

# National Surveillance Data on the Epidemiology of Cholera in Kenya, 1997–2010

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**Background.** Kenya has experienced multiple cholera outbreaks since 1971. Cholera remains an issue of major public health importance and one of the 35 priority diseases under Kenya's updated Integrated Disease Surveillance and Response strategy.

**Methods.** We reviewed the cholera surveillance data reported to the World Health Organization and the Kenya Ministry of Public Health and Sanitation from 1997 through 2010 to determine trends in cholera disease for the 14-year period.

**Results.** A total of 68 522 clinically suspected cases of cholera and 2641 deaths were reported (overall case-fatality rate [CFR], 3.9%), affecting all regions of the country. Kenya's largest outbreak occurred during 1997–1999, resulting in 26 901 cases and 1362 deaths (CFR, 5.1%). Following a decline in disease occurrence, the country experienced a resurgence of epidemic cholera during 2007–2009 (16 616 cases and 454 deaths; CFR, 2.7%), which declined rapidly to 0 cases. Cases were reported through July 2010, with no cases reported during the second half of the year. About 42% of cases occurred in children aged <15 years. *Vibrio cholerae* O1, serotype Inaba, was the predominant strain recorded from 2007 through 2010, although serotype Ogawa was also isolated. Recurrent outbreaks have most frequently affected Nairobi, Nyanza, and Coast provinces, as well as remote arid and semiarid regions and refugee camps.

**Discussion.** Kenya has experienced substantial amounts of reported cases of cholera during the past 14 years. Recent decreases in cholera case counts may reflect cholera control measures put in place by the National Ministry of Health; confirmation of this theory will require ongoing surveillance.

**Keywords.** Africa; cholera; epidemiology; Kenya; surveillance; *Vibrio cholerae*.

Cholera causes an estimated 3–5 million cases and 100 000–120 000 deaths annually worldwide [1]. Epidemic cholera has persisted in many African countries since the seventh pandemic reached the continent in 1970 [2]. The number of cholera cases and the case-fatality rate (CFR) reported from Africa have typically exceeded values reported from other areas of the world [3, 4]. Kenya has experienced several waves of cholera epidemics

causing substantial morbidity and mortality, with 15 discrete outbreaks documented from 1971–2010 [5]. The duration and severity of these outbreaks has varied; however, cholera remains a disease of major public health importance in Kenya and one of the priority diseases for public health surveillance.

Kenya is organized into 8 provinces with various geographic characteristics, including coastal, lake, highland, arid, and semiarid regions, which exhibit different environmental and climatic conditions. Kenya generally has a short rainy season, from October to December, and a longer one, from April to June, with consequent recurring periods of flooding and drought. Certain regions of the country historically have been prone to cholera epidemics, such as Nyanza province, bordering Lake Victoria (during 1997–1999 and 2007–2010); the

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densely populated urban capital, Nairobi; the arid Turkana district; and the Northeastern province, where large refugee camps are situated. However, *Vibrio cholera* also has the potential to spread to new areas with susceptible populations to cause large epidemics.

In Kenya, national cholera surveillance is conducted as part of an integrated disease surveillance and response (IDSR) strategy. The World Health Organization African Regional Office adopted the IDSR strategy in 1998 to strengthen multiple-disease surveillance capability and mitigate the impact of communicable and epidemic-prone diseases, through improving surveillance, laboratory confirmation, and appropriate and timely public health interventions [8]. Since 2000, Kenya has adapted IDSR to progressively build a multilevel surveillance and response system with 18 priority conditions, including cholera. In 2012, the country was in the final phase of adapting new IDSR guidelines in which 35 conditions, including cholera, were identified for surveillance. In the early years of IDSR implementation in Kenya, systematic collection of surveillance data was still weak. Since the adoption of IDSR, the capacity for collecting, compiling, and analyzing data has been strengthened, and adherence and timeliness of reporting have progressively improved.

This article describes the trends and distribution of cholera in Kenya from 1997 through 2010, using available WHO and Kenya Ministry of Public Health and Sanitation (MOPHS) national surveillance data and, for 2009–2010, line list data collected at the district level from healthcare facilities.

## METHODS

### Cholera Surveillance

The Kenya MOPHS provides overall coordination for public health disease surveillance at the national level. The Division of Disease Surveillance and Response oversees cholera surveillance and outbreak response and plays a lead role in implementation of IDSR. Weekly disease surveillance reports from the districts to the national level include aggregate number of cases, deaths, and number of reporting facilities in the districts for each epidemic week.

One case of confirmed cholera is the trigger for public health action. Any healthcare practitioner who attends to a case of suspected cholera is supposed to immediately inform the district disease surveillance coordinator within 24 hours. The coordinator is expected to inform the provincial and national levels within 24 hours, as well. Line lists are generated at healthcare facilities where cases are managed; data are collated at the district level when outbreaks occur. The line lists facilitate collection of standardized information, including the patient's place of residence, age, and sex; the date the case was seen at the healthcare facility; the date of illness onset; and the outcome of laboratory analysis. Reports of aggregate case counts are sent weekly from the districts to the national level and disseminated

widely in a weekly epidemiological bulletin produced by the Division of Disease Surveillance and Response.

In Kenya, most cholera cases are notified on the basis of clinical signs and symptoms specified in the national case definition in the IDSR guidelines. A suspected case of cholera was defined as a patient aged 5 or more years who developed severe acute, profuse, effortless watery diarrhea (usually with vomiting), generally considered to be 3 or more episodes in 24 hours, or as any patient aged >2 years who had acute watery diarrhea in an area where there was a cholera outbreak. Confirmed cholera was defined as a suspected case in which *V. cholerae* O1 or O139 was isolated in stool. Cases identified using the suspect case definition were included in the tally of Cholera cases in an area only after laboratory confirmation of a cholera outbreak in that particular area.

### Laboratory Testing for Cholera

The National Public Health Laboratory Services (NPHLS) Center for Microbiology Reference Laboratory serves as the national reference laboratory for cholera testing in Kenya. Microbiological testing of stool specimens from suspect cholera cases is conducted at the beginning of an outbreak, to confirm the diagnosis; for monitoring the outbreak, including changing antibiotic sensitivity patterns; and to confirm the end of an outbreak.

Collected samples include stool and rectal swab specimens, which are transported to the laboratory in Cary-Blair medium. Samples are enriched in alkaline peptone water and cultured on thiosulfate-citrate-bile salt-sucrose (TCBS) agar. Suspected *V. cholerae* isolates referred from laboratories at lower-level facilities in the healthcare system are also subcultured on TCBS agar and sheep blood agar. Culture plates are incubated overnight at a mean temperature ( $\pm$ SD) of  $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ , except for those containing alkaline peptone water, which are incubated at  $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for 6–8 hours. Characteristic yellow colonies on TCBS agar are subcultured on triple sugar iron agar and sheep blood agar and incubated overnight at a mean temperature ( $\pm$ SD) of  $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . *V. cholerae* is  $\beta$ -hemolytic on sheep blood agar, acid slant, and alkaline peptone water; yields no gas on triple sugar iron agar; is positive for oxidase; and tests positive by the string test. Testing for agglutination with *V. cholerae* O1 antiserum was first performed using polyvalent O1 antisera, and the serotypes were confirmed by monovalent Inaba and Ogawa antisera.

For special studies, additional testing and genetic analysis may be performed with collaborating institutions. In addition to testing performed by the NPHLS, confirmation and testing (by pulsed-field gel electrophoresis and polymerase chain reaction) have been performed by the laboratory at the Centers for Disease Control and Prevention–Kenya Medical Research Institute, as described elsewhere [5].

### Analysis

We reviewed the available cholera surveillance data from the WHO and the MOPHS to obtain the number of cholera cases

and associated deaths for 1997–2010. For 1997, MOPHS data were not available, and for 1999, MOPHS data were incomplete; consequently, for these 2 years, we used data from the WHO annual cholera summary report [6, 7]. For all other years, 1998 and 2000–2010, data from the Kenya MOPHS were used. We calculated the annual national incidence by using the total number of suspected cholera cases reported and the population projections from the Kenya National Bureau of Statistics for each year in the analysis period. Population censuses were conducted in Kenya in 1999 and 2009. We calculated the annual national CFR by dividing the total number of cholera deaths by the total number of suspect cholera cases reported by the district to the national level for each year.

We conducted a descriptive analysis of the cholera data from the national line lists for 2009 through 2010 to summarize the available demographic information on reported cases. Cholera cases were mapped by district to present the geographical distribution of cholera in the country for 2007–2010. Data from the NPHLS for 2007–2010 were reviewed to determine the number and percentage of stool samples tested, with distribution by serotype. Antibiotic susceptibility results were also analyzed. Analysis of the cholera surveillance data was conducted using EpiInfo (version 7.0) and STATA software, version 10.

## RESULTS

### Epidemiology

From 1997 through 2010, a total of 68 522 cases of cholera, including 2641 deaths, were reported to the MOPHS and the WHO (overall CFR, 3.9%). The trends in cholera cases and CFRs for 1997–2010 varied from year to year, as described in Table 1.

The largest outbreak during the study period occurred during 1997, with 17 200 cases (annual incidence, 60.7 cases per 100 000 population) and an estimated 555 deaths (CFR, 3.2%). The outbreak persisted during 1998 and 1999, although at a decreasing level. Following 1999, a steep decline in cholera cases occurred that persisted through 2006.

The cholera incidence began to increase again in 2007 (4.7 cases per 100 000 population), mainly because of a large outbreak originating in Nyanza province. This increase continued in 2008 (8.1 cases per 100 000 population), when a cholera outbreak with unusually high mortality occurred following civil unrest after the disputed presidential elections [9]. Despite efforts to control the epidemic, the outbreak extended into 2009, when cholera was reported in 52 districts, affecting all provinces; during the year, 11 769 cases were reported (annual incidence, 30.5 cases per 100 000 population), with 274 deaths (CFR, 2.3%). During January through July 2010, the incidence declined to lower levels (8.3 cases per 100 000 population); no cases were reported for the remainder of 2010.

**Table 1. Annual Summary Statistics of Cholera Cases in Kenya, 1997–2010**

Year	Cases, No.	Population, No., Millions	Incidence, No. of Cases/100 000 Population	Deaths, No.	CFR, No. of Deaths/No. of Cases
1997	17 200 <sup>a</sup>	28.3	60.7	555 <sup>a</sup>	3.2
1998	15 937	28.8	55.3	994	6.2
1999	10 964 <sup>a</sup>	28.7	38.2	368 <sup>a</sup>	3.4
2000	1509	30.4	5.0	93	6.2
2001	1001	31.3	3.2	55	5.5
2002	319	32.2	1	10	3.1
2003	0	33.2	0	0	0
2004	392	34.2	1.1	7	1.8
2005	828	35.1	2.4	23	2.8
2006	402	36.1	1.1	10	2.5
2007	1756	37.2	4.7	67	3.8
2008	3091	38.3	8.1	113	3.7
2009	11 769	38.6	30.5	274	2.3
2010	3354	40.4	8.3	72	2.1
Overall	68 522	...	...	2641	3.9

Abbreviation: CFR, case-fatality rate.

<sup>a</sup> Data obtained from the World Health Organization 1997 and 1999 annual summary of cholera cases [6, 7].

The overall CFR in Kenya for the period under review was 3.9%. High annual CFRs first occurred during the peak of the large outbreak in 1998 (6.2%) and remained high during 2000–2002 despite lower incidences. While case counts increased during 2007–2010, CFRs remained lower than during earlier periods. Some provinces recorded CFRs that were markedly higher than national figures, such as the Rift Valley (11.1% in 2008), Nairobi (8.6% in 2009), Nyanza (7.6% in 2007), and Western (7.1% in 2010) provinces.

Demographic information for cholera cases was available from the combined line lists only for 2009–2010. The age and sex distributions of cases for this period are presented in Table 2. A total of 11 290 cases were reported on the national line lists. Of these, sex was recorded for 11 125 cases. The number of cases was only slightly greater among males (5676 [51%]), compared with females (5449 [49%]). Of the 11 290 cases on the line list, age was recorded for 9910 (87.8%). The age group with the highest proportion of reported cases was children aged 5–14 years (2367 [23.9%]). Children <5 years old accounted for 1900 cases (19.2%).

### Geographical Distribution, by Province and District

During 2007–2010, a total 19 970 cholera cases were reported to the national level. The series of maps in Figure 1 shows the geographic distribution of cases during these 4 years and illustrates the progression of the outbreaks over time. In 2007, the cholera outbreak affected 11 districts in 5 provinces, mainly in the northeastern, northwestern and western parts of the country.

**Table 2. Distribution of Cholera Cases by Sex and Age, Kenya, 2009–2010**

Variable	Cases, No. (%)
Sex	
Male	5676 (51)
Female	5449 (49)
Age, y	
<5	1900 (19.2)
0–2	1177 (11.9)
3–4	723 (7.3)
5–14	2367 (23.9)
15–24	1694 (17.1)
25–34	1617 (16.3)
35–44	1010 (10.2)
≥45	1323 (13.3)

In 2008, pockets of cholera activity were confined mainly to Nyanza province and the lingering outbreak in the far northeastern region. In 2009, cholera spread nationwide, affecting 52 districts from all 8 provinces and resulted in the highest number of cases reported from a single province in a single year in Eastern and Rift Valley provinces. In 2010, a significant number of cases continued to be reported from 34 districts in 7 provinces during January–July. No cholera cases were reported from any district for the remainder of the year.

#### Laboratory Findings

Of the 19 970 cases reported during the 4 years, 330 specimens (1.7%) were tested at the national reference laboratory for microbiological confirmation (Table 3). Of these, 82 (24.8%) were positive for *V. cholerae* O1, and serotype Inaba was isolated in 73 (89%). Few isolates were confirmed to be serotype Ogawa.

#### DISCUSSION

From 1997 through 2010, Kenya has experienced multiple episodes of cholera outbreaks, including 2 substantial epidemics (during 1997–1999 and 2007–2009). During the 14-year period under review, 68 552 cholera cases and 2461 deaths were reported, ranging from >17 000 cases in 1997 to 0 cases in 2003. Most outbreaks were confirmed to be due to *V. cholerae* O1 serotype Inaba.

Our analysis of the demographic characteristics of patients showed that case distribution was approximately equal by sex, suggesting a relatively equal distribution of healthcare services. We found that 42% of cases were among children aged <15 years, which is identical to the 42% of the population constituted by this group. There was, however, not much difference between case occurrence in younger and older age groups, which differs from observations in cholera-endemic countries such as India, where the incidence rate among children, especially those aged 2–5 years, is consistently higher [10]. This

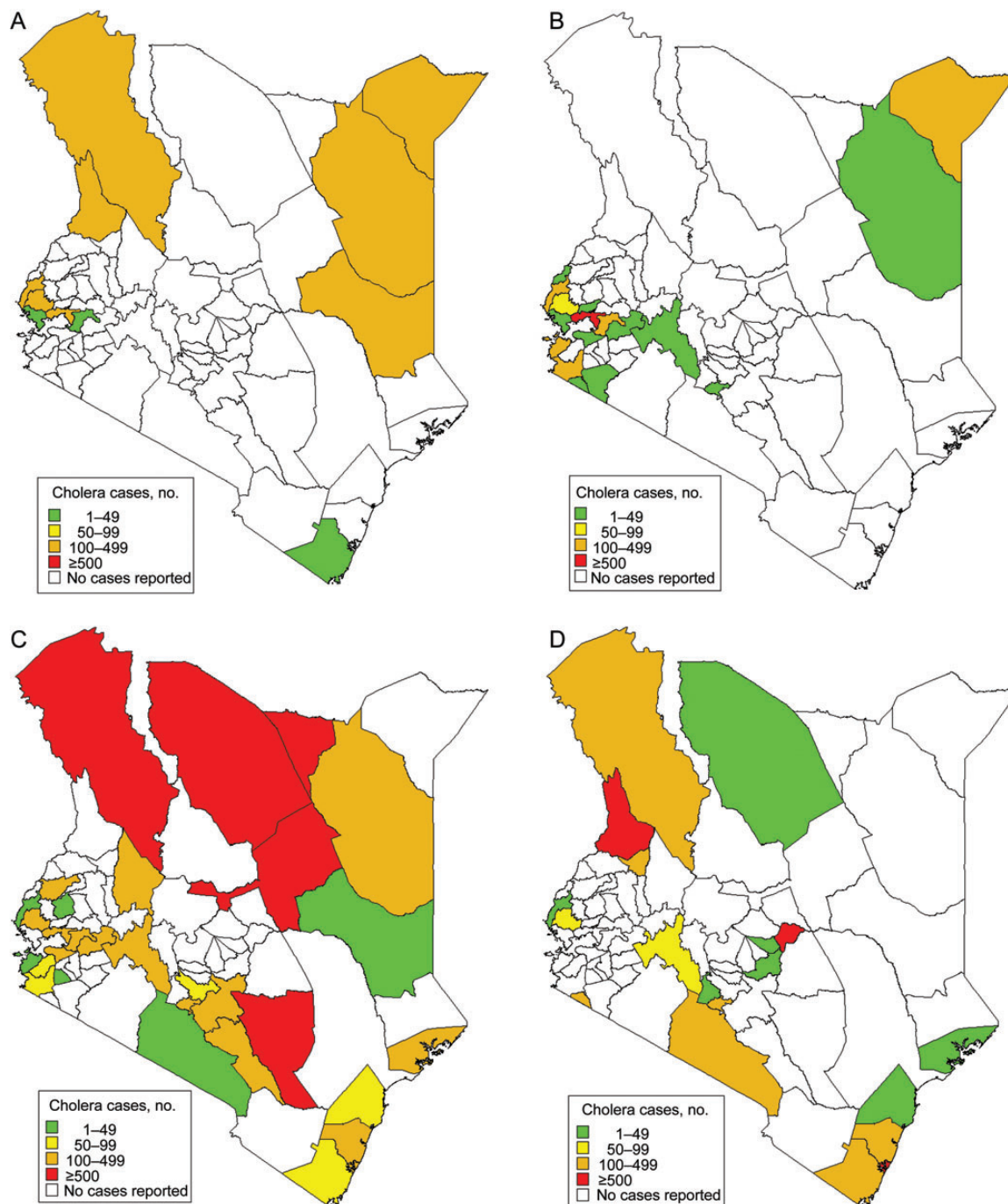
may be because cholera is possibly not endemic in Kenya and, therefore, age-related immunity has not developed, or it may be because of the case definition that was in use in Kenya at the time. The case definition restricted identification of cases to persons aged ≥5 years until an outbreak was confirmed in an area. Standardization of rates by age would provide clearer information, but it was not possible to obtain population figures by district, stratified by age category. More-detailed studies involving data from a sufficiently long period are needed to understand the occurrence of cholera in specific age groups in various communities over time.

In Kenya, high CFRs were recorded during the peaks of the large outbreaks, and CFRs also varied drastically from outbreak to outbreak. The recorded CFR may still be an underestimation of the actual rate of deaths during epidemics because of under-reporting of cases to the ministry, especially those involving patients who die in the community before seeking treatment [9]. The contributing factors to high CFRs are thought to include delayed case detection, limited healthcare access and utilization, and improper and delayed case management. Variations in these factors between different regions of the country or in the same region at different times may have been responsible for the observed variations in CFRs.

Where good treatment is readily accessible, the CFR usually is <1% [11]. Consequently, a CFR above this standard implies limited access to proper healthcare services for the most-vulnerable people and insufficiencies within the healthcare systems, including limitations in the surveillance system's capacity to trigger a timely response [12].

Our analysis of the geographical distribution of cases during 2007–2010 shows that some geographic areas have experienced prolonged and repeated outbreaks, whereas other areas have been affected sporadically. The most affected areas were in the arid and semiarid areas of the country, along Lake Turkana in the north; Nyanza province in the southwest, which borders Lake Victoria; Coast province in the southeast, which borders the Indian Ocean; and the urban slums of Nairobi. Nyanza province was the origin of the large outbreaks that peaked in 1997 and 2009, and in this area the disease may occur endemically. Other studies have proposed that after an outbreak subsides in the lake region of Kenya, *V. cholerae* becomes extinct in that particular locale, and isolated pockets of disease linger to reemerge from reservoirs when the climate becomes favorable [13].

Several studies have identified risk factors for cholera in Kenya [2]. First, a lack of safe clean water may encourage use of water from contaminated sources. In 2009, most locations in Kenya were affected by drought, and therefore shallow wells and stagnant water pans were used. Shallow wells are easily contaminated by sewage systems if the latter are not functioning properly. In some of the newly affected regions, this likely occurred, because they experienced prolonged periods of drought, forcing communities to resort to potentially contaminated water



**Figure 1.** Geographic distribution of cholera cases in Kenya during 2007 (A), 2008 (B), 2009 (C), and 2010 (D).

sources, such as shallow wells. In urban areas, such as the crowded informal settlements in Nairobi, where proper sanitation facilities are a major challenge, illegal water connections contribute to water contamination. In 2010, flooding occurred, which led to malfunctioning sewage systems in urban areas. Around Lake Victoria, bathing in and drinking lake water can increase cholera risk [14].

Second, poor sanitation standards are another contributing factor to the high case counts and high CFRs. Low latrine coverage affects some areas, such as Kamukunji (43%), Embakasi (20%), and Turkana (18%); other areas experience limited use of existing latrines (and thus increased disposal of human waste in open fields or along river beds and lakes) or lack of hand washing [15]. Declines in sanitation standards and subsequent

**Table 3. Laboratory Results for Reported Cholera Cases, National Public Health Laboratory Services, Kenya, 2007–2010**

Year	Suspected Cholera Cases Reported, No.	Specimens Tested, No. (%)	Specimens Positive for Cholera, No. (%)	Serotype, No. (%)	
				Inaba	Ogawa
2007	1756	36 (2.1)	25 (69.4)	25 (100)	0
2008	3091	16 (0.5)	2 (12.5)	2 (100)	0
2009	11 769	195 (1.7)	28 (14.4)	28 (84.8)	5 (15.2)
2010	3354	83 (2.3)	20 (24.1)	18 (90)	2 (10)
Overall	19 970	330 (1.7)	82 (24.8)	73 (89)	7 (8.5)

increases in cholera also have been reported during periods of political unrest, such as the election violence in 2008 [14].

Third, sociocultural practices and beliefs also impact cholera occurrence. Families may share meals from 1 plate. There may be a preference for untreated as compared to treated water because of a perceived unpleasant taste. Other customs also seem to contribute to conditions that favor cholera, such as it being taboo in some communities for a man and his daughter in-law to use one latrine. The importance of sociocultural practices indicates that public education programs on the causes and mitigation of cholera play an essential role in limiting cholera spread [16, 17].

The sudden influx of displaced persons or refugees can overwhelm water and sanitation resources [18]. Kenya has 2 large refugee camps, in Kakuma and Dadaab, which have previously experienced recurrent cholera outbreaks. High attack rates may occur, especially in previously unexposed populations [15, 19]. For example, a cholera outbreak with 224 cases and 4 deaths occurred in Kakuma Refugee Camp from September through December 2009. Refugee camps have several characteristics that increase their risk of cholera outbreaks. These include factors such as crowded living conditions, poor sanitation, inadequate food storage, and inconsistent availability of safe water. Vulnerable populations living in high-risk areas will benefit from comprehensive control activities, guided by surveillance data.

The analysis in this article has several limitations. First, the data presented here were obtained mainly from official reports to the MOPHS. Some data were missing, and therefore official reports from the WHO were used for 1997 and 1999. Thus, the reliability of the available epidemiological data is limited by incomplete reporting and missing information, such as a lack of demographic information for patients during most years, and weaknesses in the surveillance system, such as consistency in applying the case definition. Cases of diarrhea not due to cholera may be reported as cholera to the national surveillance system. Cholera deaths may be missed in the surveillance if they occur in the community and do not present to health facilities. Both of these possibilities can lead to overestimation or underestimation of CFR. The accuracy of the analysis is dependent on the completeness of reporting and the reliability of the

data; therefore, the actual number of cholera cases in Kenya during this period may be higher or lower. The incidence and severity of the disease is probably underestimated because of these limitations of the surveillance system.

Several challenges remain to implement robust public health disease surveillance with limited resources. Not all persons with cholera report to a health facility, and some healthcare facilities may not report all cases. Furthermore, clinical diagnosis may be incorrect and mistaken for other forms of acute watery diarrhea common in the young age groups. Despite the data limitations described, our analysis shows that cholera imposes a substantial disease burden in Kenya that has changed over time. The heavy burden underscores the urgent need for continued strengthening of surveillance and increased investments in the prevention and control of cholera.

The low proportion of bacteriologically confirmed cases observed in Kenya for 2007–2011 limits the reliability of information available to guide prevention and control strategies. Although laboratory capacity to support routine surveillance has been weak, we observed improvements in microbiological testing capacity and laboratory data management over time. The laboratory component of the IDSR should continue to be strengthened and supported at the health facility, district, provincial, and national levels.

The MOPHS had cholera response plans in place during 2008, 2009, and 2010. However, the cholera incidence and CFRs increased through the first half of 2010. In response to these cholera trends, the MOPHS has developed a new 5-year comprehensive multisectoral strategic plan for cholera prevention and control (Kenya Ministry of Public Health and Sanitation, unpublished data, 2011). New recommendations for surveillance were extended to include the reporting of all persons from whom cholera was diagnosed.

During the second half of 2010 and through 2011, reported cholera cases remained near 0. Several factors are thought to have contributed to this sustained decline. Following the 2009 outbreaks, programs emphasized increased community awareness about cholera symptoms and prevention of transmission. Many stakeholders performed intensive efforts toward raising the profile of cholera and strengthening interventions to improve

water, sanitation, and hygiene, especially in high-risk areas. Surveillance and emergency preparedness and response were also strengthened during this period. Changes in environmental and climatic factors or population immunity also may have played a role in the decline. Additional assessments are needed to determine more definitively what may have led to the observed rapid and sustained decline in reported cholera cases.

The present analysis has provided a review of cholera in Kenya over an extended period. However, because of the several limitations described, the cholera disease burden has not yet been well characterized. The MOPHS could consider focal, enhanced cholera surveillance to enable detailed study of epidemics in Africa at the local level over time, determination of cholera incidence, more-rapid detection of epidemics, and monitoring for antimicrobial resistance [20].

## Notes

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