

Incidence of Cholera Outbreak in Hodeidah, Yemen , 2024 : A Technical Report

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Abstract

Background: Cholera remains a significant public health concern in Yemen, particularly in regions like Hodeidah, where inadequate sanitation, limited healthcare infrastructure, and socio-economic challenges exacerbate disease transmission. **Objective:** This study aimed to analyze the epidemiological and clinical characteristics of the 2024 cholera outbreak in Hodeidah, Yemen (Third Wave).

Methods: The study was conducted in a retrospective design (cases series) from January to November 2024 at the Diarrhea Treatment Center (DTC) in collaboration with the Center of Tropical Medicine and Infectious Diseases (CTMID), Al-Thawra Public Hospital Authority, Hodeidah. Descriptive and inferential statistical methods were applied to analyze data on cholera cases.

Results: A comprehensive analysis of 6,526 cholera cases in Hodeidah revealed that 51.2% of cases were females, while males accounted for 48.8%. A non-significant statistically with gender disparity in cholera incidence was observed ($\chi^2 = 4.021$, p -value = 0.0449). The age distribution showed that patients over 15 years were disproportionately affected, representing 62.1% of the total cases. Children aged 1-5 years and 6-15 years accounted for 19.5% and 18.5% of cases, respectively. While the results of age distribution showed the association with cholera incidence ($\chi^2 = 2424.837$, p -value < 0.00001). Dehydration severity varied, with 69.3% of cases presenting with severe dehydration, underscoring the need for immediate medical intervention. Urban districts, particularly Al Hawak district reported the highest attack rate (AR = 2.37 %), while the overall of AR in Hodeidah Governorate was 0.19. On the other hand, the case fatality rate (CFR) was less than 1 % about 8/6,526 (0.0012 %). **Conclusion:** The findings highlight systemic vulnerabilities, including poor sanitation, overcrowding, and limited healthcare access, particularly in urban hotspots. Immediate measures, such as rehydration therapy and vaccination campaigns, coupled with long-term strategies to improve water and sanitation infrastructure, are critical to mitigating future outbreaks in Hodeidah.

Keywords: Cholera, Incidence, Hodeidah, Yemen, 2024,

1. Introduction

Cholera, caused by *Vibrio cholerae*, continues to pose a significant health threat, particularly in areas with limited access to clean water and inadequate sanitation. Yemen, and specifically the Hodeidah governorate, has experienced recurring cholera outbreaks, with one of the most severe epidemics starting in 2016. This crisis has been exacerbated by ongoing conflict and humanitarian issues in the country [1]. Cholera is primarily spread through contaminated water and food, with environmental factors such as poor sanitation and flooding playing a critical role in its transmission [2]. The ongoing cholera outbreaks in Yemen are closely linked to various socio-political and infrastructural challenges, including the destruction of water supply systems, limited healthcare access, and insufficient public health resources [3]. These challenges, along with ineffective surveillance systems and delayed responses, have intensified the disease's impact. Inadequate water systems in urban areas of Hodeidah, where overcrowding and poor sanitation are prevalent, significantly contribute to the spread of cholera. This study aimed to analyze the epidemiological characteristics of cholera in Hodeidah, Yemen, 2024 (Third Wave).

2. Methodology

Hodeidah city, situated along Yemen's western coast, has a population exceeding 600,000 residents. Its primary districts include Al Hawak, Al Hali, and Al Mina [4]. The region's geographic features, combined with challenges such as limited healthcare access, malnutrition, and inadequate sanitation, make it highly susceptible to cholera outbreaks [3]. Disparities in healthcare access and sanitation between the urban and districts of Hodeidah are central to this study. In line with WHO and CDC guidelines, the investigation followed key steps: **Prepara-**

tion: Diagnostic tools, rehydration supplies, and protective equipment were prepared for the response team. **Outbreak Confirmation:** Cholera cases surged from January to November 2024, with a higher incidence in urban areas. **Verification:** Cases were confirmed through stool cultures and rapid diagnostic tests according to WHO protocols [5]. **Case Definition:** Cases were categorized as suspected, probable, or confirmed based on epidemiological and clinical criteria [6,7]. **Data Collection:** Comprehensive demographic and clinical data were collected from cholera patients [3]. **Descriptive Epidemiology:** Data analysis aimed to identify trends and geographical distribution using statistical packaging for social sciences (SPSS). **Control Measures:** Interventions included providing rehydration solutions, ensuring clean water access, and promoting hygiene education [8]. **Surveillance:** Ongoing surveillance ensured timely interventions to reduce mortality [2]

3. Results

3.1. Sex and age

A comprehensive analysis of 6,526 cholera cases in Hodeidah revealed that 51.2% of cases were females, while males accounted for 48.8%. The age distribution showed that patients over 15 years were disproportionately affected, representing 62.1% of the total cases. Children aged 1-5 years and 6-15 years accounted for 19.5% and 18.5% of cases, respectively. A statistically non-significant gender disparity in cholera incidence was observed ($\chi^2 = 4.021$, p -value = 0.0449), while the results of age distribution showed the association with cholera incidence ($\chi^2 = 2424.837$, $p < 0.00001$). (Table 1)

Table 1. Distribution of cholera cases by sex and age groups (N=6,526)

Category	Subcategory	(n)	(%)
Sex	Females	3,344	51.2
	Males	3,182	48.8
Age Group	1-5 years	1,271	19.5
	6-15 years	1,205	18.5
	Over 15 years	4,050	62.1

3.4. Urban and rural

Urban districts in Hodeidah exhibited varying cholera attack rate (AR), with Al Hawak reported the highest incidence at 2.51%, followed by Al Hali at 1.85%. Al Mina reported a lower incidence of 0.49%. (Table 2 and 3) (Figure 1).

Table 2. Urban distribution incidence rate of cholera (n=5,063)

District	Population	n	(%)
Al Mina	157,591	771	0.49
Al Hali	98,465	1825	1.85
Al Hawak	98,465	2467	2.51

Table 3. Rural distribution incidence rate of cholera (n=1,463)

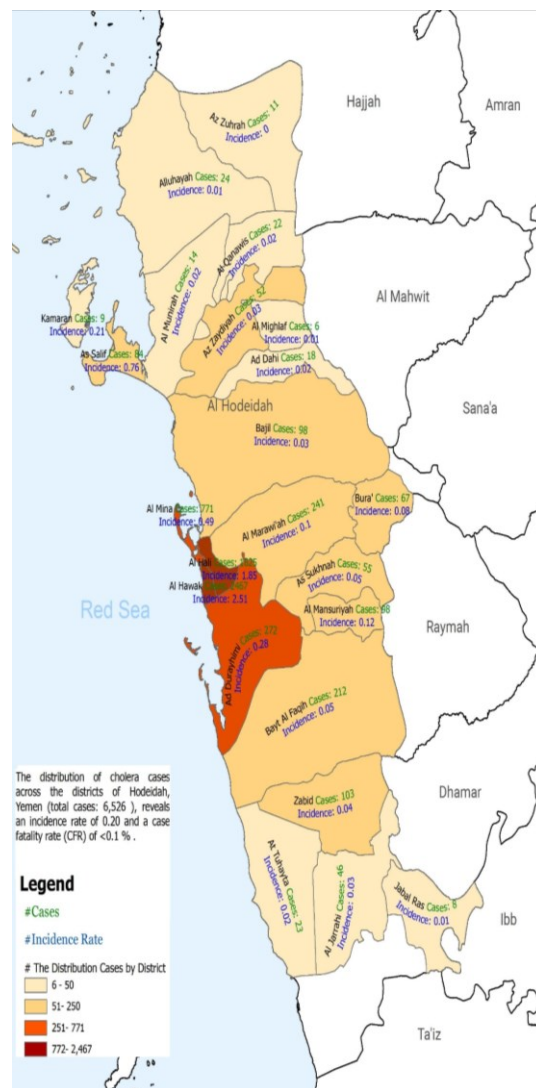
District	Population	n	(%)
Al Dahi	97,259	18	0.019
Al Durayhimi	98,465	272	0.276
Al Jarrahi	158,923	46	0.029
Al Mansuriyah	79,774	98	0.123
Al Marawi'ah	231,611	241	0.104
Al Mighlaf	71,069	6	0.008
Al Munirah	66,223	14	0.021
Al Qanawis	129,378	22	0.017
Alluhayah	188,554	24	0.013
Al Salif	11,097	84	0.757
Al Sukhnah	106,179	55	0.052
Al Tuhayta	121,620	23	0.019
Al Zaydiyah	169,479	52	0.031
Al Zuhrah	248,364	11	0.004
Bajil	302,160	98	0.032
Bayt Al Faqih	430,676	212	0.049
Bura'	80,265	67	0.083
Jabal Ras	80,399	8	0.010
Kamaraan	4,370	9	0.206
Zabid	278,475	103	0.037

3.3. Severity of cholera

Dehydration severity, a critical clinical determinant, revealed that 69.3% of cases presented severe dehydration, underscoring the urgent need for immediate medical intervention. Moderate dehydration was observed in 20.3% of cases, while mild dehydration accounted for 10.4%.

3.4. Seasonality of cholera

The 2024 cholera outbreak in Hodeidah demonstrated a distinct temporal pattern, with a maximum peak in summer namely June, accounting for 24.68% of the total annual cases (Table 4).

**Figure 1.** The map and distribution of cases by district. The attack rate (AR) in Hodeidah Governorate was 0.19 in 2024**Table 4.** Distribution of cholera cases by month (N=6526)

Month	(n)	(%)
March	368	5.64
April	370	5.67
May	654	10.02
June	1,611	24.68
July	1,060	16.24
August	520	7.97
September	635	9.73
October	762	11.67
November	546	8.37

3.5. Morbidity and mortality

The overall of AR in Hodeidah Governorate was 0.19 % in 2024 while in the urban areas was reported 0.78 % , compared to 0.053 % in rural areas. On the other hand , the case fatality rate was less than 1 % namely 8/6,526 (0.0012 %). On the other mean, the recovery was 99.88 % (Figure 2) .

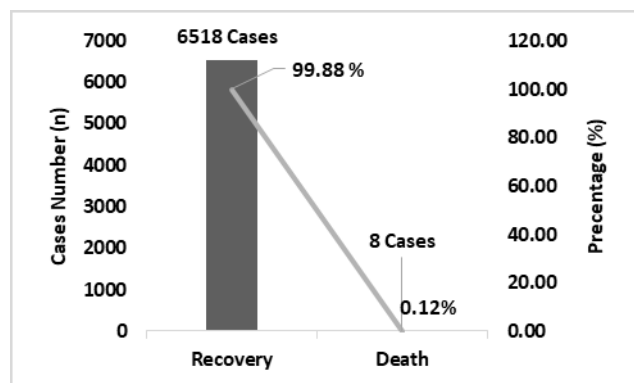


Figure 2. Cholera outcome

4. Discussion

The 2024 cholera outbreak in Hodeidah exposed significant vulnerabilities, including overcrowding, poor sanitation, and limited healthcare infrastructure, particularly in urban districts like Al Hawak and Al Hali. These issues, compounded by socio-economic and environmental factors, contributed to the rapid spread of the disease. A comprehensive analysis of 6,526 cholera cases in Hodeidah indicated a near-equal gender distribution, with females accounting for 51.2% and males for 48.8% of cases. Although a slightly higher incidence was observed among females, the difference was not statistically significant, suggesting that gender does not play a major role in cholera susceptibility in this population. In contrast, age distribution revealed a significant association with cholera incidence. Patients over 15 years comprised the majority of cases (62.1%), while patients children aged 1–5 and 6–15 years accounted for 19.5% and 18.5% of cases, respectively. These findings suggest that adults may be at elevated risk due to increased occupational and domestic exposure to contaminated water sources, as well as potential deficiencies in acquired immunity. The higher burden among adults underscores the need for targeted interventions, including improved access to clean water and sanitation facilities, particularly for working-age populations in endemic regions [7,9]. In rural districts, cholera incidence rates were considerably lower than in urban areas, with Ad Dahi, Al Qanawis, and Az Zuhrah recording incidences below 0.02%. However, As Salif showed a relatively higher incidence rate of 0.76%. These differences highlight the challenges faced by rural populations, including access to clean water and healthcare services, which necessitate tailored public health strategies to address these vulnerabilities [1,2,10]. Cholera disproportionately affected females and younger adults due to their roles in caregiving and water collection, which increased their exposure to contaminated water [5]. The case mild, moderate and severe were effectively managed with oral rehydration therapy [3,11]. These findings emphasize the demographic and clinical characteristics of cholera cases in Hodeidah and underscore the urgent need for targeted public health interventions. Strengthening healthcare infrastructure and implementing preventive measures are critical to reducing mortality and morbidity during cholera outbreaks [8,12]. The 2024 cholera outbreak in Hodeidah demonstrated a distinct temporal pattern, with a significant peak in June, accounting for 24.68% of the total annual cases. This seasonal trend suggests that environmental factors, including water availability and elevated temperatures during the summer, likely play a pivotal role in cholera transmission. Such findings underscore the importance of implementing targeted public health interventions during high-risk periods to mitigate the spread of the disease [2,8]. Efforts to control the outbreak should prioritize improving water quality, sanitation practices, and public awareness campaigns while reinforcing healthcare infrastructure. These measures can significantly reduce cholera incidence and mortality, particularly during the warmer months when transmission risks are elevated. Understanding these temporal patterns is critical for crafting precise

and effective responses to future outbreaks [7,12]. These disparities reflect differences in population density, water sanitation, and healthcare accessibility. Urban populations face unique vulnerabilities due to crowding and limited access to clean water, necessitating targeted interventions to address these challenges effectively [3, 6, 10]. To prevent future outbreaks, immediate interventions such as oral rehydration therapy and vaccination campaigns must be complemented by long-term strategies. These include rehabilitating water and sanitation infrastructure, addressing social inequalities, and improving healthcare access. Urban areas with inadequate sanitation systems emerged as the primary hotspots for cholera, highlighting the need for targeted public health interventions and community awareness initiatives [8]. The findings emphasize the importance of addressing systemic issues such as inequality, sanitation deficiencies, and limited healthcare access to reduce the incidence and impact of cholera. Comprehensive public health strategies that tackle both immediate and long-term challenges are essential for effectively controlling cholera outbreaks in Yemen [2,9,13]. These findings suggest that adults face heightened risks due to increased exposure to contaminated water sources and sanitation challenges, coupled with reduced immunity compared to children [7,9], highlighting differential risk factors between males and females [6]. Furthermore, the age distribution demonstrated a strong association with cholera, with adults constituting the most affected demographic [2].

5. Conclusion

This study emphasizes the need for targeted public health interventions in cholera-affected areas, particularly in high-risk urban districts. The DTC reported low CFR below 1%. The addressing the root causes of cholera, such as improving water supply systems and healthcare access, is essential for preventing future outbreaks. Public health efforts must be comprehensive, tackling both immediate medical needs and long-term infrastructural challenges to effectively combat cholera in Yemen.

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 Ethics Committee of Tropical Medicine and Epidemiology Studies of Hodeidah University (CTMES-HU) Hodeidah, Yemen.

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