



A case-control study to determine the risk factors of dengue infections in endemic dengue area in Yemen

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ABSTRACT

Background and aims: The effectiveness of dengue prevention in a subtropical nation such as Yemen, where the climate encourages the establishment of Aedes mosquito vectors, mostly rests on the accurate identification and management of risk factors. Thus, the purpose of this study was to investigate potential risk variables and how they relate to dengue infection.

Methods: The study included 73 dengue patients (cases) and 146 controls (non-dengue patients admitted to other departments of the same hospitals: Al-Thawra General Hospital, Al-Amal Al-Arabi Hospital, and Al-Hodeida Hospital in Al-Hodeida City, during the period from October 2024 to May 2025). Data were collected from the cases and controls by a standard questionnaire of dengue infection risk factors.

Results: Differences in the risk of dengue virus infection were not observed between sexes. However, significant associations were found in the age groups: children under five years had an odds ratio of 3.6 (CI: 1.5–9.1, χ^2 : 9.7, p: 0.001), and the 26–40 year age group had an odds ratio of 2.2 (CI: 1.1–4.5, χ^2 : 5.4, p: 0.009). Statistically significant associations were found between various risk factors and dengue fever infection. These include sleeping without mosquito nets (probability ratio 2.7), exposure to stored water tanks (4.6), wearing short-sleeved clothing (8.3), the presence of swamps and sewage (3.9), vegetation around homes (4.8), and keeping windows/doors open (7.0). All associations had a p-value of less than 0.001, demonstrating strong statistical significance.

Conclusions: Particularly in urban regions with high infection rates, these findings can aid in the creation of focused intervention tactics and public health awareness messages, such as encouraging personal preventive measures and community awareness campaigns. However, to improve the generalizability of these findings and their applicability to public policy, more study with bigger samples in various geographic, social, and environmental contexts is required.

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1. INTRODUCTION

Dengue (pronounced "DEN-gi") is one of the fastest-growing viral infections and is caused by a flavivirus that is spread by mosquito vectors. Over 120 countries worldwide have a high prevalence of this illness. Geographically, the virus is found in the Americas, Southeast Asia (SEA), and the Western Pacific, with 70% of the world's illness load occurring in Asia [1]. Every year, there are about 400 million infections, of which 100 million show

clinical symptoms. Due to its potential for epidemics, particularly in urban and tropical environments, dengue is regarded as an increasing threat to global health security [2]. Due to its potential for outbreaks, rapid geographic spread, and strain on healthcare systems, dengue has long been acknowledged by the World Health Organization (WHO) as a major public health problem [3].

Dengue was first discovered in Yemen during a significant outbreak documented in Aden between 1870 and 1873. Official reports and subsequent significant

outbreaks include: 1954: An estimated 98% of the local population was impacted by a significant epidemic that struck the AL Hodeidah Governorate. In 1994, Yemen, together with Pakistan and Saudi Arabia, reported an outbreak of dengue hemorrhagic fever to the World Health Organization for the first time. In the early 2000s, Yemen's public health continued to face challenges due to frequent major outbreaks in coastal governorates and other areas [4]. DF remains a major public health concern in Yemen, and the country's healthcare facilities are heavily burdened by periodic outbreaks. Improving disease management and control tactics requires an understanding of the epidemiological features of dengue, including the clinical-immunological traits, seroprevalence, and demographic risk factors. Policymakers and public health professionals can successfully assess, manage, and prevent future outbreaks with the use of comprehensive serological, clinical, and demographic data [5].

By 2025, AL Hodeida city is expected to have 617,871 residents, while the larger metropolitan area is expected to have 785,000 residents. During the rainy season, the city's dozens of construction sites collect stagnant water, making them perfect mosquito breeding grounds. The hazards caused by present and future disease outbreaks are also underestimated due to a lack of particular treatment and preventive measures, inefficient pesticides, and a lack of public awareness. The risk of dengue fever in urban settings is influenced by local spatial differences in temperature, humidity, rainfall, urbanization, and the standard of vector control services. Travel has also been found to contribute to the transmission of viruses to rural areas [6]. Recent research in Yemen has examined viral diseases, including dengue virus infections, and the associated factors [7–19]. The risk factors for dengue virus infection in Yemen, however, have not been studied. Thus, our goal was to investigate the risk factors for DENV infection in patients with a clinical suspicion of dengue.

2. MATERIALS AND METHODS

2.1. STUDY SETTING

This case-control study was conducted at Al-Thawra General Hospital, Al-Amal-Al-Arabi Hospital, and Al-Hodeida Hospital in Hodeida City, Yemen. The study was carried out between October 2024 and May 2025. Most dengue patient records were collected from selected hospitals.

2.2. CASE AND CONTROL SELECTION

Data from 219 patients—73 confirmed cases and 146 controls—were included in the study in order to compare characteristics and investigate possible risk factors

related to dengue fever. All patients were admitted to Al-Thawra General Hospital, Al-Amal-Al-Arabi Hospital, and Al-Hadiyah Hospital between October 2024 and May 2025 with confirmed dengue fever, as determined by NS1 antigen testing. The 146 controls, who were chosen by frequency matching based on age, sex, and location, were non-dengue patients admitted to different departments within the same hospitals.

2.3. QUESTIONNAIRE DESIGN AND DATA COLLECTION

A structured questionnaire consisting of 17 variables was designed to collect information from the case and control groups. The questionnaire included data on demographics, daily living activities, marital status, home, and surrounding environment.

2.4. DATA ANALYSIS

All data were entered into Excel and verified for completeness and consistency. The final dataset was then transferred to SPSS version 26.0 and coded for analysis. Initially, a chi-squared (χ^2) test was performed on all variables to test for statistically significant differences between cases and control groups, as well as to identify significant variables. Subsequently, stepwise binary logistic regression analysis was used to analyze the statistically significant variables identified in the chi-square test that influence the incidence of dengue fever. The statistical significance level for both the chi-square test and logistic regression was set at $p < 0.05$. Additionally, odds ratios (ORs) with 95% confidence intervals were used to express the degree of association and determine the risk.

3. RESULTS

Table (1) illustrates the relationship between sex, age, and dengue fever infection in dengue-endemic areas of Yemen. When considering sex, no differences were observed in the risk of dengue virus infection between the sexes. However, when considering age groups, a statistically significant association was found between children under five years of age and dengue virus infection, with an odds ratio of 3.6, confidence interval of 1.5–9.1, chi-squared value of 9.7, and p-value of 0.001. A statistically significant association was also found between the 26–40-year age group and dengue virus infection, with an odds ratio of 2.2, confidence interval of 1.1 – 4.5, chi-squared value of 5.4, and p-value of 0.009.

When examining risk factors, a statistically significant association was found between not sleeping under mosquito nets and dengue fever infection, with a probability ratio of 2.7, confidence interval of 1.5–5.2, chi-squared value of 11, and p-value less than 0.001. A statistically

**Table[1]: The association between sex and age with dengue infections in endemic dengue area in Yemen.**

Factors Sex	Cases (N=73)		Controls (N=146)		OR	CI	χ^2	P
	No	%	No	%				
Males	41	56.2	99	67.8	0.6	0.3–1.1	2.8	0.9
Females	32	43.8	47	32.2	1.6	0.91–2.9	2.8	0.9
≤5	14	19.2	9	6.2	3.6	1.5–9.1	9.7	0.001
6–15	25	34.2	46	31.5	1.1	0.6–2.1	0.16	0.6
16–25	7	9.6	41	28.1	0.27	0.1–0.6	9.7	0.001
26–40	20	27.4	45	30.8	2.2	1.1–4.5	5.4	0.009
≥41	7	9.6	5	4.1	0.4	0.16–1.05	3.7	0.05

OR Odds ratio ≥ 1 is (at risk of infection)

CI Confidence intervals—

χ^2 Chi-square ≥ 3.83 is (significant)

p Probability value ≤ 0.05 is (significant)

Table[2]: Probability rates of dengue virus infection among dengue fever patients (cases) compared to control group.

Factors		Cases (N=73)		Controls (N=146)		OR	95% CI			χ^2	P
		No	%	No	%						
Past infection IgG	(Yes)	6	8.2	3	2.1	4.3	0.91	22.3	4.7	0.03	
	(No)	67	91.8	143	97.9						
Using insecticide mosquitos' coil or spray	(Yes)	20	27.4	24	16.4	1.9	0.93	3.9	3.6	0.05	
	(No)	53	72.6	122	83.6						
Using creams for repelling mosquitoes	(Yes)	8	10.9	14	9.6	1.1	0.42	3.1	0.1	0.75	
	(No)	65	89.1	132	90.4						
Sleeping under mosquito nets	(Yes)	36	49.3	38	26.0	2.7	1.5	5.2	11.8	< 0.001	
	(No)	37	50.7	108	74.0						
Un-covering stored water containers	(Yes)	49	76.1	45	30.8	4.6	2.4	8.7	26.2	< 0.001	
	(No)	24	32.9	101	69.2						
Presence of water around the house	(Yes)	16	21.9	52	35.6	0.5	0.2	1.01	4.3	0.03	
	(No)	57	78.1	94	64.4						
Wearing of short sleeve shirts and trousers	(Yes)	59	80.8	49	33.6	8.3	4.1	17.4	43	< 0.001	
	(No)	14	19.2	97	66.4						
Presence of bogs, Sewages and Trash	(Yes)	47	64.4	46	31.5	3.9	2.1	7.4	21.5	< 0.001	
	(No)	26	35.6	100	68.5						
Sleeping outdoor	(Yes)	2	2.7	1	0.7	4.1	0.3	115	1.2	0.21	
	(No)	71	97.3	145	99.3						
Presence of plants around the house	(Yes)	46	63.0	38	26.0	4.8	2.5	9.3	28	< 0.001	
	(No)	27	37.0	108	74.0						
Keeping windows/ doors opened	(Yes)	54	74.0	42	28.8	7.0	3.6	13.9	40	< 0.001	
	(No)	19	26.0	104	71.2						

Cases = confirmed dengue patients

Controls = non-dengue patients admitted to the other departments of the same hospital

OR Odds ratio ≥ 1 is (at risk of infection),

CI Confidence intervals—

χ^2 Chi-square ≥ 3.83 is (significant)

p Probability value ≤ 0.05 is (significant)

significant association was also found between exposure to stored water tanks in the home and dengue fever infection, with a probability ratio of 4.6, confidence interval

of 2.4–8.7, chi-squared value of 26.2, and p-value less than 0.001. Similarly, a statistically significant association was found between wearing short-sleeved shirts and

trousers and dengue fever infection, with a probability ratio of 8.3, confidence interval of 4.1–17.4, chi-squared value of 43, and p-value less than 0.001. A statistically significant association was found between the presence of swamps, sewage, and waste and dengue fever infection, with a probability of 3.9, confidence interval of 2.1–7.4, chi-squared value of 21.5, and p-value less than 0.001. A statistically significant association was also found between the presence of plants around the house and dengue fever infection, with a probability of 4.8, confidence interval of 2.5–9.3, chi-squared value of 9.3, and p-value less than 0.001. Similarly, a statistically significant association was found between keeping windows/doors open and dengue fever infection, with a probability of 7.0, confidence interval of 3.6–13.9, chi-squared value of 40, and p-value less than 0.001.

4. DISCUSSION

In the current study, when considering sex, no differences were observed in the risk of dengue virus infection between the sexes. This contrasts with reports from Bangladesh, where an examination of recorded cases revealed that men are more likely than women to contract dengue, a pattern noted in other studies [20]. Also, every dengue outbreak in Bangladesh [20] and India [21] has shown a male predominance. According to one study, the percentage of male patients in Bangladesh was twice that of female patients during all epidemics [20]. Studies from Bangladesh, where male children are likewise more likely to get dengue, and the majority of studies from India have revealed different results than ours [21]. However, the equal prevalence of the sexes is consistent with certain data from South America, where there is a substantial correlation between the gender distribution of females and DENV virus positivity compared to males. In the current study, a statistically significant association was found between the 26–40-year age group and dengue virus infection, with an odds ratio of 2.2, confidence interval of 1.1–4.5, chi-squared value of 5.4, and p-value of 0.009. These findings are supported by previous studies [22, 23]. A higher incidence among young people could be due to their overactivity and less concern for health and diseases.

In the current study, the presence of a past dengue infection, as indicated by positive IgG antibodies, was found to be protective, indicating that prior dengue exposure provides strong immunity against the present illness. Our findings are comparable to those from Bangladesh, where the percentage of people who had previously contracted dengue fever [24]. In Bangladesh, a national seroprevalence study conducted between 2014 and 2015 revealed that 24% of patients (n = 5866) reported a prior history of dengue, with over

80% of participants being seropositive [24]. In the present study, a statistically significant association was found between not sleeping under mosquito nets and dengue fever infection, with a probability ratio of 2.7, confidence interval of 1.5–5.2, chi-squared value of 11, and p-value less than 0.001. This implies that using a mosquito net could provide a degree of dengue protection. According to certain research, sleeping with a mosquito net can help prevent mosquito bites [25]. It's crucial to remember that *Aedes* mosquitoes bite throughout the day; therefore, nets' protective value is probably restricted to naps or morning rest. Nets may be less effective if they are only used when sleeping at night. Thus, evaluating the timing and context of mosquito net use is crucial to comprehending its true effects.

The current investigation found no significant correlation between the use of mosquito repellent lotions and dengue infection. The tiny sample size (only 8 users) suggests that this conclusion should be viewed with caution. These results are comparable to those observed in Bangladesh [26], where the use of repellents indoors is linked to a decrease in dengue incidence; however, their findings were only somewhat significant. Repellents may not be as effective on the skin when applied indoors, indicating that other variables may be at play. In the current investigation, a statistically significant association was found between exposure to stored water tanks in the home and dengue fever infection, with a probability ratio of 4.6, a confidence interval of 2.4–8.7, a chi-squared value of 26.2, and a p-value less than 0.001. This uncovered water storage is a recognized *Aedes* mosquito breeding ground. The results of this study show that, similar to popular assumption, the presence of flower gardens within homes has a discernible effect. Mosquito proliferation may be more influenced by other possible *Aedes* breeding locations, such as buckets, rooftop tanks, and exposed water containers in bathrooms and kitchens [20].

Al-Hodeida City lacks a coordinated vector control policy while being severely hit by dengue. Controlling disease requires the creation and use of effective policies. The government must employ urbanization policies targeted at lowering dengue incidence to prevent dengue in the long run. The majority of locals are aware of dengue, but they do not know where mosquitoes spawn or how they bite. Social media, print media, and electronic media can all raise awareness. During vector season, many governments in the third world use fogging to target adult mosquitoes and larvicide in drains to suppress *Culex* mosquitoes [27]. The application of larvicides for outdoor water storage, chlorination, and targeted insecticide spraying on *Aedes* breeding locations are all successful management strategies. However, an integrated vector



management strategy is necessary for effective Aedes control. This covers both chemical and environmental control techniques, such as closing tanks, cleaning water containers, and community-based source-reduction initiatives. Insecticide mosquito coils or sprays were not a protective factor in the current study, which is different from the fact that mosquito coils, window and door screens, and pesticide sprays can all be used to keep mosquitoes out of homes [25]. In Asia, mosquito coils or chemical sprays are frequently employed for interior protection [25].

5. CONCLUSION

These findings can guide focused intervention tactics and public health messaging, such as encouraging individual preventive measures and community awareness campaigns, especially in metropolitan regions with high infection rates. To increase the findings' generalizability and policy significance, more research with bigger sample sizes in various environmental, social, and geographic contexts is required.

ASSERTIVE

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DISPUTE OF INTEREST

This study is not connected to any conflicts of interest.

AUTHOR'S CONTRIBUTION

Hasan Ali Ali Fateh: writing original draft, methodology, investigation. Anwar G Al-Madhaji: formal analysis, data curation, conceptualization, Al-Shamahy H: formal analysis, data curation, conceptualization.

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