Individuals who receive encouragement, information, or practical support from others are more likely to adopt and maintain preventive practices [52]. Furthermore, studies also reveal that social support can provide instrumental assistance (helping lift items, cleaning, providing tools) that reduces barriers to dengue prevention practices [26, 53]. Next, regarding individual variables, having a social role can influence dengue prevention practices.

According to several studies, social roles such as cadres or community leaders provide individuals with more information and training [54, 55], foster strong motivation and a sense of social responsibility [56], make them role models for others [57], give them access to support networks such as local health

centers, local government, or non-governmental organizations (NGOs) [53, 58-60], and frequently receive feedback and support (facilities, incentives, materials) that reinforce daily preventive behaviors [53, 56, 61]. The combination of these factors makes their dengue prevention behaviors generally better compared to those without such roles. Finally, regarding the guidance from larval surveillance cadres, it can improve dengue prevention practices in the community/households [42, 46]. This is because guidance by cadres/larval surveillance officers (Jumantik) makes dengue prevention in households more routine, focused, and supervised. Many communities already "know" about dengue, but practices at home are inconsistent and often do not follow recommendations [39, 48, 56]. Cadres bridge this gap by routinely monitoring larvae, setting examples, and providing direct reminders at home, ensuring that the 3M/4M practices are truly followed [62]. Additionally, cadres function as local motivators: Providing social support, setting examples, and applying positive pressure so that residents feel responsible for the environment [57, 62]. Therefore, guidance by cadres/Jumantik significantly improves dengue prevention practices because it turns knowledge into concrete actions through routine monitoring, direct education, and social encouragement. This is effective when cadres are trained, supported, valued, and work within a community empowerment approach.

Community factors related to dengue prevention practices include mosquito density, which can be attributed to a high perception of vulnerability and the impact of dengue, leading the community to be more diligent in prevention efforts [40, 63, 64]. Similarly, variables such as population density are significant; In densely populated areas, often urban areas, human-mosquito contact is more frequent, and there are more cases, making the community more likely to see dengue sufferers, be more frequently exposed to campaigns, and feel more vulnerable, which encourages increased dengue prevention actions [64-66]. In dense environments, there are also more social interactions and peer influences (neighbors, neighborhood associations, cadres, volunteers), which can strengthen the norms of cleaning the environment and preventing mosquito larvae [29, 67]. Density also facilitates collective mobilization (community clean-up, water container inspection, group outreach) [34, 68]. The next variable, related to living in urban areas, has been reported to be more active in prevention efforts compared to those in rural areas. This may be due to urban areas often being the epicenter of dengue cases, thus resulting in more fogging, campaigns, and intervention programs (including mHealth and community programs) that encourage prevention practices [32, 40, 69]. Furthermore, urban residents generally have higher education levels and greater media exposure (TV, internet, health campaigns), so they have better knowledge of vectors, symptoms, and prevention methods compared to those in rural areas [70, 71].

In addition to the above, limited, unattractive, and vandalized educational materials can also affect dengue prevention practices among households or communities. In Malaysia, officials only have a few banners for an area, and these banners are often stolen or damaged. This directly reduces the opportunity for residents to see messages about maintaining cleanliness and dengue prevention, making access to information very limited [25]. This results in uneven information distribution, with only a small portion of residents being exposed, and many people still not knowing the specific actions they should take at home. Several studies show that when educational media is well-designed and widely used (posters, videos, leaflets, booklets, pocket cards, and guides), knowledge and prevention behaviors significantly improve [47, 72]. This underscores that good media alone can change behavior, and therefore, a lack of media or media that is damaged/unattractive logically becomes a significant barrier. Another variable is internet use within the community, where internet access is associated with better dengue prevention practices because communities with internet access have information that is easily accessible, frequent, and relevant; Enabling peer interaction and support; And providing space for healthcare workers and digital applications to guide, remind, and motivate the community to take preventive actions [32, 47, 73, 74].

Lastly, community-level control efforts, such as fogging activities, also play a role in shaping community behaviors. Villages that rarely or never conduct fogging tend to have lower prevention practices compared to villages that regularly perform fogging [41]. In Malaysia, fogging is generally carried out in dengue-affected areas, so residents interpret it as an official signal that the situation is dangerous [75]. Another study describes fogging as part of a control package (fogging+environmental management); When applied in a targeted and routine manner, it is associated with a decrease in cases and strengthens community efforts [76]. In some local studies, the community's response to fogging programs is very positive, but it is also seen as a short-term solution, leading to discussions about the importance of sustained environmental management [77]. However, this effect can be

bidirectional. A study in Mexico found that the perception that spraying alone was sufficient could create a "false sense of security", which was associated with less optimal household practices and higher larval indices [78]. Therefore, in communities that interpret fogging as a sign of danger and are accompanied by education, prevention practices tend to improve; Conversely, when it is perceived as a sole solution, it can dull the community's initiative.

At the institutional level, limited resources and institutional capacity, particularly related to a lack of funds, personnel, and excessive workloads among staff, affect the effectiveness of dengue prevention efforts in the community [25]. The lack of budget makes it difficult to implement education programs, provide materials (banners, leaflets, mosquito nets, waste bins), conduct fogging, and perform field visits in a massive, repetitive, and intensive manner [25, 79]. Without sufficient education activities, guidance, and feedback, community motivation and responsibility decline, and they become more reliant on government actions alone [56]. The lack of resources also hampers community empowerment models, which have been proven to significantly improve knowledge, attitudes, and prevention practices [34, 69, 80]. The shortage of funds, personnel, and institutional capacity makes it difficult for dengue programs to reach all residents, resulting in infrequent and inconsistent efforts. This weakens education, guidance, and community empowerment, preventing dengue prevention practices from improving optimally or being sustained over time. In addition to the above, the variable of health information sources from media through healthcare providers also contributes to improving community dengue prevention practices [30, 35]. Institutions contribute by being able to provide accurate, structured, and continuous information, which is distributed through trusted channels. One study showed that individuals who receive encouragement, information, or practical support from others are more likely to adopt and maintain preventive practices [52]. Another study revealed that individuals who receive dengue information from healthcare professionals are more likely to engage in proactive prevention actions. Healthcare providers play a crucial role in disseminating accurate and tailored health advice that aligns with the specific needs of the community, thus increasing adherence to prevention practices [81]. This enhances knowledge, raises awareness of risks, and motivates the community to change behavior into more consistent dengue prevention practices. Community-based programs that involve village governments, health centers, and local leaders increase a shared sense of responsibility and encourage sustained prevention behaviors [82, 83]. Healthcare workers and digital opinion leaders are seen as highly credible, able to correct misconceptions, reduce doubts, and motivate the community to implement preventive measures [84, 85].

At the policy level, limited jurisdiction and coordination among institutions are factors that contribute to the challenges in dengue prevention efforts. The lack of alignment in the division of responsibilities among agencies and difficulties in enforcing regulations are barriers for the community in taking preventive steps against dengue [25]. Similar findings have been reported in other public health contexts, where fragmented governance structures limit the effectiveness of disease prevention programs [86-90]. A lack of coordination and role division has also been reported in Colombia and Ecuador, where community-level prevention protocols (participation, education, KAP studies) are not functioning optimally [91, 92]. In Bangladesh, despite having a relatively complete legal framework, the lack of coordination between levels of government (national-provincial-city) weakens the implementation of sustainable vector control efforts [93]. Therefore, a coordinated multi-sectoral approach is crucial to ensure comprehensive dengue prevention strategies. Limited jurisdiction and coordination make it difficult for policies to be translated into clear, consistent, and fair actions on the ground. The misalignment in responsibility division and weak enforcement of regulations undermine public trust and motivation, preventing dengue prevention practices from developing and sustaining effectively.

Across all levels of the SEM, this review highlights that dengue prevention behavior is the result of complex interactions between individual, social, environmental, and structural factors. Compared to studies that focus primarily on individual-level determinants, this review provides a more comprehensive perspective by integrating multiple levels of influence. This reinforces the value of using the SEM as a framework to better understand and address dengue prevention behavior. A one-size-fits-all approach is unlikely to be effective in addressing the complexity of dengue prevention behavior. From a theoretical perspective, these findings support the application of the Social Ecological Model in understanding health behavior, particularly in dengue prevention. The results indicate that integrating individual-level theories, such as perception-based models, within a broader ecological framework provides a more comprehensive understanding of behavior. From a practical

and policy perspective, these findings suggest that dengue prevention programs should go beyond interventions that focus solely on the individual or intrapersonal level, but also address other factors such as interpersonal, community, institutional, and policy factors, or adopt a multi-level strategy. Such an integrated approach is more likely to result in sustainable behavioral change.

Conclusion

Our findings offer important implications for strategic intervention programs and policies aimed at improving dengue prevention behavior at the household and community levels. This objective aligns with global health priorities, particularly the Sustainable Development Goals (SDG 3) on good health and well-being, which emphasize the prevention and control of communicable diseases, including dengue.

This systematic review highlights that dengue prevention behavior at the household level is influenced by a complex interplay of determinants across all levels of the Social Ecological Model. At the intrapersonal level, demographic, socioeconomic, cognitive, and psychological factors, particularly knowledge, attitudes, risk perception, and self-efficacy, play a central role, although evidence suggests that knowledge alone is insufficient to ensure consistent preventive practices. At the interpersonal level, social support, social roles, and engagement with community health cadres significantly strengthen individual capacity to adopt and sustain preventive behaviors. At the community level, environmental conditions such as mosquito density, population density, exposure to breeding sites, and access to information shape behavioral responses, while institutional factors including resource availability, workforce capacity, and effective health communication determine the reach and quality of prevention programs. At the policy level, weak coordination, fragmented responsibilities, and inconsistent law enforcement remain key barriers to effective dengue control.

Overall, these findings demonstrate that dengue prevention behavior cannot be addressed through single-level interventions. Instead, effective strategies require integrated, multi-level approaches that simultaneously target individual behavior, social dynamics, environmental conditions, institutional capacity, and policy implementation. Strengthening cross-sectoral coordination, enhancing community engagement, and improving institutional and policy support are essential to achieving sustainable dengue prevention outcomes. Future research should prioritize the development and evaluation of theory-driven, multi-sectoral interventions. A holistic and coordinated approach is critical to reducing dengue transmission and ensuring long-term public health impact.