Risk Factors Associated With Dengue Fever Outbreak in Taiz Governorate, Yemen, 2018: Case-control Study

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Abstract

Background: Dengue Fever (DF) is a significant health problem in Yemen especially in the coastal areas. On November 6, 2018, Taiz governorates surveillance officer notified the Ministry of Public Health and Population on an increase in the number of suspected DF in Al Qahirah and Al Mudhaffar districts, Taiz governorate. On November 7, 2018, Field Epidemiology Training Program sent a team to perform an investigation. The aims were to confirm and describe the outbreak by person, place and time in Taiz governorate, and identify its risk factors.

Methodology: Descriptive and case-control study (1:2 ratio) were conducted. WHO case definition was used to identify cases in Al Qahirah or Al Mudhaffar districts during August-November 2018. Control was selected from the same districts who did not suffer from DF. Predesigned questionnaire was used to collect data related to sociodemographic, behavioral and environmental characteristics. Bivariate and multivariate backward stepwise analyses were used. The adjusted odds ratios (aOR) and 95% confidence intervals (95%CI) were calculated. A P value < 0.05 was considered as the cut point for statistically significant. Epi info version 7.2 was used.

Results: A total of 50 DF cases were found. Almost 52% were males and 76% were <30 years of age. The overall attack rate was 1/10,000 of the population. Case fatality rate was 4%. In multivariate analysis, not working (aOR = 26.6, 95% CI: 6.8–104.7), not using mosquito repellent (aOR = 13.9, 95% CI: 1.4–136.8), wearing short sleeves/pants (aOR = 27.3, 95% CI: 4.8–156.8), poor sanitation (aOR = 5.4, 95% CI: 1.4–20.3), presence of outdoor trees (aOR = 13.2, 95% CI: 2.8–63.0) and houses without window nets (aOR = 15.7, 95% CI: 3.9–63.4) were statistically significant risk factors associated with DF outbreak. Eleven 11 (58%) of blood samples were positive for DF IgM.

Conclusions: DF outbreak in Al Qahirah and Al Mudhaffar districts, Taiz governorate was confirmed. This study provides evidence-based information regarding the identified risk factors that contributed to the occurrence of this outbreak. Raising community awareness on the importance of personal protection measures and improving the sanitation services are strongly recommended.

Introduction

Dengue fever (DF) is a mosquito-borne disease with significant morbidity and mortality [1].

It’s caused by the dengue virus that is transmitted by the Aedes aegypti mosquito [1, 2]. Severe cases are causing serious illness and death among children. Some patients may develop dengue haemorrhagic fever and dengue shock syndrome [3]. There is no specific treatment but the early detection and good clinical management can reduce the case fatality rate (CFR) to less than 1% [3].

Globally, DF incidence has increased 30-fold over the last 50 years, with increasing geographic expansion to new countries [3, 4]. DF is endemic throughout the tropics and sub-tropics with 3.5–4.1 billion people (approximately 53% of the global population) is currently at risk of dengue virus infection [4]. Nearly
390 million cases were reported annually from 120 countries [5]. The majority is in Asia, followed by Africa and the Americas [4]. In 2020, dengue affected several countries, with an increased number of cases in Bangladesh, Brazil, Ecuador, India, Indonesia, Maldives, Mauritania, Mayotte (Fr), Nepal, Singapore, Sri Lanka, Sudan, Thailand, Timor-Leste and Yemen [6].

Dengue is currently the most widely spread mosquito-borne disease in the Eastern Mediterranean Region. Reports of dengue and severe dengue epidemics in the Region started in 1998 and have increased in frequency and spread ever since, with outbreaks occurring in Djibouti, Egypt, Oman, Pakistan, Saudi Arabia, Somalia, Sudan, and Yemen [7].

In Yemen, dengue is a significant health problem especially in the coastal areas. The first case of dengue recorded was between 1870 and 1873. In 1954, DF occurred in Al Hodeidah governorate which affected 98% of the population. In 1984 travelers returned from Yemen were confirmed to have dengue antibodies. Recently, the first reported and confirmed dengue outbreak was in Shabwah governorate in 2002 and it distributed to others coastal governorates (Hadramout, Al Hodeidah, Taiz, Aden, Hajjah, Al Dhale'e, Lahj and Al Mahrah governorates) [8]. Moreover, the number of DF cases reported by electronic Disease Early Warning System (eDEWS) has escalated from 28,000 cases including 46 deaths in 2018 to more than 65,000 cases including 170 deaths in 2020 [9]. Similarly, in Taiz governorate the number of DF cases has increased from 3,000 cases with 17 deaths in 2018 to more than 5,000 cases w 4 deaths in 2020 [9].

On 6th November 2018, Taiz governorate surveillance officer reported to the Ministry of Public Health and Population about an increased number of DF in Al Qahirah and Al Mudhaffar districts, Taiz governorate. On 7th November 2018, Yemen Field Epidemiology Training Program sent a team to perform an investigation.

This study aimed to confirm the existence of DF outbreak in Al Qahirah and Al Mudhaffar districts, describe the characteristics of DF outbreak by person, place and time, identify the risk factors of DF outbreak, and recommend the appropriate control and prevention measures

**Methodology**

**Study design and area**

Descriptive and case-control design were conducted in Al Qahirah and Al Mudhaffar districts, Taiz governorate. A total of 196,923 inhabitants in Al Qahirah and 228,125 inhabitants in Al Mudhaffar district [10]. It has a humid subtropical climate. It is rainy and hot in summer and moderate in winter. Al Qahirah and Al Mudhaffar were the most affected districts with more than half of the DF cases reported from Taiz governorate [9].

**Sample size**

Sample size of 150, with ratio of 1:2 (50 cases and 100 controls) were calculated by Epi Info program using a confidence level of 95%, power of 80%, an odds ratio of 2.9 and 20% of exposed control and 42%
Case definitions

Case definition of the World Health Organization (WHO) was used. **Suspected DF**: any person has sudden fever more than 38°C for 2–10 days with two of these symptoms; severe headache, retro-orbital pain, myalgia, arthralgia, rash, hemorrhagic manifestations, leucopenia. **Confirmed DF**: a suspected case with laboratory confirmation.

Selection criteria of cases and controls

The line list of the DF cases reported by eDEWS was used for the selection of cases. A person who met the suspected or confirmed case definition of WHO and lived in Al Qahirah or Al Mudhaffar districts, Taiz governorate, during August to November 2018 was selected as a case. Cases that had a disease history before August 2018 were excluded to avoid recall bias. While any person who lived in the same area of the case and who did not develop signs and symptoms of DF was included as a control. Two controls were selected from the same area of the case.

Data and laboratory sample collection

Active search from house to house was performed to identify the cases. A predesigned questioner was used to collect data that related to the following variables: sociodemographic (age, gender, education and occupation), date of onset and clinical symptoms. As well it included data related to behavioral characteristics, such as the status of water containers, using mosquito repellents and nets, and type of clothes (sleeves/pants). Environmental characteristics such as houses surrounded by garbage, sanitation (presence of stagnant water or sewage), presence of outdoor trees and windows of the house were collected. For confirmation of the outbreak, blood samples were collected randomly from 19 cases and sent to National Center for Public Health laboratories in Taiz governorate for laboratory confirmation.

Data processing and Analysis

Data were entered and analyzed by Epi info version 7.2. Bivariate and multivariate backward stepwise analyses were used to calculate the crude Odds Ratio (cOR) and the adjusted Odds Ratio (aOR) with 95% Confidence interval (CI). A $P$ value < 0.05 was considered as the cut point for statistically significant.

Results

Patient Characteristics

A total of 50 DF cases were found in both Al Qahirah and Al Mudhaffar districts, during August to November 2018. The first case was in week 31, reaching 11 cases in week 40 (Fig. 1). Table 1 shows that 76% of cases were among age group less than 30 years and 52% were males. About 86% of cases were illiterate-basic education and 78% were not working. About 86% of cases were suffered from fever, followed by headache (94%), arthralgia (90%) and retro orbital pain (88%). The overall attack rate (AR)
was 1/10,000 of the population and the CFR was 4% of DF cases. Out of 19 blood samples, 11 (58%) were positive for DF IgM. The remaining DF cases were epidemiologically linked by place with the cases.

### Table 1

Socio demographic characteristics of cases and controls, Taiz governorate, August - November 2018

| Socio demographic characteristics | Cases | Controls |
|-----------------------------------|-------|----------|
|                                   | No. (%) (n = 50) | No. (%) (n = 100) |
| **Age group (years)**             |       |          |
| < 15                              | 18 (36) | 2 (2) |
| 15–29                             | 20 (40) | 23 (23) |
| 30–44                             | 7 (14)  | 39 (39) |
| 45–59                             | 3 (6)   | 22 (22) |
| > 59                              | 2 (4)   | 14 (14) |
| **Gender**                        |       |          |
| Male                              | 26 (52) | 62 (62) |
| Female                            | 24 (48) | 38 (38) |
| **Educational level**             |       |          |
| Illiterate-basic                  | 32 (64) | 33 (33) |
| Secondary-university              | 18 (36) | 67 (67) |
| **Occupation**                    |       |          |
| Not working                       | 39 (78) | 27 (27) |
| Working                           | 11 (22) | 73 (73) |
| **Residency**                     |       |          |
| Al Mudhaffar                      | 25 (50) | 50 (50) |
| Al Qahirah                        | 25 (50) | 50 (50) |

### Risk factors associated with dengue fever

Table 2 shows the risk factors associated with DF outbreak. In the bivariate analysis, the illiterate-basic educated and not working individuals were more likely to get DF infection (cOR = 5.2 and 95% CI: 2.2–12.8) and (cOR = 9.6 and 95% CI: 4.3–21.4), respectively. Moreover, cases were found to be more likely
among those individuals who weren't covering water containers (cOR = 2.8 and 95% CI: 1.3–6.1). The individuals who had never used mosquito repellent and nets were more likely to be cases (92% vs 74%, cOR = 4.0 and 95% CI: 1.3–12.3) and (98% vs 76%, cOR = 15.5 and 95% CI: 2.0–118.1), respectively. The individuals who wore short sleeves/pants were more likely to be infected with DF than those who wore long sleeves/pants (cOR = 15.9 and 95% CI: 5.3–47.5). Similarly, those individuals who lived in houses surrounded by garbage (cOR = 3.3 and 95% CI: 1.6–6.7), poor sanitation (cOR = 4.4 and 95% CI: 2.1–9.0), outdoor trees (cOR = 2.4 and 95% CI: 1.2–5.1) and houses without window nets (cOR = 10.6 and 95% CI: 4.8–23.5) were more likely to be infected with DF.
| Risk factors                        | Cases | Controls | Crude OR (95% CI) | Adjusted OR (95% CI) |
|------------------------------------|-------|----------|-------------------|----------------------|
|                                    | No. (%) | No. (%) |                  |                      |
|                                    | n = 50 | n = 100  |                  |                      |
| **Educational level**              |        |          |                  |                      |
| Illiterate-basic                   | 32 (64) | 33 (33)  | 3.6 (1.8–7.4)<sup>a</sup> |                      |
| Secondary-university               | 18 (36) | 67 (67)  |                   |                      |
| **Occupation**                     |        |          |                  |                      |
| Not working                        | 39 (78) | 27 (27)  | 9.6 (4.3–21.4)<sup>a</sup> | 26.6 (6.8–104.7)<sup>a</sup> |
| Working                            | 11 (22) | 73 (73)  |                   |                      |
| **Status of water containers**     |        |          |                  |                      |
| Not covering                       | 20 (40) | 19 (19)  | 2.8 (1.3–6.1)<sup>a</sup> |                      |
| Covering                           | 30 (60) | 81 (81)  |                   |                      |
| **Mosquito repellent use**         |        |          |                  |                      |
| Never                              | 46 (92) | 74 (74)  | 4.0 (1.3–12.3)<sup>a</sup> | 13.9 (1.4–136.8)<sup>a</sup> |
| Use                                | 4 (8)   | 26 (26)  |                   |                      |
| **Mosquito nets use**              |        |          |                  |                      |
| Never                              | 49 (98) | 76 (76)  | 15.5 (2.0–118.1)<sup>a</sup> |                      |
| Use                                | 1 (2)   | 24 (24)  |                   |                      |
| **Type of clothes (sleeves/pants)**|        |          |                  |                      |
| Short                              | 46 (92) | 42 (42)  | 15.9 (5.3–47.5)<sup>a</sup> | 27.3 (4.8–156.8)<sup>a</sup> |
| Long                               | 4 (8)   | 58 (58)  |                   |                      |
| **houses surrounded by garbage**   |        |          |                  |                      |
| Yes                                | 26 (52) | 25 (25)  | 3.3 (1.6–6.7)<sup>a</sup> |                      |
| No                                 | 24 (48) | 75 (75)  |                   |                      |
| **Sanitation**                     |        |          |                  |                      |
| Poor                               | 29 (58) | 24 (24)  | 4.4 (2.1–9.0)<sup>a</sup> | 5.4 (1.4–20.3)<sup>a</sup> |
| Risk factors                          | Cases | Controls | Crude OR (95% CI) | Adjusted OR (95% CI) |
|--------------------------------------|-------|----------|-------------------|----------------------|
|                                      | No. (%) | No. (%) |                   |                      |
| n = 50                               | n = 100 |
| Good                                 | 21 (42) | 76 (76) |                   |                      |
| **Presence of outdoor trees**         |        |          |                   |                      |
| Yes                                  | 37 (74) | 54 (54) | 2.4 (1.2–5.1)<sup>a</sup> | 13.2 (2.8–63.0)<sup>a</sup> |
| No                                   | 13 (26) | 46 (46) |                   |                      |
| **Windows of the house**             |        |          |                   |                      |
| Without net                          | 35 (70) | 18 (18) | 10.6 (4.8–23.5)<sup>a</sup> | 15.7 (3.9–63.4)<sup>a</sup> |
| With net                             | 15 (30) | 82 (82) |                   |                      |
|<sup>a</sup> P value < 0.05           |        |          |                   |                      |

In multivariate backward stepwise analysis (Table 2), not working (aOR = 26.6, 95% CI: 6.8–104.7), not using mosquito repellent (aOR = 13.9, 95% CI: 1.4–136.8), wearing short sleeves/pants (aOR = 27.3, 95% CI: 4.8–156.8), poor sanitation (aOR = 5.4, 95% CI: 1.4–20.3), presence of outdoor trees (aOR = 13.2, 95% CI: 2.8–63.0) and houses without window nets (aOR = 15.7, 95% CI: 3.9–63.4) were the remained significant risk factors associated with DF infection.

**Discussion**

Dengue is a significant health issue especially in the coastal areas in Yemen. This study showed that not working, not using mosquito repellent, wearing short sleeves/pants, poor sanitation, outdoor trees and houses without window nets were the potential risk factors for DF outbreak in Taiz governorate.

Our result indicates that the highest peak of DF cases occurs in week 40, this possibly attributed to accumulation of water in the watercourse during the rainy season, that creates vector breeding sites. This finding shows that males were slightly more affected than females. This might be due to higher exposure of male as a result of spending more time outdoors than females and the females have protective clothes traditionally. Our result is similar to results of outbreaks investigation conducted in some Yemeni governorates (Al Hodeidah, Taiz and Hadramout), and in Pakistan [1, 11, 12, 13]. People with an age group < 30 years were more affected. This result might be due to people at this age being more active that makes them at risk of DF infections. These results are consistent with studies conducted in Al Hodeidah governorate, Vietnam, Hadramout governorate and India [1, 2, 12, 14].
Our result indicated that there isn't a significant association between illiterate-basic educational level and getting DF infection. This result agrees with studies in India and Sudan [5, 15] and disagrees with previous study in Al Hodeidah governorate [1]. Not working people have more than twenty times the odds of getting DF infection compared with working people. This finding is similar to a study in Sudan that attributed to the fact that unemployment may pose a lifestyle behavior that provides a suitable habitat for the breeding of the mosquito vector, thus increasing the risk of mosquito contact [15]. Conversely, this finding is dissimilar to studies in India and Malaysia [5, 16].

Our findings revealed that there isn't a significant association between not covering water containers and getting DF infection. Similar findings were reported in studies from Ethiopia and India [4, 17], but dissimilar to previous studies in Al Hodeidah governorate and Vietnam [1, 2].

Our result is in agreement with the fact that mosquito repellent is a protective measure against DF infection and showed that people who do not use mosquito repellents are at higher risk of getting infection with DF. These findings are consistent with studies in India, Kenya and Pakistan [17, 18, 19] and inconsistent with two studies in Ethiopia and others studies in Malaysia and China [3, 4, 16, 20].

Our result is similar to studies in Sudan, Malaysia and China [15, 16, 20] that indicate there isn't a significant association between not using mosquito nets and the chance of getting DF infection. This finding might be due to the fact that mosquito nets are usually used at night, while Aedes aegypti mosquito is active during the day, especially in the early morning and late afternoon. However, this result is dissimilar to two studies in Ethiopia and one in Kenya [3, 4, 18].

Furthermore, our finding is similar to studies in Ethiopia [4] and Malaysia [16] reported that wearing long clothes is found to be protective and reduces the risk of DF infection, but dissimilar to study in Ethiopia [3].

The current investigation indicated that there is significant association between poor sanitation and DF infection. The people who live with poor sanitation have five times the odds of getting DF infection compared with people who have good sanitation. Our result is consistent with study in India [5], but inconsistent with studies in China and Brazil that reported that the lack of statistical significance attributable to improving the residential living environment, reducing mosquito breeding and coverage of sanitation services [20, 21].

Also there is a significant association between the presence of outdoor trees and getting DF infection. This might be due to the presence of outdoor trees that attract mosquitoes into human settlement. Conversely, a study in Vietnam reported that there isn't a significant association between vegetation around living space and DF infection [2].

Additionally, there is significant association between those who are living in houses without window nets and getting DF infection. The individuals who live in houses without window nets are at risk of getting DF infection fifteen times the odds of getting DF infection compared with those who live in houses with
window nets. This is possible to increase the exposure to mosquito biting. Our finding is consistent with studies in Malaysia and Pakistan [16, 19], but inconsistent with studies in Ethiopia and Kenya [4, 18].

As a result of limited financial resources, laboratory tests were not performed to ensure selection of the eligible controls. The wide confidence intervals in some variables is possibly attributed to small sample size of this study. However, these limitations should be taken into account when a similar study is conducted in the future.

**Conclusion**

DF outbreak in Al Qahirah and Al Mudhaffar districts, Taiz governorate was confirmed. This study provides evidence-based information regarding the behavioral and environmental factors that potentially contributed to the occurrence of this outbreak, such as not working, not using mosquito repellents, wearing short sleeves/pants, poor sanitation, presence of outdoor trees and houses without window net.

This study recommends the implementation of prevention and control measures focused on modifying the risk factors to avoid the future outbreaks. Raising community awareness on the importance of personal protection measures, such as using mosquito repellents, wearing long sleeves/pants, and screening windows. As well improving the sanitation services and covering water containers are recommended.

**Abbreviations**

AR: Attack rate; aOR: adjusted Odds Ratio; CFR: Case Fatality Rate; CI: Confidence Interval; cOR: crude Odds Ratio; DF: Dengue fever; eDEWS: electronic Disease Early Warning System; WHO: World Health Organization

**Declarations**

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**Authors’ contributions**

AAHN was the author involved in the design, implementation of the study, data collection, statistical analysis, and prepared the report and the manuscript. AAT and YAA were co-authors involved in investigation, data collection. MAA was co-author involved in statistical analysis and the final manuscript revision. All authors read and approved the manuscript.

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Availability of data and materials

All relevant data are presented in this paper; and more information can be provided upon reasonable request from the correspondence author.

Competing of interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

The study was part of an outbreak response, an official approval was obtained from the Ministry of Public Health Population of Yemen. An official letter was sent to Taiz Governorate Health Office for conducting this investigation. Methods were performed in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants. For the participants who were less than 18 years and those who are illiterate, informed consent was obtained from their parents/guardians. Confidentiality of data was assured and ensured.

Consent for publication

Not applicable.

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Figures

![Graph showing the distribution of dengue fever cases by time, Taiz governorate, August-November 2018](image)

**Figure 1**

Distribution of dengue fever cases by time, Taiz governorate, August-November 2018
Figure 2

Distribution of dengue fever cases by signs and symptoms, Taiz governorate, August-November 2018