

Knowledge, attitude, and practice towards dengue fever among medical students in Sudan: A cross-sectional study

Journal of Public Health Research
2024, Vol. 13(3), 1–10
© The Author(s) 2024
DOI: 10.1177/22799036241270370
journals.sagepub.com/home/phj



Muhannad Bushra Masaad Ahmed¹, Ahmed Balla M. Ahmed² ,
Salma Alrawa², Ahmed A. Yeddi², Asim Jamal Mustafa Talha¹
and Sohaib Mohammed Mokhtar Ahmed¹

Abstract

Background: Dengue fever, a neglected tropical disease, exhibits a total seroprevalence of 27% in Sudan. During the recent outbreak, medical students actively participated in health education and community outreach programs. This study aims to assess the knowledge, attitude, and practice (KAP) of medical students regarding Dengue Fever (DF) during its current outbreak in Sudan.

Design and methods: We conducted a cross-sectional study involving medical students from more than 15 Sudanese universities, encompassing 11 states. Data collection took place between October 23 and November 10, 2023, utilizing a Google Form questionnaire. A convenient sampling technique was employed to reach students due to its accessibility and feasibility during the ongoing conflict in Sudan. Correlation and regression analyses were used to identify predictors of KAP and establish associations between KAP domains and socio-demographic factors.

Results: Of 694 medical students, 11% reported a previous infection with DF. Among the participants, 58% demonstrated good knowledge, 74.1% exhibited a positive attitude, and less than half (46.7%) demonstrated good preventive practices. There was a positive correlation between knowledge and attitude levels with the practice level ($p < 0.001$). Gender, age, and previous DF infection emerged as significant predictors ($p < 0.05$) of the overall KAP level in multiple logistic regression.

Conclusions: Our study revealed a commendable level of knowledge and attitude but a suboptimal level of practice regarding DF among medical students. This inadequacy in practice, particularly among medical students who are expected to set an example, is concerning and warrants further investigation.

Keywords

Dengue fever, medical students, knowledge, attitude, Sudan

Date received: 12 January 2024; accepted: 19 June 2024

Introduction

Dengue fever (DF) is a viral illness caused by the dengue virus (DENV), transmitted to humans through the bite of infected mosquitoes, particularly *Aedes aegypti*, prevalent in tropical and subtropical regions.^{1,2} The clinical spectrum of the disease ranges from mild symptoms to severe conditions like dengue shock syndrome and dengue hemorrhagic fever. Without appropriate care, the mortality rate from severe dengue can escalate to 20%, particularly affecting children under the age of five and older individuals.^{3,4}

Dengue infections affect approximately 390 million people worldwide annually, spanning 129 nations, including those in Africa.^{2,5} DF epidemics have been documented in several sub-Saharan African developing nations, including

¹Faculty of Medicine and Health Sciences, University of Gadarif, Gadarif, Al Qadarif, Sudan

²Faculty of Medicine, University of Khartoum, Khartoum, Sudan

Corresponding author:

Ahmed Balla M. Ahmed, Faculty of Medicine, University of Khartoum, Khartoum 11111, Sudan.

Email: m.salahballa@gmail.com



Sudan.⁶ Notably, the first recorded outbreak of DENV occurred in 1986 among individuals in the Red Sea State, eastern Sudan.⁷ However, a concerning 44% of localities in 12 states (67%) reported dengue fever cases between July 2022 and April 2023.⁸ The total seroprevalence of DENV in Sudan stands at 27%, as indicated by a previous meta-analysis.⁹ The peak of illnesses is observed between September and November, aligning with the rainy season.⁷ Currently, there have been 4097 suspected cases of dengue fever and 13 related deaths since April 2023, with a significant concentration in Gadarif city, eastern Sudan.^{10–12}

Given the absence of specific drugs for treating dengue viral infection, managing dengue fever relies on effective illness management and vector control. Vector control involves limiting contact with mosquitoes that transmit dengue viruses by using mosquito nets, coils, draining stagnant water, and applying insect repellents.⁴ Medical students, possessing authentic knowledge, play a crucial role in community preparedness. With adequate knowledge and positive attitudes, they can effectively transfer this understanding to their communities, significantly contributing to dengue fever prevention.¹³ Despite this potential, there have been limited studies on medical students' perceptions of dengue fever in Sudan. This study specifically focuses on medical students due to their pivotal role in health education related to disease prevention and control.

The primary objective of our study is to explore the knowledge, attitude, and practice (KAP) of medical students in Sudan concerning dengue fever. It aims to provide valuable insights to enhance future disease prevention efforts.

Design and methods

Study design and population

This cross-sectional study took place between October 23 and November 10, 2023, amid the ongoing dengue fever outbreak across multiple states in Sudan. The focus was on medical students enrolled in the medical colleges of Sudanese universities at time of data collection. We excluded the students who were unwilling to fill the questionnaire or couldn't access it. The minimum sample size, determined by the Cochran formula, was 384 participants. It was calculated by employing the unknown population formula, considering a confidence level (CI) of 95%, an acceptable margin of error of 5%, an expected frequency of 50%, and an unknown target population (N). Convenience sampling was employed due to its accessibility and feasibility amid the 2023 Sudan war. The questionnaire was disseminated through various social media channels and groups such as Twitter, WhatsApp, Instagram, and Facebook.

Measurement

The questionnaire, previously developed and validated in Dhaka City, Bangladesh,¹³ comprised three sections with

mandatory response items: socio-demographic and academic information, dengue infection history, and the final Knowledge, Attitude, and Practice (KAP) section.

For the dengue infection history, Yes/No options were provided. The KAP section included twelve knowledge-related questions, eight attitude-related questions (utilizing a 5-point Likert scale), and eight preventive practice-related questions (also on a 5-point Likert scale). The internal consistency reliability of the questionnaire, assessed through Cronbach's alpha test in pilot survey data, yielded a value of 0.82, indicating very good reliability.¹⁴ This study exhibited good reliability with Cronbach's alpha values of 0.76 for knowledge, 0.67 for attitude, and 0.69 for practice.

Data management

Data analysis was performed using R programming version 4.2.2. The Shapiro–Wilk test was employed to assess the normality of numeric data, which revealed non-normal distribution. Descriptive statistical analyses were carried out, including frequency and percentage for non-continuous data, and median and inter-quartile range for continuous data.

Spearman's rank correlation was utilized to determine the correlation within the KAP domain. Eighty percent cut-off scores were established after summing the KAP section's score to categorize "Good" and "Poor" levels in the KAP domain, following Dhimal et al. (2014).

Univariate logistic regression analysis identified predictors of KAP level, while multiple logistic regression analysis, odds ratios (ORs), and 95% confidence intervals were calculated. All statistical analyses were performed at a significance level of 0.05 (α).

Ethical considerations

The study was approved by the Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, University of Gadarif, on October 22, 2023 (Ref. No.: GU/FM/REC/Q3.10.23.3). The study was conducted in accordance with the Helsinki Declaration. Data collection was conducted using an online, self-administered questionnaire via Google Forms, ensuring anonymity. All participants provided written informed consent before participation.

Results

Sample characteristics

The study included 694 participants, 62.8% were female and 37.2% were male. The median age of the participants was 21 years (IQR: 4). Majority of the participants resided with their family (92.1%), while a smaller percentage lived alone (6.2%) or in dorms (1.7%). In terms of academic

status, the distribution was as follows: first year (23.8%), second year (24.9%), third year (23.6%), fourth year (12.1%), fifth year (10.4%), and sixth year (5.2%). Social media was the most common source of Dengue fever knowledge (52.7%), followed by research and medical books (26.2%) and television (6.1%). 89.0% of participants had no previous Dengue fever infection, while 11.0% reported a prior infection. Among the participants, 72.0% had no family history of Dengue fever, while 28.0% reported a positive family history. Table 1 presents the characteristics of the sample. Figure 1 presents universities and States distribution.

Knowledge about dengue fever

The majority of participants were aware that Dengue is an infectious disease (84.7%) and that it can cause death (94.8%). Regarding the common symptoms of Dengue infection, 89.8% of participants correctly identified rash, headache, high fever, joint pain, muscle pain, and nausea as common symptoms. Additionally, a high percentage of participants knew that the Aedes mosquito is responsible for transmitting the Dengue virus (80.5%) and that it has stripes on its body (60.1%).

However, 39.9% of participants were unaware that Aedes mosquitoes breed in water containers, storage tanks, and plant pots. Furthermore, 34.0% of participants were not aware that Aedes mosquitoes typically bite early in the morning and late evening. In terms of transmission, 50.1% of participants were aware that Dengue virus can be transmitted from an infected pregnant mother to her fetus. Additionally, 69.0% of participants knew that a person can be infected with the Dengue virus more than once. Finally, the majority of participants recognized that Dengue infection can be reduced by keeping the surrounding areas clean and destroying potential breeding sites (87.5%). The participants' knowledge about Dengue fever is presented in Table 2.

Attitudes toward dengue fever

The participants' attitudes and behaviors towards Dengue fever control are presented in Table 3. A significant proportion of participants agreed (78.9%) that they have the responsibility to ensure no Aedes eggs and/or larvae are present in their house area. Similarly, a majority agreed (89.4%) that Aedes mosquito breeding sites, such as water containers, storage tanks, and plant pots, should be cleaned 1–3 times a week.

Regarding control measures, participants showed varying opinions. A substantial number agreed (78.8%) that authorities should demolish potential breeding sites and that chemical fogging alone is not enough to control Dengue fever. Additionally, a considerable number agreed (83.4%) that they should regularly check the Dengue

Table 1. Sample characteristics.

Characteristic	N (%)
Gender	
Female	436 (62.8%)
Male	258 (37.2%)
Age	
Median (IQR)	21 (4)
Residence type	
Alone	43 (6.2%)
In dorms	12 (1.7%)
With family	639 (92.1%)
Year of study	
First	165 (23.8%)
Second	173 (24.9%)
Third	164 (23.6%)
Fourth	84 (12.1%)
Fifth	72 (10.4%)
Sixth	36 (5.2%)
Source of dengue fever knowledge	
Research and medical books	182 (26.2%)
Social media	366 (52.7%)
T.V.	42 (6.1%)
All the above resources	6 (0.9%)
No source	98 (14.1%)
Previous dengue fever infection	
No	618 (89.0%)
Yes	76 (11.0%)
Family history of previous dengue fever infection	
No	500 (72.0%)
Yes	194 (28.0%)

situation around their area and remove mosquito breeding sites even in the absence of fever.

The participants acknowledged the importance of community commitment in Dengue fever control, with a significant proportion agreeing (85.9%) that Dengue fever control depends on community commitment to remove mosquito breeding sites. Moreover, a notable percentage agreed (73.4%) that they would participate in Dengue fever control public activities.

In terms of seeking medical attention, the majority agreed (88%) that they would immediately bring their family member to see a doctor if they exhibited Dengue fever symptoms.

Practices toward dengue fever

When it comes to fogging, the majority of participants reported that they sometimes (20.9%) or never (18.7%) call the municipal authority for fogging. Similarly, a significant number of participants reported that they sometimes (20.9%) or never (18.7%) use aerosol/liquid mosquito repellents, mosquito coils, electrical mosquito mats, or mosquito bed nets.

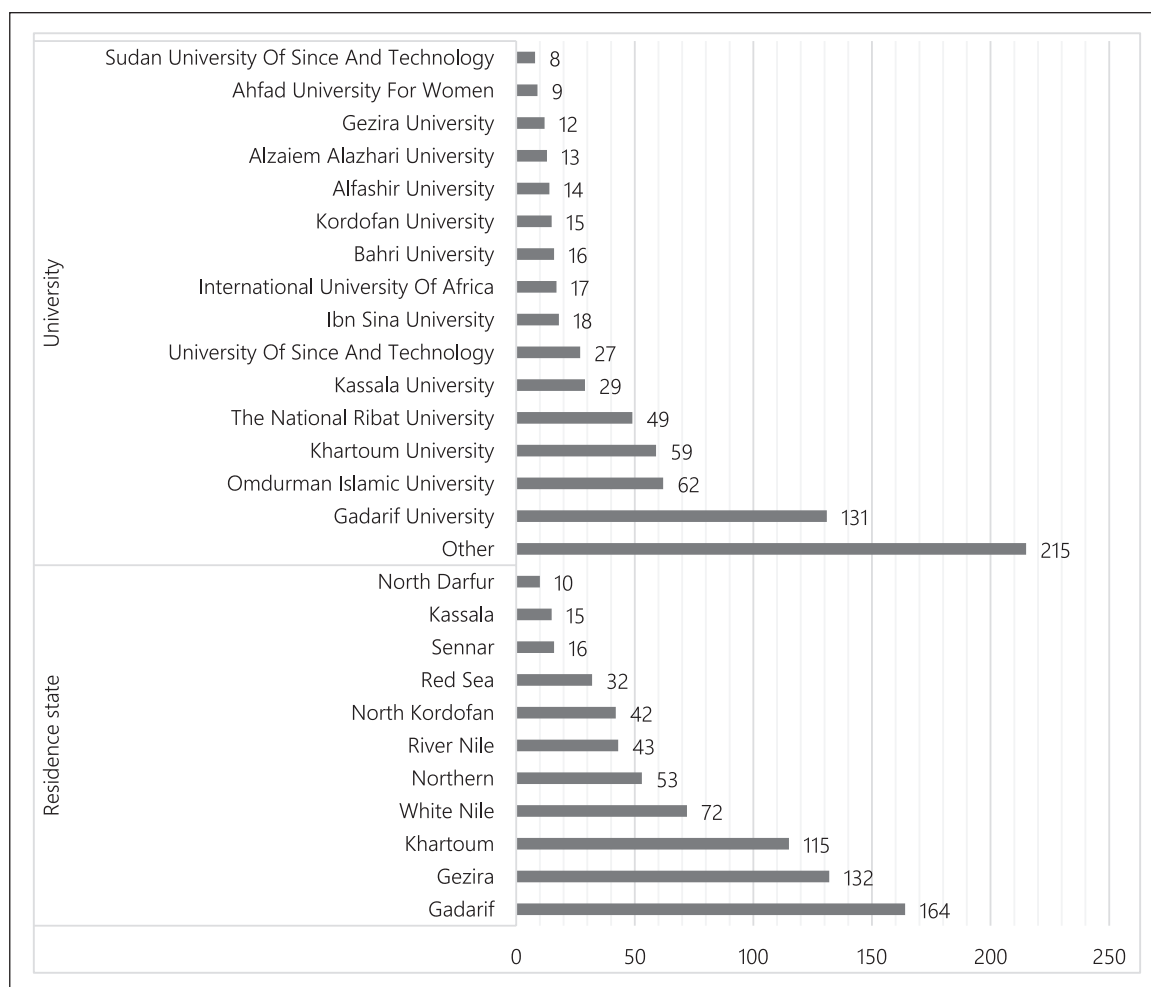


Figure 1. Universities and status distribution.

Table 2. Basic knowledge about DF and its transmitter among medical students in Sudan.

Statements	Correct answer	Incorrect answer
Dengue is an infectious disease	588 (84.7%)	106 (15.3%)
Dengue fever can cause death	658 (94.8%)	36 (5.2%)
Common symptoms of dengue infection are rash, headache, high fever, joint pain, muscle pain, nausea	623 (89.8%)	71 (10.2%)
Aedes mosquito type transmits dengue virus	559 (80.5%)	135 (19.5%)
Aedes mosquito has stripes on the body	417 (60.1%)	277 (39.9%)
Dengue virus cannot be transmitted through direct contact with an infected person	433 (62.4%)	261 (37.6%)
Aedes mosquitoes breeding site are water containers, storage tank, and plant pots	552 (79.5%)	142 (20.5%)
Aedes mosquito can breed both indoors and outdoors	451 (65.0%)	243 (35.0%)
Aedes mosquito normally bites early in the morning and late evening	458 (66.0%)	236 (34.0%)
Dengue virus can be transmitted from infected pregnant mother to fetus	346 (49.9%)	348 (50.1%)
Person can be infected with dengue virus more than once	479 (69.0%)	215 (31.0%)
Dengue infection can be reduced by keeping surrounding areas clean and destroying potential breeding sites	607 (87.5%)	87 (12.5%)

However, there were positive responses regarding water storage practices. The majority of participants reported that they always (68.6%) properly cover water

containers used for water storage. Similarly, a majority reported that they always (51.9%) scrub and clean the inner sides of the containers. In terms of checking for

Table 3. Medical students' attitudes toward DF in Sudan.

Statement	Strongly agree	Agree	Natural	Disagree	Strongly disagree
I have the responsibility to ensure no Aedes eggs and/or larvae are in my house area	328 (47.3%)	219 (31.6%)	106 (15.3%)	30 (4.3%)	11 (1.6%)
We should clean Aedes mosquito breeding sites, like water containers, storage tank, and plant pots one to three times a week	391 (56.3%)	230 (33.1%)	58 (8.4%)	12 (1.7%)	3 (0.4%)
Authorities should demolish the potential breeding sites; chemical fogging alone is not enough to control dengue fever	253 (36.5%)	289 (41.6%)	119 (17.1%)	28 (4.0%)	5 (0.7%)
We should regularly check the dengue situation around our area	304 (43.8%)	289 (41.6%)	79 (11.4%)	14 (2.0%)	8 (1.2%)
Removal of mosquito breeding sites should be on a regular basis even in the period when there is no fever	279 (40.2%)	290 (41.8%)	95 (13.7%)	22 (3.2%)	8 (1.2%)
Dengue fever control depends on the community commitment to remove mosquito breeding sites	296 (42.7%)	300 (43.2%)	65 (9.4%)	23 (3.3%)	10 (1.4%)
I will take part in a dengue fever control public activity	222 (32.0%)	288 (41.5%)	131 (18.9%)	39 (5.6%)	14 (2.0%)
I will bring my family member to see a doctor immediately if he/she has dengue fever symptoms	422 (60.8%)	189 (27.2%)	58 (8.4%)	17 (2.4%)	8 (1.2%)

Aedes eggs and larvae, a significant proportion of participants reported that they sometimes (19.6%) or never (17.6%) check for their presence inside or outside the house. Similarly, a considerable number reported that they sometimes (18.4%) or never (9.8%) keep plant pots clear and drain the extra water. Regarding seeking medical attention, a majority reported that they always (45.4%) visit the hospital for testing and treatment when they see symptoms of Dengue fever. In terms of information sources, the majority of participants reported that they follow the latest information from trusted sources, such as the WHO or their local and national health authorities. The participants' preventive practices towards Dengue fever are presented in Table 4.

Association in KAP domains

Significant positive correlations ($p < 0.001$) between knowledge and attitude, knowledge and practices, attitude and practices were determined (Table 5). Linear regression analysis identified knowledge and attitude as significant predictors ($p < 0.001$) of practices towards DF.

KAP domains level towards dengue fever

More than half of the participants demonstrated the good knowledge level ($n=402$, 57.9%), the majority exhibited good attitude level ($n=514$, 74.1%), however, less than half of them showed good preventive practice level ($n=324$, 46.7%), while more than half of them demonstrated good overall KAP level ($n=398$, 57.3%). Table 6 summarizes the univariate analysis results. Age was found to be a significant predictor of knowledge ($p=0.020$). For

each unit increase in age, the odds of having good knowledge increased by 1.07 times (OR=1.07, 95% CI: 1.01–1.14). In terms of attitude, gender was found to be a significant predictor ($p=0.047$). Females had higher odds of having a good attitude compared to males (OR=1.42, 95% CI: 1.00–2.01). Residence type was also found to be a significant predictor of attitude. Students living in dorms had higher odds of having a good attitude (OR=1.96, 95% CI: 0.46–8.30, $p=0.360$), while those living with family members had higher odds than those living alone (OR=1.96, 95% CI: 1.03–3.70, $p=0.039$).

Regarding practices, the year of study was found to be a significant predictor ($p=0.023$). Fourth-year students had higher odds of having good practices compared to first-year students (OR=1.90, 95% CI: 1.09–3.32). Family history of previous Dengue fever infection was also a significant predictor of practices ($p=0.005$). Individuals with a positive family history had higher odds of having good practices (OR=1.65, 95% CI: 1.17–2.33).

Predictors of overall KAP level

Table 7 summarizes the univariate analysis results of overall KAP. Females had significantly higher odds of having good overall KAP level (OR=1.53, 95% CI=1.122–2.09, $p=0.007$) compared to males. Age was also found to be a significant predictor of overall KAP ($p < 0.001$). For each unit increase in age, the odds of having good KAP increased by a factor of 1.111 (OR=1.111, 95% CI=1.045–1.180). Regarding residence type, individuals living with their families had significantly higher odds of having good KAP compared to those living alone ($p=0.037$), the odds ratio (OR) was 1.948 (95% CI=1.041–3.64), indicating

Table 4. Preventive practices towards dengue fever among medical students in Sudan.

Statement	Always	Usually	Often	Sometimes	Never
I call the municipal authority for fogging	166 (23.9%)	187 (26.9%)	66 (9.5%)	145 (20.9%)	130 (18.7%)
I use aerosol and/or liquid mosquito repellent and/or mosquito coil and/or electrical mosquito mat and/or mosquito bed net	249 (35.9%)	203 (29.3%)	57 (8.2%)	121 (17.4%)	64 (9.2%)
I properly cover water containers used for water storage	476 (68.6%)	115 (16.6%)	17 (2.4%)	61 (8.8%)	25 (3.6%)
I scrub and clean the inner sides of the containers	360 (51.9%)	182 (26.2%)	46 (6.6%)	80 (11.5%)	26 (3.7%)
I check for the presence of Aedes eggs and/or larvae inside or outside the house	178 (25.6%)	184 (26.5%)	74 (10.7%)	122 (17.6%)	136 (19.6%)
I keep the plant pots clear and drain the extra water	263 (37.9%)	181 (26.1%)	54 (7.8%)	128 (18.4%)	68 (9.8%)
I visit the hospital for test and treatment when I see the symptoms of dengue fever	315 (45.4%)	135 (19.5%)	51 (7.3%)	90 (13.0%)	103 (14.8%)
I follow the latest information from trusted sources, such as WHO or my local and national health authorities	306 (44.1%)	159 (22.9%)	54 (7.8%)	116 (16.7%)	59 (8.5%)

Table 5. Correlation in KAP domain among medical students in Sudan.

Association	rho-value ^a (95% CI ^b)	p-value	Interpretation
Knowledge and attitude	0.178	<0.001	Positive correlation
Knowledge and practice	0.255	<0.001	Positive correlation
Attitude and practice	0.325	<0.001	Positive correlation

^arho, correlation coefficient.

^bCI, confidence intervals.

that individuals living with their families were almost twice as likely to have good KAP. A family history of previous Dengue fever infection was found to be a significant predictor of overall KAP ($p=0.001$). Individuals with a family history of previous Dengue fever infection had higher odds of having good overall KAP (OR=1.76, 95% CI=1.243–2.49) compared to those without a family history.

Multiple regression analysis of overall KAP predictors

Females had higher odds of having good overall KAP compared to males, with an odds ratio of 1.719 (95% CI: 1.226–2.410, $p=0.002$). Age was also found to be a significant predictor of overall KAP ($p<0.001$). With each unit increase in age, the odds of having good overall KAP increased by a factor of 1.211 (95% CI: 1.094–1.340). Table 8 present multiple logistic regression analysis results of overall KAP predictors.

Discussion

The reports on Dengue fever in Sudan date back to 1906, and recently its prevalence has expanded beyond the Eastern region to encompass the entire country.¹⁵ Nonetheless, there are few studies addressing knowledge, attitude and practice towards it.

The majority of the respondents were in their preclinical years. In Sudanese universities, courses on infectious disease and tropical medicine are typically taught in the third or fourth year of medical school. Hence, the knowledge of the students in our study doesn't reflect what is taught in the curriculum, but rather what is learnt by educated University Sudanese students. This is emphasized by the fact that more than half of the students cited social media as their primary source of information, while only a quarter relied on research and medical literature. The role of social media in health promotion is increasingly recognized by health professionals.^{16,17}

The students demonstrated awareness of the symptoms and the potentially fatal nature of Dengue fever. Nevertheless, over a third of the students lacked knowledge regarding the striped body, indoor and outdoor breeding habits, and early morning and late evening biting behavior of *Aedes Aegypti* mosquitoes. The general university students in Bangladesh had better knowledge on *Aedes Aegypti* than our medical students.¹³ It is possible that students confused *Aedes* biting time for *Anopheles* which is common in Sudan.¹⁸ A similar finding was reported from Ethiopia.¹⁹ The failure to identify mosquito breeding sites and their biting times can significantly impact the effectiveness of preventive measures. Over half of the students were unaware of the potential transmission of Dengue fever from pregnant women to their fetuses. This aligns with similar findings in Bangladesh and Malaysia.^{13,20}

Table 6. Univariate analysis predictors of knowledge, attitude, and practices level towards dengue fever among medical students in Sudan.

Predictor	Knowledge				Attitude				Practices			
	p	OR	95% CI		p	OR	95% CI		p	OR	95% CI	
			Lower	Upper			Lower	Upper			Lower	Upper
Gender:												
Male												
Female	0.805	0.96	0.70	1.31	0.047	1.42	1.00	2.01	0.006	1.54	1.13	2.11
Age	0.020	1.07	1.01	1.14	0.011	1.09	1.02	1.17	0.058	1.05	0.99	1.12
Residence type:												
Alone												
In dorms	0.047	8.71	1.03	73.5	0.360	1.96	0.46	8.30	0.019	5.16	1.30	20.3
With family	0.835	1.07	0.57	1.99	0.039	1.96	1.03	3.70	0.015	2.34	1.18	4.64
Year of study:												
First												
Second	0.411	1.19	0.77	1.84	0.111	1.47	0.91	2.36	0.889	1.03	0.67	1.58
Third	0.614	1.11	0.72	1.73	0.243	1.33	0.82	2.13	0.349	1.23	0.79	1.90
Fourth	0.023	1.90	1.09	3.32	0.065	1.78	0.96	3.30	0.402	0.79	0.46	1.36
Fifth	0.410	1.26	0.72	2.22	0.040	2.02	1.03	3.93	0.717	1.10	0.63	1.93
Sixth	0.668	0.85	0.41	1.76	0.122	2.02	0.83	4.89	0.434	0.74	0.35	1.56
Source of dengue fever knowledge:												
T.V.												
Research and medical books	0.708	1.14	0.57	2.26	0.642	1.19	0.57	2.43	0.623	0.84	0.43	1.65
Social media	0.616	0.84	0.44	1.62	0.191	1.58	0.79	3.13	0.325	0.72	0.38	1.37
All the above resources	0.283	3.40	0.36	31.7	0.980	2.88e+6	0.00	Inf	0.585	1.65	0.27	10.0
No source	0.709	0.87	0.41	1.81	0.283	1.54	0.70	3.40	0.028	0.43	0.21	0.91
Family history of previous dengue fever infection:												
No												
Yes	0.005	1.65	1.17	2.33	0.159	1.33	0.89	1.96	0.003	1.65	1.18	2.30
Previous dengue fever infection:												
No												
Yes	0.029	1.78	1.06	2.97	0.236	0.73	0.43	1.23	0.392	1.23	0.76	1.98

Students had a general positive attitude towards Dengue Fever and this was positively associated with the knowledge. Positive attitude towards Dengue fever has been observed in many areas where the disease is endemic.^{21–23}

The adherence to preventive measures was inadequate, with a quarter of students either never using or only sometimes using mosquito repellents and mosquito nets. The barriers against the use of nets attracted the interest of many researchers and qualitative studies were performed to explore the issue.^{24–26} The inconvenience of use, culture and perception of cost effectiveness are some of the reported barriers.^{24–26} Over a quarter of medical students neglect to keep their plant pots clear, a significantly higher proportion compared to the less than 7% of high school students in Myanmar who exhibit similar behavior.³ We can only speculate about the cause of this behaviour, and it is conceivable that students did not consider the maintenance of plants to be their own responsibility. More than a third of participants don't check for the presence of *Aedes Aegypti* larvae or eggs inside and outside the house. Indeed

more than a third weren't even aware of the indoor breeding possibility and their behavior may reflect negligence. Interestingly more than a quarter of the surveyed medical students reported not seeking medical treatment when suspecting Dengue infection. Studies on the health seeking behaviour of medical students showed high prevalence of self-medication practice.^{27,28}

In this study, both knowledge and attitude were positively associated with practice. However it is worth noting that other studies reported that knowledge is not always translated into practice.^{29,30} The factors that govern the association should be explored in future studies.

Being female was positively associated with attitude and practice. A similar finding was reported in Bangladesh.³¹ Females are usually in charge of vector control preventive measures within the household.^{32,33} Students in the fourth grade had better knowledge, probably because it is the year when tropical medicine is taught in most medical schools. Interestingly, fifth-grade students generally displayed a more positive attitude. Further qualitative research should

Table 7. Univariate analysis predictors of overall KAP level towards dengue fever among medical students in Sudan.

Predictor	p-value	Odds ratio	95% CI	
			Lower	Upper
Gender:				
Male		1		
Female	0.007	1.53	1.122	2.09
Age	<0.001	1.111	1.045	1.180
Residence type:				
Alone		1		
In dorms	0.315	1.944	0.531	7.12
With family	0.037	1.948	1.041	3.64
Year of study:				
First		1		
Second	0.634	0.901	0.587	1.38
Third	0.862	1.039	0.672	1.61
Fourth	0.268	1.357	0.791	2.33
Fifth	0.244	1.404	0.793	2.48
Sixth	0.557	1.247	0.597	2.61
Source of dengue fever knowledge:				
T.V.		1		
Research and medical books	0.758	1.114	0.561	2.21
Social media	0.764	0.905	0.473	1.73
All the above resources	0.739	1.360	0.224	8.27
No source	0.211	0.627	0.301	1.30
Family history of previous dengue fever infection:				
No		1		
Yes	0.001	1.76	1.243	2.49
Previous dengue fever infection:				
No		1		
Yes	0.553	1.16	0.712	1.89

investigate the reasons behind this association. Individuals who did not acquire knowledge about Dengue fever through any means were more inclined to have poor practice. This aligns with the association between knowledge and practice established in this study. Those who had a family member affected by Dengue fever or had experienced the infection themselves had better knowledge compared to those who did not have a personal or family history of infection. However, having a family history of Dengue fever was linked to positive preventive practices. We hypothesize that participants may believe they can only be infected once, thus, witnessing an infected family member positively influences their preventive practices. However, after experiencing the infection themselves, they may become less vigilant about preventive measures. The misconception of a once-in-a-lifetime infection is documented in the literature.¹³

Medical students have social accountability towards their communities.³⁴ They are expected to actively participate in health education efforts during epidemics.^{35,36} The first step in ensuring an effective contribution is to guarantee their sufficient level of knowledge and exemplary

Table 8. Multiple analysis predictors of preventive practices and overall KAP level towards dengue fever among medical students in Sudan.

Predictor	p-value	Odds ratio	95% CI	
			Lower	Upper
Gender:				
Male		1		
Female	0.002	1.719	1.226	2.410
Age	<0.001	1.211	1.094	1.340
Residence type:				
Alone		1		
In dorms	0.357	1.895	0.485	7.401
With family	0.050	1.972	1.001	3.886
Year of study:				
First		1		
Second	0.185	0.733	0.463	1.160
Third	0.132	0.665	0.391	1.131
Fourth	0.292	0.674	0.324	1.403
Fifth	0.254	0.633	0.288	1.389
Sixth	0.097	0.421	0.151	1.169
Source of dengue fever knowledge:				
T.V.		1		
Research and medical books	0.812	0.914	0.439	1.906
Social media	0.537	0.807	0.409	1.591
All the above resources	0.997	0.996	0.155	6.378
No source	0.091	0.516	0.239	1.111
Family history of previous dengue fever infection:				
No		1		
Yes	0.558	0.847	0.488	1.472
Previous Dengue fever infection:				
No		1		
Yes	0.002	1.894	1.276	2.810

attitude and behavior. This study revealed an alarmingly inadequate adherence to preventive measures among medical students. It sheds light onto some associations and its results can be used to tailor educational programs as well as behavior change interventions.

Limitations

Despite the valuable insights gained from this study, there are some limitations to consider. Firstly, the study utilized a non-random sampling method. Secondly, the study relied on self-reported data, which may be subject to recall bias or social desirability bias. Additionally, the cross-sectional design of the study limits our ability to establish causal relationships or assess changes over time.

Conclusion

Our research highlights a disconcerting pattern of inadequate preventive practices among medical students concerning

dengue fever (DF), despite their commendable levels of knowledge and positive attitudes toward the disease. This incongruence necessitates further exploration to identify underlying reasons and inform the development of targeted interventions aimed at enhancing preventive practices among medical students. Addressing this issue is imperative for effectively mitigating the spread of DF.

Significance for public health

This research is crucial for public health in Sudan as it highlights the gap between knowledge, attitude, and preventive practices among medical students regarding dengue fever. While students show good knowledge and positive attitudes, their preventive practices are suboptimal. As future healthcare leaders, their role in enforcing preventive measures is vital for public health. The identified predictors offer insights for targeted interventions to enhance preventive measures and education strategies among medical students, ultimately strengthening public health responses to dengue fever outbreaks in Sudan.

Acknowledgments

We acknowledge Mahmoud Elsadig Mahmoud Ali; Mujtaba Ammar Osman Yousif; Safiya Abdelrahim Abdallah; Ahmed Hassan Alhaj Alameen; Enass Khaild Abdelgader Mohammed; Mohammed Rahamtallah Alsharif AlNour; Rawnag Mohamed nour Elshaikh Musa; and Moram Elfadel Abdelrhaman Gasmalha for their dedication in data collection. This research would not have been possible without their effort and participation.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Ahmed Balla M. Ahmed  <https://orcid.org/0009-0004-6224-485X>

References

- Ghani NA, Shohaimi S, Hee AK, et al. Comparison of knowledge, attitude, and practice among communities living in hotspot and non-hotspot areas of dengue in Selangor, Malaysia. *Trop Med Infect Dis* 2019; 4(1): 37.
- WHO. Dengue and severe dengue 2023. <https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue>
- Aung SH, Phuanukoonnon S, Mon Kyaw AM, et al. Effectiveness of dengue training programmes on prevention and control among high school students in the Yangon region, Myanmar. *Heliyon* 2023; 9(6): e16759.
- Shafie AA, Moreira ED Jr., Di Pasquale A, et al. 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.
- Rahman MS, Karamelic-Muratovic A, Baghbanzadeh M, et al. Climate change and dengue fever knowledge, attitudes and practices in Bangladesh: a social media-based cross-sectional survey. *Trans R Soc Trop Med Hyg* 2021; 115(1): 85–93.
- Usman HB, AlSahafi A, Abdulrashid O, et al. Effect of health education on dengue fever: a comparison of knowledge, attitude, and practices in public and private high school children of Jeddah. *Cureus* 2018; 10(12): e3809.
- Eldigail MH, Abubaker HA, Khalid FA, et al. Association of genotype III of dengue virus serotype 3 with disease outbreak in Eastern Sudan, 2019. *Virology* 2020; 17(1): 118.
- ReliefWeb. Republic of Sudan: dengue fever sitrep 28 July 2022—08 Apr 2023—Sudan 2023. <https://reliefweb.int/report/sudan/republic-sudan-dengue-fever-sitrep-28-july-2022-08-apr-2023>
- Elduma AH, LaBeaud AD, Plante JA, et al. High seroprevalence of dengue virus infection in Sudan: systematic review and meta-analysis. *Trop Med Infect Dis* 2020; 5(3): 120.
- 2023, 2 November (2023). Sudan key figures (1 November 2023). <https://www.unocha.org/publications/report/sudan/sudan-key-figures-1-november-2023>
- ReliefWeb. Sudan humanitarian update 28 September 2023. <https://reliefweb.int/report/sudan/sudan-humanitarian-update-28-september-2023-enar>
- ReliefWeb. Sudan humanitarian update 7 October 2023. <https://reliefweb.int/report/sudan/sudan-humanitarian-update-7-october-2023-enar>
- Rahman MM, Khan SJ, Tanni KN, et al. Knowledge, attitude, and practices towards dengue fever among university students of Dhaka City, Bangladesh. *Int J Environ Res Public Health* 2022; 19(7): 4023.
- Cronbach LJ. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951; 16: 297–334.
- Mustafa MI and Makhawi AM. The reemergence of dengue virus in Sudan. *J Infect Public Health* 2023; 16(9): 1392–1395.
- Stellefson M, Paige SR, Chaney BH, et al. Evolving role of social media in health promotion: updated responsibilities for health education specialists. *Int J Environ Res Public Health* 2020; 17(4): 1153.
- Ghahramani A, de Courten M and Prokofieva M. The potential of social media in health promotion beyond creating awareness: an integrative review. *BMC Public Health* 2022; 22(1): 2402.
- Mustafa MSEK, Jaal Z, Abu Kashawa S, et al. Population genetics of Anopheles arabiensis, the primary malaria vector in the Republic of Sudan. *Malar J* 2021; 20(1): 469.
- Kebede T, Tesema B, Mesfin A, et al. A community-level knowledge, attitude, and practice about dengue fever and the identification of mosquito breeding containers in Dire Dawa City of Ethiopia: a cross-sectional study. *Can J Infect Dis Med Microbiol* 2023; 2023(1): 4349078.
- Selvarajoo S, Liew JWK, Tan W, et al. Knowledge, attitude and practice on dengue prevention and dengue seroprevalence

- in a dengue hotspot in Malaysia: a cross-sectional study. *Sci Rep* 2020; 10(1): 9534.
21. Alyousefi TA, Abdul-Ghani R, Mahdy MA, et al. A household-based survey of knowledge, attitudes and practices towards dengue fever among local urban communities in Taiz Governorate, Yemen. *BMC Infect Dis* 2016; 16(1): 543.
 22. Hairi F, Ong CH, Suhaimi A, et al. A knowledge, attitude and practices (KAP) study on dengue among selected rural communities in the Kuala Kangsar district. *Asia Pac J Public Health* 2003; 15(1): 37–43.
 23. Saghir MA, Ahmed WAM, Dhaiban MMA, et al. Knowledge, attitude, and practices of the community toward dengue fever in Shabwah Governorate, Yemen: a descriptive study. *J Egypt Public Health Assoc* 2022; 97(1): 27.
 24. Galvin KT, Petford N, Ajose F, et al. An exploratory qualitative study on perceptions about mosquito bed nets in the Niger Delta: what are the barriers to sustained use? *J Multidiscip Healthc* 2011; 4: 73–83.
 25. Doda Z, Solomon T, Loha E, et al. A qualitative study of use of long-lasting insecticidal nets (LLINs) for intended and unintended purposes in Adami Tullu, East Shewa Zone, Ethiopia. *Malar J* 2018; 17(1): 69.
 26. Hadiza Isa L, Umar S and Justin P. Reasons for mosquito net non-use in malaria-endemic countries: a review of qualitative research published between 2011 and 2021. *Trop Med Int Health* 2024; 29(7): 647–656.
 27. Aranha PR, Lobo MR and Patil S. Assessment of health seeking behavior among undergraduate students at a university. *J Health Allied Sci NU* 2022; 12(4): 385–391.
 28. Khadka S, Shrestha O, Koirala G, et al. Health seeking behavior and self-medication practice among undergraduate medical students of a teaching hospital: a cross-sectional study. *Ann Med Surg* 2022; 78: 103776.
 29. Kumaran E, Doum D, Keo V, et al. Dengue knowledge, attitudes and practices and their impact on community-based vector control in rural Cambodia. *PLoS Negl Trop Dis* 2018; 12(2): e0006268.
 30. Sarmiento-Senior D, Matiz MI, Vargas-Cruz S, et al. Improving knowledge, attitudes, and practices on dengue and diarrhea in rural primary school students, their parents, and teachers in Colombia: a cluster-randomized controlled trial. *PLoS Negl Trop Dis* 2022; 16(12): e0010985.
 31. Rahman MM, Islam A, Khan SJ, et al. Dengue fever responses in Dhaka City, Bangladesh: a cross-sectional survey. *Int J Public Health* 2022; 67: 1604809.
 32. Bandzuh JT, Ernst KC, Gunn JKL, et al. Knowledge, attitudes, and practices of anopheles mosquito control through insecticide treated nets and community-based health programs to prevent malaria in East Sumba Island, Indonesia. *PLOS Glob Public Health* 2022; 2(9): e0000241.
 33. Winch PJ, Lloyd LS, Hoemeke L, et al. Vector control at the household level: an analysis of its impact on women. *Acta Tropica* 1994; 56(4): 327–339.
 34. Masud N, Alenezi S, Alsayari O, et al. Social accountability in medical education: students' perspective. In: *Frontiers in Education*. Vol. 7. Frontiers Media SA, 2022, p. 868245.
 35. Stachteas P, Vlachopoulos N and Smyrnakis E. Deploying medical students during the COVID-19 pandemic. *Med Sci Educ* 2021; 31(6): 2049–2053.
 36. Blom IM, Martin A, Viva MIF, et al. A descriptive study exploring the worldwide involvement of medical students in the COVID-19 pandemic. *J Public Health Emerg* 2021; 5: 23–23.