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Original Research Article

A cross-sectional survey of knowledge, attitude, and practices toward dengue fever among university students in Bengaluru

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ABSTRACT

Background: The incidence of dengue fever (DF) has been on the rise over the past few decades, with an increasing number of outbreaks in Bengaluru. This study was conducted to assess health literacy on DF among university students through a knowledge, attitude, and practices (KAP) survey.
Methods: A cross-sectional survey among university students between the ages of 18 and 21 was carried out. Data was collected using a validated questionnaire comprising 40 questions based on KAP on dengue, to assess the KAP regarding DF, descriptive statistic; univariate and multivariate logistic regressions were performed.
Results: Among 340 students, 104 (30.6%) showed a good level of knowledge, 154 (45.3%) exhibited a good attitude level, 255 (75%) displayed good preventive practice levels, and 173 (50.9%) demonstrated good overall KAP levels. 24.4% (n=83) reported of prior dengue infection history in family. Private university attendance correlated with lower odds of positive attitudes (OR=0.562, p=0.012) and overall KAP levels (OR=0.618, p=0.032) in univariate analysis, a trend confirmed in multivariate analysis (aOR=0.393, p=0.001 for attitude; aOR=0.570, p=0.035 for KAP levels).
Conclusions: The study revealed strong awareness, positive attitudes, and preventive behaviours among Bengaluru university students regarding DF. Location and institution type influenced attitudes, emphasizing the need for targeted health literacy programs for effective dengue prevention in urban areas such as Bengaluru.

Keywords: Dengue, Health literacy, University students, Urban

INTRODUCTION

Dengue is a viral disease caused by the dengue virus (DENV), which is spread to humans through the bites of infected female mosquitoes. The primary vectors for the dengue virus are *Aedes aegypti* and *Aedes albopictus*. Common symptoms include high fever, headache, body pain, nausea, and rash (in cases of dengue and severe dengue).[1] The national centre for vector borne diseases control (NCVBDC) runs a comprehensive program known as the national vector borne diseases control program (NVBDCP) aimed at preventing and controlling vector-borne diseases.[2]

In recent decades, the global incidence of dengue has surged significantly, with world health organization (WHO) reports indicating a rise from 505,430 cases in 2000 to 5.2 million in 2019.[3] As of early 2023, ongoing transmissions and an unexpected increase in dengue cases have led to close to a historic high of over five million cases, along with more than 5000 dengue-related deaths reported across over 80 countries.[3]

In India, 0.8 million dengue cases have been recorded from 2017 to 2022, followed by 1,000 deaths.[3] According to the national centre for vector borne disease control (NCVBDC), India reported 233,251 dengue cases with 303 mortalities in 2022 and 94,198 dengue cases with 91 mortalities in 2023.[3] Karnataka accounted for 9185 cases with nine deaths in the year 2023. Bengaluru reported nearly 10,468 cases and four deaths in 2024, according to the BBMP.[4] Climate change, population density, rapid

unplanned urbanisation, and neglectful behaviour towards DF could aggravate the current condition. In light of these factors, Bengaluru local government, as well as other stakeholders and city inhabitants, must prepare and respond effectively to stem the spread of the dengue outbreak.[5] There is no prophylaxis or effective vaccine for DF.[5] Health behaviours, such as adhering to authentic knowledge, maintaining a positive attitude, and following proper procedures, may help reduce the rising dengue incidence in Bengaluru.[5,6]

DF is a significant public health issue, and it is essential to understand how university students perceive and engage with the disease, as they are a critical group of learners in any community, having access to authentic knowledge.[4] If these students possess sufficient knowledge and positive attitudes, they can apply it to their community. In collaboration with university students, community can then translate knowledge and attitudes about DF into preventive practices. By assessing the KAP of university students towards DF, we can gain insights into level of awareness and preparedness of student population regarding this disease.[7]

Individuals knowledgeable about DF and its risk factors can take proactive steps to safeguard themselves and their communities. This includes understanding how *Aedes* mosquitoes transmit the disease, recognising symptoms such as fever, severe headaches, and joint and muscle pain, and implementing preventative measures like removing standing water and using protective clothing or repellents. Additionally, it is essential to recognise how environmental issues, such as poor sanitation, create breeding grounds for mosquitoes and facilitate the spread of DF. By enhancing health literacy, individuals can adopt practices and make informed choices that minimise the risk of DF transmission, ultimately creating a safer and healthier community. Health literacy is fostered through education, effective information dissemination, and community involvement.[8]

Various studies on KAP concerning dengue among diverse groups, including university students, adults, patients, and primary school children, have revealed significant deficits in understanding the disease. Research conducted in Bangladesh and Tanzania revealed that both students and adults have limited knowledge about dengue, highlighting the necessity for targeted educational programs.[8,9] Similarly, Jayawickreme et al pointed out significant knowledge gaps among dengue patients in Thailand, stressing the importance of ongoing education.[10] Meanwhile, Suwanbamrung et al discovered varying knowledge levels among primary school children in Sri Lanka, emphasizing the need for tailored educational approaches.[10] These investigations highlighted low awareness of dengue symptoms, modes of transmission, and preventive measures across multiple demographic sectors with specific misunderstandings, such as the transmission of the dengue virus during pregnancy, identified.[8] Collectively, findings underscore the necessity for targeted educational interventions, continuous training, and effective communication strategies to improve health literacy and empower individuals in preventing and managing dengue.[5]

This research specifically investigated health literacy regarding the KAP surrounding DF among university students. The findings could provide insights for governmental and non-governmental organisations, university authorities, and health and social care workers in developing comprehensive DF preparedness and response strategies for students in the city, which can ultimately contribute to reducing DF outbreaks.

METHODS

Study design

This cross-sectional study was conducted to evaluate the dengue responses through KAP survey among university students of urban Bengaluru. Cross-sectional studies are beneficial for this type of research because they enable the collection of data from a representative sample, providing an overview of the phenomenon being studied. Furthermore, this approach is ideal for investigating the interactions between multiple variables, including socio-demographic traits, health-related factors, and perceived benefits and drawbacks associated with dengue.[12]

The inclusion criteria included university students aged 18 years and above from Bangalore's university colleges in the East, West, North, and South zones, as well as those present at the time of data collection. Students who did not provide informed consent or were absent at the time of data collection were excluded.

The cover page of the questionnaire clearly described the survey's objective and confidentiality of the responses. If respondents agreed, they were requested to participate in survey. Informed consent was sought, and respondents were not provided with any incentive for filling out the questionnaire. They were allowed to withdraw the questionnaire fill-out at any time during the data entry.

Study participants

University students in the 18-21 age range who provided consent are included in the study from the chosen university colleges. University students are characterised by independence, decision-making autonomy, and responsibility for their health and health of their family. This makes them relevant target population for assessing health literacy and attitudes towards disease prevention.[7]

Sample size estimation

Sample size: $n = \frac{z^2 p(1-p)}{d^2} = \frac{(1.96)^2 \times 0.75 \times (1-0.75)}{(0.05)^2} = 288.12$

Considering non-response rate of 10%, the final sample size was estimated to be 340.

Ethical consideration

The study protocol was approved by the institutional ethical committee of M. S. Ramaiah university of applied sciences for ethical review (Annexure 1). Participants were briefed about the purpose of the study, their rights to withdraw at any time, and were assured about the confidentiality of the collected data and the data's discarding and retention period. A written informed consent was obtained from them before data collection. Participants were not provided with any incentives for their participation in the study. Participants were given a chance to withdraw from the study at any time. Permission was taken from the principal in each college before collecting the data from participants. Data collection commenced after the institutional ethics committee approved the study.

Data collection

After obtaining approval from the ethics committee, volunteers were recruited from various colleges attached to Bangalore university. Students aged 18 to 21 years who were present at their respective colleges during the data collection period and had given informed consent were eligible for inclusion. Individuals who refused to participate were excluded from the study. Data collection involved administering a validated questionnaire consisting of 2 sections: 1) socio-demographic, and 2) KAP section. The KAP section included questions on knowledge, attitude (measured on a 5-point Likert scale), and preventive practices (yes/no format). Twelve questions are for knowledge (0-2 score range, 1 for maybe), 8 for attitude (5-point Likert scale-based questions: Strongly agree, agree, neutral, disagree and strongly disagree), and seven (yes/no) for the preventive practices.[8,12] Participants were briefed on study's purpose and methods, and after having their questions answered, they were given option to complete questionnaire. Data collection method took place in classroom after academic sessions, with individuals voluntarily participating and completing questionnaire in approximately 15-20 min.

Instrumentation

The study used the KAP model, which has already been successfully applied to evaluate DF among university students.[13] As a first step, a structured questionnaire was developed. The questionnaire was developed following a literature review to identify relevant socio-demographic characteristics and knowledge domains related to DF, along with appropriate assessment scales for attitudes and practices. This literature analysis drew upon prior publications that have successfully examined similar dimensions among university students, particularly those utilising the KAP model.

Data collection

Before the main data collection, a pilot survey was conducted to test the reliability and internal consistency of the questionnaire. Cronbach's alpha was calculated using equation (1), n=number of items, c=average covariance between item pairs, and the v=average variance The Cronbach's alpha values obtained from the pilot survey were >0.70, >0.80, and >0.80 for the KAP section, indicating good internal consistency. After rerunning the final data from main study, the Cronbach's alpha values for knowledge, attitude, and practice were calculated as 0.69, 0.76 and 0.87, respectively, which were considered acceptable and reliable for assessing internal consistency within the KAP section.

The questionnaire for this study was developed following a literature review to identify relevant socio-demographic characteristics and knowledge domains related to DF, along with appropriate assessment scales for attitudes and practices. This literature analysis drew upon prior publications that have successfully examined similar dimensions among university students, particularly those utilising the KAP model.[14]

The questionnaire consisted of two main sections with mandatory response items:

Socio-demographic and academic information

This section gathered data on variables such as age, gender, educational background, and residence location.

KAP section

Section A-About socio-demographic profile, including gender, place, university type, year of study, and previous dengue history.

Section B-Based on knowledge and awareness of DF, which includes: do you know dengue is an infectious disease, DF can cause death, common symptoms of dengue infection, type of *Aedes* mosquito, transmission of dengue virus, etc.

Section C-About attitude of the DF, their responsibility to make sure there are no *Aedes* eggs or larvae in their house area, and only chemical fogging by the authority is not enough to prevent dengue infection, are they take part in a public activity for dengue control or removal of mosquito breeding sites etc.

Section D-Based on practices of the DF, do they call the municipality authority for fogging, covering the water containers used for water storage, using mosquito coil, hospital test and check-ups when they see symptoms, etc.

The final structured questionnaire (in both Kannada and English) was developed. It had two sections with mandatory response items: Socio-demographic and KAP sections. Twelve questions were for knowledge (0-2 score range, 1 for maybe) eight for Attitude (5-point Likert scale-based questions: Strongly agree, agree,

neutral, disagree, and strongly disagree), and seven (Yes/No) for the preventive practices.

After obtaining ethical approval, the primary investigator (PI) visited institutions in Bengaluru and presented principals with comprehensive information about the project. The dates for data collection were discussed and agreed. On the scheduled days, the PI approached college students, explained the project in detail, and obtained their informed consent before beginning data collection. To address potential bias, stratified sampling was used to ensure diversity, and a large sample size was employed. Anonymity was maintained, and validated instruments were used to minimise measurement bias. Confounding variables were controlled statistically.

During the data collection process, the PI addressed any questions or concerns raised by the students, ensuring they had a clear understanding of the study's objectives and procedures. Additionally, reassurance was provided about the confidentiality of their data. The data collection procedure involved a respectful and transparent approach, prioritising informed consent and confidentiality to uphold ethical standards throughout the study.

The data collection period was conducted from February 2024 to April 2024.

Data analysis

The data collected from surveys or forms were manually entered into MS excel spreadsheets. Data was entered, cleaned, and arranged using Microsoft excel. Later, the data was coded accordingly and then analysed using SPSS version 27 for statistical analysis. Categorical variables are represented by frequency and percentages. Spearman's rank correlation test was conducted to check the correlation of KAP scales. After summing the KAP section's score, 80% cut-off score is used to categorize the "good" and "poor" levels in the KAP domain. Univariate and multivariate logistic regressions are used to determine the predictors of KAP level. Odds ratios (ORs), adjusted odds ratios (AORs), and 95% confidence intervals were calculated in the logistic regression models. P value less than or equal to 0.05 indicates statistical significance.

The multivariate regression analysis found no significant predictors for knowledge of DF. However, the study found that private university students and residents of southern Bengaluru had reduced likelihood of having a positive attitude regarding dengue disease. Similarly, private university students and those in northern Bengaluru had reduced probabilities of reaching a good overall KAP level for dengue illness.

RESULTS

Data was collected from 340 students; 173 (50.9%) were female and 167 (49.1%) were male. A total of 272 (80.0%) students lived with their families. The residential units were predominantly low-rise buildings (up to 5 stories) for 226 (66.5%) students, while 31 (9.1%) students lived in high-rise buildings (over 5 stories), and 83 (24.4%) students lived in mixed-use buildings. Most students i. e., 209 (61.5%) attended public universities. In terms of academic year, 100 (29.4%) students were in their first year, 151 (44.4%) students were in their second year, and 89 (26.2%) students were in their third year. Additionally, 253 (74.4%) students didn't have any courses related to dengue. Among the students, 83 (24.41%) had a history of dengue infection, while 257 (75.59%) did not.

Most students (72.6%) recognize that dengue is an infectious disease, while a significant number (66.2%) are aware that DF can be fatal (Table 2). The majority of students (89.1%) are familiar with the common symptoms of dengue, such as rash, headache, high fever, joint pain, muscle pain, and nausea. More than half of the students (58.5%) know that the *Aedes* mosquito transmits the dengue virus, although less than half (44.7%) are aware that the *Aedes* mosquito has stripes on its body. Only 54.4% of students disagreed with the incorrect statement that dengue can be transmitted through direct contact. A large proportion of students (78.2%) understand the breeding sites of *Aedes* mosquitoes, and 60.3% know that the *Aedes* mosquito can breed both indoors and outdoors. A little more than half (57.4%) of the students comprehend the biting habits of the *Aedes* mosquito. Additionally, 54.4% of students disagree that the dengue virus can be transmitted from an infected pregnant mother to her fetus, and 62.4% are aware that a person can be infected with the dengue virus more than once. Most students (83.8%) grasp the importance of cleanliness and eliminating breeding sites to prevent dengue infection.

Majority of students (84.2%) either agreed or strongly agreed that they have the responsibility to ensure there are no *Aedes* eggs and/or larvae in their house area. Only a small percentage (7.6%) disagreed or strongly disagreed with this statement. A large portion of students (71.7%) agreed or strongly agreed that *Aedes* mosquito breeding sites, such as water containers and plant pots, should be cleaned one to three times a week. However, a notable percentage (17.7%) disagreed with this statement. Over three-fourths of the students (74.7%) agreed or strongly agreed that authorities should demolish potential breeding sites because chemical fogging alone is insufficient. A smaller proportion (15.2%) disagreed. Most students (76.4%) agreed or strongly agreed that regularly checking dengue situation around their area is important. Only 12.7% disagreed with this. A large majority of students (81.5%) agreed/strongly agreed that controlling DF depends on community's commitment to remove mosquito breeding sites. Only a small portion (8.8%) disagreed. Majority of students (90.3%) expressed a willingness to take part in public activity for DF control, with only a small percentage (1.5%) disagreeing. Most

students (84.7%) agreed/strongly agreed that they would bring their family members to see a doctor immediately if they exhibited DF symptoms. Only a small percentage (6.2%) disagreed. A substantial majority of students (85.6%) agreed/strongly agreed that mosquito breeding sites should be regularly removed even when there is no fever. Only a small percentage (4.4%) disagreed.

Majority of students (82.1%) contact municipal authorities for fogging to control mosquito populations, while 17.9% do not participate in this practice. Most students (85.3%) use some form of mosquito repellent or protection, such as aerosols, liquid repellents, mosquito coils, electrical mats, or bed nets. A smaller portion (14.7%) does not use any of these protective measures. Nearly all students (95.9%) ensure that containers used for storage are properly covered to prevent mosquito breeding, with only 4.1% failing to follow this practice. A significant majority of students (89.4%) scrub and clean the inner sides of water containers regularly, while 10.6% do not clean them. Most students (67.1%) check for *Aedes* eggs and/or larvae around their homes, though 32.9% do not perform these checks. A vast majority of students (91.8%) visit hospital for testing and treatment when they notice DF symptoms. Only 8.2% do not seek medical care. Lastly, most students (88.5%) keep up with the latest information from trusted sources such as WHO or local health authorities, while only a small percentage (11.5%) do not seek information from these sources.

From Spearman's rank correlation test, it is observed that, there is significant weak positive correlation between knowledge and attitude, as well as attitude and practices ($p<0.001$). However, the positive correlation between knowledge and practices was not significant.

Logistic regression analysis results shows that gender, location in Bengaluru city, living with family, residential unit and whether students had a dengue-relevant subject did not have a significant impact on knowledge, attitude, practices, or overall KAP levels. However, there was a significant association between university type and both attitude and overall KAP level. Private university students had 0.562 (95% CI: 0.359-0.879) times lower odds of having good attitude compared to public university students. Similarly, private university students had 0.618 (95% CI: 0.398-0.959) times lower odds of achieving good overall KAP levels compared to public university students.

Knowledge and practices were not significantly different between 2 university types. The analysis also revealed a significant correlation between university year and knowledge levels. Third-year students had 2.192 (95% CI: 1.158-4.147) times higher odds of demonstrating good knowledge compared to 1st-year students. However, attitude, practices, and overall KAP levels did not vary significantly based on the university year. There was a significant association between major and overall KAP. Business studies majors had 1.860 (95% CI: 1.040-3.328) times higher odds of good overall KAP levels compared to science and engineering majors. No significant differences in knowledge, attitude, practices, or overall KAP levels were observed in other majors when compared to science and engineering majors.

Multi-variate analysis shows that there is no significant association between sex and knowledge about DF among university students in Bengaluru, keeping other variables constant (Table 7). Similarly, location within Bengaluru city, living with family, residential unit type, university type, university year, major, and exposure to dengue-relevant subjects did not show statistically significant associations with students' knowledge of DF, when accounting for the effects of other variables in the model.

Among 340 students, 104 (30.6%) showed a good level of knowledge, 154 (45.3%) exhibited a good attitude level, 255 (75%) displayed good preventive practice levels and 173 (50.9%) demonstrated good overall KAP levels.

In terms of dengue-related practices, the analysis did not identify any significant associations with sex, location within Bengaluru city, living arrangements, residential unit type, university type, university year, major, or exposure to dengue-relevant subjects among university students, keeping other variables constant.

Regarding attitudes towards DF, the analysis found that Students from private universities had 0.393 (95% CI: 0.228-0.676) times lower odds of exhibiting good attitude compared to students from public universities in the presence of other variables. Students living in the southern part of the city had 0.343 (95% CI: 0.159-0.740) times lower odds of having good attitude compared to students residing in the western part in the presence of other variables. However, factors such as sex, living arrangements, residential unit type, university year, major, and exposure to dengue-relevant subjects did not show statistically significant associations with students' attitudes towards DF when controlling for the effects of other variables.

When considering the overall KAP level towards DF, Students living in the northern part of the city had lower odds (OR-0.512, 95% CI: 0.263-0.9996) of having good KAP level compared to students residing in the western parts. Additionally, students from private universities had lower odds (OR-0.570, 95% CI: 0.338-0.962) of exhibiting good KAP level compared to students from public universities when controlling for the effects of other variables.

Other factors such as sex, living arrangements, residential unit type, university year, major, and exposure to dengue-relevant subjects did not show significant associations with the overall KAP score among university students, when considering the influences of other variables in the model.

Table 1: Socio-demographic and dengue history information of study participants.

Variables	Sub category	N (%)	Dengue infection history, mean±SD
Sex	Female	173 (50.9)	0.47±0.85
	Male	167 (49.1)	0.50±0.87
Location in Bengaluru city	East	84 (24.7)	0.40±0.81
	North	89 (26.2)	0.63±0.93
	South	82 (24.1)	0.54±0.89
	West	85 (25.0)	0.38±0.79
Living with family	Yes	272 (80.0)	0.47±0.85
	No	68 (20.0)	0.56±0.90
Residential unit	High-rise (>5-storey)	31 (9.1)	0.52±0.89
	Low-rise (≤5-storey)	226 (66.5)	0.49±0.86
	Mixed-use building	83 (24.4)	0.48±0.86
University type	Private	131 (38.5)	0.52±0.88
	Public	209 (61.5)	0.47±0.85
University year	1st	100 (29.4)	0.46±0.85
	2nd	151 (44.4)	0.46±0.85
	3rd	89 (26.2)	0.56±0.90
Major	Arts and social sciences	110 (32.4)	0.55±0.90
	Business studies	120 (35.3)	0.53±0.89
	Science and engineering	76 (22.4)	0.37±0.78
	Others	34 (10.0)	0.41±0.82
Dengue-relevant subject	Yes	65 (19.1)	0.77±0.98
	Maybe	22 (6.5)	0.27±0.70
	No	253 (74.4)	0.43±0.83

Table 2: Knowledge regarding DF among study participants.

Statements	Correct response	Incorrect response
Dengue is an infectious disease	247 (72.6)	93 (27.4)
Dengue fever can cause death	225 (66.2)	115 (33.8)
Common symptoms of dengue infection are rash, headache, high fever, joint pain, muscle pain, nausea	303 (89.1)	37 (10.9)
***Aedes* mosquito type transmits dengue virus**	199 (58.5)	141 (41.5)
***Aedes* mosquito has stripes on the body**	152 (44.7)	188 (55.3)
Dengue virus can be transmitted through direct contact with an infected person	185 (54.4)	155 (45.6)
***Aedes* mosquitoes breeding site**	266 (78.2)	74 (21.8)
***Aedes* mosquito can breed both indoors and outdoors**	205 (60.3)	135 (39.7)
***Aedes* mosquito normally bites early in the morning and late evening**	195 (57.4)	145 (42.6)
Dengue virus can be transmitted from infected pregnant mother to fetus	185 (54.4)	155 (45.6)
Person can be infected with dengue virus more than once	212 (62.4)	128 (37.6)
Dengue infection can be reduced by keeping surrounding areas clean and destroying potential breeding sites	285 (83.8)	55 (16.2)

Table 3: Attitude towards DF among study participants.

Statements	Strongly disagree, N (%)	Disagree, N (%)	Neutral, N (%)	Agree, N (%)	Strongly agree, N (%)
I have the responsibility to ensure no *Aedes* eggs and/or larvae are in my house area	12 (3.5)	14 (4.1)	28 (8.2)	142 (41.8)	144 (42.4)
We should clean *Aedes* mosquito breeding sites, like water containers, storage tank, and plant pots one to three times a week	6 (1.8)	54 (15.9)	36 (10.6)	131 (38.5)	113 (33.2)
Authorities should demolish the potential breeding sites; chemical fogging alone is not enough to control DF	9 (2.6)	43 (12.6)	34 (10)	171 (50.3)	83 (24.4)
We should regularly check the dengue situation around our area	4 (1.2)	39 (11.5)	37 (10.9)	165 (48.5)	95 (27.9)
DF control depends on the community commitment to remove mosquito breeding sites	3 (0.9)	27 (7.9)	33 (9.7)	172 (50.6)	105 (30.9)
I will take part in a DF control public activity	1 (0.3)	4 (1.2)	28 (8.2)	185 (54.4)	122 (35.9)
I will bring my family member to see a doctor immediately if he/she has DF symptoms	3 (0.9)	18 (5.3)	31 (9.1)	149 (43.8)	139 (40.9)
Removal of mosquito breeding sites should be on a regular basis even in the period when there is no fever	3 (0.9)	12 (3.5)	34 (10)	202 (59.4)	89 (26.2)

Table 4: Knowledge of preventive practices towards DF among study participants.

Statements	No, N (%)	Yes, N (%)
I call the municipal authority for fogging	61 (17.9)	279 (82.1)
I use aerosol and/or liquid mosquito repellent and/or mosquito coil and/or electrical mosquito mat and/or mosquito bed net	50 (14.7)	290 (85.3)
I properly cover water containers used for water storage	14 (4.1)	326 (95.9)
I scrub and clean the inner sides of the containers	36 (10.6)	304 (89.4)
I check for the presence of *Aedes* eggs and/or larvae inside or outside the house	112 (32.9)	228 (67.1)
I visit the hospital for test and treatment when I see the symptoms of DF	28 (8.2)	312 (91.8)
I follow the latest information from trusted sources, such as WHO or my local and national health authorities	39 (11.5)	301 (88.5)

Table 5: Correlation in KAP domain among university students of Bengaluru city, Karnataka.

Association	Correlation coefficient	P value[SP]	Interpretation
Knowledge and attitude	0.212	<0.001*	Positive correlation
Knowledge and practice	0.077	0.155	Positive correlation
Attitude and practice	0.212	<0.001*	Positive correlation

*Indicates statistical significance. SP-Spearman's rank correlation test.

Table 6: Univariate analysis predictors of knowledge, attitude, practices, and overall KAP level towards DF among study participants.

Variables	Knowledge		Attitude		Practice		Overall KAP	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Sex								
Male	1		1		1		1	0.389
Female	0.899 (0.567-1.426)	0.652	0.894 (0.583-1.371)	0.607	1.306 (0.798-2.137)	0.288	1.206 (0.788-1.846)	
Location in Bengaluru city								
West	1		1		1		1	
East	1.253 (0.666-2.355)	0.484	0.887 (0.485-1.623)	0.698	1.672 (0.813-3.438)	0.162	0.889 (0.484-1.634)	0.705
North	0.752 (0.392-1.441)	0.390	0.957 (0.528-1.735)	0.885	0.736 (0.387-1.400)	0.350	0.657 (0.361-1.195)	0.168
South	0.657 (0.334-1.293)	0.224	0.591 (0.318-1.097)	0.095	1.911 (0.908-4.022)	0.088	0.575 (0.312-1.061)	0.077
Living with family								
No	1		1		1		1	
Yes	1.284 (0.707-2.332)	0.411	(1.233 (0.720-2.113)	0.446	0.905 (0.485-1.688)	0.754	1.631 (0.952- 2.795)	0.075
Residential unit								
Mixed-use building	1		1		1		1	
High-rise (>5-storey)	0.489 (0.189-1.268)	0.141	0.695 (0.304-1.593)	0.390	1.651 (0.560-4.867)	0.364	0.843 (0.367-1.936)	0.686
Low-rise (≤5-storey)	0.692 (0.408-1.175)	0.173	0.612 (0.369-1.016)	0.058	0.878 (0.490-1.574)	0.663	0.624 (0.375-1.038)	0.070
University type								
Public	1		1		1		1	
Private	0.740 (0.457-1.199)	0.221	0.562 (0.359-0.879)	0.012*	1.202 (0.721-2.004)	0.479	0.618 (0.398-0.959)	0.032*
University year								
1st	1		1		1		1	
2nd	1.652 (0.921-2.963)	0.092	1.292 (0.777-2.151)	0.324	1.581 (0.881-2.839)	0.125	1.341 (0.808-2.227)	0.257
3rd	2.192 (1.158-4.147)	0.016*	1.077 (0.605-1.918)	0.801	1.046 (0.555-1.969)	0.890	1.497 (0.843-2.658)	0.168
Major								
Science and engineering	1		1		1		1	
Arts and social sciences	0.787 (0.410-1.508)	0.470	0.786 (0.437-1.415)	0.423	1.018 (0.529-1.960)	0.957	1.375 (0.763-2.478)	0.289
Business studies	1.484 (0.805-2.734)	0.206	0.834 (0.469-1.484)	0.536	1.198 (0.623-2.304)	0.588	1.860 (1.040-3.328)	0.036*
Others	0.494 (0.180-1.354)	0.170	1.054 (0.469-2.367)	0.898	2.215 (0.757-6.482)	0.147	1.375 (0.610-3.097)	0.442
Dengue-relevant subject								
Maybe	1		1		1		1	
No	0.973 (0.382-2.480)	0.954	0.820 (0.343-1.961)	0.656	0.438 (0.126-1.529)	0.196	1.091 (0.456-2.607)	0.845
Yes	0.821 (0.288-2.342)	0.712	0.806 (0.306-2.121)	0.662	0.526 (0.137- 2.025)	0.350	0.857 (0.326-2.256)	0.755

*Indicates statistical significance. OR-Odds ratio, CI-Confidence interval.

Table 7: Multivariate analysis predictors of knowledge, attitude, practices and overall KAP level towards DF among study participants.

Variables	Attitude		Overall KAP	
	AOR (95% CI)	P value	AOR (95% CI)	P value
North zone	0.671 (0.346-1.302)	0.238	0.512 (0.263-0.9996)	0.0499*
South zone	0.343 (0.159-0.740)	0.006*	0.491 (0.234-1.034)	0.061
Private university	0.393 (0.228-0.676)	0.001*	0.570 (0.338-0.962)	0.035*

*Indicates statistical significance. aOR-Adjusted odds ratio, CI-Confidence interval.

DISCUSSION

Our study included 340 participants from various academic fields, predominantly aged between 18 to 21 years. The gender distribution was fairly balanced, with 49.1% male and 50.9% female participation. The majority of students (80.0%) lived with their family and attended public universities (61.5%), with the second year accounting for the most (44.4%).

This study revealed that a significant majority of university students have strong knowledge (30.6%), positive attitude (45.3%), and preventive measures (75%) against dengue disease. Students from various places showed differences in attitudes and knowledge levels, indicating that local factors influence their behaviours. Third-year students demonstrated better comprehension than first-year students, highlighting the impact of education on disease awareness. However, despite effective preventive procedures, a knowledge gap exists (30.6%), emphasising the importance of focused education programs. Attitudes and total knowledge varied between places, probably due to variable levels of awareness and contextual influences.

This study emphasises the need for enhanced health literacy programs among university students to improve awareness and knowledge about DF. This finding aligns with research conducted in Kolkata, India, which also highlighted the importance of health education in urban settings for effective dengue prevention.[7]

Rahman et al observed similar trends in their study conducted in Bangladesh, where higher educational levels were associated with better knowledge and attitudes toward dengue prevention.[8] This finding aligns with our study's observation of a significant difference in understanding about dengue between third-year and first-year students, suggesting that educational development indeed plays a role in disease-related knowledge.[6] Our study findings are contextualised by comparing them with similar studies in the field. For instance, Swain 2024 reported a comparable awareness rate of 72.6% regarding dengue as an infectious disease among university students in New Delhi. However, our study revealed a higher percentage (83.8%) recognising the importance of cleanliness in dengue prevention compared to their findings (65.2%).[14] This suggests a potentially heightened awareness of preventive measures against dengue among the student population in our study area.

When considering the prevalence of good overall KAP levels, our study found that 50.9% of participants demonstrated good overall KAP levels. In comparison, Bhandari et al reported a lower overall KAP level among non-health university students in Nepal.[15] Amanah et al reported moderate level of KAP toward DF among undergraduate students in Malaysia.[16] These comparative figures offer insights into variations in dengue-related KAP among university students across different regions in developing countries. The finding about the need for improved health literacy programs aimed at university students echoes the recommendations of several studies that emphasise the importance of comprehensive education campaigns for effective dengue prevention and control.[8-10]

Despite a majority of students demonstrating good preventive practices, a notable gap remains between awareness and actionable knowledge about dengue, as evidenced by the difference between strong knowledge levels and actual preventive practices. This highlights the need for targeted education campaigns that focus on comprehensive knowledge dissemination, including information on dengue transmission, prevention strategies, and treatment options. The gap between students' awareness and actionable knowledge about DF, as indicated by the disparity between good preventive practices and strong knowledge levels, resonates with previous study that noted a similar gap in understanding among the general population.[16]

University type significantly impacted attitude and overall KAP levels in our study, aligning with the findings of those who observed a similar trend among university students in Kolkata.[18] However, our study did not find significant gender differences in KAP levels, differing from who reported higher KAP levels among female students.[19]

The strengths of this study are that, in India, there has been insufficient research on health literacy on DF among young adults. This study fills a critical research gap by assessing KAP regarding DF in this group, offering valuable insights into a relatively underexplored topic.

The variations in attitudes and KAP levels among students from different areas of Bengaluru suggest the need for tailored intervention strategies that consider local dynamics, such as awareness campaigns, community engagement initiatives, and environmental factors.[6,20] The study's findings reveal a high prevalence of dengue cases in areas with inadequate sanitation, which had significant implications for public health policies. Health practitioners and politicians should prioritise community education and awareness campaigns about adequate sanitation, water storage, hygiene, and vector control measures. This may involve regular garbage collection, safe disposal of stagnant water sources, and the use of mosquito nets or repellents. Study findings can inform educational interventions targeting this demographic. Understanding their knowledge gaps and misconceptions about dengue transmission, prevention, and treatment can guide the development of tailored educational programs. These interventions could focus on promoting practices such as eliminating mosquito breeding sites, using repellents, and seeking timely medical care, thereby reducing dengue incidence among university students and their communities.

The study has some limitations. The cross-sectional study design measures KAP levels at a specific point in time. It does not reflect changes or trends in KAP over time, limiting the capacity to demonstrate causality or analyse the long-term consequences of interventions. The study's sample size may not adequately represent the total population at risk of dengue infection. Furthermore, because the study focused on a specific geographic site, the findings may not be applicable to other settings and countries with varying environmental and socioeconomic factors that influence dengue transmission. Location within Bengaluru city and institution type were also significant factors impacting attitude levels, with students in specific districts or attending private universities having a lower odd of being favourable about dengue prevention. Furthermore, overall KAP levels were substantially correlated with geography and university type, indicating that geographical and institutional factors influence students' actions and perceptions related to dengue.

This study highlights the importance of health literacy among undergraduate students in Bengaluru, India, in relation to DF. The findings reveal a notable level of awareness and engagement, indicating a solid foundation for preventive practices. However, a gap remains between general awareness and actionable knowledge, underscoring the need for targeted health literacy programs. These programs should emphasise comprehensive understanding, transmission routes, prevention strategies, and prompt treatment-seeking behaviours. Furthermore, this study emphasises the necessity for more research focusing on dengue among undergraduate students in India to enhance our understanding and address this significant public health concern effectively.

Future research directions could focus on implementing and evaluating targeted health literacy interventions among undergraduate students in Bengaluru to enhance their understanding of DF. Additionally, studying the effectiveness of various educational approaches, such as integrating dengue-related content into academic curricula or conducting targeted awareness campaigns, would be valuable. Longitudinal studies tracking changes in KAP over time can provide insights into the sustained impact of health literacy programs.

CONCLUSION

This study was conducted among university students on health literacy using KAP regarding DF among university students. Overall, it was discovered that a significant proportion of students had a high level of awareness, a positive attitude, and strong preventive behaviours for DF. The study found a slight positive association between knowledge and attitude, as well as attitude and practices, emphasising the interdependence of these elements in dengue prevention. However, the relationship between knowledge and practices was not statistically significant, indicating a potential gap between understanding and execution.

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