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# Dengue fever among febrile patients in Taiz City, Yemen during the 2016 war: Clinical manifestations, risk factors, and patients knowledge, attitudes, and practices toward the disease

KhairAlah A. Alghazali[b], Boon-Teong Teoh[a], Sing-Sin Sam[a], Juraina Abd-Jamil[a], Jefree Johari[a], Wahib M. Atroosh[c,d], Mohammed A.K. Mahdy[e,f], Sazaly AbuBakar[a,b,*]

[a] Tropical Infectious Diseases Research & Education Centre (TIDREC), University of Malaya, Kuala Lumpur, Malaysia
[b] Department of Medical Microbiology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia
[c] Department of Parasitology, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia
[d] Department of Para-Clinic, University of Aden, Yemen
[e] Department of Parasitology, Faculty of Medicine and Health Sciences, Sana'a University, Yemen
[f] Tropical Disease Research Center, University of Science and Technology, Sana'a, Yemen

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ABSTRACT

The current war in Yemen has displaced millions of people from their homes into living in cramped shelters where the healthcare is limited. The breakdown of Yemen's healthcare and sanitation systems has facilitated the spread of infectious diseases including mosquito-borne diseases. The present study aimed to describe the prevalence of dengue virus (DENV) infection among the febrile patients of the Taiz governorate, Yemen as well as their knowledge, attitude and preventive practices (KAPs) regarding dengue fever (DF), and to investigate the factors associated with dengue preventive practices during the war. A total of 384 clinically dengue-suspected patients who sought health care in Taiz, Yemen during the period from July 2016 until October 2016 were recruited for the study. Serum samples were obtained and screened for the presence of DENV RNA and anti-DENV antibodies by reverse transcription-recombinase polymerase amplification (RT-RPA) and dengue IgM/IgG-capture ELISA, respectively. KAP questionnaires were obtained from all participants too. In the study, dengue was laboratory confirmed in approximately 49.3% (189/384) of the clinically suspected dengue patients. In general, 67.1% of the patients had low knowledge scores regarding DF. Low scores for knowledge about DF was significantly associated with those in the age groups of ≤20 years and 21–30 years, illiterates and patients with non-skilled jobs or jobless. The most common preventive practices reported by participants were covering stored water (78.6%) and putting a screen on the house's windows (65.3%). A low proportion of participants (6.7%) had 51–100% of good DF preventive practices. Low scores of positive attitudes toward DF was identified as a risk factor. The study participants showed poor knowledge about DF and their ways of dealing with the various aspects of DF prevention was quite limited, hence, preventive measures against the disease were less likely to be undertaken. Findings from the study highlight the peril of dengue in Taiz, Yemen, which is now comparable to that of endemic regions. The ongoing civil war with disruption in regular health services compounded by the low knowledge about DF as well as the limited DF preventive practices could result in entrenchment of dengue in Yemen.

## 1. Introduction

Dengue fever (DF) is one of the most important mosquito-borne viral infection in regions where the mosquito vector breed under ideal conditions [19]. Dengue fever is caused by dengue virus (DENV), a member of the genus *Flavivirus* and family *Flaviviridae*. The virus is transmitted to humans in general through the bites of infected female *Aedes aegypti* or *Aedes albopictus* mosquitoes. In 2010, an estimated 94 million apparent DENV infections occurred with 294 million infections being unapparent [11]. DENV infection can manifest as DF, dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS). The classical DF usually present as a mild, febrile illness with headache,

* Corresponding author at: Tropical Infectious Diseases Research and Education Centre, Department of Medical Microbiology, Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia.
*E-mail address:* sazaly@um.edu.my (S. AbuBakar).

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retroorbital pain, joint pain and muscle pain which usually occurs in primary infection. In a small percentage of cases, the infection can lead to severe illnesses culminating in severe intravascular leakages, multiple organ failure, and deaths [23]. Infection with one DENV serotype, however, leads to lifelong protection against homologous challenge, but only brief cross-protection against heterologous infection with a different serotype [31].

The regions of the world reporting transmission of DENV has substantially expanded in recent years, especially in the Americas, South Asia and the Western Pacific [29]. DF cases have also been reported in the Eastern Mediterranean Region and in Egypt where it was recorded as early as in the 19th and the first half of the 20th century but the number of cases declined after 1940. This decline was attributed to the decrease in the *Aedes aegypti* population due to the extensive use of dichlorodiphenyltrichloroethane (DDT) [37]. Dengue was also reported in Somalia in 1982 and between 1985 and 1987 [36], in Djibouti [40] and in Saudi Arabia [3,6,27]. In Yemen (Aden city), dengue-like epidemics was reported by Hirsch between 1870 and 1873 [24,58]. After that DF outbreak occurred in Hodeidah governorate in 1954 which affected 98% of the population [26,58]. More recently, dengue was reported as a health threat in Yemen coastal areas of Shabwah, Aden, Hodeidah, Taiz and Al Mukalla [21]. DENV-3 was isolated from an outbreak of viral hemorrhagic fever in Al Mukalla city, the Hadhramaut governorate republic of Yemen in 2010 [21,38]. To date, all four DENV serotypes were confirmed to be present in Hodeidah governorate with DENV-2 as the predominant serotype [4,39].

An unprecedented surge in the number of dengue cases occurred soon after the eruption of the ongoing civil war in Yemen, which started in March 2015 [14,61]. The war resulted in widespread destruction of the country's infrastructure and displaced millions of people [14,44]. The breakdown of Yemen's healthcare and sanitation systems facilitated the spread of infectious diseases including the mosquito-borne diseases [5,7]. The inadequate drainage, increasing puddles of water and accumulation of garbage as well as the increased use of open water storage containers during the war has altered the environment, creating an abundance of breeding sites perfect for mosquitoes [56]. In the absence of effective vaccine or approved antiviral drugs to control DENV infection [20], the mosquito control measure, by spraying insecticide, remains the most widely used approach to contain the spread of dengue but it is almost impossible to be implemented during the war. Therefore, a clear understanding of knowledge, attitudes, and practices (KAPs) among the population is important for controlling the spread of dengue in Yemen [43]. The present study aimed to describe the prevailing and KAPs of febrile patients and to investigate the factors that could be associated with the spread of DF in Taiz, a southwestern coastal governorate in Yemen, which experienced among the fiercest fighting during the current war [44].

## 2. Methods

### 2.1. Design and setting

A hospital-based, cross-sectional study was conducted in Taiz city, where DENV outbreak has recently been reported [5]. The Taiz governorate is situated at the geographical coordinates of 13°34′44″N 44°01′19″E at an altitude of about 1400 m above the Red Sea level (Fig. 1A). Taiz governorate has an extraordinarily diverse geography. The western half of the governorate is part of the Tehama coastal plain and has an exceedingly hot, humid and arid climate. The eastern half, however, is very mountainous, with the major peak being the 3070-metre-high Saber mountain, near Taiz city (specimen collection area) (Fig. 1B). These mountains trap the moisture created by an upper-level wind reversal between April and October so that in the eastern half of the governorate annual rainfall increases from 200 mm (8 in.) in the foothills to > 1000 mm (40 in.) near Jebel Saber. Temperatures in the highlands remain high during the daytime, but at the highest elevations, they can fall dramatically to −5 °C (23 °F) overnight.

### 2.2. Sample size and sampling strategy

A total of 384 febrile patients were randomly selected as representative samples from patients seeking health care in the few surviving healthcare facilities within Taiz, in the period from July 2016 – October 2016. Inclusion criteria were fever (> 37.5 °C) and two or more of symptoms such as headache, joint pain, back pain, retroorbital pain, abdominal pain, body ache, and skin rash. The sample size of the hospital-based survey was calculated following the WHO manual using the following parameters; 0.5 confidence limit, 95% confidence level and expected outcome 50% [34].

### 2.3. Data collection

A structured, pretested and validated questionnaire [45,62] was used for collecting socio-demographic data and information about febrile patients' knowledge, attitude, and practices toward DF by face to face interview. Training of volunteer enumerators was performed to ensure that the questionnaires were well understood by the enumerators, thus avoiding any differences arisen from definitions and interpretations of the concepts. Clinical history and clinical diagnosis were conducted by physicians. Blood samples were collected and laboratory investigated for dengue by reverse transcription-recombinase polymerase amplification (RT-RPA) [52,53] and/or IgM–based ELISA [30,46,54] as previously described [5].

### 2.4. Data analysis

Data were cleaned and analyzed using the IBM SPSS Statistics version 23.0 for Windows (IBM Corp., Armonk, NY, USA). Variables were presented as proportions. Scores of "zero" and "one" were given to incorrect and correct knowledge or practice, respectively. The total scores of knowledge ranged from 0 to 31 and were divided into two categories, 0–15 and 16–31. For calculating the percentage of correct preventive practices, a new variable with the total scores of practices was created, computed to percentages and categorized as 0–50% and 51–100%. For attitudes, the positive and negative answers were given the scores of "one" and "zero", respectively. The total scores ranged from 0 to 6 and were recorded into two categories, 0–3 and 4–6. Factors associated with low knowledge scores and DF were tested using Pearson's chi-square test. The odds ratio (OR) and its 95% confidence interval (CI) were also reported. *P*-values < 0.05 were considered significant.

### 2.5. Ethical consideration

The study protocols were reviewed and approved by the ethical committee of the Faculty of Medicine at the University of Science and Technology, Yemen (approval number: 2016/24). Participation was on a voluntary basis and each patient was asked to sign a consent form after a clear explanation of the research objectives. In the case of children, the consent form was obtained from their guardians. All volunteers knew that they need not participate in the study to obtain care.

## 3. Results

### 3.1. Characteristics of study subjects

A total of 384 febrile patients who visited hospitals and health centers in Taiz city in the period from July 2016 to October 2016 were enrolled in the present study (Table 1). Among them, 108 (28.1%) were females and 276 (71.9%) were males. Age of participants ranged from one to 70 years with a median of 26 years (interquartile range: 11 years). Almost all volunteers were educated (95.3%, completed at

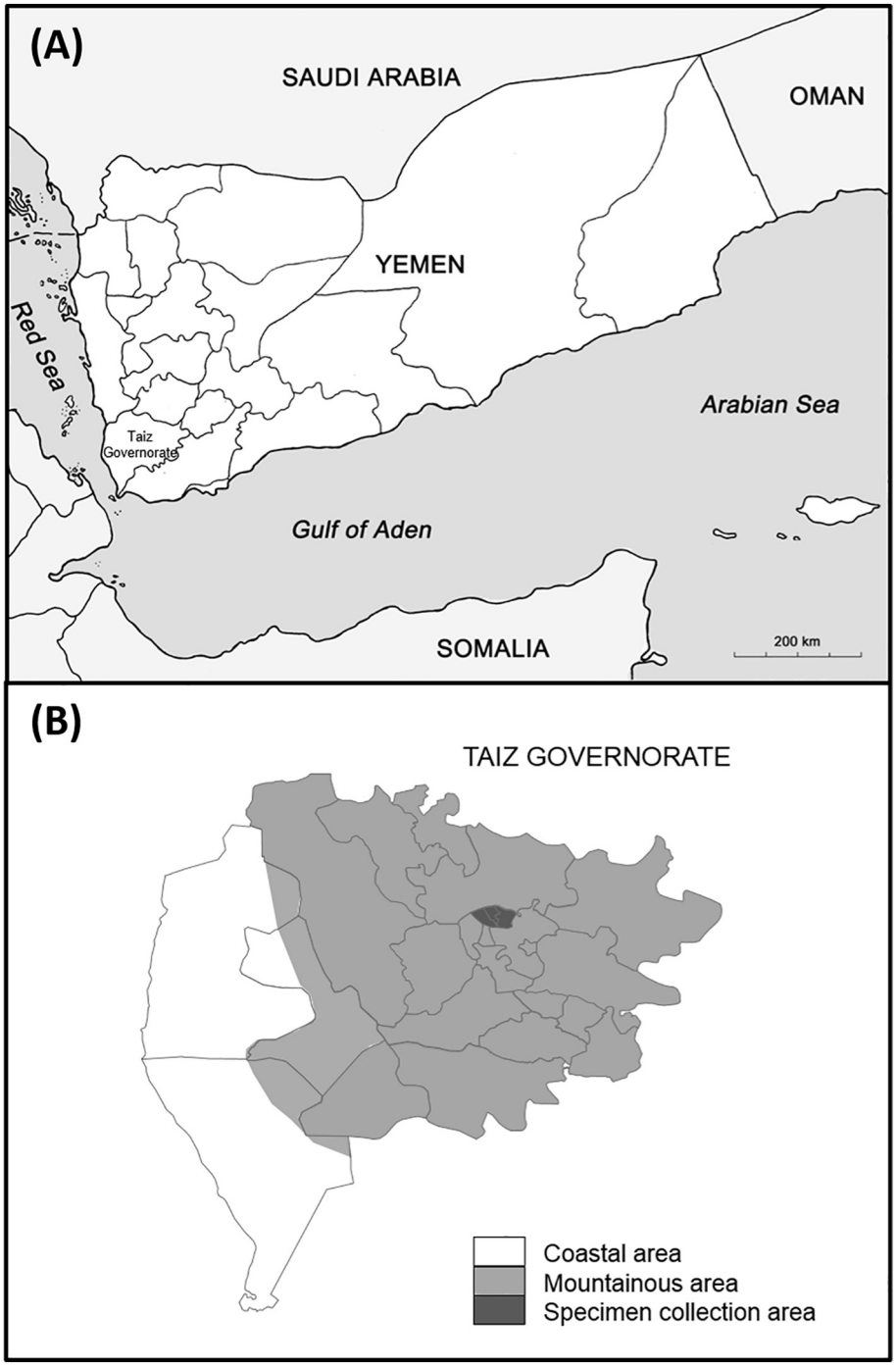


**Fig. 1.** Map of Yemen and Taiz governorate.

least primary school) and lived in flats (from one to five floors) or single houses (98.3%). More than half of the volunteers were jobless (58.2%) and the most common source of households' water was well water (54.4%).

### *3.2. Prevalence of dengue fever among febrile patients and its clinical manifestations*

Of the 384 febrile patients that participated in the study, only 379 were laboratory investigated for dengue. Of them, 187 (49.3%) had DF as demonstrated by positive with RT-RPA and/or IgM–based ELISA. All dengue cases were in the acute phase; less than or equal to seven days after the onset of fever except in one case in which it was at 10 days but without any complications. The most common manifestations of DF were a headache (94.7%), chills and rigors (94.1%), joint pain (92.5%), body ache/back pain (84.5%), muscle pain (79.7%) and nausea (57.8%). Only two cases (1.1%) had bleeding (Table 2).

### *3.3. Knowledge and attitudes toward dengue fever among febrile patients and factors associated with low knowledge scores*

Of the 353 patients who responded to the knowledge on dengue questions, 72.2% knew DF and 68.0% knew that DF is caused by DENV (Table 3). The most common symptoms of DF mentioned by participants were fever (59.2%), headache (46.2%), and chills and rigors (20.1%). These corresponded to the clinical presentations typical of

**Table 1**
Characteristics of study subjects.

| Characteristics[a] | N | % |
|---|---|---|
| Age (years) | | |
| ≤20 | 83 | 22.5 |
| 21–30 | 173 | 46.9 |
| 31–40 | 82 | 22.2 |
| > 40 | 31 | 8.4 |
| Gender | | |
| Female | 108 | 28.1 |
| Male | 276 | 71.9 |
| Patient's job | | |
| Professional | 34 | 9.7 |
| Unskilled workers | 79 | 22.4 |
| Gov. employed | 34 | 9.7 |
| Unemployed | 205 | 58.2 |
| Education level | | |
| No formal education | 15 | 4.7 |
| Completed primary school | 89 | 28.2 |
| Completed secondary school | 131 | 41.5 |
| Completed University | 81 | 25.6 |
| Type of patient's house | | |
| Flat | 195 | 55.6 |
| House | 150 | 42.7 |
| Hut, shake | 4 | 1.1 |
| Others | 2 | 0.6 |
| Water source of household | | |
| Government tap water | 27 | 7.7 |
| Well | 192 | 54.5 |
| Water truck | 36 | 10.2 |
| Rain | 2 | 0.6 |
| More than one | 95 | 27.0 |

[a] The total of items is not equal to 384 because some information is missing.

**Table 2**
Clinical manifestations of confirmed dengue patients.

| Signs and symptoms | N (%) |
|---|---|
| Headache | 177 (94.7) |
| Chills & rigors | 176 (94.1) |
| Joint pain | 173 (92.5) |
| Body ache/back pain | 158 (84.5) |
| Muscle pain | 149 (79.7) |
| Nausea | 108 (57.8) |
| Retro-orbital pain | 65 (34.8) |
| Diarrhea | 34 (18.2) |
| Vomiting | 29 (15.5) |
| Rash | 15 (8.0) |
| Abdominal pain | 12 (6.4) |
| Bleeding | 2 (1.1) |

dengue described in Table 2 with headache and chills and rigors described in > 94% of the patients. Approximately 64.0% of the patients knew that DENV is transmitted from an infected person to other by bites of infected mosquitoes and only 24.9% knew that the mosquitoes transmitting dengue have black and white strips on their legs and bodies, referring to *Aedes aegypti*. The facts that mosquitoes mainly bite during dusk and dawn, as well as breed in clean and stagnant water, were mentioned by 27.8% and 54.4% of patients, respectively. A higher proportion of patients reported sleeping under bed net (66.3%), spraying insecticides (64.6%) and covering water containers (64.9%) as correct preventive practices. In contrast, 37.7% and 5.7% of patients mentioned the weekly emptying of water containers and proper disposal of items that retain water as correct preventive practices, respectively. In general, about 67.1% of patients had low knowledge scores about DF. About half of patients believe that DF is dangerous and that children and old people are at risk. Awareness about the ability of dengue to cause severe disease and death was found in 66.9% of patients. However, only 3.7% of patients were aware of the risk of secondary infection. Low scores of knowledge about DF was significantly

**Table 3**
Knowledge and attitudes toward dengue fever among febrile patients in Taiz city, Yemen, the civil war ($n$ = 353).

| Items | N (%) |
|---|---|
| Correct knowledge about dengue | |
| Knows dengue fever | 255(72.2) |
| Dengue fever is caused by a virus called dengue | 240(68.0) |
| Signs and symptoms of dengue fever mentioned | |
| Fever | 209(59.2) |
| Headache | 163(46.2) |
| Chills & rigors | 71(20.1) |
| Body ache/Back pain | 67(19.0) |
| Sweating | 15(4.2) |
| Muscle pain | 22(6.2) |
| Vomiting | 19(5.4) |
| Joint pain | 93(26.3) |
| Nausea | 56(15.9) |
| Diarrhea | 70(19.8) |
| Rash | 29(8.2) |
| Bleeding | 51(14.4) |
| Retro-orbital pain | 44(12.5) |
| Abdominal pain | 7(2.0) |
| Knowledge about mosquito mentioned | |
| Mosquitoes transmit dengue virus from infected person to other by biting | 226(64.0) |
| Mosquitoes transmitting dengue have black and white strips on its leg and body | 88(24.9) |
| Mosquitoes transmitting dengue mainly bite during dusk and dawn | 98(27.8) |
| Mosquito is not born with dengue virus | 96(27.2) |
| Mosquitoes transmitting dengue breed in clean and stagnant water | 192(54.4) |
| Methods of prevention mentioned | |
| Dengue fever is preventable | 245(69.4) |
| Cleaning the house or environment, including draining wet areas | 159(45.0) |
| Elimination of breeding sites | 104(29.5) |
| Sleeping under a bed net | 234(66.3) |
| Spraying insecticides | 228(64.6) |
| Weekly change of stagnant water in and around the house. | 136(38.5) |
| Put Abate/chemical in the water container. | 158(44.8) |
| Covering water containers. | 229(64.9) |
| Periodically emptying or drying out containers that can retain water in and around the house. | 133(37.7) |
| Proper disposal of items that can retain water in and around the house | 20(5.7) |
| Knowledge scores | |
| 0–15 | 237(67.1) |
| 16–31 | 116(32.9) |
| Perception of severity and risk of dengue fever | |
| Dengue is dangerous | 238(67.4) |
| Dengue is dangerous to children | 188(53.3) |
| Dengue is dangerous to old people | 189(53.5) |
| Dengue can cause severe illness and death | 236(66.9) |
| The person who has had dengue fever can get severe dengue following the second infection | 13(3.7) |
| Immediate medical treatment can reduce the chances of complication and death | 214(60.6) |
| Perception scores | |
| 0–3 | 172(48.7) |
| 4–6 | 181(51.3) |

associated with age groups ≤20 years and 21–30 years, illiterates and patients with non-skilled jobs or jobless (Table 4).

### 3.4. Good preventive practices of febrile patients about dengue fever

Good preventive practices of febrile patients were illustrated in Table 5. The most common preventive practices reported by patients were covering stored water (78.6%) and putting the screen on the house's windows (65.3%). Only 33.1% of patients reported that health workers from the Ministry of Health came for spraying insecticide. However, only 15.0% of patients confirmed that spraying of insecticides was done within the previous 6 months. Overall low proportion of patients (6.7%) had 51–100% of good preventive practices.

**Table 4**
Bivariate analysis of factors associated with low knowledge scores on dengue.

| Variable | Knowledge scores n (%) | | | | |
|---|---|---|---|---|---|
| | N | 16–31 | 0–15 | OR (95%CI) | *p* value |
| Gender | | | | | |
| Male | 253 | 78(30.8) | 175(69.2) | Reference | |
| Female | 100 | 38(38.0) | 62(62.0) | 1.38(0.85–2.23) | 1.96 |
| Age (years) | | | | | |
| ≤20 | 80 | 19(23.8) | 61(76.3) | 2.74(1.38–5.43) | 0.004 |
| 21–30 | 162 | 51(31.5) | 111(68.5) | 1.86(1.06–3.25) | 0.03 |
| 31–40 | 76 | 35(46.1) | 41(53.9) | Reference | |
| > 40 | 25 | 7(28.0) | 18(72.0) | 2.2(0.82–5.87) | 0.12 |
| Education of patients | | | | | |
| Complete university | 79 | 39(49.4) | 40(50.6) | Reference | |
| Completed primary school | 87 | 25(28.7) | 62(71.3) | 2.42(1.27–4.60) | 0.07 |
| Completed secondary school | 128 | 46(35.9) | 82(64.1) | 1.74(0.98–3.07) | 0.06 |
| No school | 44 | 3(6.8) | 41(93.2) | 13.3(3.8–46.60) | < 0.001 |
| Job of patients | | | | | |
| Professional | 34 | 19(55.9) | 15(44.1) | Reference | |
| Gov. employed | 32 | 13(40.6) | 19(59.4) | 1.85(0.67–4.90) | 0.22 |
| Unskilled worker | 76 | 17(22.4) | 59(77.6) | 4.4(1.85–10.45) | 0.001 |
| Unemployed | 202 | 67(33.2) | 135(66.8) | 2.55(1.22–5.34) | 0.013 |

**Table 5**
Good preventive practices of febrile patients against dengue fever in Taiz city.

| Practice items[a] | N (%) |
|---|---|
| Spraying/fogging insecticide by the Ministry of Health | 126 (33.1) |
| Spraying insecticide within 6 months. | 57 (15.0) |
| Sleeping under mosquito nets | 21 (5.8) |
| House's window screen | 235 (65.3) |
| Using creams for repelling mosquitoes | 25 (6.9) |
| Covering stored water | 283 (78.6) |
| Keeping windows/doors closed | 100 (27.8) |
| Using mosquitoes' coil or spray | 41 (11.4) |
| Percentage of good preventive practices[b] | |
| 0–50% | 336 (93.3) |
| 51–100% | 24 (6.7) |

[a] The sample size was 381 for the first and the second items and 360 for the rest of items.
[b] Only personal practices were scored.

### *3.5. Factors associated with acute dengue fever in Taiz city during the civil war*

Bivariate analysis shown in Table 6 suggested that people in the age group ≤20 years were significantly at higher risk of contracting DF (OR = 1.99, 95% CI = 1.07–3.71; $p = 0.03$). Also, people living in Al Qahirah (OR = 13.0, 95% CI = 1.67–101.32; $p = 0.004$), Al Mudaffer (OR = 12.6, 95% CI = 1.59–99.16; $p = 0.016$) and Salh districts (OR = 19.5, 95% CI = 2.36–161.03; $p = 0.006$) were significantly at higher risk of contracting DF. People with low scores of perceptions about DF were at about two times more likely to be positive to DF (OR = 1.60, 95% CI = 1.04–2.43; p = 0.03).

**Table 6**
Bivariate analysis of factors associated with acute dengue infection in Taiz city during the civil war, 2016.

| Variable | N | Infected N (%) | OR (95%CI) | p value |
|---|---|---|---|---|
| Gender | | | | |
| Male | 273 | 135(49.5) | 1.02(0.65–1.60) | 0.95 |
| Female | 106 | 52(49.1) | Reference | |
| Age (years) | | | | |
| ≤20 | 83 | 49(59.0) | 1.99(1.07–3.71) | 0.03 |
| 21–30 | 172 | 82(47.7) | 1.26(0.47–2.15) | 0.4 |
| 31–40 | 81 | 34(42.0) | Reference | |
| > 40 | 31 | 15(48.4) | 1.30(0.56–2.9) | 0.54 |
| Education | | | | |
| No school | 46 | 26(56.5) | 1.67(0.80–3.47) | 0.17 |
| Completed primary school | 86 | 39(45.3) | 1.07(0.58–1.97) | 0.84 |
| Completed primary school | 130 | 58(44.6) | 1.05(0.59–1.82) | 0.90 |
| Completed University | 80 | 35(43.8) | Reference | |
| Job of patients | | | | |
| Unskilled worker | 79 | 35(44.3) | 0.90(0.40–2.01) | 0.79 |
| Unemployed | 204 | 100(49.0) | 1.08(0.52–2.24) | 0.83 |
| Government employed | 33 | 13(39.4) | 0.73(0.28–1.93) | 0.53 |
| Professional | 34 | 16(47.1) | Reference | |
| Districts of residence | | | | |
| Al Qahirah | 194 | 97(50.0) | 13.0(1.67–101.32) | 0.014 |
| Al Mudaffer | 114 | 56(49.1) | 12.6(1.59–99.16) | 0.016 |
| Salh | 50 | 30(60.0) | 19.5(2.36–161.03) | 0.006 |
| Others | 14 | 1(7.1) | Reference | |
| History of traveling outside Taiz | | | | |
| Yes | 10 | 3(30.0) | 0.49(0.12–1.92) | 0.35 |
| No | 342 | 160(46.8) | Reference | |
| Fumigation by Ministry of Health | | | | |
| No | 253 | 132(52.2) | 1.41(0.92–2.17) | 0.118 |
| Yes | 126 | 55(43.7) | Reference | |
| House's structure | | | | |
| Single house | 149 | 75(50.3) | 1.24(0.81–1.90) | 0.32 |
| Flat and others | 200 | 90(45.0) | Reference | |
| Presence of plants around the house | | | | |
| Yes | 280 | 138(49.3) | 0.99(0.63–1.57) | 0.97 |
| No | 97 | 48(49.5) | Reference | |
| Source of patients' water | | | | |
| Others | 323 | 147(45.5) | 0.57(0.26–1.28) | 0.17 |
| Tap water | 27 | 16(59.3) | Reference | |
| Percentage of good preventive practices | | | | |
| 0–50% | 334 | 161(48.2) | 1.55(0.67–3.64) | 0.31 |
| 51–100% | 24 | 9(37.5) | Reference | |
| Knowledge scores | | | | |
| 0–15 | 236 | 112(47.5) | 1.02(0.65–1.60) | 0.93 |
| 16–31 | 115 | 54(47.0) | Reference | |
| Perception scores | | | | |
| 0–3 | 171 | 91(53.2) | 1.60(1.04–2.43) | 0.03 |
| 4–6 | 180 | 75(41.7) | Reference | |

## 4. Discussion

The present study reported the incidence of dengue among febrile patients seen at the healthcare facilities in Taiz, Yemen between July to October 2016 during the 2016 civil war period. The study also assessed knowledge, attitudes, and practices toward DF and identify factors that could be associated with the outbreak of dengue during the study period. The study was undertaken in the background that even before the ongoing war, Yemen's Ministry of Health was already lacking in capability and capacity to detect and respond to many infectious disease outbreaks including DF [43]. Better preparedness and response to the epidemics is made more difficult with the ongoing war, therefore, it would seem more sensible that an approach whereby the general population is directly targeted by public health initiatives, to improve their knowledge and attitude toward prevention of the disease. This would obviate having to depend on responses from the ministry of health. However, with the increasing reports of DENV infections in recent years in Yemen [43], it is still ambiguous as to whether the general population's knowledge, attitude and preventive practices against dengue are sufficient for the purpose.

In this study, the author (K. A. Alghazali) had braved tremendous fear to collect patient specimens within Taiz in the midst of the war. The journey to the hospitals took longer than usual because most roads

were damaged or interrupted and had numerous security checkpoints. The access to health care was limited to a few operating healthcare facilities, many of which were overwhelmed with the war-injuries and patients too. A severe shortage of medical supplies and equipment have also led to increased pressure on the healthcare facilities [60]. An atmosphere of anxiety and fear among staff and patients in the hospitals were noticed, as intermittent tremors were felt as a result of bombings. Prolonged worrisome thinking and anxiety have been associated with severely compromised physical health leading to high blood pressure, heart disease, weak immune system, headaches, insomnia, depression and digestive issues [13,16]. Despite the psychosocial impact from the stress of war, most febrile patients in the hospitals were willing to participate in the present study.

Findings from the present study suggested that at least half of the febrile patients seeking treatment at healthcare facilities in Taiz city during the study period had DF. This finding would be useful for doctors to take into consideration when seeing febrile patients in their respective healthcare facilities. In the absence of proper laboratory diagnostics, doctors would have to rely mostly on patients' clinical presentations. Findings from the study further revealed that most DF patients seen in the study, presented with symptoms typical of dengue as described in the WHO's comprehensive guidelines for prevention and control of dengue and dengue hemorrhagic fever [59] as well as that reported among patients in Bangkok [49]. While there are other possible causes for their febrile illnesses, at least those who present with typical clinical symptoms of DF which include fever, headache, retro-orbital pain, joint pain muscle pain, and skin rash, could well be having the infection. The most common symptoms of DF mentioned by participants were fever (59.2%), headache (46.2%), joint pain (26.3%) and chills and rigors (20.1%). In a study conducted in the rural communities of Hodeidah, a western governorate of Yemen, showed that the majority (93.7%) of the participants were aware of DF symptoms which include fever, headache, pain behind the eyes, joint pain, muscle pain and skin rash [43]. Another study conducted in Malaysia reported also that the majority (95%) of the respondents mentioned that chills and high fever, intense headache, muscle and joint pains are the most common presentation of DF [2]. A possible reason for this low level (< 60%) of febrile patients' knowledge of DF symptoms is that there have been no regular awareness programs on DF. This poor knowledge may also arise from confusion between DF and other febrile illnesses such as malaria, chikungunya, influenza and other diseases endemic in Yemen. This lack in awareness of symptoms of DF among the public could lead to delays in patients' getting the appropriate medical attention.

Findings from the present study also suggested that approximately two thirds (72.2%) of the febrile patients seeking healthcare in Taiz hospitals and healthcare centers knew or have heard of DF. This finding is quite similar to reports from an urban community of Thailand [50], and Brasilia (Brazil) [17] but was lower than those reported from Malaysia which ranged from 90.0% to 98.5%. [2,42]. In contrast, a much lower rate of awareness of DF was found in a study conducted in India (34.5%) [8]. Knowing that DF is caused by DENV was reported by 68% of febrile patients enrolled in this study which was consistent with studies conducted India [1,2,42]. It should be noted that the differences in the awareness rate between studies could be attributed to several factors including the type of study population and the sample size. The fact that the remaining one-third of febrile patients did not know DF and its cause, represents a challenge for the overall effort to control DF. This is in spite of DF has been reported in Yemen for many years earlier, long before the onset of the current civil war [7].

The present study suggested that approximately two-thirds of the febrile patients knew that mosquitoes transmit DENV from the infected person to another through bites of the infected mosquitoes. This finding is lower than that reported among rural communities of Hodeidah, Yemen (83.4%) [43], Malaysian public (98.1%) [63] and among people visiting tertiary care hospitals in Pakistan (86.9%) [25]. About a quarter of febrile patients knew that mosquitoes transmitting DENV have black and white strips on their legs and bodies, this finding was also lower than that reported from nationwide survey of the Malaysian public (92.8%) [63] while previous community-based study conducted in Taiz city [7] showed that 82.2% of participants mentioned that dengue is transmitted by black mosquitoes. Although 27.8% of participants in this study mentioned that mosquitoes mainly bite during dusk and dawn, which is quite similar to that reported from the rural area of Hodeidah, Yemen [43], ~71% of the participants in Taiz [7] and 80% of the participants in Thailand realized that these mosquitoes bite during daytime [50]. Poor knowledge of the biting time of dengue vector, however, was reported from a study conducted in Nepal, where only 8% of the lowland and 5% of the highland participants knew that *Aedes albopictus* and *Aedes aegypti* mosquitoes bite during daytime [18]. The facts that mosquitoes mainly breed in clean and stagnant water is mentioned by 54.4% of the patients, whereas previous studies, conducted in Yemen [7], showed that the majority of the respondents recognized stagnant water as a factor contributing to the spread of mosquitoes. Higher proportions of correct awareness of the breeding sites of *Aedes aegypti* were also reported from other countries such as Malaysia [2,15,33,41], Thailand [50] and Pakistan [51]. About 66.3% of the febrile patients mentioned that sleeping under a bed net is a correct preventive practice. In the previous KAPs study conducted in Taiz city, > 90% of the respondents mentioned that using mosquito bed net can prevent from DENV infection [7], whereas 22.8% of the respondents in Thailand knew that using a mosquito bed net can prevent from DENV infection [50]. It is a well-established fact that mosquito bed net is overwhelmingly utilized at night, however, *Aedes aegypti* bites during day time. Among the corrective preventive practices mentioned by febrile patients who participated in this study, covering water containers and spraying of insecticides ranked second and third highest at 64.9% and 64.6%, respectively. Very low proportions of patients recognized weekly emptying of water containers (37.7%) and proper disposal of items that retain water (5.7%) as correct preventive measures. In the previous KAPs study conducted in Taiz, 90% of the respondents were aware of the importance of covering water containers, emptying of water containers and proper disposal of items that retain water in dengue prevention [7], as well as in Malaysia where 98.5% of respondents knew that the proper disposal of items that retain water as correct preventive measures for dengue [63]. Whereas 45.8% of the respondents in Thailand knew that covering of water containers can prevent from DENV infection [50]. The scarcity of water during the period of an ongoing civil war could also be among the reasons that emptying of water containers was not practiced in the majority of those interviewed.

The most common preventive practices reported by patients were covering stored water (78.6%) and this quite similar to that reported from Malaysia (85.3%) [2], and resemble that reported from the rural area of Yemen (93.5%) [43]. As a result of the current war, conventional water supply is no longer available and the majority of participants stored water at home. With the diligence carried out by participants in covering water right after use, community engagement became a vital aspect in the elimination of mosquito breeding sites existing in water containers. The majority of the participants mentioned that putting a screen on house's windows (65.3%) and this percentage is almost nine times higher than that of the previous study in the rural area in Yemen (7.3%) [43]. This difference in practices may be associated with the type of building in urban and rural areas. About one-third of patients reported that health workers from Ministry of Health came to spray insecticide and only 15.0% of the patients confirmed that spraying of insecticides was done within the previous 6 months and this differs from that reported from Malaysia (60.3%) [2]. Lack of effective adherence to such important routine of insecticide spraying as a protective measure is a direct consequence of the ongoing war in the country which ultimately contributes to more new infections among most vulnerable communities.

In the present study, the good knowledge on dengue preventive measures such as the use of bed nets and spraying of insecticides did not lead to good preventive practices. Most of the patients understood that bed nets prevent exposure to mosquito bites and an insecticide spraying kills adult mosquitoes, however, none of these measures were being put into practice. These findings differed from those reported in Nepal and Laos which showed that there were relatively good attitudes and practices of dengue prevention [18] and Laos [35] despite their low level of knowledge on dengue. These results also differed from those reported in Malaysia [2,22], Thailand [28] and Jamaica [48] where good knowledge on dengue led to good preventive practices.

The lack of preventive practices among the participants of this study may reflect the unstable conditions and economic status of the individuals and country as a result of the on-going war. Many government and private-sector employees have lost their jobs [55]. The main concern of these people is to provide their family with daily food requirements and safe drinking water kept at home in large uncovered containers, which increase the number of man-made mosquito breeding sites. On the other hand, large numbers of people in the city centre of Taiz have been displaced to the outskirts of city centre, which is safer and relatively away from the hot-spot of war [47]. A surge in refugee arrivals has crowded the population in the outskirts region and increased the number of individuals per house, which in turn has forced many men than women to stay out of the house, exposing themselves to mosquito bites. The financial shortage has impacted the people's preventive behavior against dengue and other vector borne diseases. There was no longer of any interest in screening doors and windows to prevent mosquitoes from entering the house. Similarly, Yemen's Ministry of Health have stopped all the governmental preventive measure efforts; neither insecticides sprayed in the houses or insecticides fogged in the area, nor mosquito nets distributed to people at risk. Another point which has been thought to have significant impact on the increase of mosquito population in the area was the evident increase of water collections in the military zones created around the cities, which includes the temporary military constructions, digging trenches, and open water tanks brought to the camps for utilization, became the important foci for mosquito breeding especially in summer rain season.

In Yemen, at least 15 million people are currently living under famine condition without access to basic healthcare [57]. Widespread starvation and malnutrition have negatively impacted on the immune function [12]. Immune dysfunctions could lead to increased host susceptibility to infection [10] even at a lower infectious dose of virus. Furthermore, the individuals with weakened immunity in virus clearance may develop enhanced and prolonged viremia, which could facilitate both biological and mechanical transmission of DENV [32] in the household crowding environment infested with mosquitoes. In a war rage zone where food is scarce and survival is of the utmost importance, priorities shift to focus on the essential needs to live. Disease preventive measures became irrelevant and less important next to ensuring life preservation, thus leading to increased host exposure to the mosquito biting and disease transmission.

In general, although dengue KAPs studies in Yemen are limited, there is a significant variation in the knowledge of DF between the study populations. Among the reasons could be attributed to the differences in the study areas, study population and design. The two earlier studies were conducted on the heads of each households in the rural of Hodeidah [43] and the urban communities of Taiz [7] while the current study was conducted among the febrile patients with suspected dengue seeking health care in hospitals and health centers in Taiz. This recent hospital-based study showed poor knowledge of DF among dengue suspected patients where about 67.1% of participants had low knowledge scores. Bivariable analyses identified that low scores of knowledge about DF were significantly associated with age groups $\leq 30$ years, illiterates and patients with non-skilled jobs or jobless. These findings are in concordance with findings from a study conducted in Malaysia which found that there is a significant association between knowledge scores and socio-demographic variables [63].

With respect to attitudes toward DF, about half of patients believe that DF is dangerous and that children and old people are at risk which is similar to a previous study from Malaysia reported that all age groups are at risk of dengue fever [2]. Positive perception about the ability of dengue to cause severe disease and death was found in 66.9% of patients, which is similar to a previous study from rural area in Yemen which reported that 65.7% of the study respondents agreed that DF is a serious and sometimes life-threating disease [43]. Only a minority of patients (3.7%) had a positive perception of the secondary infection of dengue. It is alarming that most of the participants are unaware of the potential complications associated with secondary dengue. This finding is similar to the previous study in Malaysia that found only 4% of the participants expressed fear of dengue [2].

Bivariable analysis showed that only people living in Al Qahirah, Al Mudaffer and Salh districts were significantly at higher risk of DF. While the study did not specifically address the potential risk factors potentially contributing to the higher risk, it is worth noting that these districts are urban areas where DF is usually more commonly reported, especially in other endemic regions [9,62]. The potential of having a higher presence of *Aedes aegypti*, the more dominant vector reported in Southeast Asia's urban areas, was also not addressed in the current study. This was mainly due to the unfavorable conditions of war limiting the undertaking of such studies. Similar limitations are also inherent in the study as it was a hospital-based and the selected sample may not represent the overall population. Additionally, the size of the sample may negatively affect the precision of bivariate relationships between variables, hence, not enough sample or power across certain risk factors for comparison. The study nonetheless gives a glimpse of dengue in Taiz city and its potential to become a serious endemic disease threat in the immediate future.

## 5. Conclusions

Dengue is emerging to be an important mosquito-borne disease in the war-torn Taiz, Yemen. The lack of knowledge on DF and the undesirable attitudes toward various aspects of the disease and weak prevention practices against the disease compounded by the continuing civil war posed a serious health threat to Yemen. A rigorous education campaign is needed to improve the knowledge, attitudes, and practices toward DF and identify factors associated with dengue. Emphasis on community participation is needed in light of the fact that frontline health services are fairly poor and unlikely to be able to distinguish DF from other infectious diseases.

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