

**ORIGINAL ARTICLE****Three Consecutive Waves of Cholera Outbreak in Ethiopia (2015-2017): Explanatory Analysis**Neamin Tesfay<sup>1\*</sup>, Mengistu Biru<sup>1</sup>**OPEN ACCESS**

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**ABSTRACT**

**BACKGROUND:** Cholera is an acute epidemic infectious disease. It is characterized by watery diarrhea, extreme loss of fluid and electrolytes, and severe dehydration. Ethiopia faced three consecutive waves of cholera outbreaks: nearly all regional states and city administrations, with the exception of one, were affected. The study was conducted with the aim of describing the epidemiology of the outbreak within the defined three years.

**METHODS:** Secondary data review was conducted along with explanatory methods of analysis individual patient data reported from different corners of the country in the time period of 2015 – 2017. Cases were identified using the case definition stated on the national guideline for cholera control in Ethiopia.

**RESULT:** A total of 36,154 cholera cases and 246 deaths were reported (overall case-fatality rate [CFR=0.7%] affecting all regions of the country except Gambella). The outbreak began in 2015 with 238 cases and 2 deaths [CFR=0.8%]. The largest outbreak during the period under this study occurred in 2016, with 29,338 cases and 188 deaths [CFR=0.6%]. Following a decline in disease occurrence, the country experienced a resurgence of epidemic cholera during 2017 (6,578 cases and 56 deaths; CFR, 0.9%), which declined rapidly to a few cases. AR was higher in males [37.01/100,000] and persons in the age group of 15–44years [44.10/100,000] in 2016.

**CONCLUSION:** The outbreak affected nearly every corner of the country. Taken together, the epidemiological trends of cholera in Ethiopia showed an annual decrement in frequency and length of outbreaks during the 3 years under review. The recent decreases in cholera case counts may reflect cholera control measures put in place by public health authorities of the national Ministry of Health.

**KEYWORDS:** Cholera, Ethiopia, Outbreak, Consecutive

**INTRODUCTION**

Cholera is an acute bacterial enteric disease characterized by its severe form by sudden onset, profuse painless, watery stool (rice-water stool), nausea and profuse vomiting early in the course of

illness (1). In untreated cases, rapid dehydration, acidosis, circulatory collapse, hypoglycemia in children, and renal failure can rapidly lead to death (2,3). In most cases, the infection is asymptomatic or causes mild diarrhea, especially with organisms of the *El Tor* biotype; asymptomatic carriers can transmit the infection (4). In severe dehydrated cases (cholera Gravis), death may occur within a few hours, and the case-fatality rate may exceed 50%. However, with proper and timely rehydration, this can be less than 1% (5). Cholera is a severe, acute, dehydrating diarrhea that can kill children and adults in less than 12 hours (4).

The Diagnosis of cholera is confirmed by isolating *Vibrio cholerae* of the serogroup O1 or O139 from feces. *V. Cholerae* grows well on standard culture media, the most widely used of which is thiosulphate citrate bile -salt sucrose agar. The strains are further characterized by O1 and O139 specific antisera (6).

Globally, an estimated 3 – 5 million cholera cases and 28,000 –150,000 deaths occur yearly (7,8). Recent estimations also fall within this range with Cholera killing an estimated 95, 000 persons per year and sickening more than 2.86 million people annually (9). It is the main public health problem in South Asia, particularly the Indian sub-continent while it has endemic-epidemic status in sub-Sahara Africa (10). Except for the United States of America, cholera cases were reported both sporadically as well as at endemic levels in countries and dependent territories in North America (11). On the other hand, cases reported from the European Union were mostly imported from countries where cholera is endemic or an outbreak was ongoing (11). From North America, a high number of cases were reported from Haiti, 754,373 cases and 8,964 deaths reported. Similarly, Dominican Republic reported 32,064 cases and 472 deaths with a case fatality of 1% during the year 2011-2017 (12). In Yemen, which is located in the Gulf of Aden, astonishingly a high number of cholera cases and deaths have been recorded with above 500,000 cases reported in just a single year (2016-2017) while the number of deaths reported up until July 2017 exceeded 1,800 (13). In Africa, Somali reported 129,324 cases and 1,228 deaths just from 2016-2017.

Tanzanian reported 2,511 cases and 390 deaths with a total case fatality rate of 14 % from 2015-2017 (11).

In Ethiopia, it was indicated that there was cholera epidemic in 1990 which persisted with recrudescence of cases till 1998 (14). Moreover, from July 2008 to June 2009, there were a total of 9,485 cases and 193 deaths (with a case-fatality rate of 2.0%) of cholera in six regions including the capital Addis Ababa (15). Currently, in Ethiopia, 5.9 million people are estimated to be living in cholera hot spot areas, which are specific and relatively small areas where the cholera burden is most concentrated and that plays a central role in the spread of cholera (16). Besides, Ethiopia is surrounded by countries like Somalia and South Sudan, which are currently unstable and more favorable for the cholera outbreak. On the other hand, due to climatic change, Ethiopia also faced consecutive waves of cholera outbreak nationwide in the last three years (17). However, burden and severity were varying from year to year; it was affected almost in all regions and city administrations of the country.

Currently, in Ethiopia, cholera is under control even if sporadic and unrelated cases were reported from the regions. The objective of this study was to assess the epidemiology of the outbreak in the past three years in Ethiopia.

## METHODS

**Study area:** Ethiopia is located at 9.1450° N, 40.4897° E. Ethiopia has nine regions and two city administrations. According to the latest United Nations estimates, the current population is estimated at 100,613,986 with an annual growth of 2.9% and in 2017 contributed to 1.39% of the total world population (18). The total land area is nearly 1,100,000 square kilometers (19), with the population density reaching 105 people per sq. km of land area in 2017 (20). Ethiopia has nine regions and two city administrations in the current federal system arrangement. The study was conducted from June 29-July 17, 2019.

**Study design:** A secondary data review was conducted with explanatory methods of analysis from the collected line list reported from

different regions and city administrations of the country from August 2015 up to July 7, 2017.

**Case definition:** Suspected case

A case of cholera should be suspected when:

- In an area where the disease is not known to be present, a patient aged 5 years or more develops severe dehydration or dies from acute watery diarrhea;
- In an area where there is a cholera epidemic, a patient aged 5 years or more develops acute watery diarrhea, with or without vomiting (21).

In the health post and at community levels, a suspected cholera case can be defined as follows: any person 5 years of age or more with profuse acute watery diarrhea and vomiting.

**Probable cases:** Probable cases refer to suspected cases in which *Vibrio cholerae* O1 or O139 has been isolated from their stool using the cholera rapid diagnosis tool (RDT) (21).

**Confirmed case:** Confirmed case refers to a suspected case in which *Vibrio cholerae* O1 or O139 has been isolated from stool using culture (21).

**Population under surveillance:** This refers to all populations lives in the country. The number

of populations mentioned in the document is used based on the projection of the Ethiopian Central Statics Agency (22).

**Data type and source:** Secondary data were used from the Ethiopian Public Health Institute (EPHI) specifically from the Center for Public Health Emergency Management.

**Data analysis and presentation:** Data were analyzed using Tableau 10.4 and Arc GIS 10.5.

**Ethical clearance:** A formal letter was submitted to the data manager at EPHI to access the data. Ethical clearance was obtained from the data manager of EPHI. For the sake of confidentiality, personal identifiers were not used in the study. Since the study used secondary data sources, consent and other ethical measures were not applicable.

## RESULTS

A total of 36,154 cholera cases were reported from all regions and city administrations in Ethiopia, except Gambella region. Of the cases, 29,501(81.50%) were from three regions and one city administration of the country; namely Somalia, Oromia, Amhara, and Addis Ababa as depicted in (Table 1).

Table 1: Distribution of cholera case by place in Ethiopia from 2015-2017

	Frequency	Percentage	Cumulative percentage
<b>Somali</b>	8547	23.60%	23.60%
<b>Addis Ababa</b>	8110	22.40%	46.00%
<b>Oromia</b>	7318	20.20%	66.20%
<b>Amhara</b>	5526	15.30%	81.50%
<b>Tigray</b>	3346	9.30%	90.80%
<b>Afar</b>	1609	4.50%	95.30%
<b>SNNPR</b>	949	2.60%	97.90%
<b>B/Gumuz</b>	426	1.20%	99.10%
<b>Harari</b>	273	0.80%	99.90%
<b>Dire Dawa</b>	50	0.10%	100.00%
<b>Gambella</b>	0	0.00%	100.00%
<b>Grand total</b>	36,154	100%	

**Distribution by person and time:** Men were more affected with a maximum attack rate of 37.01/100,000, and those who were between the ages of 15-44 years were also more affected with an attack rate of rate 44.10/100000 in 2016. In 2016, 29,338(81%) cholera cases were reported with attack rate 31.9/100000: Region-wise, four regions of the country reported 22,989(78%) cases in 2016. The detailed level of

attack rate is shown in Table 2. The epidemic curve (Figure 1) shows that the outbreak began rapidly on week 35/2015 when 3 cases were reported. There were 5 peaks during the outbreak in the period under study (2015 – 2017). However, all of the peaks occurred in 2016: in week 29(1,669 cases), week 31(1,450 cases), week 32(1,570 cases), week 33(2,203 cases), and week 36(1,525cases).

Table 2: Distribution of attack rate of cholera case by a person and place in Ethiopian from 2015-2017

Category	Population			Number of cases			Attack rate /100000		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
<b>Sex</b>									
<b>Male</b>	45,879,613	46,963,870	49,232,195	122	17,379	3334	0.27	37.01	6.77
<b>Female</b>	44,080,412	45,122,150	47,301,521	116	11,959	3244	0.26	26.5	6.86
<b>Age group</b>									
<b>&lt; 5</b>	24,019,327	24,586,967	25,774,502	71	2,112	879	0.3	8.59	3.41
<b>5_14</b>	39,762,331	40,702,021	42,667,902	103	17,302	2,826	0.26	42.51	6.62
<b>15-44</b>	13,494,004	13,812,903	14,480,057	39	6086	1461	0.29	44.1	10.09
<b>45+</b>	12,684,364	12,984,129	13,611,254	25	3838	1412	0.2	29.56	10.37
<b>Region</b>									
<b>Addis Ababa</b>	3,273,000	3,352,000	3,471,792	3	8,104	3	0.1	241.8	0.1
<b>Afar</b>	1,723,007	1,769,002	1,911,039	2	1,363	244	0.1	77	12.8
<b>Amhara</b>	20399004	20769985	21,993,893	0	4,435	1091	0	21.4	5
<b>B/Gumuz</b>	1005001	1033999	1,065,966	0	394	32	0	38.1	3
<b>Dire Dawa</b>	440,000	453,000	466,000	0	50	0	0	11	0
<b>Gambella</b>	409,002	422,002	435,999	0	0	0	0	0	0
<b>Harari</b>	232000	2,400,00	246000	0	273	0	0	113.8	0
<b>Oromia</b>	33,691,991	34,575,008	36573613	127	5,372	1819	0.4	15.5	5
<b>SNNPR</b>	18,276,012	18,719,008	19549496	0	941	8	0	5	0
<b>Somali</b>	54,529,94	5,598,002	5694291	106	5,078	3363	1.9	90.7	59.1
<b>Tigray</b>	50,559,99	5,151,998	5123610	0	3,328	18	0	64.6	0.4
<b>Total population</b>	89,960,025	92,086,020	96,533,716	238	29,338	6578	0.3	31.9	6.8

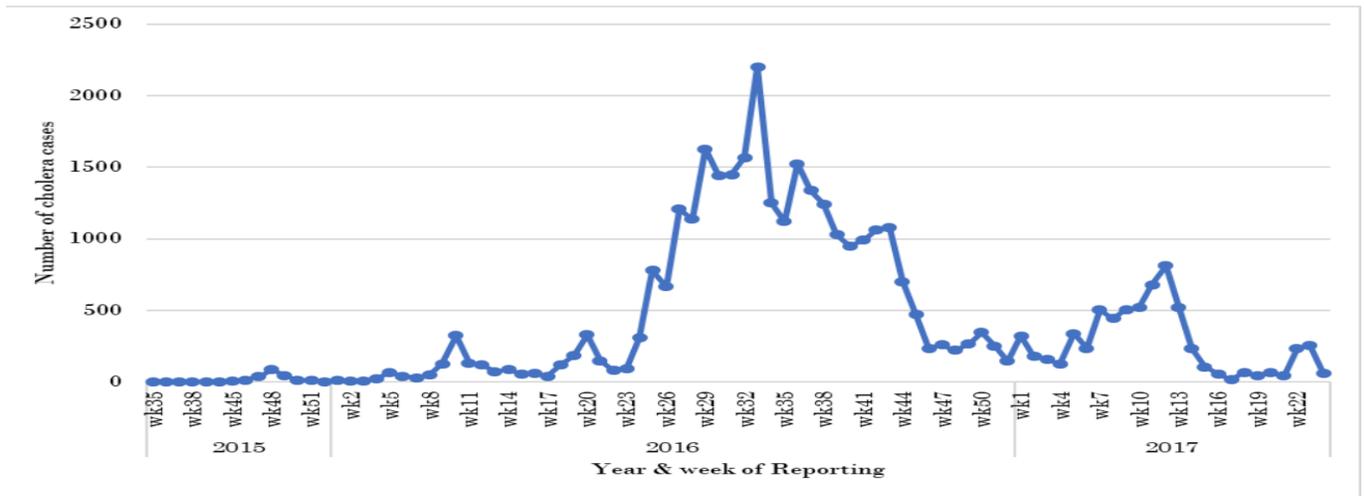


Figure 1: The trend of cholera outbreak by WHO epi week from 2015-2017

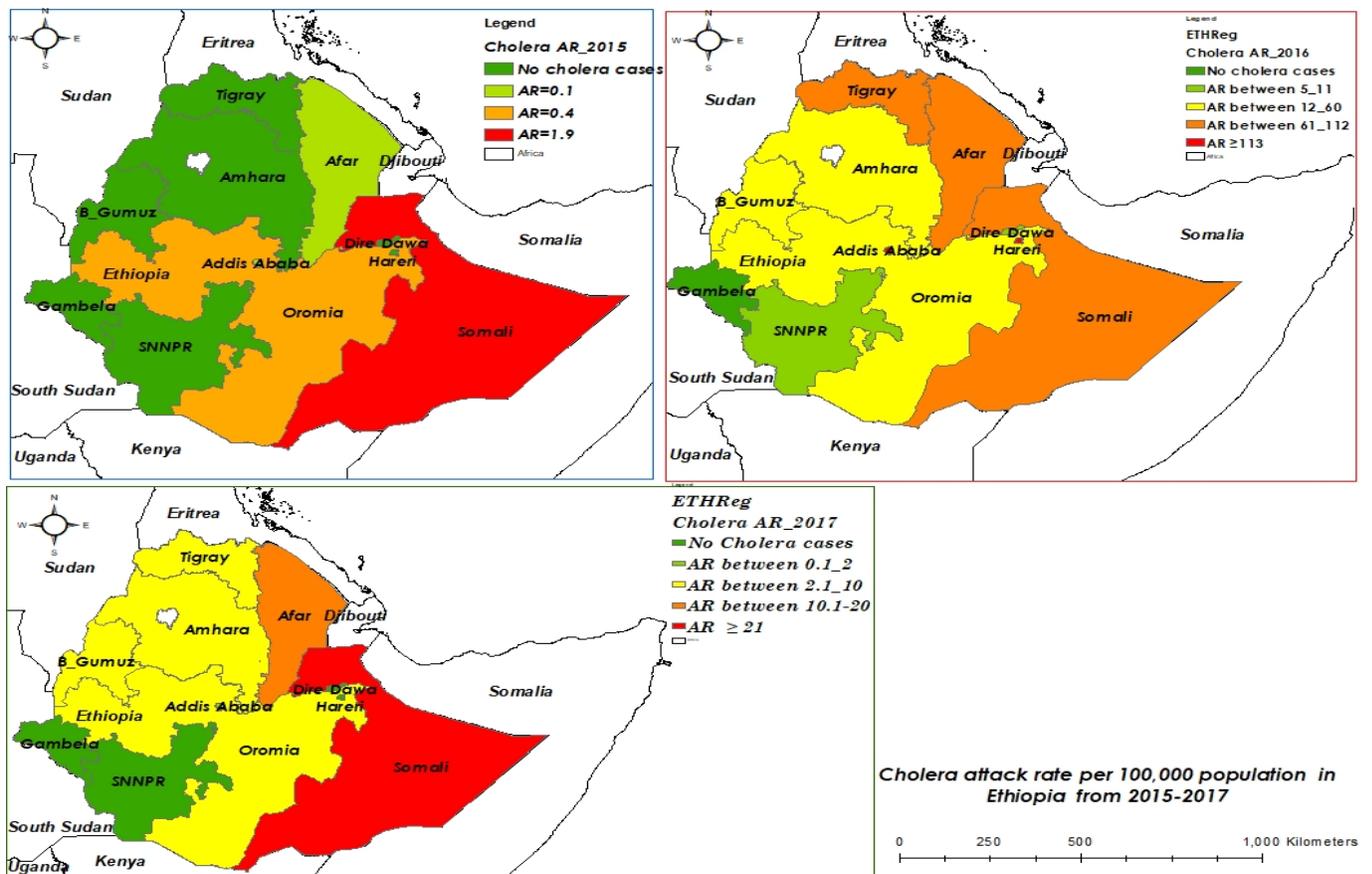


Figure 2: Level of cholera attack rate per 100000 populations in Ethiopia from 2015-2017

Regarding case management, from total cases, 13,176(36%) were classified as severely dehydrated. A total of 246 deaths were recorded which makes the case fatality rate of 0.8 % within the defined period of time as described in Table 3. Regarding the classification of the case, only

193(0.5%) cases were confirmed and 3,861 (10.7%) were treated as suspected cholera cases. However, the remaining cases were treated as probable cases of cholera. The details are summarized in Table 4.

Table 3: pattern of case fatality by sex, age group and region in Ethiopia from 2015-2017

Category	No. of Cholera Cases			No. of Cholera Death			CFR (%)		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
<b>Sex</b>									
<b>Male</b>	122	17379	333	2	113	31	1.64	0.65	0.93
<b>Female</b>	116	11959	324	0	75	25	0.00	0.63	0.77
<b>Age group</b>									
<b>&lt;5</b>	71	2112	879	0	22	10	0.00	1.04	1.14
<b>5_14</b>	25	3838	141	0	24	9	0.00	0.63	0.64
<b>15_44</b>	39	6086	146	2	79	19	5.13	1.30	1.30
<b>45+</b>	103	17302	282	0	63	18	0.00	0.36	0.64
<b>Region</b>									
<b>Addis Ababa</b>	3	8104	3	0	15	0	0	0.2	0
<b>Afar</b>	2	1363	244	0	11	4	0	0.8	1.6
<b>Amhara</b>	0	4435	109	0	0	17	0	0	1.6
<b>B/Gumuz</b>	0	394	32	0	22	6	0	5.6	18.8
<b>Dire Dawa</b>	0	50	0	0	0	0	0	0	0
<b>Gambella</b>	0	0	0	0	0	0	0	0	0
<b>Harar</b>	0	273	0	0	0	0	0	0	0
<b>Oromia</b>	127	5372	181	1	60	5	0.8	1.1	0.3
<b>SNNPR</b>	0	941	8	0	10	0	0	1.1	0
<b>Somali</b>	106	5078	336	1	28	24	0.9	0.6	0.7
<b>Tigray</b>	0	3328	18	0	42	0	0	1.3	0
<b>Grand Total</b>	238	29338	657	2	188	56	0.8	0.6	0.9

Table 4: Distribution cholera case by laboratory confirmation in Ethiopia from 2015-2017

Laboratory confirmation	Frequency	# Positive cases	(%) Positive cases from total cases	Positive rate
RDT	4256	3861	10.7%	90.7%
Culture	221	193	0.5%	87.3%
<b>Total case diagnosis by (RDT &amp; culture)</b>	4477	4054	11.2	90.6%
NA	31677	–	87.6%	–
<b>Total Reported cases</b>	36154		100.0%	

NA= (No laboratory confirmation)

## DISCUSSION

The study aimed to describe the overall situation of the cholera outbreak in Ethiopia. Ethiopia was affected by consecutive waves of cholera outbreaks from 2015 to 2017. However, it was not reported to the WHO due to fear of economic repercussions resulting from trade restrictions and decreased tourism (23). Besides, Ethiopia has signed an agreement under International Health Regulations (IHR) to notify such an event to WHO according to the defined criteria. Yet, Ethiopia failed to notify the event via the assigned international health regulation (IHR) focal to WHO (24).

Generally, overcrowding, inadequate water both in quantity and quality, inadequate personal hygiene, poor washing facilities, poor sanitation practice, and inadequate food safety were the major contributing factors identified for the spread of cholera outbreak in different places (21). Every corner of the country was affected by the outbreak except the Gambella region. The number of cases was higher in four regions of the country by reporting more than 80% cases within the three years of the outbreak; namely, Somali region, Addis Ababa City Administration, Oromia and Amhara regions. From the reported cholera cases, the highest number of cholera cases was observed in Somali region, and the lowest was in Dire Dawa City administration. The burden had similarities with the outbreak reported in west Bengal India (25).

The analysis of the demographic characteristics of patients showed that males and persons aged 15-44 years were more affected as compared to the remaining categories. This might be explained by the fact that men and people in the age group of between 15-44 years tended to be more mobile and were more likely to eat and drink outside the home. This finding was supported by a study conducted in the Oromia region, Ethiopia, and Niger (23,26).

The analysis of the geographical distribution of cases during 2015–2017 shows that some geographic areas have experienced prolonged and repeated outbreaks, whereas other areas were affected sporadically. In 2015, the burden and the distribution of cases were limited to small geographical areas: with an average attack rate of 0.3/100,000 population with a range of (0.1-1.9)/100,000. However, in 2016, nearly 30,000 cases were reported from all regions and city administrations of the country, except Gambella region. The capital Addis Ababa took the lead by reporting 8,107(27.4%) cases followed by Oromia and Somali regions which reported 5,372(18.3%) and 5,078(17.3%) cases respectively, from the total cases reported in 2016. The average attack rate for 2016 was 31.9/100,000 with a range of (5.0-241.8)/100,000 population with the minimum attack rate observed in Southern Nations and Nationalities and People's (SNNP) region while the maximum AR was observed in Addis Ababa City Administration. In 2017, the number of cholera cases sharply declined as compared to

2016; the outbreak was not reported in Harari region, Dire Dawa City Administration, and Gambella region.

The outbreak reports begun from WHO EPI-week 35 in 2015, and it was initially limited to remote parts of Somali and Oromia regions. However, following the rainy season, the number of cases began to increase and the outbreak expanded to the remaining part of the county. The level of attack rate varies for region to region with the year of the report. For instance, the attack rate was higher in Addis Ababa City Administration and Harari region with a rate of 241.8 and 113.8 per 100,000 populations respectively in 2016. This might be explained by the high population density in these areas which facilitates person-to-person transmission (27).

Quality of management and level of awareness regarding the illness is determined by dehydration status and case fatality rate. The CFR ranged from 0.62-1.52 % in the reported three years and the highest rates were observed in 2017. This might be explained by reduced commitment and a decline in political attention compared to the previous year. On the other hand, the lowest CFR was observed in 2016 compared to the remaining outbreak reported years; even if a high number of cholera cases were reported.

Moreover, region-wise, the highest CFR was observed in the Somali region while the lowest was in the Oromia region in 2015. This might be explained by relatively weaker access to healthcare in Somalia region which has many pocket areas which are inaccessible by road.

In 2016, the lowest CFR was seen in the capital Addis Ababa, and the highest CFR was reported from Benishangul Gumuz region. This might be explained by Addis Ababa is the capital city of Ethiopia which has relatively full availability of basic infrastructures and health professionals as compared to the remaining other regions (28).

In 2017, the number of cholera cases and deaths fell sharply as compared to 2016. However, the highest CFR was observed with a rate of 18.8% in Benishangul Gumuz region at the end of the outbreak. One of the explanations

may be because of staff exhaustion and poor case management (21).

The overall case fatality rate was 0.7% which is within the acceptable range of CFR (29). Moreover, it is lower as compared to other countries like South Sudan, Democratic Republic of Congo and Nigeria (30,31). This may be due to good management of cases, decentralization of cholera treatment unit and ensuring the availability of supply along with enhancing prevention and control activity.

During treatment, 13,176(36%) cases were severely dehydrated which may indicate low level of awareness among cases about the illness, or it may be due to misclassification of dehydration status. From the total reported cases within the defined period of time, only 4,477(12.4%) cases were diagnosed using laboratory: from them, only 193(0.5%) cases were confirmed by the gold standard which is below the expected level. However, not every reported case has to be confirmed in the laboratory. If most patients have signs and symptoms compatible with the working diagnosis, and, perhaps, 15% to 20% are laboratory-confirmed, countries do not need more confirmation (32). The finding was similar to the studies conducted in Niger (33) and Kenya (34) where very low proportion of bacteriologically confirmed cases were observed which limits the reliability of information available to guide prevention and control strategies. Although laboratory capacity to support routine surveillance has been weak, improvements were observed in microbiological testing capacity and laboratory data management overtime on using both rapid diagnostics tests and culture. The laboratory component of the public health surveillance should continue to be strengthened and supported at the health facility, district, provincial and national levels (35).

The present analysis has provided a review of cholera in Ethiopia over the defined period. However, the study has the following limitations. On the one hand, only health facility deaths were reported, which affect the estimation of CFR as it does not take deaths that occurred outside facilities among communities into account. Additionally, microbiological confirmation of most cases was unknown and can influence the

distribution of the case. Due to such limitations, the burden of cholera has not yet been well characterized.

A cholera outbreak is becoming a major public health problem in Ethiopia for the last few years. It needs both short- and long-term evidence-based interventions. In this regard, advanced predictive epidemiological modeling like Generalized Additive Modeling (GAM) and Multiple Linear Regression (MLR) approaches would enable the country in quantifying the influence of climate and socioeconomic variables in explaining the spatial and temporal variability of cholera is needed.

In conclusion, the outbreak was not notified to WHO based on the decision instrument set by International Health Regulations. The outbreak affected almost all regions and city administrations of the country with a high attack rate and low case fatality in the central part of the country whereas the reverse was observed in remote parts of the country. Besides, the outbreak highly affected the working-age group. A small number of cases were confirmed by the laboratory during the period of the outbreak. As a way forward, improving the quality of management across the country with maximum utilization of laboratory confirmation is recommended. Also, the level of preparedness and commitment for managing and controlling the outbreak should be similar regardless of the status of the outbreak; the level of commitment can be maintained by training health workers, employing a rotation-based system that helps avoid burn out and avail different incentive mechanism such as risk allowance and public recognition, because high CFR was seen within a smaller number of cases at the termination of the outbreak. Since cholera is not endemic to Ethiopia alone, it is mandatory to report with adherence to International Health Regulations.

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