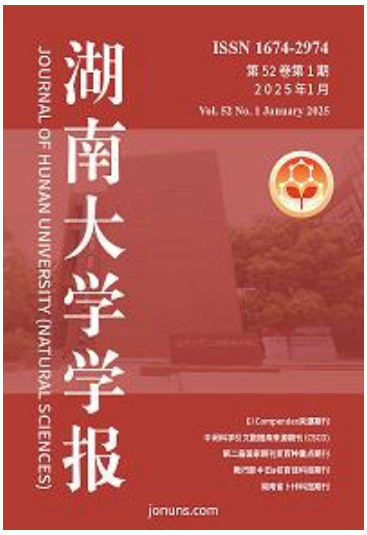

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Knowledge, Attitudes, Practices, and Cases of Dengue in Tuluá, Colombia in 2024

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Abstract: Dengue fever is a significant public health issue, particularly in tropical and subtropical regions. Tuluá, a city located in the central region of Valle del Cauca in southwestern Colombia, is historically endemic and possesses ideal conditions for the proliferation of the vector. During the first half of 2024, the city experienced an unprecedented outbreak. Despite local efforts, gaps persist in community knowledge about the factors influencing transmission. This study is pioneering and novel as it evaluates knowledge, attitudes, and practices (KAP) and relates them to dengue in the region, integrating geographic information systems (GIS) and spatial analysis of cases and associated variables, which enables the design of targeted and efficient public health interventions. The objective was to determine the KAP of residents regarding dengue and the incidence of cases during the first half of 2024. A descriptive cross-sectional study was conducted, encompassing 401 KAP surveys, household verifications, and reported cases. Data were analyzed using SPSS and QGIS through tables and heat maps to identify spatial and

statistical patterns. The results showed that 39.94% of the respondents recognized dengue symptoms, and 87.5% understood its mode of transmission. However, only 35.1% correctly identified the vector breeding sites. Preventive attitudes were limited (12.9% positive), and practices were inadequate: 46.6% of households had breeding sites, and only 12% adequately cleaned water tanks. Heat maps revealed critical areas where breeding sites, larvae, and confirmed cases overlapped, with high-density clusters separated by 10 to 20 m. The findings highlight significant gaps in KAP, which contribute to the persistence of dengue. Strengthening prevention and control measures, epidemiological surveillance, and promoting preventive practices are essential. The integration of KAP with georeferencing provides a replicable model for future research on dengue and other arboviral diseases transmitted by vectors, as it allows for targeted interventions in critical areas and optimizes public health planning in vulnerable urban communities.

Keywords: Dengue, knowledge, attitudes, practices, georeferencing, health, medicine, public health.

2024 年哥伦比亚图卢阿的登革热知识、态度、实践和病例

摘要：登革热是一个重大的公共卫生问题，尤其是在热带和亚热带地区。图卢阿是哥伦比亚西南部考卡山谷中部地区的一座城市，历史上登革热就是一种地方病，为病媒的繁殖提供了理想的条件。2024 年上半年，该市经历了前所未有的疫情。尽管当地做出了努力，但社区对影响传播的因素的了解仍然存在差距。这项研究具有开创性和新颖性，因为它评估了知识、态度和实践 (KAP) 并将其与该地区的登革热联系起来，整合了地理信息系统 (GIS) 和病例及相关变量的空间分析，从而能够设计有针对性和有效的公共卫生干预措施。目的是确定 2024 年上半年居民对登革热的 KAP 和病例发病率。进行了一项描述性横断面研究，包括 401 份 KAP 调查、家庭核实和报告病例。使用 SPSS 和 QGIS 通过表格和热图分析数据，以识别空间和统计模式。结果显示.39.94% 的受访者认识到登革热症状.87.5% 的受访者了解其传播方式。然而，只有 35.1% 的人正确识别了媒介繁殖地。预防态度有限（12.9% 为积极态度），实践不足：46.6% 的家庭有繁殖地，只有 12% 的家庭充分清洁了水箱。热图显示了繁殖地、幼虫和确诊病例重叠的关键区域，高密度集群相隔 10 至 20 米。研究结果强调了 KAP 的重大差距，这导致了登革热的持续存在。加强预防和控制措施、流行病学监测和促进预防措施至关重要。KAP 与地理参考的结合为未来对登革热和其他媒介传播的虫媒病毒疾病的研究提供了一个可复制的模型，因为它允许在关键区域进行有针对性的干预，并优化脆弱城市社区的公共卫生规划

关键词：登革热、知识、态度、实践、地理参照、健康、医学、公共卫生

1. Introduction

Dengue virus (DENV) is an infectious viral disease transmitted by Aedes aegypti and Aedes albopictus mosquitoes, affecting millions of people in tropical and subtropical regions. This situation has made dengue a significant public health concern. The World Health Organization (WHO) estimates that approximately 2.5 billion people are at risk of contracting dengue, with reports of 100 to 400 million infections annually [1]. In 2024, the highest number of global cases was recorded, prompting the Pan American Health Organization (PAHO) to issue an alert in the Americas, where nearly 11 million cases were reported by September of that year. Although most cases are mild, a substantial fraction of those infected develop severe forms, such as dengue with warning signs and severe dengue. These manifestations include shock and hemorrhage, posing a considerable burden on public health systems. Moreover, it primarily affects vulnerable populations,

with a small percentage of cases resulting in fatalities [2].

The dengue virus belongs to the Flavivirus genus within the Flaviviridae family and comprises four distinct serotypes (DENV 1–4) [3]. Infection with any serotype can be asymptomatic or lead to symptoms such as fever, headache, malaise, rash, joint pain, nausea, and vomiting. Severe cases may present with fluid accumulation, liver enlargement, pleural effusion, thrombocytopenia, hemorrhagic manifestations, and shock, thereby endangering the patient's life. In addition, reinfection with a different serotype significantly increases the risk of developing severe disease forms [4]. This phenomenon has raised significant concern regarding the management and control of dengue, particularly in regions where multiple serotypes circulate. In Central and South America, particularly in Colombia, dengue has become one of the leading vector-borne diseases, with its incidence increasing over the past two decades due to factors such as population growth, climate change, and migration [5].

Mosquitoes breed in any container holding stagnant water. While A. aegypti, originally from Africa, is primarily found in urban areas, A. albopictus, native to Asia, inhabits suburban and vegetated areas, with its eggs capable of surviving desiccation [6]. Factors such as rapid urbanization, population growth, inadequate sanitation services, and poor waste management contribute to increased mosquito populations and, consequently, virus transmission [7]. Furthermore, these mosquitoes can transmit other arboviral diseases, including Zika, yellow fever, chikungunya, and Rift Valley fever [6].

In 2009, the WHO introduced a new dengue classification based on clinical progression: dengue without warning signs, characterized by nonspecific febrile syndrome; dengue with warning signs, indicating greater disease severity, including abdominal pain, persistent vomiting, fluid accumulation, mucosal bleeding, altered mental status, hepatomegaly, and progressive hematocrit increase; and severe dengue, which encompasses shock, respiratory distress, fluid extravasation, and liver impairment [4].

Various strategies have been studied and implemented for dengue prevention and control [3]. Vector control is crucial, involving environmental monitoring, eliminating or treating breeding sites (e.g, stagnant water containers), using insecticides [8], biological control by releasing mosquitoes carrying Wolbachia bacteria that reduce virus transmission capability, and natural larval predators like fish. Additional measures include traps, repellents, protective clothing covering the arms and legs, bed nets, and bite prevention methods. Epidemiological and entomological surveillance is essential for monitoring mosquito populations, larvae, and potential transmission hotspots. Public education and community participation are necessary to inform individuals about the disease and encourage the implementation of these strategies and collective actions [9]. The development of vaccines, ideally for previously infected individuals to reduce the severity of reinfection, represents a significant advancement, but the most effective approach combines strategies and research [10].

Dengue is endemic in several Colombian regions, including Valle del Cauca, specifically Tuluá, an area characterized by climatic variability conducive to mosquito proliferation. This region encompasses all thermal floors and experience temperatures ranging from 18.5°C to 30°C, with an average of 25°C. Its approximate altitude of 1.000 m above sea level creates ideal conditions for virus transmission, providing a favorable environment for the vector mosquito [7]. Dengue incidence has risen in recent decades due to climatic factors, unplanned urban growth, and deficiencies in vector control programs and health education [11]. The circulation of all four dengue serotypes in the country has increased the risk of severe disease forms, prompting health authorities to prioritize epidemiological surveillance and community education to reduce morbidity and mortality [12].

In recent years, dengue cases have risen significantly, with 2024 being regarded as the worst outbreak recorded in the America [7, 12]. However, dengue has historically been underdiagnosed and underreported, which hinders the implementation of effective control measures [3]. Previous studies have demonstrated inconsistent findings regarding community risk perception and the adoption of preventive measures [3].

Although the population is generally aware of dengue's severity, research conducted in various cities across Colombia and Latin America reveals that many individuals continue to engage in behaviors that facilitate mosquito proliferation. These include storing water without adequate protection, failing to eliminate household breeding sites, and accumulating waste that serves as mosquito habitats (e.g, discarded items) [5]. Moreover, factors such as population mobility, poverty, limited access to health care services, and inadequate health education further exacerbate the situation.

Studies on knowledge, attitudes, and practices (KAP) are crucial for understanding how communities perceive and manage disease risks like dengue. These investigations are valuable for planning and designing prevention and control strategies. Globally, KAP study findings are heterogeneous [13], but generally, knowledge about dengue is low, even in endemic areas of Asia and Latin America. Attitudes toward prevention are often positive, yet disease control practices are inadequate and incorrect [3, 5, 14]. Thus, studying KAP is essential to identify knowledge gaps, incorrect

behaviors, and inadequate practices, aiding in improving intervention strategies and public health policies [13].

In this context, health authorities in Valle del Cauca and Tuluá have regularly conducted health education campaigns and prevention initiatives. However, these efforts appear insufficient given the persistent annual incidence of cases and periodic disease peaks, as seen in 2024. Therefore, this research addresses questions regarding the KAP of residents toward dengue and case incidence during the first half of 2024. This study addresses a gap in the literature, as no similar research has been conducted in this locality, and it uniquely incorporates the georeferencing of cases and inadequate practices within this community. It seeks to identify knowledge gaps and incorrect practices, facilitating the design of more effective strategies for dengue prevention and control in vulnerable areas like Tuluá [13, 15]. The findings contribute to dengue knowledge in the urban contexts of Latin America, where socioeconomic and environmental conditions increase disease vulnerability, and offer a useful model for future research integrating KAP analysis with georeferencing tools.

2. Methods

2.1. Study Design

A cross-sectional, descriptive, quantitative study was conducted in two neighborhoods of Tuluá during the first semester of 2024. A CAP (Knowledge, Attitudes, and Practices) survey was administered to the population. Data on dengue cases reported by the local health authority for the same period were collected and georeferenced, along with cases reported by the community, the presence of discarded items, and mosquito larvae.

2.2 Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and current national regulations. This study was approved by the Research Ethics Committee of the Faculty of Health Sciences at the Unidad Central del Valle del Cauca (UCEVA) in Tuluá on April 23, 2024, for studies involving human subjects (Project Code: PI-1300-50.2-2024-PDP-04). Informed consent was obtained from all participants who were of legal age according to Colombian law. Each participant was informed that participation was voluntary and that they could withdraw at any time. They were also briefed on the study's objectives, significance, and potential benefits.

The local health authority was requested to provide the dengue case database for the first semester of 2024, along with authorization for its use in the study and for publishing the results. All survey forms and case records were assigned unique codes, and data processing was performed exclusively by the research team, ensuring the confidentiality of personal information.

2.3. Study Area

The study was conducted in Tuluá, a city located in the central region of the Valle del Cauca department. Its elevation ranges from 960 m above sea level in the urban area to 4.400 m above sea level in the rural zone. The city's geographic coordinates are 4°05'16" N latitude and 76°12'03" W longitude. Tuluá has an average temperature of 24°C and an average annual rainfall of 1.302.2 mm. The city covers a total area of 910.55 km², of which 98.78% corresponds to the rural area and 1.22% to the urban area (Figure 1.)

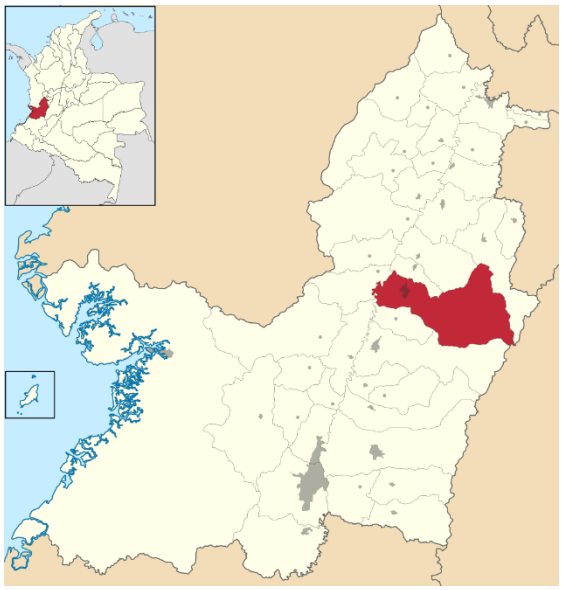

Figure 1. Map and location of Tuluá in the Valle del Cauca department, Colombia (Source: Tuluá City Hall)

The city has 10 communes and 145 neighborhoods. Two neighborhoods were selected (one from Commune 1 and the other from Commune 5), which, according to the 2023 data, had the highest incidence of dengue (Figure 2).

2.4. Sample Calculation

The sample size was calculated using the EPIDAT 4.2 software based on a statistical sampling formula for estimating proportions in finite populations. The total number of households in each neighborhood was considered as the population (n), with a 95% confidence level and a 5% margin of error. The results were as follows: Neighborhood 1 (n: 675), sample size (245); Neighborhood 2 (n: 263), sample size (156). The sample obtained for each neighborhood was distributed using cluster random sampling, with city blocks serving as clusters.

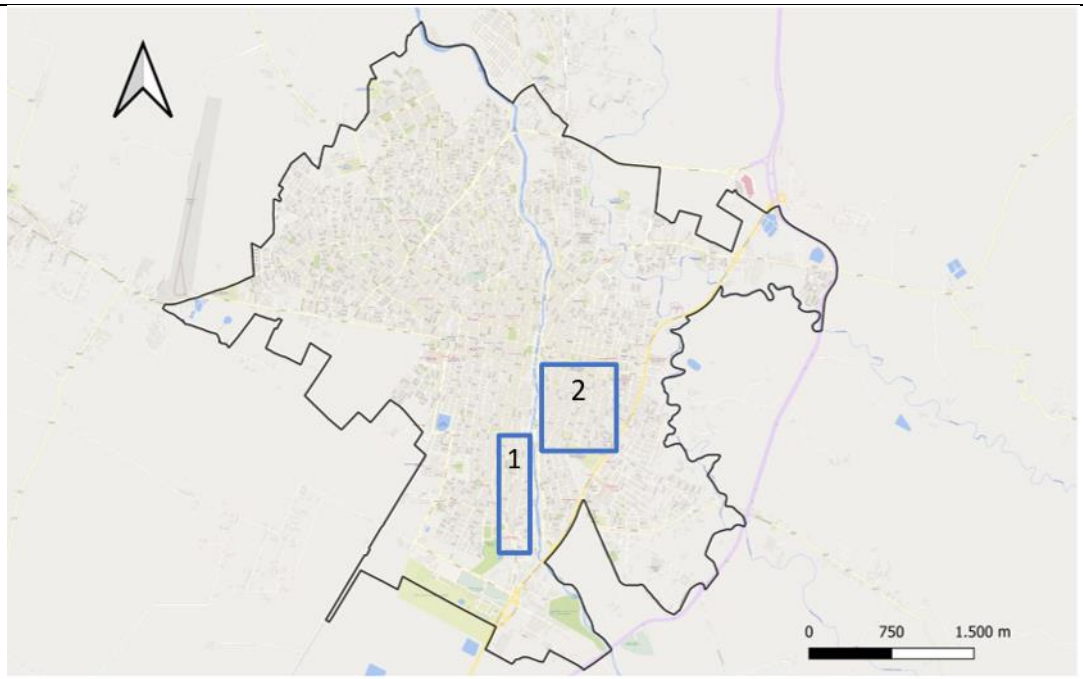

Figure 2. Map of Tuluá and the location of the studied neighborhoods (Developed by the authors using QGIS software)

2.5. Instrument

The primary data collection instrument was the "Knowledge, Attitudes, and Practices on Dengue" survey developed by Cáceres-Manrique [16], which was used with prior authorization from the authors. The survey comprises four sections: general sociodemographic data, nine questions on knowledge, nine on attitudes, and a seven-point section for practice verification. The latter includes the identification of discarded items, breeding sites, and mosquito larvae, conducted by trained personnel.

Additionally, the official database of dengue cases reported by the city's health authority was used. Relevant data such as case classification and geographic location from the epidemiological records were extracted for geolocation.

2.6. Selection and Inclusion Criteria

2.6.1. Inclusion Criteria:

Participants were required to be over 18 years old, i.e, adults in accordance with the current legislation in Colombia. Additionally, they had to be residents of the surveyed neighborhood. To ensure the representativeness of the sample and accurate georeferencing, only one individual per household was surveyed.

2.6.2. Exclusion Criteria:

Participants who did not grant permission for the verification and inspection of their households were excluded from the study. Furthermore, surveys containing incomplete information, omissions, or significant errors in the completion of the questionnaires were excluded to maintain data integrity.

2.7. Data Collection

Interviews were conducted during the first semester of 2024 through home visits conducted by health professionals and pre-trained medical and nursing students. They conducted the informed consent process and interviews using a standardized questionnaire, including home verification and inspection. Each visit took approximately 30 minutes.

2.8. Data Processing

The collected data were transcribed and tabulated using Word and Excel software. Subsequently, the data were processed using IBM SPSS Statistics for statistical analysis through the generation of tables facilitating the interpretation of the results. The analysis focused on describing responses by neighborhood.

Households reporting dengue cases within the past month, those with discarded items capable of retaining water, and those with mosquito larvae were geolocated using Google Maps. Similarly, dengue cases from both neighborhoods reported by the city's health authority were geolocated. The open-source QGIS software was then used to manage, analyze, visualize, edit, and design maps, generating point and heat maps to identify the geographic distribution of the studied variables.

3. Results

3.1. Demographic profile

A total of 401 surveys were conducted across the two neighborhoods: 156 (38.9%) in Neighborhood 1 and 245

(61.1%) in Neighborhood 2. In both groups, females predominated, with 253 respondents (63.1%) being women (60.9% in Neighborhood 1 and 64.5% in Neighborhood 2). The respondents' ages ranged from 18 to 80 years, with a mean age of 50.86 years (SD: 17.89). In terms of educational attainment, secondary and higher education were the most common levels in both groups, with only a small proportion reporting no formal education. The distribution was as follows: higher education 144 (35.9%) and secondary education 145 (36.1%). Table 1 presents a detailed summary of the demographic data.

Table 1. Sociodemographic Characteristics (compiled by the authors)

Variable	n	Percentage	n	Percentage
Gender				
Female	95	60.9%	158	64.5%
Male	61	39.1%	87	35.5%
Education				
Higher education	62	39.7%	82	33.5%
Secondary	61	39.1%	84	34.3%
Elementary	32	20.5%	60	24.5%
None	1	0.6%	19	7.8%

Age	Minimum	Maximum	Mean	Standard deviation
	18	80	50.86	17.899

3.2. Knowledge about Dengue

Regarding dengue knowledge, 87% of participants from both neighborhoods recognized dengue as a disease, while 3.5% considered it a flu-like illness, 4.2% identified it as a mosquito, 4.7% mentioned various unrelated symptoms, and 0.7% admitted not knowing what it was. When asked about typical symptoms, 160 respondents (39.94%) correctly identified them (41.3% in Neighborhood 1 and 39.07% in Neighborhood 2). Fever was recognized as the most common symptom by 90.7% of the participants, followed by body pain (63.8%) and rash (11.4%). A total of 87.5% of the respondents understood how dengue is transmitted. Additionally, 21.19% knew the mosquito's scientific name, 45.13% could describe its appearance, 35.1% were aware of its breeding sites, and 44.63% recognized its larvae. Most respondents (70.07%) considered dengue a very serious disease. Furthermore, 18% (74 respondents) reported having a dengue case at home in the past month. Overall, the average correct knowledge score among the participants was 49.5%. Table 2 shows the frequency and percentage distribution by neighborhood.

Table 2. Knowledge about Dengue (compiled by the authors)

Variable	Neighborhood 1		Neighborhood 1	
	n	%	n	%
Definition of Dengue				
A mosquito-borne disease	62	39.70%	91	37.10%
A disease	58	37.2%	65	26.5%
A virus	23	14.70%	31	12.70%
Refers to symptoms	5	3.20%	14	5.70%
A mosquito	0	0%	17	6.90%
A cold	4	2.6%	10	4.1%
Other	2	1.3%	8	3.3%
A bite	2	1.3%	4	1.6%
Unknown	0	0%	3	1.20%
A parasite	0	0%	2	0.80%
Symptoms				
Fever	147	94.2%	217	88.6%
Body aches	89	57.1%	171	69.8%
Headache	101	64.7%	121	49.4%
Vomiting	68	43.6%	102	41.6%
Rash	76	48.7%	45	18.4%
Joint pain	48	30.8%	72	29.4%
Diarrhea	47	30.1%	71	29%
Nosebleed	40	25.6%	48	19.6%
Stomach pain	44	28.2	42	17.1%
Gum bleeding	40	25.6%	44	18%
Eye pain	33	21.2%	33	13.5%

Sweating	25	16%	28	11.4%
Cough	19	12.2%	6	2.4%
Knowledge about Transmission	144	92.3%	207	84.5%
Knows the name of the mosquito	36	23.1%	49	20.0%
Knows the appearance of the mosquito	66	42.3%	115	46.9%
Knows the time of the mosquito bite	35	22.4%	18	7.3%
Knows where it breeds	71	45.5%	70	28.6%
Knows the larva	69	44.2%	110	44.9%
How dengue is classified				
Very severe	105	67.3%	176	71.8%
Moderately severe	33	21.2%	52	21.2%
Not very severe	14	9.0%	7	2.9%
Not severe	4	2.6%	10	4.1%

3.3. Attitudes toward Dengue

Regarding attitudes and participation in dengue prevention and control actions, low proportions of positive responses were observed across all survey questions, with an overall average of 12.9% (5.3% in Neighborhood 1 and 17.4% in Neighborhood 2). Positive response rates were generally higher in Neighborhood 2 than in Neighborhood 1. A detailed summary of these results is presented in Table 3.

Table 3. Attitudes toward Dengue (compiled by the authors)

Variable	Neighborhood 1		Neighborhood 1	
	N	%	N	%
Educates others about prevention	24	15.4%	112	45.7%
Believes that their suggestions are heard	10	6.4%	91	37.1%
Sees the possibility of conducting control actions	13	8.3%	79	32.2%
Demands prevention actions from the authorities	3	1.9%	34	13.9%
Collects discarded items from the community	10	6.4%	23	9.4%
Attends community meetings	6	3.8%	16	6.5%
Seeks assistance for prevention programs	4	2.6%	15	6.1%
Leads prevention campaigns	2	1.3%	13	5.3%
Participates in prevention activities	3	1.9%	7	2.9%

3.4. Practices, Verification, and Dengue Cases

Regarding practices related to dengue, the following behaviors were observed: when someone presents with symptoms, 59.9% of respondents reported seeking healthcare services, 18% care for the individual at home, 12.2% self-medicate, and 4% do nothing. As for dengue prevention measures, 32.9% of respondents applied environmental measures such as fumigation, using nets, fans, or repellents, while 52.6% eliminated breeding sites. Another 14.5% either took incorrect actions or did nothing. Additionally, 86% of respondents stored water in tanks, but only 12% cleaned them properly. All of this information is presented in Table 4.

Table 4. Practices Regarding Dengue (compiled by the authors)

Variable	Neighborhood 1		Neighborhood 1	
	N	%	N	%
In the case of dengue				
Visit the hospital	14	9.0%	127	51.8%
Visit a private doctor	52	33.3%	47	19.2%
Home care	41	26.3%	31	12.7%
Self-medication	27	17.3%	22	9.0%
Go to the pharmacy	14	9.0%	10	4.1%
Do nothing	8	5.1%	8	3.3%
To prevent dengue				
Control the environment (fumigate, wash, clean)	66	42.3%	66	26.9%
Eliminating useless items	76	48.7%	135	55.1%
Incorrect practices	6	3.8%	24	9.8%
Do nothing	8	5.1%	20	8.2%
To prevent mosquito bites				
Fumigate, use repellent, fan	118	75.6%	181	73.9%
Eliminating breeding sites	5	3.2%	4	1.6%

Incorrect practices	0	0.0%	4	1.6%
Do nothing	33	21.2%	56	22.9%
Water storage in other				
Buckets	21	13.5%	44	18.0%
Bottles	6	3.8%	6	2.4%
Barrels	12	7.7%	20	8.2%
Pots	0	0.0%	10	4.1%
Water storage in tanks	137	87.8%	193	78.8%
Methods to prevent mosquito breeding in the tank				
Wash	121	77.6%	108	44.1%
Nothing	20	12.8%	91	37.1%
Cover	10	6.4%	33	13.5%
Apply chlorine	4	2.6%	9	3.7%
Apply insecticide	1	0.6%	4	1.6%
Tank washing frequency				
Once a month	40	25.6%	13	5.3%
Twice a month	28	17.9%	9	3.7%
Twice a week	39	25.0%	64	26.1%
Once a week	27	17.3%	49	20.0%
Daily	16	10.3%	44	18.0%
Never	6	3.8%	66	26.9%
The tank washing method				
Detergent and brush	70	44.9%	139	56.7%
Water and brush	34	21.8%	14	5.7%
Detergent	35	22.4%	13	5.3%
Water only	17	10.9%	22	9.0%
Does not wash	0	0.0%	57	23.3%

In the observation and verification of practices conducted in homes after the survey, the presence of various items such as garbage and containers was found in 46.6% of the homes, primarily in Neighborhood 1. In 21.19% of the homes, mosquito larvae were found, and 18.45% self-reported a dengue case in the home within the last month. According to the report from the city's health office, 131 cases of dengue were officially reported in both neighborhoods during the first half of 2024, representing 2.28% of the total cases reported in Tuluá (n: 5739). Of these cases, 25.9% required hospitalization, and no cases of severe dengue were reported. All of the information is contained in Table 5.

Table 5. Verification in Homes and Dengue Cases (compiled by the authors)

Variable	Neighborhood 1		Neighborhood 1	
	N	%	N	%
Presence of useless items	100	64.1%	87	35.5%
Presence of the larvae	38	24.4%	47	19.2%
Dengue in the last month	21	13.5%	53	21.6%
Dengue without warning signs	24	77.40%	64	65.9%
Dengue with warning signs	10	29.40%	33	34%
Cases reported by the health department	34	23.60%	97	74%
Hospitalizations	8	23.52%	26	26.8%

3.5. Georeferencing of Cases, Discarded Items, and Larvae

In this study, georeferencing and the generation of heat maps were used for the first time in the city and the surrounding region to facilitate data interpretation. Different graphic conventions were employed on the maps: yellow triangles indicate cases reported by the community, light blue diamond mark discarded items and waste containing stagnant water, green circles highlight homes where mosquito larvae were found, and yellow-red patches represent dengue cases reported by the city's health authority. It can be observed that these various elements are geographically distributed throughout the entire territory of both neighborhoods.

In both neighborhoods, the presence of breeding sites and mosquito larvae is evident throughout the area, as well as dengue cases. There is also a spatial proximity between these elements, ranging from ten to twenty meters. The heat and point maps reveal clearly defined clusters of variable overlap in the two studied areas. In Neighborhood 1, four well-defined clusters are identified starting from the north, along with a scattered cluster in the central area and a group of cases in the south. In Neighborhood 2, six clusters were detected

across all zones, showing high geographical overlap, as well as three dispersed areas in the south and two groups of cases (Figures 3).

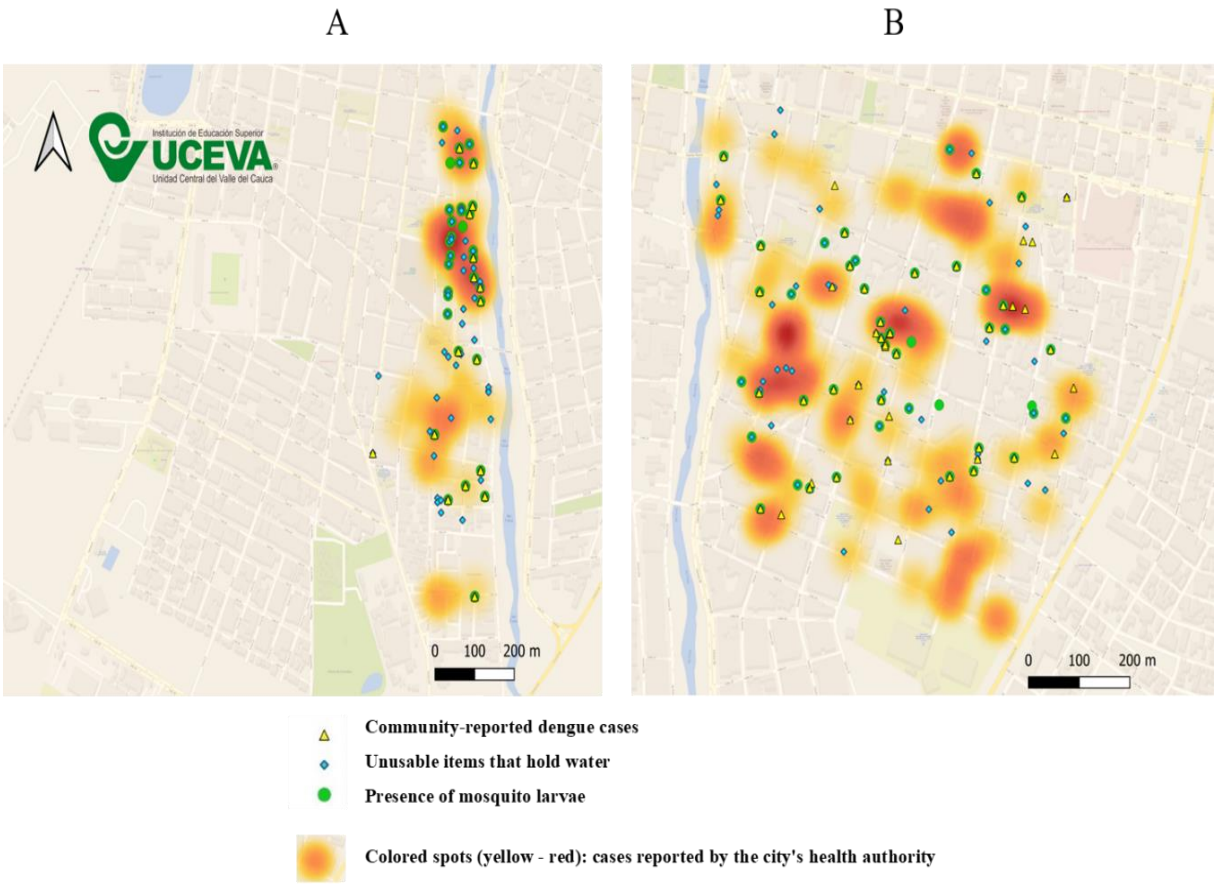

Figure 3. Point and Heat Map. A: Neighborhood 1, B: Neighborhood 2 (developed by the authors)

5. Discussion

This study surveyed the residents of two neighborhoods in Tuluá to describe their knowledge, attitudes, practices, and cases of dengue. According to our review, this is the first study to evaluate KAP in the city. During the study period, the worst dengue outbreak in the history of the America was occurring, a situation described as a health threat [3].

KAP studies on the disease revealed significant gaps and associated factors affecting the prevention and control of dengue in different regions. In this research, the main findings indicate that participants have acceptable knowledge; 87% of the participants recognized dengue as a disease and knew the classic symptoms and the mode of transmission. However, knowledge about the mosquito's name, appearance, larvae, or biting time was low. Regarding attitudes, only 12.9% showed positive responses. Practices related to prevention showed significant deficiencies, such as inadequate tank washing (12%) and the accumulation of breeding sites in 46.6% of households. Additionally, it was found that 18.45% of respondents self-reported dengue cases in their households during the last month, coinciding with the high incidence officially recorded in these neighborhoods. This panorama contrasts with studies conducted in Latin America and Asia in 2023 [17], which found a low overall score for Knowledge (48%) and Practice (44%), and a moderate score for Attitude (66%). Similarly, a study conducted in Malaysia showed that only half of the participants had good knowledge about dengue, and more than 50% had inadequate attitudes and practices for its control [18]. The lack of alignment between knowledge, attitudes, and preventive practices is an important factor in the occurrence of dengue outbreaks in urban areas.

The results of our work reaffirm previous findings linking the presence of mosquito breeding sites and inadequate water storage practices with higher dengue incidence, as shown in two studies conducted in Bangladesh [19] and another in Malaysia [18]. Misconceptions about habitats and other inadequate prevention measures favored mosquito breeding. In all three, the disparity between dengue knowledge (87% recognition) and the application of preventive measures was also evident, partially aligning with research conducted in similar contexts in Latin America [17].

This underscores the need to adapt intervention strategies specifically to communities with particular socioeconomic and cultural dynamics.

In the community, knowledge was adequate, and regarding education, three-quarters of our respondents had completed secondary or higher education, similar to findings from Bangladesh [20], Malaysia [9], Brazil [21], and Cali, Colombia, where 76% of participants answered correctly [22], as well as from the Colombian Caribbean [23]. Previous studies have shown that higher educational levels are associated with better knowledge of the disease. In contrast, in Nepal, a study among university students unrelated to health fields revealed that only 15.2% had good knowledge of dengue, and both age and educational level were linked to preventive practices [24]. In Brazil, a study in Fortaleza found high scores in knowledge and attitudes but highlighted that knowledge alone, without action, does not improve the situation regarding the number of cases [21]. These studies emphasize the importance of enhancing education and awareness campaigns to close the knowledge gaps and encourage effective preventive practices against dengue, adapting them to different contexts.

The findings of this study, reflecting limited community attitudes and participation in dengue prevention and control actions (overall average of 12.9%), contrast with other studies, such as the one conducted in Laos, where attitude levels were reported to be moderately good (96%) on average [25], and the study conducted in Argentina, Brazil, Colombia, Mexico, Indonesia, Malaysia, and Singapore, where countries obtained a comparable moderate score for Attitude (66%) [17]. In another study in China, participants reported a high attitude and willingness to control and prevent the disease at 97% [26]. Similarly, in Pakistan, it was found that 90.1% had positive attitudes and showed significant associations between poor knowledge/attitude and poor preventive practices [27]. On the other hand, our results are similar to the findings of a meta-analysis and systematic review conducted in the Philippines, where 15 studies showed, on average, low levels of positive attitudes (49.86%), and in some studies, 95% of respondents exhibited several negative attitudes [10]. In Sri Lanka, a study revealed that a population with lower awareness of dengue prevention and management was associated with a higher number of cases [28].

In the Jazan region of Saudi Arabia, a positive evaluation was identified between the KAP constructs, highlighting the need for further research to improve the generalization of the results [14]. In Malaysia, among migrant workers, it was observed that knowledge was positively correlated with attitude but negatively correlated with practices [29]. This suggests the need for specific educational interventions, particularly targeting younger individuals and those with lower educational levels.

Regarding practices, our study found that 46% of the population had adequate practices, 52.6% reported eliminating useless items and breeding sites, which were verified in 46.6% of the houses, and mosquito larvae were found in 21.2%. This correlates with a study in Bangladesh, where people agreed that their families, communities, and authorities should monitor and maintain their environment to prevent the reproduction of Aedes mosquitoes. However, in general, 60% of the study group had inadequate preventive measures. Many participants lacked necessary practices, such as taking additional measures (cleaning and covering the water tank) and monitoring potential breeding sites. Education and types of media for dengue information promoted dengue prevention practices [29, 30]. Moreover, it is important to adapt communication strategies to the demographic and cultural characteristics of each population to maximize the impact of public health campaigns.

Regarding dengue hospitalizations, no KAP studies were found that described them in their results. In general dengue research, variability in results is observed, depending on the characteristics of the population, which differ from ours. For example, a study conducted in India reported that 17% of patients had severe dengue, while 89% of non-severe cases showed warning signs [31]. In Malaysia, the proportion of severe cases was 4.9%, and 91.2% presented with warning signs [32]. In contrast, our figures coincide with those reported in a systematic review on the impact of dengue in Colombia [33], as well as with an analysis of dengue cases in 4.359 people, where 10.5% presented warning signs and 20.7% did not present them [34].

Regarding geoinformation work, a study conducted in Rawalpindi, Pakistan, mapped dengue cases between 2017 and 2019 to identify potential sites where subsequent KAP surveys would be applied [27]. Unlike this study, our work adopted a reverse approach, starting with KAP surveys to georeference the obtained data. Both approaches demonstrate that georeferencing is an invaluable tool for identifying and monitoring dengue outbreaks and other vector-borne arboviruses. This not only optimizes resources and generates early warnings for the population and authorities but also facilitates public health decision-making, as indicated by other studies [15].

Geographic Information Systems (GIS) and spatial analysis not only improve the understanding of the distribution and risk factors associated with dengue [35], but also demonstrate that the implementation of these geospatial tools is essential for the effective fight against these diseases [27]. Evidence suggests that these technologies allow targeting interventions at critical points and optimizing the planning of public health

strategies, thus contributing to more effective epidemic management. The integration of KAP data with georeferencing tools allows the creation of detailed maps that can identify spread patterns and areas of high incidence.

These tools, which are easily accessible to the community as they only require a mobile device, are crucial for designing more specific and effective prevention campaigns, as well as for the efficient allocation of resources. For example, by identifying areas where mosquito breeding sites and reported cases are concentrated, authorities can focus more on control and mitigation efforts, which increases the effectiveness of interventions. Continuous and real-time surveillance provides updated data that quickly informs health authorities and the community about changes in the epidemiological situation. This level of detail is especially important in vulnerable urban environments, where resources may be limited, and the ability to respond quickly is crucial to preventing larger outbreaks [15, 27, 35]

6. Conclusion

The results of this study highlight both advances and challenges in dengue management in urban communities. Although general knowledge about the disease is high, with 87% of the population recognizing dengue and 90.7% identifying fever as the main symptom, significant gaps persist in understanding key details about the vector, such as its breeding sites, with only 35.1% of people being aware of this. This gap underscores the need to strengthen educational campaigns to include detailed and precise information on vector control. Regarding attitudes toward prevention, the study revealed a notable lack of willingness to adopt preventive measures, with only 12.9% positive responses, reflecting cultural factors, distrust, or structural barriers that hinder action. Preventive practices are also deficient, with only half of the population eliminating mosquito breeding sites and only 12% adequately managing stored water, leaving room for improvement in implementing effective strategies at the individual and collective levels.

Additionally, the georeferencing of dengue cases showed a clear relationship between the presence of breeding sites, larvae, and reported outbreaks, identifying high-risk areas in both neighborhoods. This finding highlights the importance of focused and sustainable interventions aimed at critical points to effectively reduce virus transmission. Compared to other global studies, this work evidences an even more marked disconnection between knowledge, attitudes, and practices in this local context, compared to countries like Brazil, Malaysia, and Bangladesh, underscoring the need to adjust strategies to specific sociocultural dynamics. Despite the relatively high educational levels in the studied population, which do not translate into optimal preventive behaviors, the study suggests that other factors, such as risk perception and limited access to resources, influence the adopted practices. For future research, it is recommended to explore additional sociocultural and economic factors, as well as the evaluation of educational campaigns adapted to the local context. Finally, it is proposed to implement focused educational programs that combine mass and personalized strategies, complemented by the use of georeferencing for a replicable model in vulnerable urban contexts, contributing to more effective public health planning.

7. Limitations and Recommendations

The cross-sectional design of the study means that the findings reflect a snapshot of knowledge, attitudes, and practices (KAP) at a specific point in time, without allowing for the evaluation of changes over time. Additionally, the research was conducted in two specific neighborhoods of an endemic city, which limits the generalizability of the results to regions with different demographic, climatic, and social characteristics. Another limitation is that the findings from the first part of the survey are based on self-reported data from participants, which may introduce memory biases or social desirability bias. Furthermore, the cases reported in this study are derived from national surveillance system records, a context where underdiagnosis and underreporting of dengue have historically been observed, potentially affecting the accuracy of the data on the true incidence of the disease.

It is recommended to conduct longitudinal studies with a larger population sample to obtain a more precise and detailed understanding of the evolution of dengue and the effectiveness of interventions over time. Although various health education activities were implemented and multiple entities collaborated after the surveys were conducted, it is crucial to strengthen educational processes and community participation through a multisectoral approach. In addition, continuing the use of georeferencing to identify high-risk areas and direct interventions in a more focused and efficient manner is advised. Finally, it is essential to establish a continuous evaluation system to measure the effectiveness of interventions, allowing for timely adjustments to strategies and maximizing their impact on dengue prevention.

Declarations

Author Contributions

The following statements should be used:

Conceptualization, M.T.C.C. and J.S.H.A, methodology, M.T.C.C, software, L.A.S.J, validation, M.T.C.C, J.S.H.A. and L.A.S.J, formal analysis, L.A.S.J, investigation, M.T.C.C, resources, UCEVA, data curation, M.T.C.C, writing—original draft preparation, M.T.C.C, writing—review and editing, M.T.C.C. and S.A.O.V, visualization, S.A.O.V, supervision, J.S.H.A. and L.A.S.J, project administration, M.T.C.C, funding acquisition, M.T.C.C. and S.A.O.V. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Data available on request due to the ethical and privacy restrictions of participant data.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and current Colombian regulations and was approved by the Research Ethics Committee of the Faculty of Health Sciences at the Unidad Central del Valle del Cauca in Tuluá on April 23, 2024, for studies involving human subjects (project code: PI-1300-50.2-2024-PDP-04).

Informed Consent Statement

Informed consent was obtained from all the subjects involved in the study.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

References

[1] WORLD HEALTH ORGANIZATION (WHO). Dengue and severe dengue, 2024. https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue

[2] PAHO/WHO | PAN AMERICAN HEALTH ORGANIZATION. Epidemiological Alert - Increase in dengue cases in the Americas Region, 2024. https://www.paho.org/en/documents/epidemiological-alert-increase-dengue-cases-americas-region-7-october-2024

[3] KHAN, M. B, YANG, Z. S, LIN, C. Y, HSU, M. C, URBINA, A. N, ASSAVALAPSAKUL, W, ... & WANG, S. F. Dengue overview: An updated systemic review. *Journal of Infection and Public Health*, 2023, 16(10): 1625-1642. https://doi.org/10.1016/j.jiph.2023.08.001

[4] TSAI CY, LEE IK, LEE CH, YANG KD, & LIU JW. Comparisons of dengue illness classified based on the 1997 and 2009 World Health Organization dengue classification schemes. *Journal of Microbiology, Immunology, and Infection*, 2013, 46(4): 271-281. https://doi.org/10.1016/j.jmii.2012.07.005

[5] PARANÁ VC, FEITOSA CA, DA SILVA GCS, GOIS LL, & SANTOS LA. Risk factors associated with severe dengue in Latin America: A systematic review and meta-analysis. *Tropical Medicine & International Health*, 2024, 29(3): 173-191. https://doi.org/10.1111/tmi.13968

[6] LETA S, BEYENE TJ, DE CLERCQ EM, AMENU K, KRAEMER MUG, & REVIE CW. Global risk mapping for major diseases transmitted by Aedes aegypti and Aedes albopictus. *International Society for Infectious Diseases*, 2018, 67: 25-35. https://doi.org/10.1016/j.ijid.2017.11.026

[7] ORTEGA-LENIS D, ARANGO-LONDOÑO D, HERNÁNDEZ F, MORAGA P. Effects of climate variability on the spatio-temporal distribution of Dengue in Valle del Cauca, Colombia, from 2001 to 2019. *PLoS ONE*, 2024, 19(10): e0311607. https://doi.org/10.1371/journal.pone.0311607

[8] HIDAJAT MC, MARTINI M, WAHYUNINGSIH NE, SAYONO, RISTIYANTO, GARJITO TA, WIDIARTI, LASMIATI, SISWOKO SP, AYUNINGTYAS RTD, YANTI AO, & HADISAPUTRO S. Comparison of CDC Bottle Bioassay Test with WHO Standard Method for Assessment of Aedes Aegypti Susceptibility to Carbamates and Organophosphates Insecticides in Semarang, Indonesia. *Journal of Hunan University (Natural Sciences)*, 2021, 48(6): 241-251. http://jonuns.com/index.php/journal/article/view/614

[9] WONG LP, SHAKIR SMM, ATEFI N, & ABUBAKAR S. Factors Affecting Dengue Prevention Practices: Nationwide Survey of the Malaysian Public. *PLoS ONE*, 2015, 10(4): e0122890. https://doi.org/10.1371/journal.pone.0122890

[10] GUAD RM, CARANDANG RR, SOLIDUM JN, and AZIZAN N. Different domains of dengue research in the Philippines: A systematic review and meta-analysis of questionnaire-based studies. *PLoS One*, 2021, 16(12): e0261412. https://doi.org/10.1371/journal.pone.0261412

[11] PIEDRAHITA AR, CASTELLANOS-GARZÓN J, JE, CANIZALES MT, HENAO-AGUDELO J S, MARTINEZ

LAR, & LOPEZ-MEJIA S. Exploring the Use of Digital Twin in Smart Healthcare: A Case Study of Dengue Epidemic Control and Prevention. *Trends in Sustainable Smart Cities and Territories. Springer Nature Switzerland*, 2023, 732: 183-193. https://doi.org/10.1007/978-3-031-36957-5_16

[12] GRUBAUGH, N. D, TORRES-HERNÁNDEZ, D, MURILLO-ORTIZ, M. A, DÁVALOS, D. M, LOPEZ, P, HURTADO, I. C....LÓPEZ-MEDINA, E. Dengue Outbreak Caused by Multiple Virus Serotypes and Lineages, Colombia, 2023–2024. *Emerging Infectious Diseases*, 2024, 30(11), 2391-2395. https://doi.org/10.3201/eid3011.241031

[13] HIGUERA-MENDIETA DR, CORTÉS-CORRALES S, QUINTERO J, & GONZÁLEZ-URIBE C. KAP Surveys and Dengue Control in Colombia: Disentangling the Effect of Sociodemographic Factors Using Multiple Correspondence Analysis. *PLoS Neglected Tropical Diseases*, 2016, 10(9): e0005016. https://doi.org/10.1371/journal.pntd.0005016

[14] AHMED AE, ALMARHABI MA, SHAMI MO, ALHAZEMI AA, ALSHARIF HM, ABU HAYYAH AE, ALHAZMI WA, ALFAIFI MA, ABDALI AQ, & ALSHIHRI MS. Knowledge, Attitudes, and Practices of the Population in Jazan Region, Saudi Arabia Regarding Dengue Fever and Its Prevention Measures: A Community-Based Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 2022, 19(24): 16812. https://doi.org/10.3390/ijerph192416812

[15] HERNÁNDEZ-ÁVILA JE, RODRÍGUEZ M-H, SANTOS-LUNA R, SÁNCHEZ-CASTAÑEDA V, ROMÁN-PÉREZ S, & RÍOS-SALGADO VH. Nation-Wide, Web-Based, Geographic Information System for the Integrated Surveillance and Control of Dengue Fever in Mexico. *PLoS ONE*, 2013, 8(8): e70231. https://doi.org/10.1371/journal.pone.0070231

[16] CÁCERES-MANRIQUE FDM, VESGA-GÓMEZ C, PEREA-FLOREZ X, RUITORTE M, & TALBOT Y. Conocimientos, actitudes y prácticas sobre dengue en dos barrios de Bucaramanga, Colombia. *Revista de Salud Pública,* 2009, 11: 27-38. https://repositorio.unal.edu.co/handle/unal/71803

[17] SHAFIE AA, MOREIRA ED, JR, DI PASQUALE A, DEMUTH D, & YIN J.Y.S. Knowledge, Attitudes and Practices toward Dengue Fever, Vector Control, and Vaccine Acceptance Among the General Population in Countries from Latin America and Asia Pacific: A Cross-Sectional Study (GEMKAP). *Vaccines*, 2023, 11(3): 575. https://doi.org/10.3390/vaccines11030575

[18] SELVARAJOO S, LIEW JWK, TAN W, LIM XY, REFAI WF, ZAKI RA, SETHI N, WAN SULAIMAN WY, LIM YAL, VADIVELU J, & VYTHILINGAM I. Knowledge, attitude and practice on dengue prevention and dengue seroprevalence in a dengue hotspot in Malaysia: A cross-sectional study. *Scientific Reports*, 2020, 10(1): 9534. https://doi.org/10.1038/s41598-020-66212-5

[19] HOSSAIN MI, ALAM NE, AKTER S, SURIEA U, AKTAR S, SHIFAT SK, and MOHIUDDIN AKM. Knowledge, awareness and preventive practices of dengue outbreak in Bangladesh: A countrywide study. *PLoS ONE*, 2021, 16(6): e0252852. https://doi.org/10.1371/journal.pone.0252852

[20] BANIK R, ISLAM MS, MUBARAK M, RAHMAN M, GESESEW HA, WARD PR, & SIKDER MT. Public knowledge, belief, and preventive practices regarding dengue: Findings from a community-based survey in rural Bangladesh. *PLoS Neglected Tropical Diseases*, 2023, 17(12): e0011778. https://doi.org/10.1371/journal.pntd.0011778

[21] ZHANG Y, ZAHREDDINE M, ABREU K, DANTAS MA, CHARLAND K, PIERCE L, RIDDE V, & ZINSZER K. Knowledge, attitude and practice (KAP) and risk factors on dengue fever among children in Brazil, Fortaleza: A cross-sectional study. *PLoS Neglected Tropical Diseases*, 2023, 17(9): e0011110. https://doi.org/10.1371/journal.pntd.0011110

[22] DESJARDINS MR, CASAS I, VICTORIA AM, CARBONELL D, DÁVALOS DM, & DELMELLE EM. Knowledge, attitudes, and practices regarding dengue, chikungunya, and Zika in Cali, Colombia. *Health Place*, 2020 63: 102339. https://doi.org/10.1016/j.healthplace.2020.102339

[23] DIAZ-QUIJANO FA, MARTÍNEZ-VEGA RA, RODRIGUEZ-MORALES AJ, ROJAS-CALERO RA, LUNA-GONZÁLEZ ML, & DÍAZ-QUIJANO RG. Association between the level of education and knowledge, attitudes and practices regarding dengue in the Caribbean region of Colombia. *BMC Public Health*, 2018, 18(1): 143. https://doi.org/10.1186/s12889-018-5055-z

[24] BHANDARI S, RAJBANSHI M, ADHIKARI N, ARYAL R, KUNWAR K, & PAUDEL R. Knowledge, attitude, and practice regarding dengue among non-health undergraduate students of Nepal. *PLoS Neglected Tropical Diseases*, 2024, 18(5): e0012222. https://doi.org/10.1371/journal.pntd.0012222

[25] MAYXAY M, CUI W, THAMMAVONG S, KHENSAKHOU K, VONGXAY V, INTHASOUM L, SYCHAREUN V, & ARMSTRONG G. Dengue in peri-urban Pak-Ngum district, Vientiane capital of Laos: a community survey on knowledge, attitudes and practices. *BMC Public Health*, 2013, 13: 434. https://doi.org/10.1186/1471-2458-13-434

[26] LIU H, FANG CJ, & XU JW. The health perceptions, dengue knowledge and control willingness among Dai ethnic minority in Yunnan Province, China. *BMC Public Health*, 2021, 21: 1843. https://doi.org/10.1186/s12889-021-11864-9

[27] NAQVI SAA, SAJJAD M, TARIQ A, SAJJAD M, WASEEM LA, KARUPPANNAN S, REHMAN A, HASSAN M, AL-AHMADI S, & HATAMLEH WA. Societal knowledge, attitude, and practices towards dengue and associated factors in epidemic-hit areas: Geoinformation assisted empirical evidence. *Heliyon*, 2023, 10(1): e23151. https://doi.org/10.1016/j.heliyon.2023.e23151

[28] JAYAWICKREME KP, JAYAWEERA DK, WEERASINGHE S, WARAPITIYA D, & SUBASINGHE S. A study on knowledge, attitudes and practices regarding dengue fever, its prevention and management among dengue patients presenting to a tertiary care hospital in Sri Lanka. *BMC Infectious Diseases*, 2021, 21(1): 981. https://doi.org/10.1186/s12879-021-06685-5

[29] CHAUDHARY MN, LIM VC, FALLER EM, REGMI P, ARYAL N, MOHD ZAIN SN, AZMAN AS, & SAHIMIN N. Assessing the basic knowledge and awareness of dengue fever prevention among migrant workers in Klang Valley, Malaysia. *PLoS One*, 2024, 19(2): e0297527. https://doi.org/10.1371/journal.pone.0297527

[30] RAHMAN MM, TANNI KN, ROY T, ISLAM MR, AL RAJI RUMI MA, SADMAN SAKIB M, ABDUL QUADER M, BHUIYAN NU, SHOBUJ IA, SAYARA RAHMAN A, HAQUE MI, FARUK F, TAHSAN F, RAHMAN F, ALAM E, & MD TOWFIQUL ISLAM AR. Knowledge, Attitude and Practices towards Dengue Fever among Slum Dwellers: A Case Study in Dhaka City, Bangladesh. *International Journal of Public Health*, 2023, 68: 1605364 https://doi.org/10.3389/ijph.2023.1605364

[31] ANIKA US, ISLAM M, MOU FEN, SAHA M, DEB A, TUI RR, MANZOOR JR, JESMIN A, MARTUJA A, FARDOUS J, SHARIF M, RAFI MA, & HASAN MJ. The 2023 Dengue Outbreak in Bangladesh: Exploring the Epidemiology in Hospitalized Patients. *American Journal of Tropical Medicine and Hygiene*, 2024, 110(6): 1165-1171. https://doi.org/10.4269/ajtmh.23-0806

[32] AHMAD MH, IBRAHIM MI, MOHAMED Z, ISMAIL N, ABDULLAH MA, SHUEB RH, & SHAFEI MN. The Sensitivity, Specificity and Accuracy of Warning Signs in Predicting Severe Dengue, the Severe Dengue Prevalence and Its Associated Factors. *International Journal of Environmental Research and Public Health*, 2018, 15(9): 2018. https://doi.org/10.3390/ijerph15092018

[33] RODRÍGUEZ-MORALES, A. J, LÓPEZ-MEDINA, E, ARBOLEDA, I, CARDONA-OSPINA, J. A, CASTELLANOS, J. E, FACCINI-MARTÍNEZ, Á. A, GALLAGHER, E, HANLEY, R, LOPEZ, P, MATTAR, S, PÉREZ, C. E, KASTNER, R, REYNALES, H, ROSSO, F, SHEN, J, VILLAMIL-GÓMEZ, W. E, & FUQUEN, M. The Epidemiological Impact of Dengue in Colombia: A Systematic Review. *The American Journal of Tropical Medicine and Hygiene*, 2024, 121: 182-188. https://doi.org/10.4269/ajtmh.23-0907

[34] ROMERO-VEGA L, PACHECO O, DE LA HOZ-RESTREPO F, & DÍAZ-QUIJANO FA. Evaluation of dengue fever reports during an epidemic, Colombia. *Revista de Saude Publica*, 2014, 48: 899-905. https://doi.org/10.1590/s0034-8910.2014048005321

[35] BABU AN, NIEHAUS E, SHAH S, UNNITHAN C, RAMKUMAR PS, SHAH J, BINOY VV, SOMAN B, ARUNAN MC, JOSE CP. Smartphone geospatial apps for dengue control, prevention, prediction, and education: MOSapp, DISapp, and the mosquito perception index (MPI). *Environmental Monitoring and Assessment*, 2019, 191(Suppl 2): 393. https://doi.org/10.1007/s10661-019-7425-0

参考文:

[1] 世界卫生组织 (WHO)。登革热和重症登革热，2024。https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue

[2] PAHO/WHO | 泛美卫生组织。流行病学警报 - 美洲地区登革热病例增加，2024。https://www.paho.org/en/documents/epidemiological-alert-increase-dengue-cases-americas-region-7-october-2024

[3] KHAN, M. B、YANG, Z. S、LIN, C. Y、HSU, M. C、URBINA, A. N、ASSAVALAPSAKUL, W, ... 和 WANG, S. F. 登革热概述：最新的系统评价。《感染与公共卫生杂志》，2023，16(10)：1625-1642。https://doi.org/10.1016/j.jiph.2023.08.001

[4] TSAI CY、LEE IK、LEE CH、YANG KD 和 LIU JW。根据 1997 年和 2009 年世界卫生组织登革热分类方案对登革热疾病进行分类的比较。《微生物学、免疫学和感染杂志》，2013，46(4)：271-281。https://doi.org/10.1016/j.jmii.2012.07.005

[5] PARANÁ VC、FEITOSA CA、DA SILVA GCS、GOIS LL 和 SANTOS LA。拉丁美洲重症登革热相关风险因素：系统评价和荟萃分析。热带医学与国际卫生，2024，29(3)：173-191。https://doi.org/10.1111/tmi.13968

[6] LETA S、BEYENE TJ、DE CLERCQ EM、AMENU K、KRAEMER MUG 和 REVIE CW。埃及伊蚊和白纹伊蚊传播的主要疾病的全球风险图。国际传染病学会，2018，67：25-35。 https://doi.org/10.1016/j.ijid.2017.11.026

[7] ORTEGA-LENIS D、ARANGO-LONDOÑO D、HERNÁNDEZ F、MORAGA P. 2001 年至 2019 年气候变化对哥伦比亚考卡山谷省登革热时空分布的影响。公共科学图书馆，2024，19(10)：e0311607。https://doi.org/10.1371/journal.pone.0311607

[8] HIDAJAT MC, MARTINI M, WAHYUNINGSIH NE, SAYONO, RISTIYANTO, GARJITO TA, WIDIARTI, LASMIATI, SISWOKO SP, AYUNINGTYAS RTD, YANTI AO, 和 HADISAPUTRO S. CDC瓶生物测定测试与世界卫生组织评估埃及伊蚊对氨基甲酸盐和氨基甲酸酯敏感性的标准方法的比较印度尼西亚三宝垄的有机磷杀虫剂。湖南大学学报（自然科学版），2021，48(6)：241-251. http://jonuns.com/index.php/journal/article/view/614

[9] WONG LP、SHAKIR SMM、ATEFI N 和 ABUBAKAR S。影响登革热预防措施的因素：马来西亚全国公众调查。公共科学图书馆，2015，10(4)：e0122890。https://doi.org/10.1371/journal.pone.0122890

[10] GUAD RM、CARANDANG RR、SOLIDUM JN 和 AZIZAN N。菲律宾登革热研究的不同领域：基于问卷调查的系统评价和荟萃分析。公共科学图书馆，2021，16(12)：e0261412。https://doi.org/10.1371/journal.pone.0261412

[11] PIEDRAHITA AR、CASTELLANOS-GARZÓN J、JE、CANIZALES MT、HENAO-AGUDELO J S、MARTINEZ LAR 和 LOPEZ-MEJIA S。探索数字孪生在智能医疗中的应用：以登革热疫情控制和预防为例。可持续智慧城市和地区的趋势。施普林格·自然瑞士，2023，732：183-193。 https://doi.org/10.1007/978-3-031-36957-5_16

[12] GRUBAUGH, N. D, TORRES-HERNÁNDEZ, D,

MURILLO-ORTIZ, M. A, DÁVALOS, D. M, LOPEZ, P, HURTADO, I. C....LÓPEZ-MEDINA, E. 多种病毒血清型和谱系引起的登革热爆发，哥伦比亚，2023-2024 年。新发传染病，2024, 30(11), 2391-2395。https://doi.org/10.3201/eid3011.241031

[13] HIGUERA-MENDIETA DR、CORTÉS-CORRALES S、QUINTERO J 和 GONZÁLEZ-URIBE C. 哥伦比亚的 KAP 调查和登革热控制：使用多重对应分析理清社会人口因素的影响。 《公共科学图书馆》被忽视的热带病，2016，10(9)：e0005016。https://doi.org/10.1371/journal.pntd.0005016

[14] AHMED AE、ALMARHABI MA、SHAMI MO、ALHAZEMI AA、ALSHARIF HM、ABU HAYYAH AE、ALHAZMI WA、ALFAIFI MA、ABDALI AQ 和 ALSHIHRI MS。沙特阿拉伯吉赞地区民众对登革热及其预防措施的知识、态度和实践：一项基于社区的横断面研究。国际环境研究与公共卫生杂志，2022，19(24)：16812。https://doi.org/10.3390/ijerph192416812

[15] HERNÁNDEZ-ÁVILA JE、RODRÍGUEZ M-H、SANTOS-LUNA R、SÁNCHEZ-CASTAÑEDA V、ROMÁN-PÉREZ S 和 RÍOS-SALGADO VH。墨西哥全国范围内基于网络的登革热综合监测和控制地理信息系统。公共科学图书馆，2013，8(8)：e70231。https://doi.org/10.1371/journal.pone.0070231

[16] CÁCERES-MANRIQUE FDM、VESGA-GÓMEZ C、PEREA-FLOREZ X、RUITORTE M 和 TALBOT Y。哥伦比亚布卡拉曼加两个社区对登革热的认识、态度和实践。公共卫生杂志，2009，11：27-38。https://repositorio.unal.edu.co/handle/unal/71803

[17] SHAFIE AA、MOREIRA ED、JR、DI PASQUALE A、DEMUTH D 和 YIN J.Y.S.拉丁美洲和亚太地区国家普通人群对登革热、媒介控制和疫苗接受度的知识、态度和实践：一项横断面研究 (GEMKAP)。疫苗，2023，11(3)：575。https://doi.org/10.3390/vaccines11030575

[18] SELVARAJOO S、LIEW JWK、TAN W、LIM XY、REFAI WF、ZAKI RA、SETHI N、WAN SULAIMAN WY、LIM YAL、VADIVELU J 和 VYTHILINGAM I。马来西亚登革热热点地区登革热预防和登革热血清流行率的知识、态度和实践：一项横断面研究。科学报告，2020，10(1)：9534。https://doi.org/10.1038/s41598-020-66212-5

[19] HOSSAIN MI、ALAM NE、AKTER S、SURIEA U、AKTAR S、SHIFAT SK 和 MOHIUDDIN AKM。孟加拉国对登革热疫情的知识、意识和预防措施：一项全国性研究。 公共科学图书馆，2021，16(6)：e0252852。https://doi.org/10.1371/journal.pone.0252852

[20] BANIK R、ISLAM MS、MUBARAK M、RAHMAN M、GESESEW HA、WARD PR 和 SIKDER MT。公众对登革热的知识、信念和预防措施：来自孟加拉国农村社区调查的结果。PLoS 被忽视的热带疾病，2023，17(12)：e0011778。https://doi.org/10.1371/journal.pntd.0011778

[21] ZHANG Y、ZAHREDDINE M、ABREU K、DANTAS MA、CHARLAND K、PIERCE L、RIDDE V 和 ZINSZER K。巴西福塔莱萨儿童登革热知识、态度和实践 (KAP) 及风险因素：一项横断面研究。PLoS 被忽视的热带疾病，2023，17(9)：e0011110。https://doi.org/10.1371/journal.pntd.0011110

[22] DESJARDINS MR、CASAS I、VICTORIA AM、CARBONELL D、DÁVALOS DM 和 DELMELLE EM。哥伦比亚卡利关于登革热、基孔肯雅热和寨卡病毒的知识、态度和实践。健康场所，2020, 63：102339。https://doi.org/10.1016/j.healthplace.2020.102339

[23] DIAZ-QUIJANO FA、MARTÍNEZ-VEGA RA，RODRIGUEZ-MORALES AJ、ROJAS-CALERO RA、LUNA-GONZÁLEZ ML 和 DÍAZ-QUIJANO RG。哥伦比亚加勒比地区教育水平与登革热知识、态度和实践之间的关联。BMC 公共卫生，2018，18(1)：143。https://doi.org/10.1186/s12889-018-5055-z

[24] BHANDARI S、RAJBANSHI M、ADHIKARI N、ARYAL R、KUNWAR K 和 PAUDEL R。尼泊尔非健康本科生对登革热的知识、态度和实践。PLoS 被忽视的热带疾病，2024，18(5)：e0012222。https://doi.org/10.1371/journal.pntd.0012222

[25] MAYXAY M、CUI W、THAMMAVONG S、KHENSAKHOU K、VONGXAY V、INTHASOUM L、SYCHAREUN V 和 ARMSTRONG G。老挝首都万象巴努县城郊登革热疫情：社区知识、态度和实践调查。BMC 公共卫生，2013，13：434。https://doi.org/10.1186/1471-2458-13-434

[26] LIU H、FANG CJ 和 XU JW。中国云南省傣族人民的健康认知、登革热知识和防治意愿。 BMC 公共卫生，2021，21：1843。https://doi.org/10.1186/s12889-021-11864-9

[27] NAQVI SAA、SAJJAD M、TARIQ A、SAJJAD M、WASEEM LA、KARUPPANNAN S、REHMAN A、HASSAN M、AL-AHMADI S 和 HATAMLEH WA。流行病地区对登革热及相关因素的社会知识、态度和做法：地理信息辅助经验证据。 太阳神，2023，10(1)：e23151。 https://doi.org/10.1016/j.heliyon.2023.e23151

[28] JAYAWICKREME KP、JAYAWEERA DK、WEERASINGHE S、WARAPITIYA D 和 SUBASINGHE S。一项关于斯里兰卡一家三级医院的登革热患者对登革热及其预防和管理的知识、态度和实践的研究。 BMC 传染病，2021，21(1)：981。https://doi.org/10.1186/s12879-021-06685-5

[29] CHAUDHARY MN、LIM VC、FALLER EM、REGMI P、ARYAL N、MOHD ZAIN SN、AZMAN AS 和 SAHIMIN N。评估马来西亚巴生谷移民工人对登革热预防的基本知识和认识。公共科学图书馆，2024，19(2)：e0297527。 https://doi.org/10.1371/journal.pone.0297527

[30] RAHMAN MM、TANNI KN、ROY T、ISLAM MR、AL RAJI RUMI MA、SADMAN SAKIB M、ABDUL

QUADER M、BHUIYAN NU、SHOBUJ IA、SAYARA RAHMAN A、HAQUE MI、FARUK F、TAHSAN F、RAHMAN F、ALAM E 和 MD TOWFIQUL ISLAM AR。贫民窟居民对登革热的知识、态度和做法：孟加拉国达卡市的案例研究。国际公共卫生杂志，2023，68：1605364 https://doi.org/10.3389/ijph.2023.1605364

[31] ANIKA US、ISLAM M、MOU FEN、SAHA M、DEB A、TUI RR、MANZOOR JR、JESMIN A、MARTUJA A、FARDOUS J、SHARIF M、RAFI MA 和 HASAN MJ。2023 年孟加拉国登革热疫情：探索住院患者的流行病学。美国热带医学与卫生杂志，2024，110(6)：1165-1171。 https://doi.org/10.4269/ajtmh.23-0806

[32] AHMAD MH、IBRAHIM MI、MOHAMED Z、ISMAIL N、ABDULLAH MA、SHUEB RH 和 SHAFEI MN。警告信号在预测重症登革热、重症登革热患病率及其相关因素中的敏感性、特异性和准确性。国际环境研究与公共卫生杂志，2018，15(9)：2018。https://doi.org/10.3390/ijerph15092018

[33] RODRÍGUEZ-MORALES，A.J、LOPEZ-MEDINA，E、ARBOLEDA，I、CARDONA-OSPINA，J.A、CASTELLANOS，J.E、FACCINI-MARTÍNEZ，Á. A、GALLAGHER、E、HANLEY、R、LOPEZ、P、MATTAR、S、PÉREZ、CE、KASTNER、R、REYNALES、H、ROSSO、F、SHEN、J、VILLAMIL-GÓMEZ、WE 和 FUQUEN、M.《登革热在哥伦比亚的流行病学影响：系统评价》。美国热带医学与卫生杂志，2024，121：182-188。 https://doi.org/10.4269/ajtmh.23-0907

[34] ROMERO-VEGA L、PACHECO O、DE LA HOZ-RESTREPO F 和 DÍAZ-QUIJANO FA。对哥伦比亚登革热疫情期间报告的评估。公共卫生杂志，2014，48：899-905。 https://doi.org/10.1590/s0034-8910.2014048005321

[35] BABU AN，NIEHAUS E，SHAH S，UNNITHAN C，RAMKUMAR PS，SHAH J，BINOY VV，SOMAN B，ARUNAN MC，JOSE CP。用于登革热控制、预防、预测和教育的地理空间智能手机应用程序：MOSapp、DISapp 和蚊子感知指数 (MPI)。环境监测与评估，2019，191（补编2）：393。https://doi.org/10.1007/s10661-019-7425-0

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