



Review

Cholera in Lebanon: A new epidemic in an on-going endemic of weak infrastructure

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ABSTRACT

On October 6, 2022, the WHO declared the start of a cholera outbreak in Lebanon, the first cholera outbreak since 1993. The aim of this review is to advance the evolution of the cholera epidemic in Lebanon and its underlying risk factors. Early during the outbreak, the majority of confirmed cases were reported among displaced Syrian refugees living in suboptimal conditions; however, three weeks following the former, cholera spread nationwide. This spread was exacerbated by the decline in water treatment investments, lack of electric supply in water treatment plants and collapsing healthcare and economic infrastructures. Addressing the structural root causes is urgently needed in order to mitigate the re-emergence of cholera and other infectious diseases spreading among vulnerable populations and thus threatening national and regional health security.

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Introduction

Cholera has been a global public health problem that resulted in 7 pandemics since 1961 [1]. Cholera is caused by the bacterium *Vibrio cholerae*, serogroups O1 and O139, and transmitted from person-to-person via the fecal-oral route through the ingestion of contaminated water or food [1]. The majority of cholera cases are mild with approximately 20% suffering from severe disease with dehydration and death reported among high-risk groups [1]; the latter includes children < 5 years old, elderly, individuals with chronic diseases, and those with limited access to rehydration therapy and medical services [2]. Globally, it is estimated that cholera results in 1.3–4 million cases and approximately 21,000–143,000 deaths per year [2]. Vaccination and access to safe water have been effective in reducing cholera cases and deaths worldwide. The Global Task Force on Cholera Control (GTFCC) advanced a global strategy to control cholera in 2017 [1]. The aim of this strategy is to reduce cholera-related deaths by 90% and eradicate cholera in around 20 endemic countries by 2030 through early detection and quick multi-sectorial response to contain outbreaks or prevent their recurrence. In an attempt to implement this strategy, the GTFCC established a Country Support Platform (CSP) in 2020 to effectively support, fund, and control cholera at local and global levels. Despite these efforts, the incidence of cholera was reported in 27 countries in 2020 leading to 323,360 cases and 857 deaths [3]. Recently, the World Health Organization (WHO) declared an unprecedented rise in cholera cases leading to outbreaks in African and Asian countries [4]. The Eastern Mediterranean Region (EMR) had a greater portion of cholera outbreaks reported specifically in Syria [5], Lebanon [6], Afghanistan, Islamic Republic of Iran, Pakistan, Iraq, Yemen, and Somalia [7]. These outbreaks were attributed to floods, droughts, conflicts, population displacements, and limited access to clean water.

Lebanon is a small country in the EMR bordered to the North and East by Syria with an estimated population of 5.4 million. The country hosts the largest number of refugees per capita and per square kilometer in the world with an estimate of 1.5 million Syrian refugees, 210,000 Palestinian refugees, and more than 13,700 refugees of other nationalities [8]. This increased the burden of the national economy and weakened the already fragile healthcare system and its infrastructure. October 2019 marked the beginning of a severe and persistent economic and financial crisis in Lebanon, which was exacerbated by the COVID-19 pandemic. The World Bank described this economic and financial crisis among the worst globally since the mid-19th century with an estimated nominal Gross Domestic Product (GDP) of \$23.1 billion in 2021 compared to \$52 billion in 2019; with the Lebanese pounds losing more than 90% of its value against the US dollar [9]. During the last two years, the banking sector implemented informal capital controls due to the depletion of foreign exchange (FX) reserves; consequently, Lebanon witnessed a drastic collapse in basic services and inability to import basic goods including necessary medical devices and essential medications [10]. The complex economic crisis resulted in increasing the poverty level to 80% of the Lebanese population [11]. The lack of electric supply in wastewater treatment plants and water pumping stations contributed to increasing the risk of spread of waterborne and foodborne infectious diseases including cholera. On October 4 and October 12, 2022, the first cholera case, a 51-year-old Syrian man living in an informal settlement in North Lebanon, and the first cholera-related death, a 16-year-old Syrian refugee, were reported in Lebanon, respectively [8,12]. On October 6, 2022, the WHO declared the first cholera outbreak in Lebanon since 1993 [12]. The 1993 cholera outbreak started in Syria and spread to Lebanon; this outbreak lasted for 3 months and resulted in 344 laboratory confirmed cases and 29 deaths [10,13,14].

The aim of this minireview is to advance the evolution of the cholera epidemic in Lebanon and its underlying risk factors.

Methods

Study design and data extraction

This is a descriptive epidemiological study relying on secondary data reported by the Ministry of Public Health (MoPH) in Lebanon. The MoPH screened for cholera by rapid diagnostic testing (RDT) among patients presenting with acute watery diarrhea; positive RDTs were confirmed by culture. The cholera surveillance reports published on the official website of the MoPH were used to extract data on culture-confirmed cases [10]. The following data were extracted: geographic distribution of cases, gender and age distribution, the number of cholera cases confirmed by culture, the number of suspected cases, hospitalizations, mortality and case fatality rates (CFR). Data on vaccine coverage and vaccine rates were also extracted from the MoPH statements on cholera in Lebanon [10], the United Nations High Commissioner for Refugees (UNHCR) reports [15–17], and the WHO reports [18]. The extracted data extended between October 4, 2022 and June 2, 2023, the last date of cholera surveillance reports in Lebanon.

Data analysis

We compiled the data on cholera cases, deaths, and hospitalization using Microsoft excel. Microsoft excel was also used to calculate the number of cases per month for data completion as well as CFR. We calculated the monthly CFR as follows: (Cumulative number of deaths/Cumulative number of confirmed cases) × 100; since the monthly CFR data reported by the MoPH surveillance reports was calculated out of the cumulative number of confirmed and suspected cases per month rather than only confirmed cholera cases. We generated a map (Microsoft PowerPoint) using the Lebanese Map template to highlight the distribution of cholera cases in Lebanon. Pie charts and graphs were generated using GraphPad Prism version 10 (GraphPad Software Inc., USA).

Results

Cholera epidemiology in Lebanon

October 2022 marked the first cholera outbreak in Lebanon since 1993. This outbreak started 6 weeks following a reported outbreak in Syria caused by the same subtype, *Vibrio cholerae* O1 *El-Tor* *Ogawa* [15]. The re-emergence of cholera in Lebanon was first detected in a Syrian man followed by spread to Syrians living in settlements as well as Lebanese. The high number of Syrian refugees residing in Lebanon in addition to the regular movement of citizens from both countries through the Lebanese-Syrian borders suggest an epidemiologic link to cases detected in Syria.

Between October 11, 2022 and June 6, 2023, a total of 671 confirmed cases were detected in Lebanon. The first cholera case and first cholera-related death were reported among two Syrian refugees in Northern Lebanon. Since the beginning of the cholera outbreak in Lebanon, the majority of confirmed cases have been reported among displaced Syrian refugees living in suboptimal conditions in North Lebanon, Akkar and the Bekaa [6,11]. However, soon after, cholera started to spread and cases were reported from the eight Lebanese governorates (Figs. 1 and 2).

Between October 11 and October 31, 2022, more than 21-fold increase in the cumulative number of cases was recorded with the majority detected in Akkar (n = 191) and North Lebanon (n = 90) (Fig. 2). This was accompanied by a 17-fold increase in the cumulative number of deaths (n = 17) along with an increase in the total number of occupied hospital beds (n = 93) [10]. The number of cases kept on the rise with an average confirmed daily cases of eight in November compared to five in October 2022 (Fig. 2). The

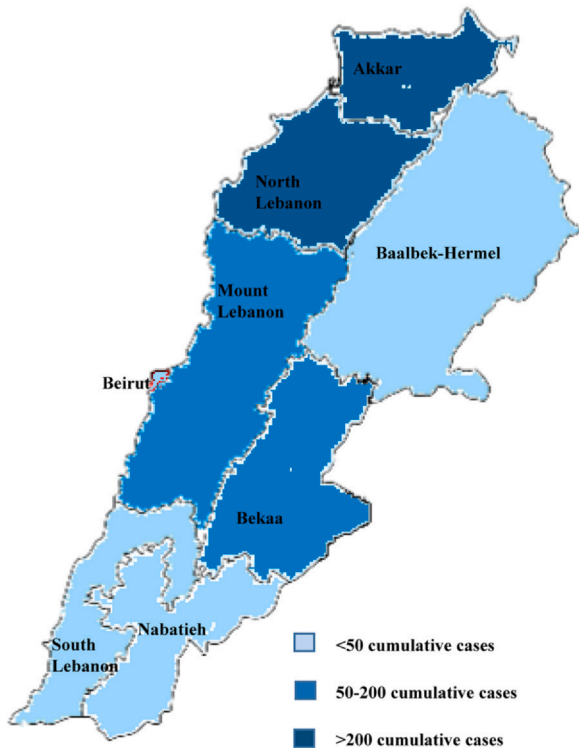


Fig. 1. Geographic distribution of cholera in Lebanon (October 2022-April 2023). The map of Lebanon displays the 8 Governorates with Akkar and North Lebanon showing the highest numbers of confirmed cholera cases. Light blue color: governorates with < 50 cumulative cholera cases; dark blue color: governorates with 50–200 cumulative cholera cases; navy blue color: governorates with > 200 cumulative cholera cases.

majority of these cases continued to be mainly detected in Akkar (n = 81) and North Lebanon (n = 88) followed by Mount Lebanon (n = 26), Bekaa (n = 12), Baalbek-Hermel (n = 9), South Lebanon (n = 8), Beirut (n = 5), and Nabatieh (n = 1) (Figs. 1 and 2). By November 30, 2022, the total number of cases with acute watery diarrhea (AWD) was 4594 out of which a total of 622 were

confirmed cholera cases and 20 cholera-related deaths. The majority of AWD cases were females (53%) followed by children less than 5 years old (29%) [10].

By December 2022, a 99% decrease in the average of daily confirmed cases was reported compared to previous months (Fig. 2) with one confirmed case reported in January 2023, and none detected since February 2023 compared to 231 confirmed cases in November 2022 (Figs. 2 and 3). This was also accompanied by a decrease in the number of cholera-associated deaths per month from 17 with a CFR of 4.35% in October 2022 to a CFR of 0% in January 2023 (Fig. 3). As of June 2, 2023, the surveillance reports of the MoPH and the UNHCR showed that the number of AWD cases (n = 8007) was highest among children 0–4 years (31%), 5–14 years old (23%) and adults 25–44 years old (18%) with the majority of these cases being females (53%), Lebanese (69%) followed by Syrian (29%) and other nationalities (2%) and 16% of all cases required hospitalization (Fig. 4). By the end of June 2023, the total number of confirmed cholera cases and deaths was 671 and 23, respectively, whereby the *V. cholerae* O1, serotype Ogawa strains of the seventh pandemic El Tor (7PET) lineage were responsible of the former [10,19].

Cholera response in Lebanon: Oral cholera vaccine (OCV)

The decline in the number of confirmed cases, hospitalization, and deaths observed in January 2023 coincided with the administration of cholera vaccines. Vaccination against cholera in Lebanon was implemented through the administration of targeted door-to-door single dose of the oral cholera vaccine (OCV) rather than two doses due to global shortages of cholera vaccines [16]. The first phase of cholera vaccination campaign was implemented between November 12 and December 12, 2022 and reached over 90% coverage of the targeted population. The latter included children above one year old, healthcare workers, refugees and their communities, and prisoners in the most affected areas in Lebanon (Akkar, Bekaa, North, and Baalbek-Hermel); a total of 585,940 persons were vaccinated in the first phase of OCV campaign (Fig. 5) [10,16,18,20]. The second phase of the vaccination campaign started on December 16, 2022 and lasted for three weeks reaching a total of 454,743 persons. This campaign was launched following the delivery of 900,000 doses and targeted vulnerable populations in 295 cities and villages from the 8

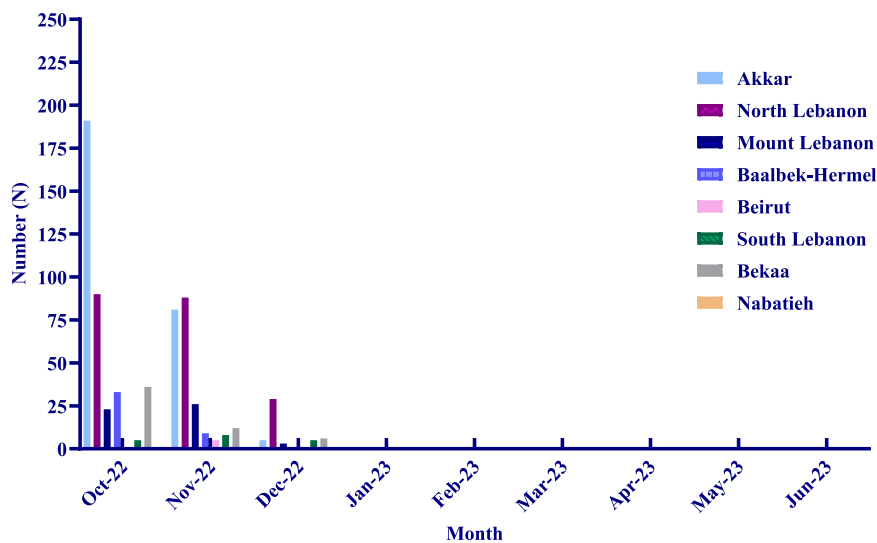


Fig. 2. The distribution of cholera cases in Lebanon. The highest number of culture-confirmed cases was observed in Akkar and North Lebanon (October–December 2022) followed by a decline in the cumulative number of confirmed cases across the 8 Governorates between December 2022 and April 2023. X-axis: month-year; Y-axis: Number of confirmed cholera cases per governorate.

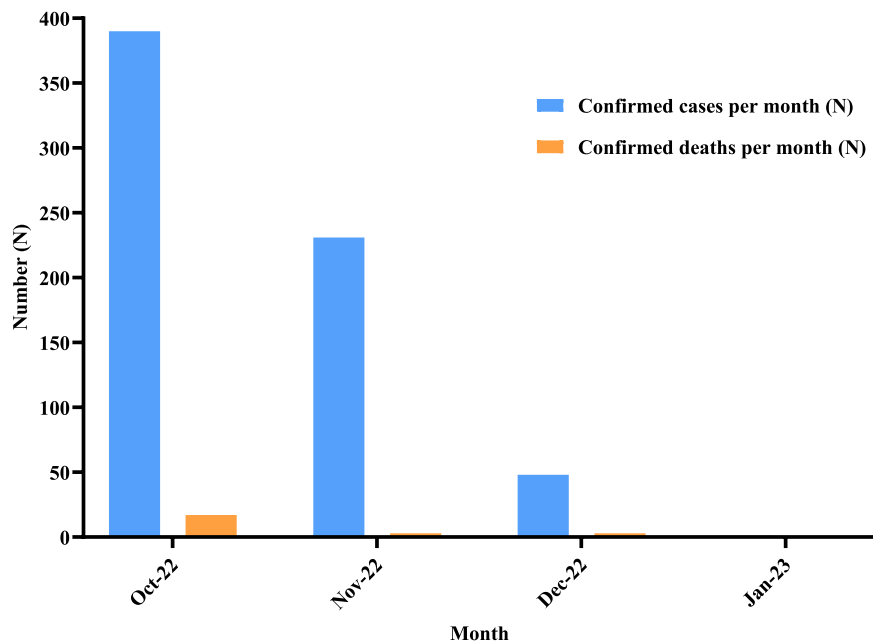


Fig. 3. Morbidity and Mortality due to cholera in Lebanon during the 2022–2023 outbreak (October 2022–January 2023). The absolute numbers of culture-confirmed cases and deaths per month are displayed and show a gradual decline between October 2022 (n = 390 cases; n = 17 deaths) and January 2023 (n = 1 case; n = 0 death). X-axis: month-year; Y-axis: number of confirmed cholera cases and deaths per month.

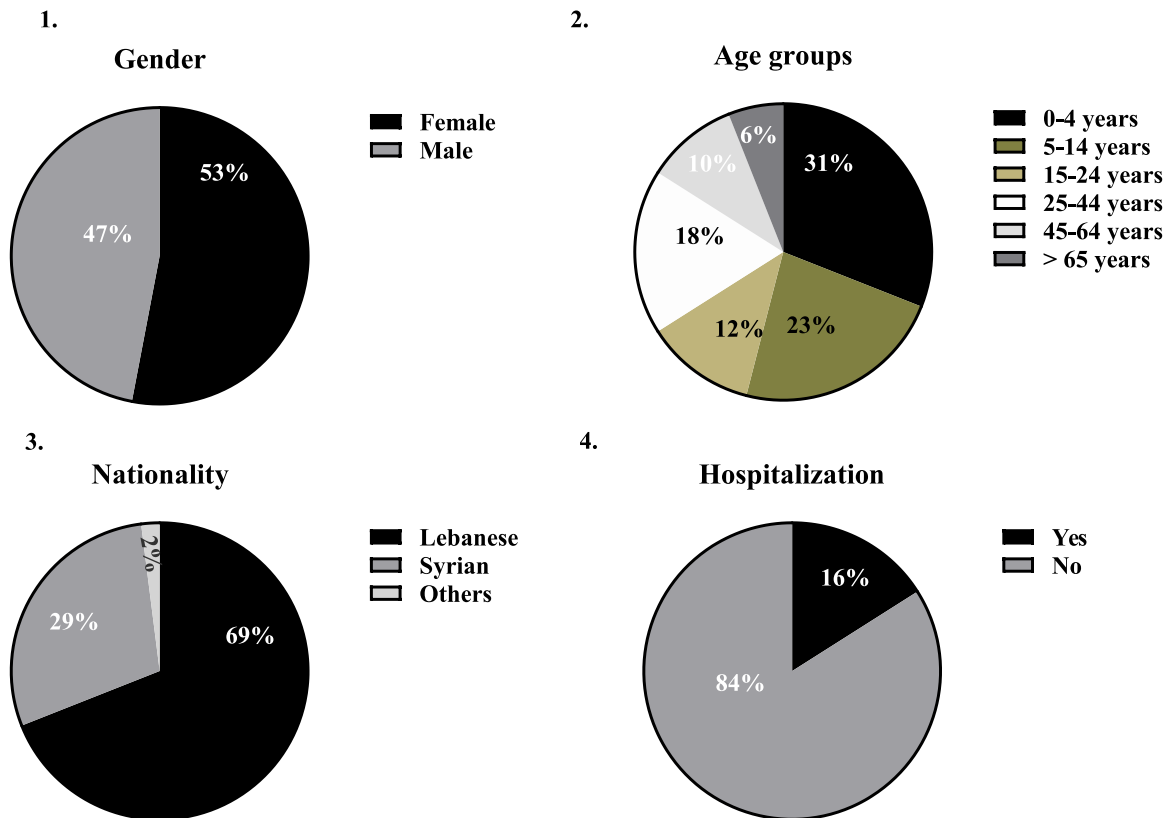


Fig. 4. The demographic distribution of cholera in Lebanon. Data displayed in this figure include gender (1), age (2), nationality (3), and hospitalization (4) of cholera cases as of June 2, 2023. These aggregated percentages were calculated by the MoPH using the total number of confirmed and suspected cholera cases (n = 8007).

governorates reported to have high number of cases (Fig. 5) [18]. The national vaccination campaign in collaboration with Médecins Sans Frontières (MSF) and non-governmental organizations (NGOs) also offered cholera awareness through distributing cholera-related educational materials [10,15]. By the end of the vaccination

campaign, more than 1 million single doses of OCV had been administered (Fig. 5). The majority of those who received the vaccine were women (53%) and children (48%) from the Lebanese (61%) and Syrian (35%) populations who lived in vulnerable areas across Lebanon (Fig. 6) [10,18,21].

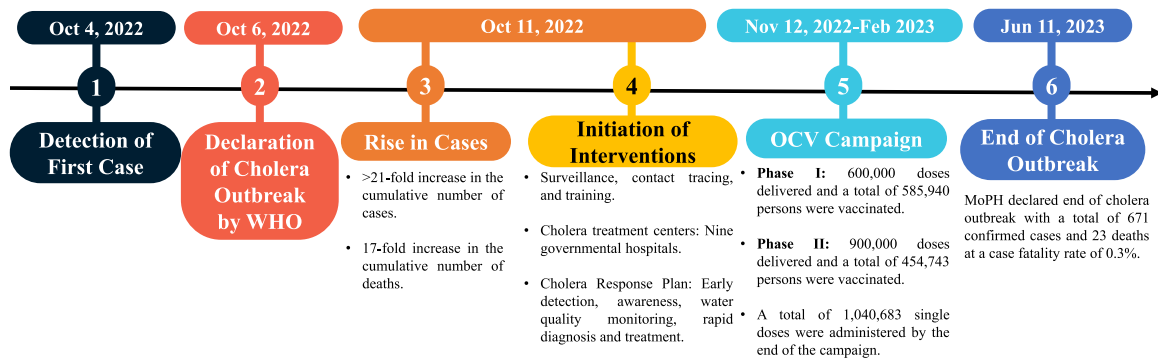


Fig. 5. Timeline and key events of cholera response in Lebanon. This figure summarizes the evolution of cholera across time since the detection of the first confirmed case as well as the response to this outbreak including OCV and non-pharmaceutical interventions (October 22 and June 2023).

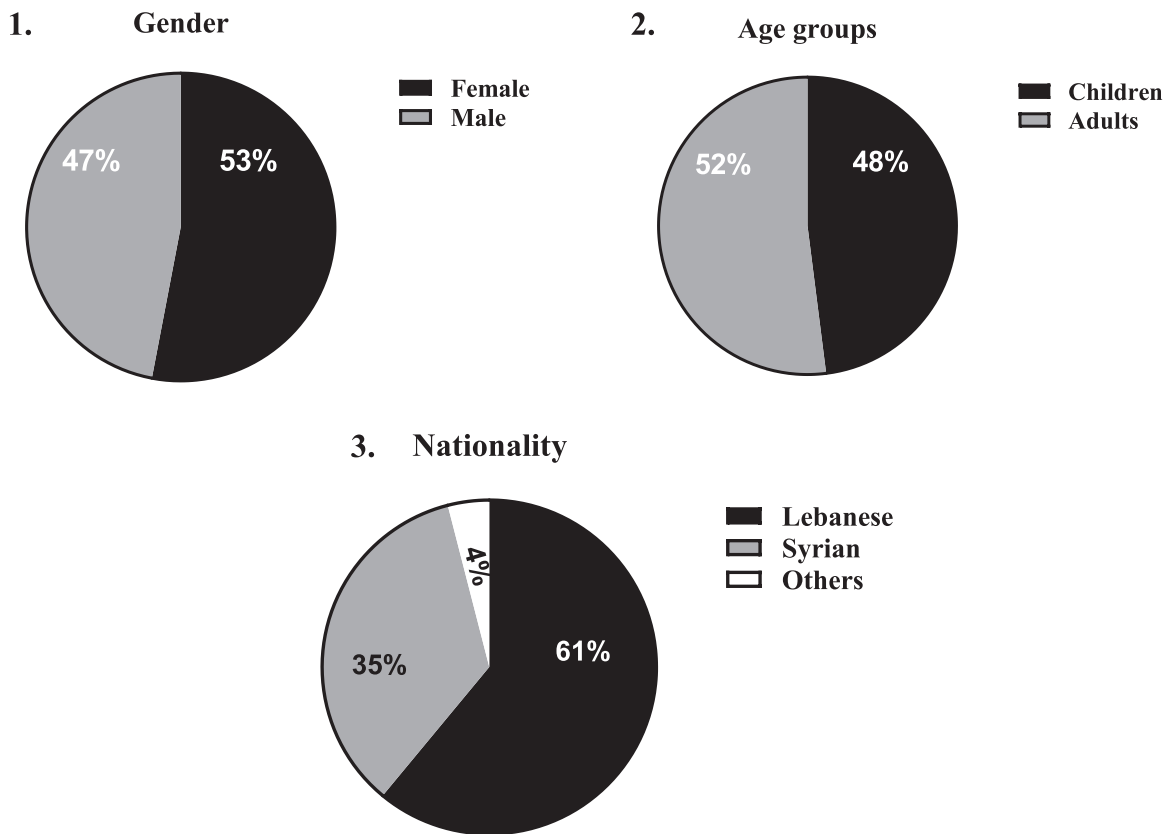


Fig. 6. The distribution of single-dose OCV in Lebanon (n = 1,040,683). The administration of OCV to high-risk groups reached a total of 1,040,683 distributed by gender (1), age (2), and nationality (3) as shown in the respective pie charts.

Cholera response in Lebanon: Non-pharmaceutical interventions

The cholera response in Lebanon was based on a dual approach combining OCV as well as non-pharmaceutical interventions in order to control the spread of cholera among vulnerable people living in suboptimal conditions with lack of access to clean and safe water. Consequently, the MoPH in coordination with the Ministry of Energy and Water (MoEW), the WHO, the United Nations International Children’s Emergency Fund (UNICEF), and the International Committee of the Red Cross (ICRC) prepared a strategic plan to control further spread of cholera. This plan included increasing surveillance and contact tracing, monitoring water quality, training trainers for the central and peripheral teams of the surveillance unit, training registered local physicians, hospitals, and medical centers, preparing and assigning nine referral governmental hospitals to act as cholera treatment centers, and developing a

cholera preparedness and response plan [1]. The latter focused on increasing capacity for early detection of cholera cases, distributing rapid diagnostic tests, securing medicines, and requesting additional doses of OCV from the International Coordinating Group (ICG) on Vaccine Provision (Fig. 5). The plan also included the assessment of the quality of water testing laboratories in eight hospital laboratories in various Lebanese regions for quick detection of *V. cholerae* as well as the establishment of a crisis cell and the collaboration with different ministries including MoEW, interior and municipalities, and environment to ensure access to clean water and sanitation among people living in informal settlements [1].

The coordination between governmental and non-governmental organizations at different levels was successful in implementing the cholera response plan and mitigating disease transmission in Lebanon. The Risk Communication and Community Engagement Task Force Lead (UNICEF) organized several awareness campaigns

and disseminated information targeting cholera transmission, symptoms, treatment, prevention, and importance of water treatment and chlorination at the national and household levels [17]. The ICRC also supported the cholera national response through restoring the water supply systems in affected areas along with water testing, distributing water purification tablets to around 2700 households throughout the country, supporting the development of standard procedures for infection control, waste management and case management in public hospitals, specifically in the North [6]. Moreover, the UNICEF Water, Sanitation, and Hygiene (WASH) facilitated access to clean water for drinking and domestic use in hotspot areas and distributed over 498,703 liters of fuel to support the functioning of water and wastewater plants in 5 Lebanese governorates (North Lebanon, South Lebanon, Bekaa, Beirut and Mount Lebanon) reaching around 841,500 people living across the affected areas [17]. The UNICEF WASH also provided medicines, disinfection kits (n = 7983), and hygiene kits (n = 8949) to affected areas in addition to awareness campaigns in collaboration with the MoPH and WHO [17]. As of May 2024, the UNICEF WASH continued to support access to clean water and sanitation services to vulnerable population living in informal settings in Lebanon despite the numerous challenges and the lack of funds [22]. Training sessions for both Rafiq Hariri University Hospital and Tripoli Governmental Hospitals on early cholera detection, isolation and treatment were also held by the WHO throughout the country [6,23]. These interventions along with the administration of vaccines supported the control of cholera for more than 12 weeks between January 6 and June 11, 2023. The MoPH declared the end of the cholera outbreak in Lebanon on 11 June 2023 (Fig. 5) which resulted in a total of 671 confirmed cases and 23 deaths (Fig. 3) [10].

Discussion

Cholera has been described as a disease of the poor living in suboptimal conditions with poor sanitation and lack of access to safe water [2]. Importantly, countries in conflict are increasingly vulnerable to cholera and other infectious diseases due to displacement and living in settlements, overcrowding and poor access to healthcare services [24–26].

The 2022–2023 cholera outbreak was the first in Lebanon since 1993 and resulted in a total of 671 confirmed cases and 23 deaths [10]. Importantly, both the 1993 and the recent outbreaks were preceded by outbreaks in Syria and then spread to Lebanon and were caused by *Vibrio cholerae* O1 El-Tor Ogawa [13–15,19]. The high number of Syrian refugees residing in Lebanon and living in suboptimal conditions as well as the weak healthcare infrastructure exacerbated by the COVID-19 pandemic and the economic crisis, are important drivers of cholera re-emergence and spread in Lebanon. Lebanon has been also suffering from a decline in investments in public water treatment, mixing sewage with drinking water due to lack of monitoring the safety of the latter, lack of electric supply in water treatment plants, shortage of medicine and collapsing healthcare and economic infrastructures [3]. The latter played a significant role in the spread of cholera and other infectious diseases outbreaks in Lebanon including Hepatitis A virus (HAV) which started in 2022 and is still ongoing with the majority of cases reported in North Lebanon and the Bekaa; the same hotspots of cholera [27]. A total of 2407 HAV confirmed cases were detected since January 2024 [28].

The national cholera response included door-to-door vaccination of single doses of OCV vaccine, designating treatment centers to treat severe cholera cases, implementing WASH, facilitating access to safe and clean water among vulnerable population, strengthening cholera laboratory testing, monitoring cholera strains in various clinical and environmental samples, distributing hygiene kits and oral rehydration solutions, and spreading awareness on cholera

prevention and control. Despite the success of the national response in ending the outbreak in Lebanon, the short-term protection of the single dose OCV along with the detection of cases in the region, specifically Syria, will continue to exert a risk of cholera re-emergence in Lebanon thus, threatening national and regional health security. To overcome this threat, a systemic treatment of the structural root causes should be implemented. Therefore, the government must ensure access to clean water and sanitation through the rehabilitation of water treatment plants and continuous microbiologic monitoring of water quality. Importantly, continuous epidemiologic and genomic surveillance programs of diarrheal illnesses, especially environmental surveillance, are urgently needed in order to continuously predict trends and inform public health interventions. The implementation of these collective measures would reduce and prevent the re-emergence of cholera and other infectious diseases' outbreaks in Lebanon and the region.

Conclusion

The cholera outbreak in Lebanon highlights the urgent need for immediate national interventions to address the structural root causes and strengthen the fragile water, sanitation and healthcare infrastructure. It also underscores the importance of implementing long-term measures including environmental surveillance programs of diarrheal illnesses and sustainable WASH systems to prevent future outbreaks to uphold national and regional health security. Improved preparedness plans are needed in order to prevent future outbreaks while capitalizing on the strengths and weaknesses of the response as well as conducting gap analysis at the national and governorate levels in Lebanon. This is critical to support healthcare system strengthening, intersectoral coordination as well as re-positioning needed supplies and vaccines.

List of Abbreviations

AWD: Acute Watery Diarrhea
 CFR: Case Fatality Rate
 CSP: Country Support Platform
 EMR: Eastern Mediterranean Region
 FX: Foreign Exchange
 GDP: Gross Domestic Product
 GTFCC: Global Taskforce on Cholera Control
 ICG: International Coordinating Group
 ICRC: International Committee of the Red Cross
 MoEW: Ministry of Energy and Water
 MoPH: Ministry of Public Health
 MSF: Médecins Sans Frontières
 OCV: Oral Cholera Vaccine
 RDT: Rapid Diagnostic Testing
 UNHCR: United Nations High Commissioner for Refugees
 UNICEF: United Nations International Children's Emergency Fund
 WASH: Water, Sanitation, and Hygiene
 WHO: World Health Organization

Ethical approval

Ethical approval was not required for this study. Analysis of secondary data reported by the Ministry of Public Health was performed.

Author contributions

MBH was responsible for literature review, data collection and analysis, generating figures, and drafting the first draft of the manuscript. NMM conceptualized, designed, revised and critically appraised the manuscript and finalized the final version. All authors

had full access to all the data in the study and had final responsibility for the decision to submit for publication. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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