



## **An Overview of Cholera Epidemiology: A Focus on Africa; with a Keen Interest on Nigeria**

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### **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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### **ABSTRACT**

Cholera is still a problem in the world today. A huge population of deaths due to cholera disease still occur in Sub-Saharan Africa (Nigeria most especially), Asia, the Americas and other developing countries, where approximately 1.7 billion inhabitants are still served by faecally polluted water sources. Approximately, 2.4 billion inhabitants of these areas of the world lack the majorly required sanitary conditions of living. Legros, asserts that, as of 2019, about forty-seven countries of the globe, are still affected by cholera. Raw or undercooked, contaminated seafood, serves as a vehicle for the transmission (especially to non-endemic areas). A Case Fatality Rate of 4.87% was recorded from 34 Local Government Areas of Bauchi, Borno, Kaduna, Kano and Zamfara state in Nigeria by the 34<sup>th</sup> week, in 2018, while 298 confirmed cases and 38 deaths (CFR 1.5%) were recorded from three Local Government Areas in two States (Adamawa & Borno) by Epidemiological week 41 in 2019. Cholera in some cases is regarded as a “disease of the poor” because the populations most affected are those that cannot afford to provide the basic health facilities for themselves. For example, waste management systems, and good accommodation with toilet facilities (the living and health conditions of the people) are wanting. In 2017, *A Global Roadmap to 2030* was launched by the Global Task Force on Cholera Control (GTFCC Ending Cholera) to decrease the death rate due to cholera by 90%. By so doing, the disease can be eradicated from at least half of the 47 cholera-affected countries. The objectives of this roadmap are: to fortify health

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systems, water, sanitation and hygiene (WASH), and to coordinate different ways by which cholera can be controlled in these countries by 2030 (ensuring early detection and prompt response to contain outbreaks). This review aimed to understand the epidemiology of cholera in Nigeria, Africa and the world at large, to assess the level of spread, management and preventive measures so far implemented in the endemic regions.

**Keywords:** Cholera; epidemiology; Africa; Nigeria.

## 1. INTRODUCTION

Shockingly, the global cholera epidemiology shows that a huge population of deaths due to cholera disease still occur especially in Sub-Saharan Africa and Hispaniola. This is because about 1.7 billion inhabitants of these areas are still served by faecally polluted water sources, while close to 2.4 billion, lack the majority required sanitary conditions of living [1]. This is a clear indication that cholera is still a major global public health challenge [2]. An estimated 1.4 to 4.0 million cases of cholera were reported between 2008-2012, in 69 cholera-endemic nations [3]. This infection leaves about 21,000 to 143,000 people dead each year [3-8]. This estimate is contrasted by Chioma et al. [9], who stated that in 2019, the globally estimated number of cholera cases range from 3 to 5 million with 28,000 to 150,000 deaths yearly. This increased in death rates (70%) due to cholera disease is promoted by the late administration of fluid therapy to cholera patients Thandavarayan et al. [10]. There has been no substantive decrease in the annual number of cholera cases reported over the last three decades. As recorded so far, in 2015, approximately 172,454 cases were reported from at least 47 countries around the world [11], with threats to spread to many others, especially, those facing water, sanitation and hygiene crises [12,13,14]. However, the global records in 2016, decreased by a 23% compared to 2015, even though, there was an observed increase in the case fatality rate recorded from the 38 affected countries (1.8% in 2016 and 0.8% in 2015). The data by countries affected shows a total of 17 from Africa, Asia 12, Europe and Americas 4 each, and Oceania one. These records show that 80% of the global cases were from Haiti, the Democratic Republic of the Congo (DRC), Yemen, Somalia, and the United Republic of Tanzania [2].

In 2017, 34 countries were reportedly affected by cholera. Of this number of countries, 9 (Yemen (over 1 million cases) Democratic Republic of Congo, Ethiopia, Haiti, Nigeria (Borno state most especially), Somalia, South Sudan and Zambia

(Lusaka)) faced very severe outbreaks. The outbreaks led to the infection of approximately 1,227,391 people, from which 5654 deaths were recorded (179,835 cases 3220 deaths from 14 African countries and 13,818 cases and 163 deaths, from the Americas; (Haiti alone recorded 13,681 cases) [5,15].

Furthermore, Legros [16], stated that as of date forty-seven countries were still affected by cholera whose major route of transmission remains the raw or undercooked contaminated seafood, especially to non-endemic areas [6]. Cholera in some cases is regarded as a "disease of the poor" because, the people who are affected the most are those who cannot afford to provide the basic social facilities for themselves [17,9]. For example, waste management systems and good accommodation with toilet facilities (the living and health conditions of the people).

The Global Roadmap to 2030, was launched by the Global Task Force on Cholera Control (GTFCC *Ending Cholera*) to decrease death rate due to cholera by 90%, especially from at least half of the cholera-affected countries. The objectives of this roadmap are; to fortify health systems, water, sanitation and hygiene (WASH) as well as to coordinate different ways by which cholera can be controlled in these countries by 2030 [18]. This article therefore basically seeks to review the epidemiology of cholera in Nigeria, Africa and the world at large, to understand the level of spread, management and preventive measures so far implemented in these endemic regions.

## 2. ENVIRONMENTAL RESERVOIRS: WHERE CHOLERA LURKS DURING INTER-EPIDEMIC PERIODS

The bacterium *V. cholerae*, definitely has reservoirs in the environment, which harbour it until it gets to be released into the definitive host (humans), to cause disease outbreaks. Since its proliferation is fostered by salty environments like estuarine and marine waters, there is, therefore, a close relationship between *V. cholerae* and

marine organisms, especially seafood like crabs, crayfish, bivalves (shellfishes) [19]. However, in the Indian continent, Zanzibar and Malawi in Africa, egg masses of the “non-biting midges” (Diptera Chironomidae), have been reported to serve as reservoirs of *V. cholerae* [20]. Many other potential areas that could harbour cholera in the environment may include sewage disposal systems, on-site sanitation systems, wetlands, landfills, heavily polluted surface water systems, septic tanks, groundwater systems, lagoons, gutters, contaminated shallow springs, streams and rivers brooks [21].

### 3. RISK FACTORS

Most frequently, cholera outbreaks occur in regions of the world devoid of knowledge about cholera, those having pets at home, conflicts and wars zones, those with increased population growth, climate change, urbanization, overcrowding, inadequate water and sanitation, lack of social amenities (like waste management systems, good accommodation with toilet facilities, and good health facilities) [17,9].

High cholera-related mortality has also been associated with food insecurity which leads to malnutrition, suppressed/ impaired immunity, gastrointestinal function, growth and mental retardation [11].

Cholera (a “disease of the poor”) [17,9], was reported by Richterman et al. [10], to have affected 550,106 people from thirty low or middle-income countries with available Global Food Security Index [GFSI] from 2012 to 2015. The median yearly incidence rate recorded during this period was 3.1 cases per 100 000 people for a total of 120 country-years. Therefore, it will only be a wise decision to reduce the annual cholera burden by implementing multi-sectoral cholera control and surveillance programmes in high-risk areas; especially those situated around notable cholera hotspots [22].

### 4. TRANSMISSION

In Nigeria, most especially, even though cholera infections seem to have been occurring during all the seasons, with most cases reported at the onset of the rainy and dry seasons, the Gomani cholera outbreak [9] and the Zimbabwean 2008\2018 cholera outbreaks occurred at the peak of the dry season [23]. Raw or undercooked contaminated seafood serve mostly as vehicles

for the transmission of cholera especially to non-endemic areas [5]. Since the bacterium (*Vibrio cholera*) is often excreted in stool and vomitus, it can easily be carried by vectors such as house flies to contaminate food most especially. Vegetables contaminated by faeces carried by surface runoff can also serve as vehicles for the transmission of these pathogens to human if they are eaten raw or undercooked. Sometimes person to person transmission also occurs mostly when one comes in contact with faeces from an infected individual and the hands are not properly washed. This is exemplified by infections from healthcare providers and patients' aids. Those who live in areas that lack potable water supply and good toilet systems drink from brooks, springs, streams and shallow wells which are easily polluted by sewage from the environments. This condition is common in refugee settlement camps, during political unrest, natural disasters and prisons. This is one of the easiest ways of becoming infected with cholera since usually, there is overcrowding and lack of good social amenities.

### 5. EARLIER CHOLERA OUTBREAKS IN AFRICA (1970-2009)

The invasion of sub-Saharan West Africa by El Tor Ogawa cholera, was a momentous epidemiologic event, though *Vibrio cholerae* O1 Inaba had been associated with African cholera for many years before this time. Sub-Saharan West Africa in the early 1970s became the first hot spot of sporadic and explosive outbreaks. These affected more than 400,000 people in 16 countries out of the 36 (Countries) that were reported in parts of the world with cholera. Within 1970–1971, West Africa recorded more than 400,000 cases in 25 countries with a high case fatality rate (CFR) of 16 % in one year. This wildfire swept through most African countries, recording case fatality rates ranging from 4 to 12% by 1972–1991. The contributing factors being the lack of background immunity in the population, insufficient transport to move severe cases to treatment facilities, and inadequacies in the health care infrastructure [24,25]. Since then, approximately 3,000 and 43,000 cholera cases were reported yearly until after 1990, when more than 100,000 cases and 10,000 deaths were reported from a large epidemic that affected 14 countries [26].

In Burundi, Zaire, and Congo, the first Cholera cases were reported during 1978–1979. South Africa in 1980, over 20,000 cases were reported

in KwaZulu-Natal, the worst-affected province, in Limpopo and Mpumalanga. The worst cholera epidemics in the country's history occurred between 1997 and 2005 with the climax in 2001. This epidemic was traced to have originated from the Mhlathuze River in the northern part of the KwaZulu-Natal Province [24]. Initially, the killer was identified as *V. cholerae* O1, Ogawa but in mid-2001, the El Tor Biotype O1, Inaba emerged in KwaZulu. This *V. cholerae* serotype was subsequently isolated in other provinces with a 2001/2002 epidemic death rate of less than 1 % [25].

In Togo epidemics occurred during 1970–1973, affecting more than 1,000 people with CFR of 4 10. Guinea's first outbreak was in 1970 and since then, cholera recurred every 8 years till 1994, and then, it entered Ghana, a few months later [27].

In, Algeria the serotype Ogawa was associated with the early cholera outbreaks of 1971–1975.

In Mozambique, the seventh pandemic ushered in cholera in the early 1970s when it entered Africa from the Indian subcontinent. Several epidemics were registered in the country since then but the 1997-1999 epidemic was the most extended and these left Mozambique an endemic area for cholera, characterized by yearly outbreaks occurring with a seasonal pattern [28].

The first record of a cholera outbreak reported in Nigeria, was in a village near Lagos on the 26<sup>th</sup> of December 1970, with 22, 931 cases and 2945 deaths [29,30]. The disease spread in Nigeria between 1970-1990 [31,32], with the Hikojima serotype that reacts with both Ogawa and Inaba antisera prevalently isolated in Zaria, from 1976 to 1978 [25]. However, the storm of this water drinking disease that ravaged the Lake Chad basin in 2009 began in Maiduguri, Nigeria [33].

When the 7<sup>th</sup> cholera pandemic struck the African continent, Cameroon became one of the culprits and Bepanda in Douala received one of the primary bullets that landed in 1971. This terrorizing agent within a short while affected more than 2000 people with a high case fatality rate (CFR) of 15%. In the following years (1972 and 1984), the cases recorded minimal but 1985, 1991 and 1996 registered 1000, 4000 and 5786 cases with case fatalities of 9%, 12% and 8.3% respectively [29].

Bepanda has been the source of most outbreaks since 1971 [34] and in 2004, Littoral region

reported close to about 700 weekly cases of cholera with a total estimate of 8,000 cases registered in Bepanda, New Bell, Nylon, and the entire town of Douala [29].

A report from the Ministry of Health showed that from the Littoral and West Regions, a total number of 2924 cases and 46 deaths were recorded from the 1st of January to the 9th of June 2004, 514 cases and 13 deaths reported from Douala only. A case fatality rate of 2.5% resulting from the confirmed agent *Vibrio cholerae* O1 El Tor [35].

A total of 2,847 cases and 110 deaths (CFR 3.86%) were reported in the whole country in 2005, with 70% of the cases coming from the Littoral region were reported in 2005 [29]. In 2006, 922 cases including 35 deaths (CFR 3.8%) were recorded with the first outbreak record coming from Bafoussam in the western region and the second from Far North region [29].

The most treacherous of the outbreaks recorded in Cameroon since the first cases in 1971 was in 2009 in the Extreme North region with a case fatality rate as high as 13%, with 70% of this from the local community.

The attack rate in Malawi was 2.6% with CFR of 3.3% in 1988, resulting from an outbreak due to the consumption of contaminated shallow waters [25].

Benin, Burundi, Cameroon, Democratic Republic of the Congo, Ghana, Guinea, Liberia, Malawi, Mozambique, Niger, Nigeria, South Africa, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, and Zimbabwe have reported cholera Outbreaks yearly since 2000 -2005 with the highly, endemic region of the eastern provinces of DR Congo recording a total of 67,738 cases and 3,666 deaths (CFR 5.4%) between 2000 and 2005 [25]. Mali reported 12,176 recorded cholera cases, including 1,406 deaths, between 1995 and 2004.

The Senegalese epidemic of 2004–2005, resulted in 31,719 cases, i.e., 293 cases/100,000 habitants, with 458 deaths (case fatality rate (CFR) of 1.44%) [36].

The cholera density during the period between 2000 and 2005 was recorded as follows: Mozambique 793/ million, Liberia 594/million, Somalia 441/million, and the Democratic Republic of the Congo 242/million people. In 2005, sub-Saharan Africa reported incidence of

indigenous cholera in 166 cases/million population and this was 95 times higher than the reported incidence in Asia (1.74 cases/million population) which was also 16,600 times higher than the reported incidence in Latin America (0.01 cases/million population).

Kenya has been tormented by outbreaks of cholera since 1971 and the same trend of outbreaks has been reported yearly from 1974 to 1989, with an average case fatality rate of 3.6%. Five cholera outbreaks locations in Kenya were identified by the Ministry of Health: The Busia along the Ugandan border, Malindi along the Kenya's Indian Ocean coast, Kibwezi in East-Central Kenya, Nairobi in the Eastland informal settlement, a high populated area with poor sanitary services, mixed ethnicity, and notably occupied by Sudanese, Somalis and Kakuma refugee camps, and the adjacent town in North-East [37]. In the period between 1997 and 1999, more than 33,400 notified cases of cholera were reported in Kenya, representing 10% of all *V. cholerae* cases reported from the African continent during this period [38]. The 2007 cholera outbreak started in Nyanza in Kenya and was characterized by widespread infection and high mortality rate that left 1243 people infected and 67 dead by November 2007 [39]. Since then, the Division of Disease Surveillance and Response (DDSR) of the Ministry of Public Health and Sanitation in 2009 recorded an increased number of cholera cases in Kenya (CFR = 2.3%) with 11,769 cases reported as compared with 3091 cases (CFR 3.7%) in 2008 [38].

In Zimbabwe, 56 districts in the 10 provinces were affected in 2008, by the largest ever recorded cholera epidemic outbreak that more than 90,000 cholera cases were suspected with more than 4,000 deaths. Zimbabwe experienced two outbreaks caused by *Vibrio cholera* O1 El Tor from August 2008–July 28, 2009 [40], which affected 55 of the 62 districts in this country. The Zimbabwean Ministry of Health and Child Welfare reported 98,592 cases and 4,288 cholera deaths. The crude case-fatality rate (CFR) was 4.3%, and 61.4% of the cholera deaths occurred in communities outside areas with health facilities [41]. These large cholera epidemics in Zimbabwe (2008-2009) and Sierra Leone (2012) have made the international community aware of the need, not to merely control endemic disease, but also to strengthen epidemic preparedness and response capacity [42].

Of the 632 cholera outbreaks that were reported worldwide between 1995 and 2005, 66.0% of the cases and 87.6% of deaths were reported from sub-Saharan Africa. The great epidemics recorded in Africa were between 1984–1986, and this affected the drought-affected countries of Burkina Faso, Niger, Mali, Mauritania, Senegal, Ghana, and the United Republic of Tanzania and Cameroon in 1985.

## 6. GLOBAL EPIDEMIOLOGY OF CHOLERA; CURRENT TREND

The Global distribution of cholera shows that about 50 countries (Africa and Asia most especially), have reported cholera for at least three to five past years, showing that it has become a pointer for underdevelopment especially for most of the neglected countries. Furthermore, La Rocque et al. [43] reported that an estimated 3 million are infected and approximately 100,000 die each year of diarrheal illnesses caused by *V. cholerae* worldwide.

### Haiti

A report by the ECDC [44] showed that Haiti recorded a total of 816, 773 suspected cholera cases plus 9,783 deaths (CFR: 1.2%) from 2010 to 3 February 2018. More than 7000 deaths were recorded during the 2010-2011 cholera outbreak that preceded an earthquake in Haiti and the Dominican Republic [6,3,8]. About 41 421 cholera cases plus 447 deaths (CFR: 1%) were recorded in 2016 and 13,681 cases plus 159 deaths in 2017. The rate in Haiti decreased from 374 to 112 cases per 100,000 population and the number of cholera related deaths decreased by 64% (from 446 to 159 deaths) between 2016 and 2017.

As of 10 March 2018, about 773 cholera cases, plus eight deaths (CFR: 1%) were recorded in all ten departments of the country [44]. The ECDC [45], report showed that Haiti reported 3,777 cholera cases, including 41 deaths (CFR: 1.1%) in 2018. The total number of cases reported in Hispaniola as at epidemiological week (EW) 29 of 2018, was 2,883 and 99% of these (2,843 cases, including 34 deaths) were reported from Haiti. This represented the least incidence rate (24 cases per 100,000 people for 2018 (by EW 31) recorded, since the onset of the outbreak. A huge decrease in the number of cases and deaths was therefore recorded in 2018 (less than 4,000 suspected cases and 41 deaths) [46].

The number of cases reported in Haiti as of 16 March 2019, was 218 including 3 deaths (CFR: 1.4%). But the total number of suspected cholera cases reported from January to 16 March 2019, rose to 819, 995, including 9 792 deaths (CFR: 1.2%) [45]. Following the incessant cholera outbreaks observe in this country since, after the 2010 deadly cholera outbreak that left more than 10000 people dead, the Victims of this outbreak have petitioned the US Supreme Court, accusing the United Nations as being responsible for the transmission of cholera into Haiti [47].

**Mexico**

Mexico has almost been freed from this dreaded cholera disease because the overall case-fatality rate (CFR) has since 2011 been revolving around 1%; with only one toxigenic *Vibrio cholerae* O1 case (which was supposedly picked

from Sinaloa) reported from a woman, (aged 43-years) [48].

**Dominican Republic**

A huge reduction in the number of cases and deaths was recorded in the Dominican Republic in 2017 compared to 2016, (rate of cases per 100,000 people reduced from 11. 5 to 1.20%), and deaths decreased from 27 to 4 (85%). Dominican Republic: in 2017 reported 48 cholera cases as of 3 March and six cases in the same period in 2018 [44]. Between EW 1 and EW 29 of 2017, the cumulative number was 96 cases reported while 41 suspected cholera cases (57% decrease), with no death, were reported, compared to this epidemiological period in 2018 [48]. As of May 2018, 17 cholera cases were reported but during the same period in 2019, six cholera cases and no deaths were reported [45].

**Table 1. Cholera epidemiology in the Dominican Republic and Haiti 2010-2018**

Year	Dominican Republic			Haiti		
	Cases	Deaths	CFR (%)	Cases	Deaths	CFR (%)
2010#	191	0	0	179,379	3,990	2.2
2011#	20,851	336	1.6	340,311	2,869	0.8
2012#	7,919	68	0.8	112,076	894	0.8
2013#	1,954	42	2.1	58,809	593	1.0
2014#	603	11	1.8	27,753	296	1.1
2015	546	15	2.7	36,045	322	0.9
2016	1,159	27	2.3	41,421	446	1.1
2017*	122	4	3.4	13,681	159	1.1
2018*	41	0	0	2,842	34	1.2

Source: WHO, Weekly Epidemiological Bulletins [49]



**Fig. 1. Map showing different countries affected by major cholera outbreaks in 2017-2018 study location. Source: Global Task Force on Cholera Control (WHO) [50]**

## Iraq

Iraq, since the first cholera outbreak of 1966 (with a case fatality rate of 8.8%), has remained endemic to this disease. From the epidemiological picture, it shows that the cholera epidemics in this zone, seem to be a four-five year's cyclical event that has left the country with four major cholera peaks since that of 1998/1999 (in 2003, 2007, 2012, and 2015). Approximately 3000 cases of cholera were recorded in the middle and south provinces in the most recent epidemic that affected both the old and the young alike [51].

## India

As of May 2019 in India, 16 suspected cholera cases were reported in Ahmedabad, 50 plus one death, in Bhopal, 18 (four confirmed) in Wayanad District, Kerala, and 50 in Puri District, Odisha after the Cyclone Fani [45].

## Yemen

The political unrest marked by civil war and a humanitarian crisis has left Yemen in a state of cholera rampage since 2016 [19]. The first outbreaks which started in September 2016, and the second in April 2017, have registered above 1000,000 suspected cases. It has been observed that there seem to be a relationship between the Yemen epidemic *Vibrio cholerae* strain and the South Asian 2012 strain, now isolated throughout the globe (Eastern Africa, 2013 and 2014 and Yemen in 2016). This strain that is causing the worst cholera outbreak in recorded history, originated from Eastern Africa and is susceptible to many of the antibiotics to which other *Vibrio* strains were formally resistant [52].

From October 2016 to 18 March 2018, approximately 1,080,878 suspected cholera cases and 2,266 deaths (CFR: 0.2%) were reported in Yemen [42]. The attack rate recorded nationwide was 3.69% with 2,385 deaths (case fatality risk 0.22%) caused by *Vibrio cholerae* O1 Ogawa strain [53]. Further reports in Yemen showed that from the start of the 2017 outbreak to the 6th of June 2019, close to 1,768,477 suspected cholera cases plus 3,390 deaths (CFR: 0.2%) have been recorded [44].

## 7. THE AFRICAN CASE

Africa has remained the seat of cholera since the 1970s. Since then, annual reports, have shown that approximately 550 million sub-Saharan

Africans (SSA) are at risk of cholera with an estimated 17 million cases reported annually. Furthermore, it has also been ascertained that about 19.8 million to 23.7 million sub-Saharan Africa inhabitants are occupants of high-cholera incidence areas ( $\geq 1$  in 1000 people infected with cholera annually) [54].

From 2009 to 2015, 11 countries (Benin to Mauritania) along the Atlantic Coast of West Africa, recorded a total of 97,887 cases (about 30,475 cases in 2014 alone). Ghana alone reported, about 51,333 suspected cases (52.4%) out of the total number, while a mean close to 694 was recorded from Benin and Togo [55].

Over 27,000 cases and 510 deaths were reported in Lake Chad Basin (LCB) outbreak by epidemiological week 34 in 2018 and out of this number, Nigeria reported 24,000 cases [56]. An estimated seven SSA countries: Cameroon, Democratic Republic of Congo, Tanzania, Kenya, Mozambique, and Zambia and Zimbabwe, in 2017 and 2018, reported cholera outbreaks [20].

The cholera situation report of March 2018, shows that from Angola 822 cases and 15 deaths (CFR: 1.8%) were reported from Uige and Cabinda provinces. While the end of outbreak reports came from Burundi in February 2018, the total number of suspected cases reported was 171 and zero deaths from seven districts. Further reports coming from Chad showed that 1,250 suspected cases plus 81 deaths, (CFR: 6.5%), were reported from Chad in 2017, but the outbreak terminated in March 2018 [44].

In the Democratic Republic of the Congo, the situation was such that the people of age  $> 5$  years were more affected than those  $< 5$  years of age; CFR for suspected cases 2.1% and 1.4% respectively. From 2008 and a decade after that, more than 270,852 people were reportedly affected with 5,231 dead (CFR 1.9%) nationwide. Moreso, the nationwide case report thereafter, was as follows; more than 53,000 cases and 1,145 deaths in 2017 from 20 of the 26 provinces in the country [57], 31,387 cases, including 1,042 deaths in 2018 and 10,469 suspected cases, including 241 deaths (CFR: 2.3%) by May 12, 2019, across the country [45].

In the Ethiopian case, approximately 48,912 cases of severe watery diarrhoea that left 880 dead with a CFR of 1.8% were reported between January 2017 and February 21<sup>st</sup> 2018 [44].

Another epidemic that started in Amhara and spread to Oromia, Somali and Tigray, affected about 424 cases, leaving 15 dead (CFR: 3.5%), by the 6 of June 2019, but, only 13 cases were confirmed in the laboratory [45].

In Kenya, as at 15 January 2016, the number of cases reported was 11,033 from 22 areas of the country [58]. But by the 26<sup>th</sup> of February 2018, the total of 5,555 cases was reported from an outbreak that started in January 2017. About 29 deaths were recorded in 2018 alone [44]. From this ongoing outbreak, Garissa, Kajiado, Mandera, Mombasa, Nairobi, Machakos, Embu, Narok and Wajir, reported 2137 cases and 14 deaths (CFR: 0.7%) as at the 19<sup>th</sup> of May 2019 [43], and 2,789 cases including 19 deaths by the 2<sup>nd</sup> of June 2019 [59].

Reporting further on cholera epidemiology in Africa, Malawi took its turn in 2018, and as at the 5<sup>th</sup> of March, 759 cases and 23 deaths (CFR: 3%) were recorded.

From Mozambique, by the 15<sup>th</sup> of March 2018, the WHO reported 2 147 including 5 deaths from an outbreak that centred in Nampula and Cabo Delgado province [44], and in April 22, 2019, they reported 6,739 cases, and eight deaths (CFR: 0.1) from Beira, Buzi, Dondo and Nhamatanda [45].

Namibia, after the hospitalization of on case of cholera on the of 28 January 2018, declared the country free from cholera on the 2<sup>nd</sup> March 2018, and till date, no other case has been reported from any other part of the country.

South Africa: No new cholera case has been reported in the country after the sole case that was confirmed in KwaZulu-Natal province on the 15<sup>th</sup> of February 2018 [45].

Sudan, after the central Darfur 77 recorded suspected cholera cases including one death in March 2018 [44], the Blue Nile State (BNS), south-eastern Sudan, bordering Ethiopia and South Sudan, on the 28th of August to 12 October 2019, reported a case fatality ratio of 2.88% (278 suspected cholera cases, and 8 deaths). The majority of them (62%) were women, while 93.1% were of the age range above 5 years [60]. The overall confirmed number of cases as of this period was 215 [61]

In Somalia, from December 2017, till the 26<sup>th</sup> of May 2019, about 7, 235 suspected cholera

cases, including 46 deaths (CFR: 0.6%), were reported by the WHO [45]. However, there have been reports of an increasing epidemic trend because, cumulatively, about 889-1,203 cases have been reported, although without any case of deaths from January 2019. This epidemic has affected mostly the under five years of age group (representing about 62% - 77% of the total number of cases reported in week 22). The most affected areas of Banadir districts from Epi. Week 1-18, 2019; were Medina (71-135 cases; AR 0.11-0.2), Hodan (70-137; AR 0.05- 0.1), Daynile (57-125; AR 0.09-0.21) and Darkeneley (48; AR 0.06) [62,59].

On 11 July 2017, Tanzania, (Zanzibar) reported a sole case of cholera and since then, Tanzania only reported an escalating epidemic of cholera which affected 1, 440 persons as of 11 March 2018 and killed 27 (CFR: 1.9%). Thereafter, an outbreak was reported in Dar es Salaam city on the 26<sup>th</sup> of May 2019, which affected about 277 people and left five dead in the whole country (CFR: 1.8%). This further affected 165 cases including 2 deaths (CFR, 1%) in Dar es Salaam city, as of 13 June 2019 [45]. On the whole, the cholera burden in the United Republic of Tanzania from August 2015 till date, is cumulatively reported as, 33,702 cases plus 556 deaths [59].

The Ugandan case was mostly seen amongst the fishing communities which though form only a minority of the Ugandan population (5±10%), report the greatest number of cholera cases and deaths in the country. Bwire et al. [63] in their study on cholera outbreaks along the African Great Lakes and River Nile in Uganda, between 2011 and 15, observed that approximately 1,827 suspected cholera cases and 43 deaths, with a Case-Fatality Ratio (CFR) of 2.4% were reported during this period. The frequency of infection was more among the males than the females (3.2% against 1.3%). However, in 2018, close to 1,695 suspected cholera cases including 36 deaths were reported (CFR: 2.1%) from refugees from the Democratic Republic of Congo who settled in Hoima district and those from fishing villages along Lake Albert [44].

From October 4, 2017, to February 15, 2018, Zambia reported 4, 876 cholera cases including 97 deaths (CFR: 2%), with the majority of the cases coming from Lusaka City to other parts of the nation [44]. The total number of provinces affected as of May 12, 2018, was seven out of the 10 provinces in Zambia and the number of



suspected cases reported were 5,905 cases with a case fatality rate (CFR) of 1.9% (5,414 cases (91.7%) and 98 deaths (CFR = 1.8%) from Lusaka alone) [64]. In Mpulungu District, near Lake Tanganyika in Zambia, an outbreak that was reported to have started early in April 2019, affected 312 cases and left 7 dead by May 31, 2019, (CFR: 2.2%) [45]. In the whole of Zambia, approximately 417 cases, including 10 deaths have been recorded in this country since January 2019 [65].

In Zimbabwe, in 2008, a total of 11,735 cases, 484 deaths (CFR of 4%), almost approaching 20–30% in rural areas were recorded. In Harare, 98% of the 3,621 cases and 32 deaths were reported in 2017, while 111 suspected and 4 deaths (CFR: 3.6%) were reported in Chegutu Municipality, southwest of Harare as of 13 March 2018 [63]. In Contrast to the reducing world trend in the cholera Case Fatality Rate, the ratio here has remained unchanged at 2% [20].

Since the declaration of the cholera outbreak in Mozambique on March 27 2019, about 7,034 cases and 8 deaths (CFR, 0.1%) have been registered in the country. However, approximately 6,768 of these cases and eight deaths were recorded from Beira, Buzi, Dondo and Nhamatanda (the districts affected by Cyclone Idai, in Sofala Province and 266 cases from Metuge, Mecufi and Pemba city; the districts affected by Cyclone Kenneth, in Cabo Delgado province [59].

In Algeria, the Ministry of Health reported 173 cholera cases and two deaths on 28 August 2018 (CFR: 1.2%) [44]. On the other hand, in Cameroon, a cholera outbreak started on the 18<sup>th</sup> of May from the North region of the country and spread to the Central and Littoral regions, with the total number of suspected cholera cases recorded as 367, including 31 deaths (case fatality ratio 8.4%) [66]. The total number of registered cases as of July was 470 including 34 deaths [67]. Moreover, as at the 16<sup>th</sup> of October 2018, one confirmed and one new case was reported in the Littoral region, while 36 suspected new cases and 2 deaths were recorded in the North [68]. By January 2019, a total of five cases were reported in the north region [69], while Pitoa, Garoua 1 and Garoua 2 health districts, reported seven new suspected cases and one death from 1 to 5 April 2019. This gave a cumulative sum of 1, 039 suspected cases [70]. Still, in Cameroon, the North and Far North regions, by September 23,2019 up till date, have

recorded 613 cases and 31 deaths (CFR 5%), with 9 of these from 15 of the affected health districts [71]. From the onset of the outbreak in May 2018, the cumulative number of cases stands at 1 060 with 64 deaths (CFR: 6%) [46].

## **8. A FOCUS ON NIGERIA**

Since the first outbreak of Cholera in Nigeria in 1970, severe occurrences have been reported especially in1990, 1991, 1996, 1999, 2009 to 2011. A Case Fatality Rate (CFR) of approximately 3.7% was reported between 2004 and 2013, while 4.1%, (above the accepted 2.4% mean overall CFR for Africa from 2000 to 2005 and the 1% WHO acceptable rate), was reported in 2010 [72,9]. The Nigerian Center for Disease Control (NCDC) asserts that Nigeria recorded 189 cholera related deaths between 2016 and 2018, and 4,221 cases with 107 deaths in 2017 from 20 states [73]. A CFR of 1.9% was recorded in 2017 from 6 LGAs in two States, while CFR of 2.67% was recorded from 47 LGAs of 16 states in 2017.

In 2018 (4 February), Nigeria reported 172 suspected cholera cases, including 13 deaths (CFR: 7.6%). The number of cases continued to be on the rising side with 13,009 suspected cases and 1161 deaths recorded from 12 states (Adamawa, Anambra, Bauchi, Borno, Kano, Kaduna, Kogi, Nasarawa, Niger, Plateau, Yobe and Zamfara) by June 2018 [74]. While the epidemiological picture of the Lake Chad basin in 2018, showed that the highest number of cholera cases recorded in this region (24,000cases) came from Nigeria [75], a comparative analysis of the case fatality rates recorded in 2018, showed that 3.36% was reported from 38 LGAs from 11 States; Ekiti (1), Yobe (3), Abia and Adamawa (4) each, Borno and Ebonyi (9) each, FCT (20), Kaduna (24), Kano (119), Katsina (122), and Zamfara (280) in week 31 and 1.62%, was reported from 122 LGAs from 22 States. A total of 1068 suspected cases and 29 deaths (CFR, 2.72%) were reported from 36 LGAs from 15 States at this same time in 2017 [76]. Contrastingly, a higher CFR of 4.87%, was recorded from 34 Local Government Ares from 5 states (Bauchi, Borno, Kaduna, Kano and Zamfara) by the 34<sup>th</sup> Epidemiological Week, whereas, 1.78% was registered from Epi. Week 1 to 34 of 2018, from 135 local Government Areas [77]. However, from the beginning of the epidemic in 2018 to the third of September, 2018, 18 States including Adamawa, Anambra, Bauchi, Borno, Ebonyi, FCT, Gombe, Jigawa,

Kaduna, Kano, Katsina, Kogi, Nasarawa, Niger, Plateau, Yobe, Sokoto and Zamfara, reported 24,106 suspected cholera cases with 444 deaths, (CFR of 1.84%). The epidemic was more severe on the females (50.2%) as well as on the 5-14 years age range (26.47% of the confirmed cases) than the males (49.8%) and adult age group. Furthermore, reports from the NCDC, stated that a total of 42,466 cholera cases including 830 deaths (Case Fatality Ratio = 1.95%) were registered from Nigeria in 2018.

In summary, the CFR by state as reported in 2017 for Borno state was 2.6% [78], Kwara state 0.7% with 50.7% of the reported cases as males, although 16.1% of these cases were between the age range of 1-5 years [79] and Yobe State, 6.2% [80,81]. The Epidemiological summary of the case fatality rates by Epi-Week 35, 3rd September, was as follows; Bauchi 0.36, Zamfara 1.77, Katsina 3.48, Adamawa 1.56, Borno 0.19, Kano 4.25, Sokoto 5.34, Niger 5.12, Yobe 4.54, Kaduna 6.23, Plateau 1.72, FCT 6.42, Ebonyi 3.84, Kogi 7.84, Gombe 8.70, Anambra 4.35, Jigawa 6.67, Nasarawa 0.00% respectively [82], and the cumulative Mean CFR from all affected states was 1.84% [83].

At the beginning of 2019, 15 suspected cases of Cholera were reported from three LGAs in two states (Adamawa & Borno); seven laboratories confirmed cases and no death was recorded. In Adamawa State as at 18 June 2019, a cholera

outbreak was declared in Yola North, Yola South, Girei and Song local government areas (LGAs). This outbreak resulted to the infection of 320 people with a total of three deaths by the 15<sup>th</sup> of July 2019, Yola North LGA, 183 cases with 2 deaths (CFR= 1.1%); Girei LGA, 118 cases with 1 death (CFR= 0.85%), 18 cases with no death (CFR= 0%) in Yola South and 1 case in Song [83].

From epidemiological records, it can be observed that cholera remains a major threat to many countries such as Yemen, South Sudan and Nigeria, even though, a drastic reduction has been registered especially in Southern Sudan where no case has been reported in 2018 and 2019. Thanks to the considerations given towards the implementation of the Oral cholera Vaccine (OCV) and WASH campaigns in these areas. The success of the Global Road Map for ending cholera by 2030, may be impeded in some of the cholera endemic regions like Nigeria, because of the challenges that may be encountered in the field; especially during evaluation. Nigeria still requires a lot of technical and financial assistance to help drive the impact assessment, which must be a continuous process. More so, since the country may want to commence operational research and special intervention strategies, this aid will foster the implementation of the plans and help them to achieve the ending cholera goal by 2030 [22].

**Table 2. Epidemiological parameters of cholera outbreaks by main affected state in Nigeria, 2004–2014**

State	Cases / Deaths	% of total cases	CFR (%)	Number of year with notified cases
Katsina*	61 790 / 1 240	31.1	2.0	9
Bauchi*	33 430 / 290	16.8	0.9	8
Kano*	13 430 / 160	6.8	1.2	9
Borno*	12 510 / 510	6.3	4.0	7
Gombe*	10 340 / 180	5.2	1.8	7
Kaduna*	9 520 / 170	4.8	1.8	5
Zamfara*	6 410 / 180	3.2	2.8	4
Adamawa	6 360 / 440	3.2	6.9	4
Sokoto*	6 330 / 360	3.2	5.7	5
Taraba	5 590 / 180	2.8	3.2	6
Niger	4 590 / 110	2.3	2.4	2
Lagos	4 060 / 20	2.0	0.6	6
Yobe*	3 180 / 160	1.6	5.1	2
Kebbi*	2 850 / 70	1.4	2.5	3
Jigawa*	2 690 / 120	1.3	4.3	5
Nassarawa	2 550 / 70	1.3	2.5	6

*Between 2004 and 2013, a total of 105,483 cases and 3,913 deaths were reported (CFR ≈ 3.7%)*

*Source: Unicef Cholera Epidemiology and Response Factsheet Nigeria Cholera Overview [70]*

**Table 3. Cholera Situation in Africa 2017-2019**

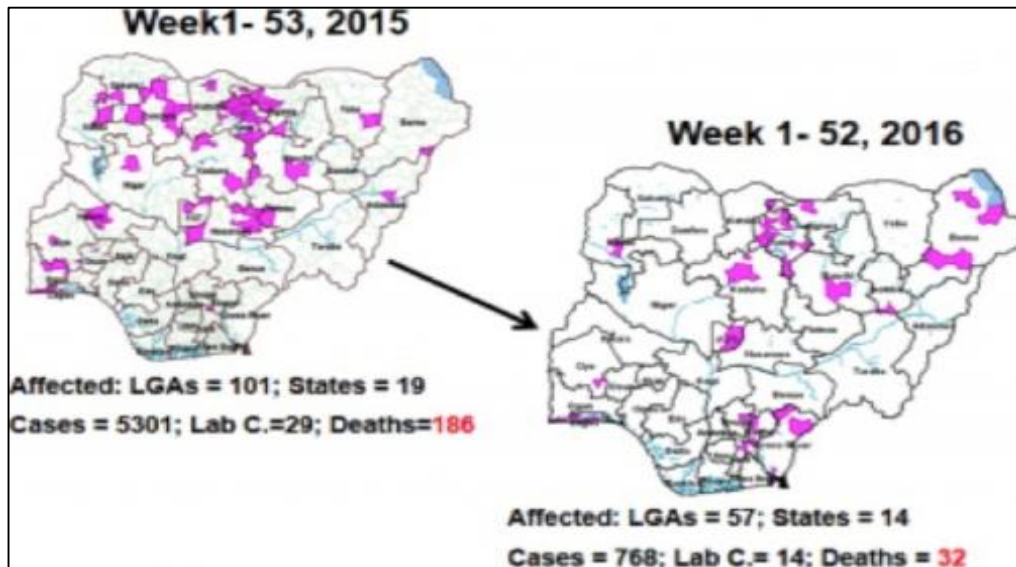
Country	2019 Cumulative			2018 Cumulative			2017 Cumulative			Cumulative since the beginning of the outbreak			Beginning of Outbreaks	Status of the outbreak
	Cases	Deaths	CFR(%)	Cases	Deaths	CFR(%)	Cases	Deaths	CFR(%)	Cases	Deaths	CFR(%)		
Mozambique	6382	8	0.1	863	3	0.3	3274	5	0.2	6382	8	0.1	Mar-19	Active
Kenya	1735	11	0.6	5782	78	1.3	4129	76	1.8	1735	11	0.6	Jan-19	Active
Somalia	806*	0	0	6447	45	0.7	78596*	1118	1.4	806	0	0.0	Jan-19	Active
Tanzania	216*	3	1.4	4688	84	1.8	4276	76	1.8	33537*	53	1.6	Aug-15	Active
Burundi	104	1	1.0	102	1	1.0	330	0	0.0	206	2	0.97	Dec-18	Controlled
Zambia	88	4	4.5	4127	55	1.3	747	18	2.4	88	4	4.5	Mar-19	Controlled
Zimbabwe	79	4	5.1	10807	71	0.7	6	3	50.0	10730	69	0.6	Sep-18	Controlled
Uganda	53	3	5.7	2699	60	2.2	253	2	2.0	53	3	5.7	Dec-18	Controlled
Angola	19	0	0	1262	18	1.4	389	19	4.9	331	3	0.9	Sep-18	Controlled
Malawi	12	0	0	785	28	3.6	155	5	0.7	12	0	0.0	Feb-19	Controlled
Rwanda	0	0	0	3	0	0.0	5	0	0.0	3	0	0.0	Jan-18	Controlled
South Sudan	0*	0	0	0	0	0.0	17285*	387	2.2					
DRC	10,469*	241	2.3	31 387	1,042		53,000*	1,145	2.3					
Cameroon	1, 063	64	6	578	36	8.8							May-18	Active

\*Regions with reduced number Cholera Cases in 2019

Source: Bulletin and AWD Outbreaks in Eastern and Southern Africa [59], [57,45 66,67]

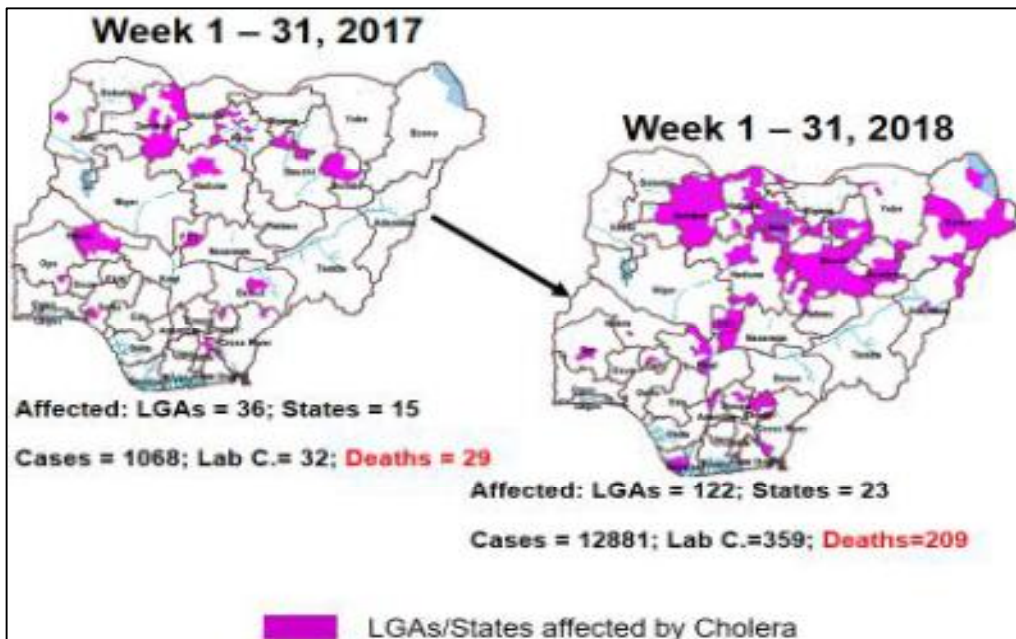
**Table 4. Cholera Burden in Nigeria 2017-2019**

Year	No of states affected	No of LGA	Cumulative no of cases	No of deaths	CFR (%)	References
2017	20	49	4,221	107		[73]
2018	18	135	24106*	444	1.84	[77,78]
2019	2	3	15*	-		[83]



**Fig. 2. Status of Local Government Areas and States That Reported Cholera Cases in Week1-53, 2015, 2016**

Source: Nigeria Centre for Disease Control Protecting the health of Nigerians [81]



**Fig. 3. Status of LGAs/States that reported Cholera cases in week 1 - 31, 2017 & 2018**

Source: Weekly Epidemiological Report [83]

## 9. CONCLUSION

Cholera from this review can be seen as a “disease of the poor” since it is still affecting a huge population of people from low or middle-income countries (Nigeria inclusive). The yearly incidence rate is recorded as 3.1 cases per 100 000 population. This is fostered by lack of the knowledge about cholera, food insecurity, population growth, conflicts and wars, climate change, urbanization, overcrowding, inadequate water and sanitation, lack of waste management systems, good accommodation with toilet facilities, in appropriate/proper health facilities and lack of surveillance/ response systems. Therefore, it will only be a wise decision to reduce the annual cholera burden by implementing multi-sectoral cholera control and surveillance programmes in high-risk areas (especially the Northern part of Nigeria).

## CONSENT AND ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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