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Epidemiological Features of Dengue Fever in Hodeidah Governorate, Yemen: Outbreak 2019-2020

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Abstract

Background: Dengue fever, a mosquito-borne viral disease caused by the dengue virus (DENV), remains a significant public health challenge, particularly in tropical regions such as Hodeidah, Yemen. The 2019 - 2020 outbreak in Hodeidah highlighted the urgent need to understand its epidemiological features to improve prevention and control strategies. **Objective:** This study aimed to describe the epidemiological features of dengue fever patients in Hodeidah governorate from 2019 to 2020. **Methods:** A retrospective study used data from the Center of Tropical Medicine and Infectious Diseases (CTMID) in the Authority of Public at Al Thawara Hospital, Hodeidah, Yemen, that included 3874 dengue cases recorded between November 2019 and March 2020. Blood samples were collected and analyzed for dengue infection, and concurrent conditions such as malaria and thrombocytopenia were also documented. Data were analyzed using Microsoft Excel 2019 and SPSS version 27.0. **Results:** The results showed that the males were 65% (n = 2529) while the females were 35% (n = 1345). This difference was statistically significant (p-value < 0.00001). In addition**,** the majority of cases (47%) were observed in the 19–50 years age group, followed by the 6–18 years age group (30%). Children aged 1–5 years accounted for 18 % of the cases, whereas individuals over 50 years represented only 5%. The age distribution of cases reveals a significant variation across (p-value = 0.00001). Also, the distribution of cases across districts shows a significantly higher concentration in urban areas more than rural that indicated statistically significant association between district and case distribution (p-value < 0.00001). On the other hand, dengue infection was predominant, accounting for the majority of cases. Hemorrhagic dengue fever (HDF) was the most frequent diagnosis (45.64%), followed closely by dengue fever (DF) (42.90%). Dengue shock syndrome (DSS) was relatively rare, comprising only 0.46% of the total cases. Co-infections of dengue and malaria were notable, with 5.45 % of cases involving DF-malaria and 5.55 % involving HDF – malaria coinfection. Finally, the attack rate (AR) was reported 0.11 % and the case fatality rate (CFR) was 0.57 %. **Conclusion:** The study concluded a significant gender disparity among reported cases, with males comprising more than females. The age associated with dengue infection where the adults and children. Dengue was the predominant infection, with hemorrhagic dengue fever (HDF) being the most common diagnosis, followed by dengue fever (DF). Co-infections with malaria were noted. The CFR was less than 1%. Integrated public health measures, including enhanced surveillance, vector control, and community education, are critical for reducing dengue transmission in high-risk areas. These insights can guide policymakers in developing targeted interventions for future outbreaks of the disease.

Keywords: *Dengue Fever, Epidemiological Features, Hodeidah, Yemen*

1. INTRODUCTION

The most people in Hodeidah, Yemen is particularly vulnerable. The vector – borne diseases such as Dengue (DEN), Malaria [1], Chikungunya fever (CHIK) [3] and West Nile virus (WNV) [4]. Dengue fever, commonly known as breakbone fever, is a mosquito-borne tropical disease caused by the dengue virus (DENV), a member of the Flavivirus family. DENV is a single-stranded, positive-sense RNA virus with four antigenically distinct serotypes (DENV-1 to DENV-4) [4]. Primarily transmitted by *Aedes aegypti* and *Aedes albopictus* mosquitoes [5-7]. The disease presents a wide clinical spectrum, ranging from mild flu-like symptoms, such as fever, nausea, vomiting, rash, and body aches, to severe and potentially fatal manifestations, including dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS), the latter of which can lead to severe bleeding, organ failure, and shock, with mortality rates reaching 20% if untreated [7]. Historically, the World Health Organization (WHO) has classified dengue into three categories: dengue fever (DF), DHF, and DSS. Dengue presents diagnostic challenges because of its nonspecific symptoms with other acute febrile illnesses (AFIs), emphasizing the need for reliable diagnostic tests [8]. Despite ongoing efforts in vector control, the absence of licensed vaccines or specific antiviral treatments has hindered global containment efforts, contributing to the persistent emergence and spread of dengue [9]. Globally, dengue poses a significant health burden, with the WHO estimating approximately 390 million infections annually, of which 96 million cases exhibit clinical symptoms [10]. Recent outbreaks, such as the 2020 surge in Yemen, where suspected cases were seven times higher than in 2019, highlight this escalating threat [11]. Climate change further exacerbates transmission by enhancing mosquito survival, reproduction, and viral replication, potentially extending dengue's reach into previously unaffected regions, including parts of Europe, North America, and Australia [12]. Given these challenges, integrated prevention strategies that combine vaccination (where available), public education, and vector control are essential for sustainable dengue management [13]. This study aimed to describe the epidemiological features of dengue fever cases in Hodeidah governorate during the 2019 outbreak.

2. METHODOLOGY

2.1. Study Area

Hodeidah governorate is the fourth-largest governorate in Yemen, with an estimated population of 2.1 million. The capital of the governorate is a major port city in the country, situated on the Red Sea, and is known as an epicenter for several outbreaks of vector-borne diseases [14]

2.2. Study Design

A retrospective study was conducted using data from the Center of Tropical Medicine and Infectious Diseases (CTMID) - Authority of Public Al Thawara Hospital in Hodeidah, Yemen. The study included children, young adults, and elderly patients with dengue fever (DF), hemorrhagic dengue fever (HDF), dengue shock syndrome (DSS), dengue fever (DF)-malaria co-infection, and hemorrhagic dengue fever (HDF)-malaria co-infection within the age group of 1–91 years, during the period from November 30 20219 to 9th march 2020 (N: 3874). The samples were collected from 24 districts, including Al-Hawak, Al-Hali, Al-Mina, Bayt Al Faqih, Bajil, Az Zaydiyah, Al Marawi'ah, Zabid, Al Munirah, Al Qanawis, Ad Dahi, Al Jarrahi, As Salif, Az Zuhrah, Alluhayah, Al Mighlaf, As Sukhnah, Bura', At Tuhayta, Ad Durayhimi, Hays, Al Mansuriyah, and Kamaran, in Hodeidah governorate, Yemen.

2.3. Diagnosis Dengue and Other Vector–Borne Diseases [15,1]

2.3.1. Clinically based case definition: Dengue presents with nonspecific symptoms such as fever, headache, retro-orbital pain, myalgia, arthralgia, and rash. However, these signs overlap with those of other febrile illnesses, making laboratory confirmation essential.

2.3.1. Laboratory diagnosis is generally categorized as follows:

- **NS1 antigen detection**: Useful for early diagnosis; rapid tests and ELISA methods are commonly used for this purpose. Effective in the acute phase (0–5 days after symptom onset). Malaria was diagnosed based on **a** rapid diagnostic test (RDT) and microscopic examination (gold standard)
- **Serological methods** – Used in the later phase (after day 5): IgM antibody detection: Appears ~5 days after onset and suggests recent infection. IgG antibody detection: Indicates past exposure or secondary infection if levels rapidly increase.

- **Other investigations: The diagnosis of dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS)** is based on clinical, laboratory, and hematological findings. These two conditions are severe forms of dengue infection and require early identification to prevent complications and death in patients. **Dengue Hemorrhagic Fever (DHF). WHO diagnostic criteria for DHF:** A patient with **confirmed dengue infection** plus all the following: A. **Fever**: Acute onset and lasts 2–7 days. B. **Hemorrhagic manifestations**: Positive tourniquet test; Petechiae, purpura, ecchymosis; Bleeding from mucosa, GI tract, gums, or nose; Hematemesis or melena (in severe cases). C. **Thrombocytopenia**: Platelet count < 100,000 cells/mm^3. D. **Evidence of plasma leakage due to increased vascular permeability**, such as: Hemoconcentration: Hematocrit increased by ≥20% from baseline; Pleural effusion or ascites (clinically or radiologically detected) and Hypoproteinemia or hypoalbuminemia. DSS is a severe complication of DHF, characterized by circulatory failure. Diagnostic features: All criteria of DHF plus signs of shock, including rapid, weak pulse; narrow pulse pressure (<20 mmHg) or hypotension; cold, clammy skin, restlessness; delayed capillary refill (>2 seconds); and severe plasma leakage leading to intravascular volume depletion.

2.4. Data Collection and Statistical Analysis

The data were entered and analyzed in Microsoft Excel 2010 and Statistical Package for Social Sciences (SPSS) version 27.

3. RESULTS

3.1. Demographic Analysis

3.1.1 Sex and Dengue Fever

The distribution of cases by sex revealed significant disparities (N:3874). Out of the total cases, 65% were males (n = 2529) while 35% were female (n = 1345). This difference was statistically significant, as indicated by a χ^2 value of 361.863 and p-value < 0.00001.

3.1.2. Age and Dengue Fever

The majority of cases (47%) were observed in the 19–50 years age group, followed by the 6–18 years age group (30%). Children aged 1–5 years accounted for 18% of the cases, whereas individuals over 50 years represented only 5%. The age distribution of cases reveals a significant variation across different age groups, as confirmed by the chi-square test (χ^2 = 1487.26, p-value < 0.00001), indicating a highly significant association between age and dengue incidence.

Table 1. Distribution of Dengue Fever Cases by Sex and Age in Hodeidah, Yemen (N=3874)

Category	Subcategory	(n)	(%)	X^2	p – value
Sex	Males	2529	65	361.863	0.00001
	Females	1345	35		
Age	1-5 years	710	18	1487.26	0.00001
	6-18 years	1148	30		
	19-50 years	1826	47		
	>50 years	190	5		

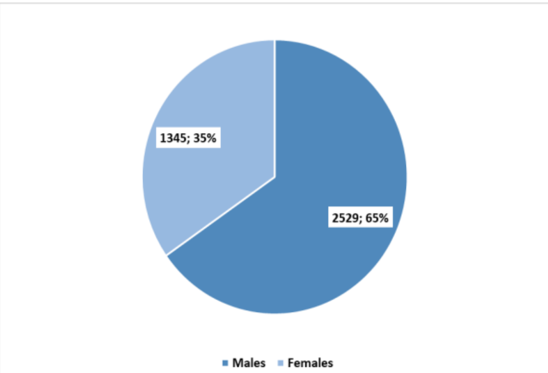

Figure 1 . Sex and dengue fever in Hodeiadah, Yemen (N: 3874)

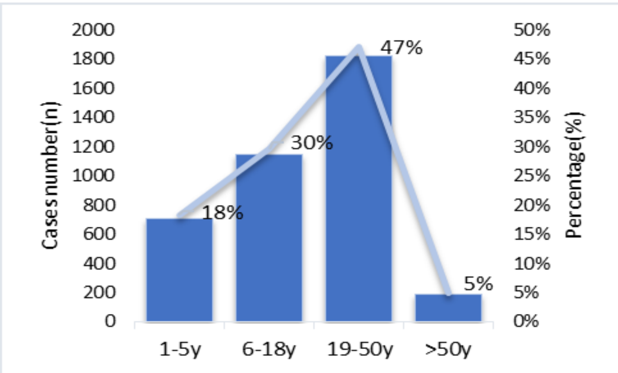

Figure 2. Age and dengue fever in Hodeiadah, Yemen (N: 3874)

3.1.3. Geographic Distribution

The distribution of cases across districts shows a significantly higher concentration in urban areas, particularly Al Hawak (46%), Al Hali (24%), and Al Mina (12%), accounting for over 82% of total reported cases. Other districts, such as Bayt Al Faqih, Bajil, and Az Zaydiyah, reported moderate case levels ranging from 1.19 % to 3.38 %, suggesting localized outbreaks or intermediate risk factors. In contrast, rural and less populated districts such as Kamaran, Al Mansuriyah, Hays, and Ad Durayhimi reported the lowest case proportions, each contributing less than 0.1% to the total. The chi-square test (χ^2 =4227.442 , p-value < 0.00001) indicates a statistically significant association between district and case distribution, supporting that location strongly influences both incidence and outcomes of the disease (Table 2 and Figure 3).

3.2. Morbidity and Mortality Rate

Table 2 presents the geographical distribution of dengue fever cases across various districts of Hodeidah Governorate, Yemen. The total number of reported cases was 3874, with a marked difference in case distribution between urban, semi-urban, and rural settings.

3.2.1. Urban Districts

The urban districts , Al Hawak, Al Hali, and Al Mina—accounted for the majority of dengue cases: Al Hawak reported the highest number of cases (1795, 46.33%), with an Attack Rate (AR) of 0.680 % and a Case Fatality Rate (CFR) of 0.17%. Al Hali followed with 931 cases (24.03%), with an AR of 0.381% and (CFR) of 0.21%. Al Mina had 468 cases (12.08 %) with an AR of 0.324 % and (CFR) of 0.21%.

3.2.2. Semi-Urban Districts

Semi-urban areas such as Bayt Al Faqih**,** Bajil**,** and Az Zaydiyah had considerably moderate cases: The combined percentage of semi-urban districts was 11.87**%**. AR was reported from 0.048 to 0.20 %. Az Zaydiyah had a high CFR (3.70%)**,** Al Marawi'ah (3.23%), Bajil (2.41%), Bayt Al Faqih (1.53%) while Zabid reported the highest CFR among semi-urban areas at 5.26 %, indicating potentially delayed access to healthcare or under-reporting of milder cases, skewing the fatality data.

3.2.3. Rural Districts

Rural districts reported very few cases overall (approx. 5.67% combined), but some alarming ARs ranged from 0.279 to 0.001 %. On the other mea, many districts like Al Munirah**,** Al Jarrahi, and others reported no fatalities, but their ARs remained low (mostly below 0.1%**).** In addition, the CFRs were reported " Ad Dahi (CFR : 2.50 %) , Az Zuhrah (CFR: 5.00 **%**) and Bura'a (CFR: 16.67 %**)** highlight potential gaps in healthcare delivery, delayed diagnosis, or lack of access to timely treatment.

Table 2. Distribution of Dengue Fever Cases in Districts of Hodeidah, Yemen (N=3874)

	District	**(n)**	**(%)**	**AR (%)**	**CFR (%)**	**χ^2**	***p*-value**
Urban	Al Hawak	1795	46.33	0.680	0.17		
	Al Hali	931	24.03	0.381	0.21		
	Al Mina	468	12.08	0.324	0.21		
Semi – Urban	Bayt Al Faqih	131	3.38	0.030	1.53		
	Bajil	83	2.14	0.027	2.41		
	Az Zaydiyah	81	2.09	0.048	3.70		
	Al Marawi'ah	62	1.60	0.027	3.23		
	Zabid	57	1.47	0.020	5.26		
	Al Qanawis	46	1.19	0.036	2.17		
Rural	Al Munirah	45	1.16	0.068	0.00		
	Ad Dahi	40	1.03	0.041	2.50	4227.442	0.00001
	Al Jarrahi	37	0.96	0.023	0.00		
	As Salif	31	0.80	0.279	0.00		
	Az Zuhrah	20	0.52	0.008	5.00		
	Alluhayah	17	0.44	0.009	0.00		
	Al Mighlaf	8	0.21	0.008	0.00		
	As Sukhnah	7	0.18	0.010	0.00		
	Bura'a	6	0.15	0.007	16.67		
	At Tuhayta	4	0.10	0.003	0.00		
	Ad Durayhimi	2	0.05	0.002	0.00		
	Hays	1	0.03	0.001	0.00		
	Al Mansuriyah	1	0.03	0.001	0.00		
	Kamaran	1	0.03	0.023	0.00		
	Total	**3874**	**100 %**	**0.11**	**0.57**		

Note : 100 cases (severe and critical) were confirmed based on Enzyme Linked Immunosorbent Assay (ELISA) . Other cases (mild and moderate) were confirmed epidemiologically (epidemiologically linked case) **[15]**

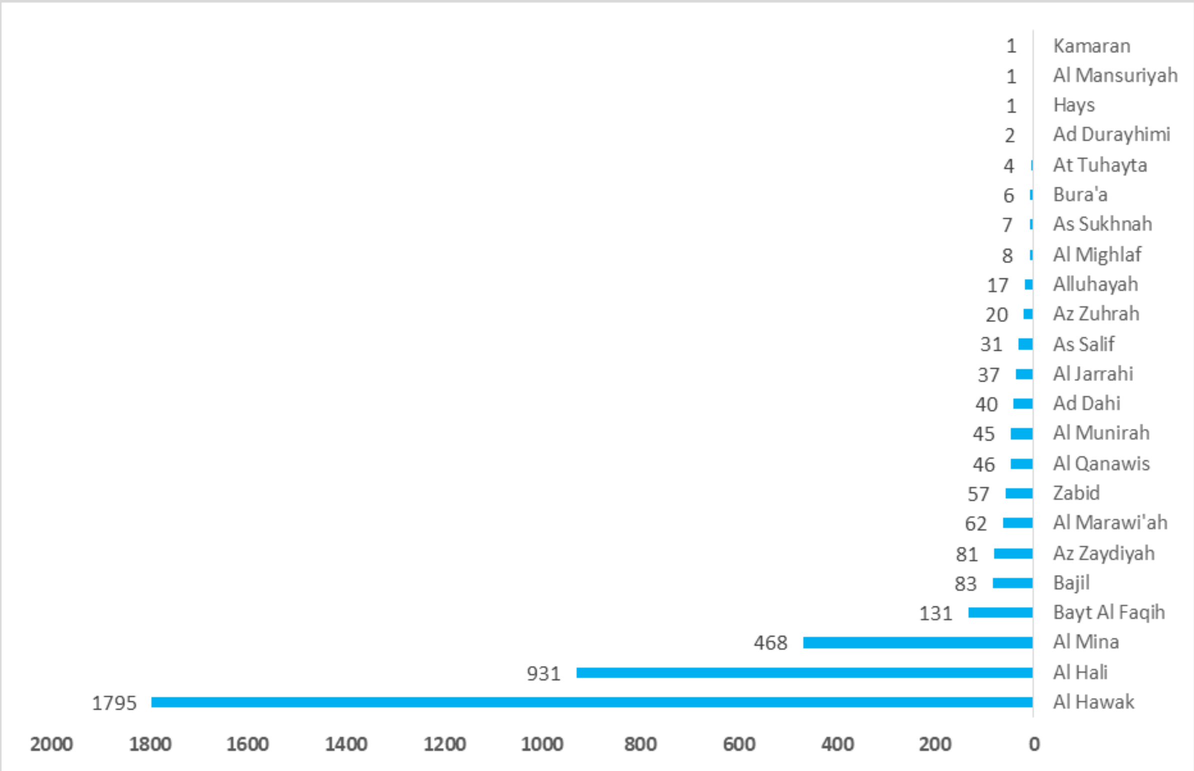

Figure 3. Distribution of dengue fever cases in districts of Hodeidah, Yemen (N=3874)

3.3. Dengue and co-infection

A total of 3874 febrile cases were recorded with various diagnoses related to dengue and malaria. Dengue infection was predominant, accounting for the majority of cases. Hemorrhagic Dengue Fever (HDF) was the most frequent diagnosis (45.64%), followed closely by Dengue Fever (DF) (42.90%). Dengue Shock Syndrome (DSS) was relatively rare, comprising only 0.46% of the total cases. Co-infections of dengue and malaria were notable, with 5.45 % of cases involving DF-malaria and 5.55% involving HDF – malaria coinfection. On the other mean 11 % of dengue – malaria coinfection (Table 3 and Figure 4).

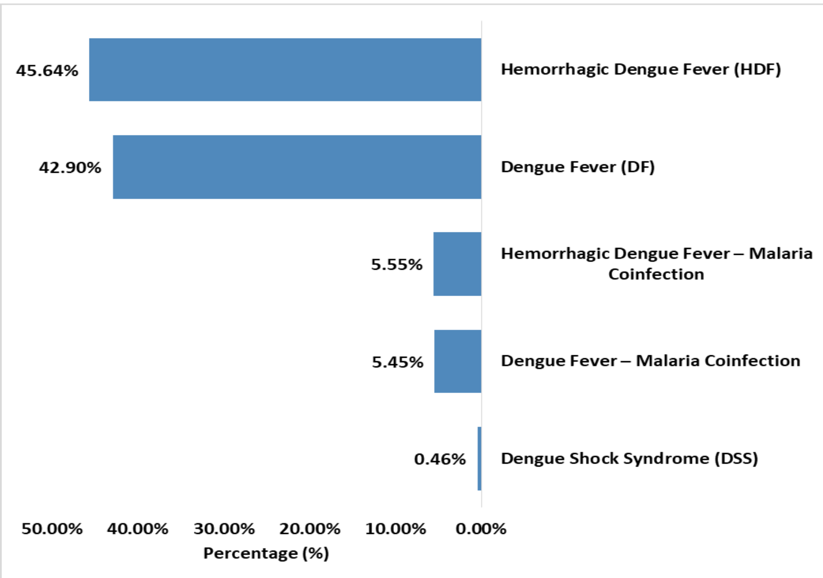

Figure 4: Dengue fever diagnosis cases in Hodeidah, Yemen (N:3874) : Note : 11 % of dengue – malaria co-infection

Table 3. Classification of dengue fever diagnosis and co-infection cases in Hodeidah, Yemen (N=3874)

Diagnosis	(n)	(%)
Dengue Fever (DF)	1768	42.90
Hemorrhagic Dengue Fever (HDF)	1662	45.64
Hemorrhagic Dengue Fever – Malaria Coinfection	215	05.55
Dengue Fever – Malaria Coinfection	211	05.45
Dengue Shock Syndrome (DSS)	18	00.46
Total	3874	100 %

4. DISCUSSION

The study highlighted a significant male predominance (65% of cases) in dengue infections. This aligns with global observations, where males often report higher incidence rates due to occupational exposure (e.g., outdoor work) or healthcare-seeking behaviors [10]. Also, in another study reported in Hodeidah about " dengue fever infection in Hodeidah, Yemen: These three urban districts collectively accounted for 82.44 % of all cases, highlighting a strong urban clustering of the disease. High population density, urban crowding, poor sanitation, and stagnant water may contribute to the favorable breeding conditions for *Aedes aegypti*, the mosquito vector of dengue. Risk factors and socioeconomic indicators concluded that the peak incidence of dengue fever occurs in males of secondary school and graduate study who live in a random house [16]. However, biological factors, such as hormonal influences on immune responses, may also play a role [17]. Further research is needed to disentangle the sociocultural and biological determinants in Hodeidah. Al Hawak district accounted for 46.33 % of cases, likely due to its urban setting and favorable conditions for *Aedes aegypti* breeding (e.g., water storage practices, poor sanitation). Similar urban clustering has been documented in studies from Brazil and India, where population density and inadequate vector control amplify transmission [18]. Climate factors, such as temperature and humidity in coastal Hodeidah, further accelerate mosquito life cycles [12]. Confirmed DF cases (42.90 %) and hemorrhagic dengue (45.64 %) predominated, with a small but critical DSS subset (0.46%). The high proportion of severe cases suggests delayed diagnosis or limited healthcare access, as early detection reduces the progression to severe forms [12]. The DF-malaria co-infection rate (11%) reflects that coinfections complicate diagnosis and treatment, as seen in sub-Saharan Africa [19, 20]. A clinical case study is very rare and was reported in Hodeidah, Yemen. Co-infection with other diseases, such as dengue, is a significant concern. This case represents the first reported instance of COVID-19 and dengue co-infection presenting as underscoring the complex challenges in diagnosis and treatment in tropical settings like Hodeidah, Yemen [21, 22]. In addition, multiple DENV serotypes and CHIKV co-circulate in the port city of Al Hodeidah, Yemen was reported [3]. Differential diagnosis tools (e.g., rapid tests for both pathogens) are essential in such The report underscores gaps in Yemen's healthcare infrastructure, exacerbated by war, which disrupts vector control and surveillance [14]. The integrated strategies recommended by the authors, such as community education and larval source reduction, mirror the WHO's *Global Strategy for Dengue Prevention* (2020–2030), emphasizing multi-sectorial collaboration. Although no licensed dengue vaccine was available in Yemen during the study, recent advances (e.g., TAK-003) show promise for high-burden regions [13]. Vaccine deployment must consider seroprevalence to avoid antibody-dependent enhancement (ADE) [23]. The study's retrospective design and reliance on hospital data may underrepresent asymptomatic/mild cases. Population-based serosurveys could provide fuller prevalence estimates [24]. Projected warming in Yemen may expand *Aedes* habitats, necessitating adaptive vector control [25].

5. CONCLUSION

The study concluded a significant gender disparity among reported cases, with males comprising more than females. The age associated with dengue infection the adults and children. Dengue was the predominant infection, with hemorrhagic dengue fever (HDF) being the most common diagnosis, followed by dengue fever (DF). Co-infections with malaria were noted. The CFR was less than1 %. Integrated public health measures, including enhanced surveillance, vector control, and community education, are critical for reducing dengue transmission in high-risk areas. These insights can guide policymakers in developing targeted interventions for future outbreaks of the disease.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was conducted during our work at CTMID – Al Thawara Public Hospital Authority, Hodeidah,Yemen.

Ethical Approval

The studies involving human participants were reviewed and approved by the Ethics Committee of Tropical Medicine and Epidemiology Studies of Hodeidah University (CTMES-HU), Hodeidah, Yemen .

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