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Knowledge, attitudes, and practices of healthcare professionals regarding dengue fever in high-risk regions of southeastern Iran

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Abstract

Background Dengue fever (DF) is one of the most prevalent arboviral infections worldwide. In Iran, the dengue-positive serological cases as well as the presence of the dengue vector *Aedes aegypti* have raised health concerns, highlighting the need to enhance the dengue surveillance system. This study aims to assess the knowledge, attitudes, and practices (KAP) of healthcare professionals (HCPs) regarding dengue fever in a large and high-risk region of southeastern Iran.

Methods A total of 492 HCPs were recruited using a multi-stage sampling method from May 2022 to July 2023. Data were collected using a self-administered questionnaire. Data analysis was done using independent t-tests, one-way analysis of variance (ANOVA), one-factor and multi-factor general linear models, and simple and multiple regression models.

Results About two-thirds (71%) of the participants did not receive any training on DF. A small percentage of participants were familiar with ovitrap (32.6%) and only 21.7% knew that destroying larval breeding sites could not eliminate the dengue vector. The knowledge of disease symptoms among HCPs was found to be lower in border areas compared to non-border areas ($P=0.018$). However, the practice situation in HCPs working in border areas was better than in non-borders ($P=0.003$). According to the multiple regression model, the most influential factors associated with knowledge, attitude, and practice were the type of healthcare facility and passing the DF training course. Additionally, education level, work experience, and gender were identified as other factors associated with it, respectively. Significant correlations were found between knowledge and practice ($P<0.001$), indicating that higher knowledge led to better practice. Similarly, a positive attitude was significantly linked to better practice ($P<0.001$).

Conclusion Regular, targeted, and continuous training courses are necessary to improve the knowledge level of HCPs, particularly those with lower education levels working in low-level health centers. Utilizing comprehensive dengue KAP studies to evaluate the status and impact of health education programs and identify gaps between knowledge and practice should be a research priority.

Keywords Knowledge, Attitude, Practice, Dengue fever, Healthcare professionals, Iran

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Background

Dengue fever (DF) is one of the most prevalent arboviral infections worldwide [1]. Over the last fifty years, there has been a thirty-fold increase in the annual incidence of DF cases [2]. It is estimated that 100–400 million infections and 21,000 deaths occur annually [1]. About 20,000 out of every 100,000 cases die, especially due to the lack of specific treatment. This significant health concern is particularly highlighted by the fact that approximately half of the world's population resides in areas where dengue is a risk [1, 3, 4].

The *Aedes (Ae)* mosquitoes *Ae. aegypti* and *Ae. albopictus* spread DF, and the capability to transmit other viruses such as chikungunya, Zika, and yellow fever renders them highly hazardous [5]. The rising trend in vector populations across various regions globally has heightened concerns. Climate changes, population growth, expanded agriculture, deforestation, urbanization, increased international travel rates, inefficient vector control strategies, no specific treatment, and the lack of a common vaccine are frequently cited as the primary reasons for the rise in both vector populations and cases of DF [6, 7].

The tropical and subtropical regions of the Americas, Southeast Asia, and the Western Pacific nations have experienced the most outbreaks of DF [3, 7]. However, 75% of the global dengue burden is concentrated in Asia, notably in Southeast Asian countries. Over the past 40 years, DF swiftly extended to the West Asian regions, where the countries Yemen, Saudi Arabia, Pakistan, Afghanistan, Oman, and Iran, reported positive seroprevalence and/or confirmed autochthonous transmission [6, 8–13]. In the meantime, Pakistan recorded approximately 147,200 cases of DF and over 800 deaths from 1995 to 2019. In the year 2021, this country saw the reporting of 48,906 cases, which included 183 deaths. It has experienced and is still grappling with significant DF outbreaks every year [6, 14–16].

However, its western neighbor, Iran, has not yet experienced dengue outbreaks, although it has reported positive serology and serology plus polymerase chain reaction (PCR) [17]. Nevertheless, the southern and southeastern regions of the country exhibit favorable climatic conditions for the presence of dengue vectors due to monsoon currents [18]. The presence of both *Ae. albopictus* and *Ae. aegypti* has previously been documented in these areas [19, 20]. While subsequent studies did not prove their establishment, modeling indicates that they have the potential to be present in the future [5, 21]. The province of Sistan and Baluchestan, located in the southeast of Iran and bordering Afghanistan and Pakistan, has reported positive serological cases without a history of traveling to endemic countries. Between 2000 and 2012, six dengue cases were reported in this province through serum samples collected from suspected patients of Crimean-Congo hemorrhagic fever [17]. In 2014, serological screening of 540 blood donors, showed 32 positive confirmed cases by immunofluorescence assay [22]. In 2015, among 60 clinically suspected patients, 13 seropositive dengue cases with no travel histories were reported [23]. In 2018, 10 positive dengue cases were detected between 200 samples without travel history [24]. The reporting of these cases and the history of vector presence have raised health concerns, highlighting the need to enhance the dengue surveillance system [23].

Simultaneously, it is crucial to emphasize the importance of enhancing the knowledge of healthcare professionals, as studies have demonstrated its influence on their attitudes and practices. A Knowledge, Attitude, and Practice (KAP) study conducted on 348 Healthcare Professionals (HCPs) in Ethiopia revealed that approximately 50% of participants demonstrated a moderate or low level of knowledge and practice in preventing DF. The authors recommended implementing the World Health Organization (WHO) guidelines and training programs on DF prevention in response to these unsatisfactory results [25]. Another KAP study in Taiwan evaluated 264 HCPs through a 10-question quiz focusing on dengue disease control measures, notification protocols, and clinical practices. The study revealed a lack of familiarity regarding the timing of notifications and important clinical aspects of dengue. Interestingly, HCPs who worked in medical centers scored higher on notification-related questions compared to their non-medical center counterparts but achieved lower scores associated with control measures. The authors suggested prioritizing continuous education as a means of improving efforts to control dengue [26]. In Ecuador, a 37-item questionnaire was used to investigate the knowledge, attitude, and practice of 76 healthcare providers including medical doctors and nurses. The participants showed a good understanding of the symptoms and treatment of DF, but they required more training on prevention measures. The research revealed that there were some gaps in knowledge about the feeding habits of *Ae. aegypti* mosquitoes and the epidemiology of DF [27]. It is expected that the knowledge, attitude, and practice of HCPs in border and non-border areas are different. Mobility and travel patterns, healthcare infrastructure, and socioeconomic factors can create this distinction. Increased human mobility, trade, and transportation networks in border areas can contribute to the introduction of new virus serotypes, vectors, and outbreaks of emerging/re-emerging infectious diseases [28]. In this situation, despite challenges faced by HCPs in border areas, increased exposure to patients or outbreaks of infectious diseases may have a positive impact on their knowledge, attitude, and practice compared to non-border areas [29].

As dengue has continued to spread over the last century, it is crucial to improve the knowledge of healthcare professionals as part of healthcare strategies. This even applies to regions like southeastern Iran, which haven't experienced dengue outbreaks before. Sistan and Baluchestan Province, with its unique geography and climate, could potentially host DF vectors, patients, and outbreaks. Given these factors, we designed this study to assess the knowledge, attitude, and practice of healthcare professionals in this large and high-risk region regarding DF.

Methods

Study design and site

At the first level of the Iranian Primary Healthcare (PHC) system, trained community health workers (CHWs) known as Behvarz provide health services in the health houses, which represent the smallest healthcare unit in villages. One or more CHWs (Behvarz) work in each health house, offering a wide range of services, including care for pregnant mothers, environmental and occupational health, school health, surveillance of communicable and non-communicable diseases, and collaboration with physicians [30]. At the next level, rural Comprehensive Health Service Centers (CHSCs) are established in larger villages and are managed by general physicians (GPs). These GPs deliver public health, preventative, and curative services to the covered population, focusing on treatment and referring patients to secondary care [31]. In cities, CHSCs and associated subsets called health posts offer similar services, with healthcare providers (HPs), also known as healthcare workers in Iran, delivering a varied range of primary health services without a treatment role. Urban and rural CHSCs, along with city hospitals, form the district health networks. At the regional level, the provincial health center (Health Deputy) in Medical Sciences Universities oversees district health networks in compliance with regulations set forth by the Ministry of Health and Medical Education (MHME) [32, 33]. In the current investigation, CHWs, HPs, and GPs were considered healthcare professionals (HCPs). This cross-sectional study was carried out in urban and rural CHSCs and their affiliated bases in the seven counties of Sistan and Baluchestan Province (also called Sistan-Baluchestan or Sistan-va-Baluchestan) (Latitude: 25.09° *N* to 31.44° *N*; Longitude: 58.78° E to 63.26° E), which are linked with Zahedan and Iranshahr Universities of Medical Sciences. The study took place from May 2022 to July 2023 in the second-largest Iranian province, which shares a long border with Pakistan and Afghanistan. Its unique geographical and climatic conditions, situated between Hormozgan Province (with reported *Ae. aegypti* collection) [19] and Pakistan (with a history of vector presence, DF cases, and numerous outbreaks) [6], make it a potential area for the presence of DF vectors, patients, and even outbreaks.

Study population and sampling

Considering a standard deviation of 5 for practice, an estimation error of 0.5, a type I error of 0.05, and a design effect of 1.2, the sample size was estimated to be 461. Eventually, a total of 492 healthcare professionals participated in this study. General physicians, HPs, and CHWs (Behvarzs) were selected as the study population using a multi-stage sampling method. The inclusion criteria were a minimum of one year of work experience, working in areas with a potential risk of dengue vector presence, and providing informed consent for participation. In the initial stage, a purposive sampling approach was employed in collaboration with public health officers from the Health Deputy of Zahedan University of Medical Sciences to select cities situated in areas with a potential risk of dengue vector presence [5]. The chosen cities encompassed Zahedan, Mirjaveh, Saravan, Sib-va-souran, Rask, Nikshahar, and Chabahar (Fig. 1). They were classified into two categories including border and non-border counties based on having or not having direct land or maritime traffic with Pakistan. In this study, Zahedan and Nikshahr were considered as non-border counties and the other ones as border. In the subsequent step, a list of urban health centers, rural health centers, health posts, and health houses in each city was compiled, and a simple random sampling method was used to select them based on the population served by each county.

In each city, urban health centers, rural health centers, health posts, and health houses were selected using a simple random sampling method. Since the area and population covered by each city were different, the selected number in each city was selected proportionally to the size. In the final stage, all healthcare professionals who met the inclusion criteria were included in the study within each urban and rural CHSCs, health post, and health house.

Data collection

Data collection was conducted using a self-administered questionnaire, which was developed following an extensive review of relevant literature and consultation with experts in health education, medical entomology, infectious diseases, and epidemiology at Zahedan University of Medical Sciences.

The questionnaire comprised four sections: [1] sociodemographic and job-related information [2], dengue knowledge consisting of 43 questions [3], attitude towards dengue with 16 questions, and [4] dengue-related practices with 29 questions.

The socio-demographic and job-related information section encompassed variables such as age, gender,

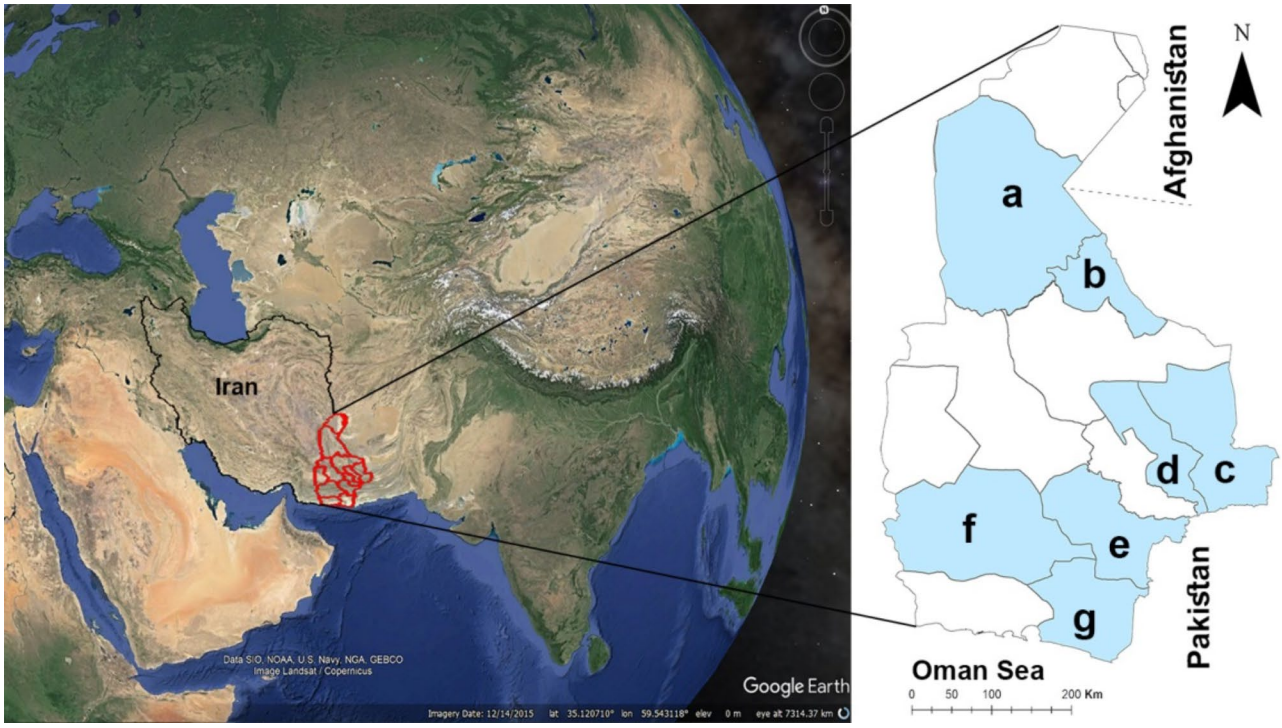

Fig. 1 The Location of the study area consists of 9 counties including **a**: Zahedan; **b**: Mirjaveh; **c**: Saravan; **d**: Sib-va-souran; **e**: Rask; **f**: Nikshahar; **g**: Chabahar

education, job, work location, work experience, and completion of a dengue fever training course. The knowledge assessment section included questions on general knowledge (18 questions), symptoms (10 questions), prevention (7 questions), and referral practices related to dengue infection (8 questions). Participants responded to these knowledge assessment questions using a true/false/don't know format. Correct answers were awarded one point, while incorrect answers received zero points. The total knowledge score ranged from 0 to 44.

Attitudes towards dengue infection were evaluated using 16 statements, for example, "I believe drying stagnant water decreases the number of vector mosquitoes". Participants indicated their level of agreement on a 3-point Likert scale, with options of disagree, neutral, and agree. The total attitude score ranged from 16 to 48. The section on dengue-related practices consisted of 29 questions, for example, "Have you monitored water sources?". Participants expressed their actions or behaviors through yes/no responses. The practice score ranged from 0 to 29. The questionnaire was uploaded in Appendix 1.

The panel of experts confirmed the validity of the questionnaire. To evaluate the content validity of the questionnaire, we calculated the Content Validity Index (CVI) and Content Validity Ratio (CVR). These measures involved expert reviews where a panel of subject matter experts assessed each item in the questionnaire for its relevance and clarity. The CVI for each item was calculated, and items that did not meet the minimum threshold were revised or removed. The CVR was used to determine the essentiality of each item, ensuring that only the most relevant questions were included. To assess the reliability of the questionnaire, we calculated Cronbach's alpha, a measure of internal consistency. The Cronbach's alpha value obtained (Table 1) indicated a high level of reliability, demonstrating that the questionnaire items consistently measure the intended constructs.

Before the commencement of the study, the questionnaire was distributed among 20 participants to ensure its clarity, relevance, and consistency. Adjustments were made based on their feedback. These 20 participants did not participate in the official survey.

Statistical analysis

Categorical variables were presented as frequencies and percentages, while continuous variables were reported as mean±standard deviation (SD). The chi-square test was employed to compare the frequency distribution of demographic variables between the border and non-border areas. The independent samples t-test or one-way analysis of variance (ANOVA) was used to compare the means of knowledge subscales between the groups. The factors associated with knowledge, attitude, and practice were evaluated using both one-factor and multi-factor general linear models. All significant factors in the one-factor models were entered in the multi-factor model and

Table 1 Mean and standard deviation of outcome variables

Items	Mean	SD	Maximum possible score	(Mean/Maximum possible score) %	α*
Total knowledge	27.41	7.60	43	63.7	0.93
General Knowledge	11.37	3.68	18	63.2	0.83
Symptoms	6.63	2.36	10	66.3	0.79
Prevention	5.71	1.86	7	81.6	0.84
Referring	3.71	1.44	8	46.4	0.82
Attitude	40.77	5.80	48	84.9	0.84
Practice	12.54	4.46	29	43.2	0.83

* α=Cronbach's alpha

a backward selection procedure was used to remove one-by-one non-significant factors. The relationship between knowledge and attitude with practice was examined using correlation tests and multiple regression models. All variables significantly correlated with practice were entered into the multiple model and a stepwise selection procedure was used to select the significant independent variables. Data analysis was performed using SPSS version 24 and a significance level of $P<0.05$ was considered for all statistical tests and models.

Results

Demographic characteristics of participants

A total of 492 healthcare professionals, with a mean age of 35.88±7.98 years, participated in this study. Almost half of the participants were female (52.8%), employed as healthcare providers (52.6%), and held a university degree (52.8%). The average work experience was 11.12±7.81 years. Among the participants, 42.1% worked in health houses, and 29% had received training on dengue fever.

There was a significant difference in the distribution of job types between the border and non-border areas ($P<0.001$). In border areas, the percentage of Behvarzs was 63.6%, compared to 39.9% in non-border areas. However, there was no significant difference in the percentage of GPs between the two regions. The level of education was lower in border areas compared to non-border areas ($P<0.001$) (Table 2).

Knowledge about dengue

The average score for staff knowledge regarding disease symptoms accounted for 66.3% of the total score. Knowledge about preventive methods constituted 81.6% of the total score, whereas the score for referrals was only 46.4%. In terms of attitude, the average score was 84.9%, while for practice, it was 43.2% of the total score (Table 1).

Answers to general knowledge questions about dengue

While 86.2% ($n=424$) correctly identified *Aedes* mosquitoes as the vectors of dengue fever, a significant proportion (80.7%, $n=397$) believed that all mosquitoes could transmit the disease. Surprisingly, 78.1% ($n=377$) considered transmission possible through food, and 74.6% ($n=364$) believed it could occur through respiration. It is worth noting that only 32.6% ($n=158$) of the personnel were familiar with ovitraps, and 44% ($n=214$) were aware of dengue vector reporting in the province. However, a significant percentage demonstrated awareness of the existence of dengue fever (80.8%, $n=396$) and its vector in Pakistan (79%, $n=383$). Unfortunately, only 21.7% ($n=105$) were aware that destroying dengue vectors' breeding habitats does not destroy their eggs (Table 3).

Knowledge about dengue symptoms, prevention, and referring

Total knowledge was significantly more in urban and rural CHSC ($P<0.001$), GPs ($P<0.001$), staff with a work experience of up to 10 years ($P=0.025$), staff with a postgraduate degree ($P<0.001$), and those taking a dengue fever training course ($P<0.001$).

The staff's knowledge of the disease symptoms was found to be lower in border areas compared to non-border areas ($P=0.018$) and in health houses and health posts compared to urban and rural health centers ($P<0.001$). Additionally, GPs exhibited higher knowledge of disease symptoms compared to healthcare providers and Behvarzs ($P<0.001$). Moreover, there was a positive association between education level and knowledge of disease symptoms, with higher education levels corresponding to increased knowledge ($P<0.001$). Individuals who had received dengue training also demonstrated higher knowledge of symptoms ($P<0.001$).

The knowledge of prevention methods was lower in health houses and health posts compared to urban and rural health centers ($P<0.001$). However, individuals who had received dengue training exhibited higher knowledge of preventive methods ($P<0.001$). The knowledge of referrals was lower in health houses and health posts compared to urban and rural health centers ($P=0.001$). Additionally, GPs showed higher knowledge of referrals compared to HPs and Behvarzs ($P<0.001$). The knowledge of referrals decreased with an increase in work experience ($P=0.010$) but increased with an increase in education ($P<0.001$). Individuals who had received

Table 2 Demographic characteristics and knowledge, attitude, and practice of participants (*N* = 492) (border vs. non-border counties)

Demographic characteristics		Non-Border *n* (%)	Border *n* (%)	Total *N* (%)	*P*-value
Type of healthcare facility (Services level)	Urban CHSC*	81 (35.5)	62 (23.6)	143 (29.1)	< 0.001
	Rural CHSC*	37 (16.2)	36 (13.6)	73 (14.8)	
	Health post	43 (18.9)	26 (9.8)	69 (14.0)	
	Health house	67 (29.4)	140 (53.0)	207 (42.1)	
Age (year)	≤25	14 (6.1)	21 (8.0)	35 (7.1)	0.638
	26–30	62 (27.2)	64 (24.2)	126 (25.6)	
	31–35	38 (16.7)	45 (17.0)	83 (16.9)	
	36–40	48 (21.1)	67 (25.4)	115 (23.4)	
	41–45	26 (11.4)	34 (12.9)	60 (12.2)	
	46–50	28 (12.3)	23 (8.7)	51 (10.4)	
	> 50	12 (5.3)	10 (3.8)	22 (4.5)	
Sex	Female	129 (57.1)	129 (49.0)	258 (52.8)	0.076
	Male	97 (42.9)	134 (51.0)	231 (47.2)	
Job	Behvarz (CHW**)	91 (39.9)	168 (63.6)	259 (52.6)	< 0.001
	HP	86 (37.7)	42 (15.9)	128 (26.0)	
	GP	51 (22.4)	54 (20.5)	105 (21.3)	
Work experience (year)	≤5	76 (33.3)	86 (32.6)	162 (32.9)	0.152
	6–10	37 (16.2)	55 (20.8)	92 (18.7)	
	11–15	45 (19.7)	41 (15.5)	86 (17.5)	
	16–20	33 (14.5)	52 (19.7)	85 (17.3)	
	> 20	37 (16.2)	30 (11.4)	67 (13.6)	
Education	Elementary & Secondary	18 (7.9)	14 (5.3)	32 (6.5)	< 0.001
	High school diploma	60 (26.3)	140 (53.2)	200 (40.7)	
	Associate Degree	24 (10.5)	28 (10.6)	52 (10.6)	
	Bachelor's Degree	69 (30.3)	27 (10.3)	96 (19.6)	
	M.Sc., Ph.D., and GP***	57 (25.0)	54 (20.5)	111 (22.6)	
Dengue fever training course	Yes	48 (21.2)	93 (35.6)	141 (29.0)	< 0.001
	No	178 (78.8)	168 (64.4)	346 (71.0)	

* CHSC = Comprehensive Health Service Center, ** CHW = Community Health Worker, *** GP = General Practitioner

Table 3 Frequency and percent of correct answers to general knowledge questions on dengue fever

Question		*N*	Correct answers *n* (%)
1	Do you know the term arboviral disease?	492	239 (48.6)
2	Can all mosquitoes transmit dengue fever disease?	492	397 (80.7)
3	Can *anopheles* mosquitoes transmit dengue fever disease?	491	360 (73.2)
4	Is dengue fever transmitted by *Aedes* mosquito?	492	424 (86.2)
5	Do both sexes of mosquitoes (male and female) can transmit dengue fever?	491	247 (50.3)
6	Are *Aedes* mosquitoes diurnal (active during the day)?	483	302 (62.5)
7	Is it more likely to be bitten by a dengue vector in the early morning and in the evening?	487	340 (69.8)
8	Is dengue fever disease transmitted by food?	483	377 (78.1)
9	Is dengue fever disease transmitted through breathing?	488	364 (74.6)
10	Is dengue fever disease caused by the virus?	483	313 (64.8)
11	Do you know ovitrap?	485	158 (32.6)
12	Has dengue vector case been reported from Sistan and Baluchestan province?	486	214 (44.0)
13	Is there dengue fever disease in Pakistan?	490	396 (80.8)
14	Is there a dengue vector in Pakistan?	485	383 (79.0)
15	Is dengue fever included in the International Health Regulations (IHR) ?	484	339 (70.0)
16	Is international travel effective in spreading dengue disease?	488	378 (77.5)
17	Does destroying dengue vectors' breeding habitats destroy their eggs?	484	105 (21.7)
18	Is it easy to distinguish between dengue fever and other febrile diseases in the early stages of fever?	487	259 (53.2)

dengue training also had higher knowledge of referrals ($P=0.001$) (Table 4).

According to the multiple regression model, the most important factors associated with knowledge were the type of healthcare facility (services level), education level, and completion of dengue training. The average knowledge in urban health centers ($P=0.003$) and rural health centers ($P<0.001$) differed significantly from health houses, but there was no significant difference between health houses and health posts ($P=0.828$). Individuals with postgraduate and doctoral education had a significant difference in knowledge compared to individuals with primary or middle school education ($P=0.004$) and individuals with high school education ($P=0.025$). Trained individuals had significantly higher knowledge compared to others ($P<0.001$) (Table 5).

Attitude towards dengue

The average attitude score did not show a significant difference between border and non-border areas ($P=0.178$). However, the average attitude score was lower in health houses and health posts compared to urban and rural health centers ($P<0.001$). Attitude was higher among GPs and Behvarzs compared to HPs ($P=0.014$). The average attitude score was higher in individuals with less than 6 years of work experience ($P=0.001$) and increased with an increase in education level ($P=0.001$). Attitude was also higher in individuals who had received dengue training ($P<0.001$).

According to the multiple regression model, the most important factors associated with attitude were work location, work experience, and completion of dengue training. The average attitude differed significantly between urban health centers ($P<0.001$) and rural health centers ($P<0.001$) compared to health houses, but there

Table 4 Mean and standard deviation of subscales of knowledge (general knowledge, symptoms, prevention, and referring) based on demographic characteristics and work characteristics

Independent variable		General knowledge		Symptoms		Prevention		Referring	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
County	Non-Border	11.07	3.76	6.90	2.34	5.78	1.82	3.62	1.59
	Border	11.63	3.60	6.40	2.36	5.65	1.90	3.79	1.29
Comparisons all groups		P=0.091		$P=0.018$		$P=0.425$		$P=0.195$	
Type of healthcare facility (Services level)	Urban CHSC*	12.33	3.13	7.20	1.82	6.01	1.44	3.96	1.40
	Rural CHSC*	13.20	3.12	7.42	2.20	6.42	1.42	4.11	1.38
	Health post	9.98	4.16	6.20	2.24	5.29	1.93	3.46	1.56
	Health house	10.53	3.64	6.09	2.61	5.38	2.11	3.48	1.39
Comparisons all groups		$P<0.001$		$P<0.001$		$P<0.001$		$P<0.001$	
Sex	Female	11.08	3.60	6.72	2.39	5.63	1.85	3.83	1.45
	Male	11.70	3.73	6.51	2.33	5.80	1.86	3.57	1.41
Comparisons all groups		$p=0.061$		$p=0.318$		$p=0.310$		$p=0.052$	
Job	Behvarz (CHW**)	10.776	3.57	6.28	2.53	5.58	1.98	3.44	1.42
	HP	11.24	3.94	6.70	2.26	5.93	1.72	3.71	1.55
	GP	13.00	3.14	7.41	1.78	5.74	1.67	4.37	1.09
Comparisons all groups		$P<0.001$		$P<0.001$		$P=0.226$		$P<0.001$	
Work experience (year)	≤ 5	11.86	3.67	7.00	2.04	5.80	1.74	3.92	1.40
	6–10	11.97	3.30	6.80	2.19	6.10	1.56	3.92	1.17
	11–15	10.72	3.84	6.27	2.74	5.41	1.96	3.63	1.41
	16–20	10.72	3.88	6.38	2.51	5.63	2.12	3.52	1.56
	> 20	11.04	3.56	6.28	2.47	5.42	1.95	3.28	1.63
Comparisons all groups		$P=0.025$		$P=0.061$		$P=0.074$		$P=0.010$	
Education	Elementary & Secondary	10.62	3.47	5.59	2.34	5.19	2.10	2.66	1.66
	High school diploma	10.62	3.70	6.30	2.56	5.52	2.05	3.54	1.37
	Associate Degree	12.08	3.78	6.79	2.02	6.15	1.51	3.75	1.47
	Bachelor's Degree	11.02	3.67	6.74	2.34	5.96	1.68	3.72	1.50
	M.Sc., Ph.D., and GP***	12.94	3.18	7.40	1.81	5.76	1.66	4.30	1.16
Comparisons all groups		$P<0.001$		$P<0.001$		$P=0.054$		$P<0.001$	
Dengue fever training course	Yes	12.86	2.85	7.33	1.91	6.64	0.89	4.02	1.21
	No	10.76	3.83	6.35	2.46	5.33	1.10	3.57	1.51
Comparisons all groups		$P<0.001$		$P<0.001$		$P<0.001$		$P<0.001$	

* CHSC = Comprehensive Health Service Center, ** CHW = Community Health Worker, *** GP = General Practitioner

Table 5 Factors associated with knowledge in healthcare professionals

Independent variable		One-factor model			Multi-factor model	
		Mean	SD	*P*-value	B ± SE	*P*-value
County	Non- Border	27.37	7.77	0.914		
	Border	27.44	7.46			
Type of healthcare facility (Services level)	Urban CHSC*	29.51	5.92	< 0.001	3.18 ± 1.05	0.003
	Rural CHSC*	31.16	6.24		4.16 ± 1.17	< 0.001
	Health post	24.94	8.40		-0.25 ± 1.17	0.828
	Health house	25.46	7.91		Reference	
Sex	Female	27.24	7.54	0.612		
	Male	27.59	7.66			
Job	Behvarz (CHW**)	26.06	7.58	< 0.001		
	HP	27.59	7.98			
	GP	30.52	6.17			
Work experience (year)	≤5	28.55	7.08	0.008		
	6–10	28.79	6.55			
	11–15	26.02	8.32			
	16–20	26.25	8.65			
	> 20	26.03	7.18			
Education	Elementary & Secondary	24.06	7.07	< 0.001	-4.45 ± 1.53	0.004
	High school diploma	25.95	7.88		-2.56 ± 1.13	0.025
	Associate Degree	28.77	7.33		-1.23 ± 1.93	0.303
	Bachelor's Degree	27.44	7.53		-1.79 ± 0.98	0.70
	M.Sc., Ph.D., and GP***	30.40	6.33		Reference	
Dengue fever training course	Yes	30.85	5.03	< 0.001	5.09 ± 0.71	< 0.001
	No	26.01	8.02		Reference	

* CHSC = Comprehensive Health Service Center, ** CHW = Community Health Worker, *** GP = General Practitioner

was no significant difference between health houses and health posts ($P=0.490$). Attitude was significantly higher in individuals with less than 6 years of work experience compared to those with more than 20 years of work experience ($P=0.015$). Trained individuals showed a significant difference in attitude compared to others ($P<0.001$) (Table 6).

Dengue-related practice

Practice in individuals living in border areas was better ($P=0.003$). Men had a higher average practice score ($P<0.001$). Behvarzs' practice was better than HPs and GPs ($P=0.033$). Practice was lower in the group with work experience of less than 5 years and more than 20 years compared to others ($P=0.042$). Individuals with a high school and diploma education level had a better average practice score ($P=0.003$). The average practice score was higher in individuals who had received dengue training ($P<0.001$). According to the multiple regression model, the most important factors associated with practice were the service location, gender, and completion of dengue training. The average practice was lower in non-border areas compared to border areas ($P=0.045$) and lower in females compared to males ($P=0.001$). Trained individuals had significantly better practice than others ($P<0.001$) (Table 7).

Association between knowledge, attitude, and practice

The correlation between knowledge and practice was found to be significant ($P<0.001$), suggesting that higher knowledge was associated with better practice. Similarly, the correlation between attitude and practice was also significant ($P<0.001$), indicating that a more positive attitude was associated with better practice. Even after controlling for the effects of place of residence, gender, and dengue training, a significant relationship between knowledge and practice persisted ($P=0.001$), as well as between attitude and practice ($P<0.001$) (Table 8).

Discussion

This study was conducted for the first time in the second-large province of Iran, which has a history of reporting the presence of the dengue vector and positive serological cases. Considering the potential establishment of *Ae. aegypti* and even dengue outbreaks in this province, it is crucial to assess the knowledge, attitude, and practice of healthcare professionals to enhance decision-making and dengue fever surveillance [34]. Poor knowledge and low education levels in border areas, inadequate training courses for most participants, and unsatisfactory practice scores are the findings that unmistakably highlight the challenges facing the health system. Only a small percentage of the personnel were familiar with ovitrap and aware of dengue vector reporting in the province. Despite

Table 6 Factors associated with attitude in healthcare professionals

Independent variable		One-factor model			Multi-factor model	
		Mean	SD	*P*-value	B ± SE	*P*-value
County	Non- Border	41.15	5.99	0.178		
	Border	40.44	5.61			
Type of healthcare facility (Services level)	Urban CHSC*	42.10	4.65	< 0.001	2.76 ± 0.62	< 0.001
	Rural CHSC*	43.40	3.27		3.61 ± 0.76	< 0.001
	Health post	39.27	6.59		0.38 ± 0.78	0.490
	Health house	39.44	6.39		Reference	
Sex	Female	40.86	5.68	0.745		
	Male	40.69	5.96			
Job	Behvarz (CHW**)	40.07	5.10	0.17		
	HP	41.43	5.23			
	GP	41.71	5.79			
Work experience (year)	≤ 5	42.02	4.92	0.001	1.95 ± 0.80	0.015
	6–10	41.23	5.17		0.83 ± 0.88	0.349
	11–15	39.00	7.09		-0.35 ± 0.89	0.696
	16–20	40.41	5.64		0.89 ± 1.23	0.218
	> 20	39.89	6.39		Reference	
Education	Elementary & Secondary	38.31	8.90	0.001		
	High school diploma	39.91	5.64			
	Associate Degree	41.60	4.87			
	Bachelor's Degree	41.83	4.97			
	M.Sc., Ph.D., and GP***	41.78	5.69			
Dengue fever training course	Yes	42.72	3.34	< 0.001	2.90 ± 0.56	< 0.001
	No	39.96	6.39		Reference	

* CHSC = Comprehensive Health Service Center, ** CHW = Community Health Worker, *** GP = General Practitioner

Table 7 Factors associated with practice in healthcare professionals

Independent variable		One-factor model			Multi-factor model	
		Mean	SD	*P*-value	B ± SE	*P*-value
County	Non- Border	11.91	4.41	0.003	-0.79 ± 0.39	0.045
	Border	13.09	4.44		Reference	
Type of healthcare facility (Services level)	Urban CHSC*	12.05	4.25	0.078		
	Rural CHSC*	12.94	4.53			
	Health post	11.74	4.66			
	Health house	13.01	4.46			
Sex	Female	11.78	4.49	< 0.001	-1.28 ± 0.39	0.001
	Male	13.43	4.26		Reference	
Job	Behvarz (CHW**)	13.04	4.34	0.033		
	HP	11.91	4.49			
	GP	12.09	4.61			
Work experience (year)	≤5	11.92	4.20	0.042		
	6–10	13.49	4.41			
	11–15	12.42	4.74			
	16–20	13.20	4.20			
	> 20	12.07	4.87			
Education	Elementary & Secondary	11.66	5.10	0.003		
	High school diploma	13.32	4.26			
	Associate Degree	13.13	4.05			
	Bachelor's Degree	11.38	4.44			
	M.Sc., Ph.D., and GP***	12.08	4.55			
Dengue fever training course	Yes	14.55	3.69	< 0.001	2.51 ± 0.43	< 0.001
	No	11.70	4.50		Reference	

* CHSC = Comprehensive Health Service Center, ** CHW = Community Health Worker, *** GP = General Practitioner

Table 8 Relationship between knowledge and attitude with practice in healthcare professionals

Independent variable		Correlation/Mean ± SD	*P*_value	Multiple regression	
				Standardized beta	*P*_value
County			0.003		0.007
	Non-border	11.91 ± 4.41			
	Border	13.09 ± 4.44		0.110	
Sex			< 0.001		< 0.001
	Female	11.78 ± 4.49			
	Male	13.43 ± 4.26		0.163	
Training			< 0.001		0.001
	Yes	14.55 ± 3.69			
	No	11.70 ± 4.50		-0.143	
Knowledge		0.401	< 0.001	0.202	0.001
Attitude		0.384	< 0.001	0.210	< 0.001

the observed weaknesses, the study revealed several notable strengths, including satisfactory total knowledge and attitude scores, higher knowledge among individuals with higher education levels, and a strong understanding of referrals among GPs. Notably, a significant correlation was observed between knowledge and practice, as well as between attitude and practice.

This study underscores the insufficient dengue fever [34] training among the majority of participants, emphasizing the pressing need for improved education. Notably, completion of a DF training course was significantly associated with enhanced knowledge, attitude, and practice, highlighting the pivotal role of training in enhancing outcomes. Similarly, research conducted in Ethiopia revealed that 96.7% of physicians and nurses had not received training regarding DF. The authors reported that the dengue fever prevention training status was significantly linked to the knowledge, attitude, and practice of HCPs, as indicated by the multinomial logistic regression analysis. Additionally, HCPs who completed dengue fever prevention training had 10 times higher odds of demonstrating favorable knowledge, attitude, and practice compared to those who did not receive such training [25]. In a research carried out in Pakistan, it was concluded that physicians had a basic level of knowledge but lacked essential training [35]. Similarly, another study undertaken in that country revealed that approximately 50% of physicians were not familiar with the diagnostic criteria for DF. The lack of training and the absence of standard guidelines for the DF treatment were cited as the main reasons for this [36]. A similar study performed in Iran emphasized holding training courses for HCPs. The authors recommended that KAP studies be utilized to assess the impact of health education programs, as a research priority [37].

In this study, while respondents correctly identified *Aedes* mosquitoes as DF vectors, many also attributed this role to other mosquito species, showing a lack of specific knowledge. Additionally, familiarity with ovitrap and larval breeding site drying as prevention methods was low, suggesting gaps in understanding vector control strategies and disease transmission routes. Similarly, a dengue KAP study conducted on physicians in six major cities of Pakistan revealed that their general knowledge of DF vectors and their biology was insufficient. Only 38% of them were aware of the biting time of *Ae. aegypti*, which typically occurs after dark [36]. Similar findings were reported in Taiwan, where only 14.4% of health professionals correctly identified *Aedes* mosquito behavior and biology, whereas 82.8% accurately knew about *Anopheles* mosquito habits. The researchers concluded that medical school educational programs tend to emphasize disease diagnosis and treatment, resulting in graduates having limited knowledge about vectors' behavior, indicating weaknesses in medical education [38]. Contrary to our results, a study conducted on healthcare providers in northern Iran showed that a majority of them (73.9%) were familiar with the use of ovitrap as a measure for monitoring dengue fever vectors [37]. HCPs can prevent dengue by providing proper health education. This can be accomplished by possessing accurate knowledge of the behavior of dengue mosquitoes [39].

The study findings indicate that most participants were aware of dengue fever's endemic status and the presence of its vectors in Pakistan, recognizing the potential role of international travel in spreading the disease. Evidence has shown that possessing a general knowledge of travel medicine can assist healthcare providers in delivering satisfactory pre-travel consultation and post-travel care [40]. In the province that we studied, healthcare professionals need to be aware of the role of international travel in spreading DF. This awareness can aid in early detection and even prevent potential outbreaks.

Training personnel and raising their education levels, particularly in border regions, can help with the early detection of incoming patients [41]. According to our findings, Behvarzs (CHWs) in border areas exhibited a lower level of education compared to other groups. In

addition to the negative impact of low education levels on their knowledge, this factor can also lead to a decrease in the number of referrals to them, as research has shown that educated individuals in rural areas are less inclined to follow Behvarz (CHW) with lower levels of education [42]. Findings of a similar study in the Arizona-Sonora border region indicated that the educational background of healthcare providers which authors mentioned as "a predictor of KAP score", could influence dengue knowledge. In our study, despite the lower education level, the practice situation in HCPs working in border areas was better than in non-borders. Similar to our findings, healthcare providers (nurse practitioners and physician assistants) in border counties in the Arizona-Sonora region had a notably higher mean practice score compared to those in non-border counties [43]. Perhaps this can be attributed to the special attention of health systems to border areas and the personnel working in those regions. It appears that they have improved their practical skills through the completion of additional training courses. In the study area, the HCPs' knowledge of disease symptoms was found to be lower in border areas compared to non-border areas. Similarly, Ruberto et al. suggested that healthcare providers should be trained in clinical management, inquiring about travel history, and reporting suspected dengue cases [43]. The evidence from studies conducted in Iran and Malaysia strongly supports the notion that the level of education has a direct relation with dengue preventive practices [44].

The current study revealed that the GPs exhibited higher mean knowledge and attitude compared to other HCPs. Additionally, individuals with postgraduate or doctorate education exhibited higher knowledge compared to those with primary/guidance or high school education. However, it appears that higher levels of knowledge do not necessarily result from higher levels of education and may even still vary among educated individuals [44]. Our findings indicated that individuals with a high school and diploma education level (Behvarzs) had a higher average practice score than HPs and GPs. A study carried out in Yemen's Al-Hodeidah Governorate to assess the knowledge and attitudes of health workers regarding DF revealed that nurses with a lower level of education exhibited higher levels of knowledge and more positive attitudes compared to physicians [45]. A study in Karachi, Pakistan found that around 57% of general practitioners have a basic understanding of dengue symptoms but require training for diagnosis and clinical management [35]. It is evident from these findings that the relationship between education level and knowledge or attitudes towards dengue is complex. Such insights highlight the need for targeted training and educational programs. Understanding these nuances is crucial for developing effective educational strategies to improve healthcare provision.

Work experience was identified as a significant factor influencing knowledge, attitude, and practice, yet knowledge of referrals and practice tended to decrease with increased work experience. An investigation in Finnish health centers examined the influence of doctors' professional experience on referral rates, revealing that younger and pre-graduates tended to make more referrals compared to their specialized, experienced counterparts [46]. A KAP study among medical practitioners in Pakistan revealed that although they possessed a good knowledge of dengue fever and mosquito control measures, they did not effectively implement this knowledge into practice [47]. This suggests that there may be a gap between knowledge and practice among HCPs, which could have implications for patient care and health outcomes. Further research and interventions may be needed to bridge this gap and ensure that HCPs are effectively translating their knowledge into practice [37].

In our study, while there was no significant difference in the knowledge and attitude between genders, males exhibited a higher average practice score than females. A survey among health centers in Finland revealed that female doctors exhibited a greater tendency to make referrals as a practice behavior than their male counterparts [46]. A KAP study on healthcare workers in the north of Iran revealed that a higher percentage of females exhibited knowledge regarding symptoms and clinical management compared to males. Additionally, in the context of attitudes and practices related to dengue, females provided more accurate answers than males [37].

Limitations

This study has a few limitations that must be taken into account while interpreting its results. Firstly, the use of a cross-sectional design may restrict our ability to establish causal relationships. Additionally, the study relies heavily on self-reported data, which could potentially introduce recall or social desirability bias, affecting the accuracy of participants' understanding, attitudes, and behaviors about dengue fever. Despite these limitations, the findings of this study provide valuable insights for policymakers and healthcare administrators. It can help in formulating preventive strategies for DF, particularly within this vulnerable population.

Conclusions

The lack of dengue training among 71% of participants, combined with only 32.6% familiar with ovitraps and 21.7% aware that destroying larval breeding sites could not eliminate the dengue vector, raises concerns for both the healthcare system and the community. Regular, targeted, and continuous training courses are necessary to

improve the knowledge level of HCPs, particularly those with lower education levels. These initiatives can effectively mitigate dengue outbreaks by equipping healthcare workers with the necessary knowledge to deliver appropriate health education to the community. Our findings underscore the significance of training in fostering a comprehensive understanding of symptoms and prevention methods among participants, resulting in improved attitudes and practices.

Supplementary Information

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Supplementary Material 1

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Author contributions
Jalil Nejati: Conceptualization, Supervision, Reviewing and Editing. Mahdi Mohammadi: Formal analysis, Data Curation. Hassan Okati-Aliabad: Methodology, Designing the questionnaire, Writing - Original Draft. Morteza Akbari: Data collection, Investigation. Alireza Ansari Moghaddam: Validation, Reviewing and Editing.

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Data availability
All data supporting the findings of this study are available within the paper and its supplementary Information.

Declarations

Ethics approval and consent to participate
The survey began by providing participants with a comprehensive explanation of the study's objectives and detailed instructions on how to respond to the questionnaire. Before their participation, all participants provided written informed consent. This research adhered to the principles outlined in the Declaration of Helsinki, ensuring the ethical conduct of the study. The study protocol was approved by the ethical review committee of Zahedan University of Medical Sciences (IR.ZAUMS.REC.1400.112).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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