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Outbreak Investigation

Cholera outbreak in Niger State Nigeria, May to August 2021: An unmatched case-control study

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ABSTRACT

Introduction: Cholera is an infectious disease characterized by acute watery diarrhea. It is caused by the ingestion of food or water contaminated with the toxigenic strains of *Vibrio cholerae* serogroups O1 or O139. On May 14, 2021, a case of cholera was reported from Gurara Local Government Area of Niger State. A Rapid Response Team was deployed immediately to describe the outbreak, determine its source, and risk factors, and institute control measures. **Methods:** We defined a suspected case of cholera as any person with acute watery diarrhea with or without vomiting living in Niger State from 14 May to 30th August 2021. We reviewed routine surveillance data obtained from the Integrated Disease Surveillance and Response (IDSR)and conducted active case searches in hospitals and communities. We calculated attack rates (AR) and case fatality rates (CFR) and generated an epi curve and spot maps. We conducted a case-control study using a structured interviewer-administered questionnaire to collect sociodemographic, clinical, and hygiene practice data from 67 cases and 134 controls. We tested 67 stool samples, 10 vendor salad samples, and 36 water samples. Bivariate analysis was conducted to determine factors associated with cholera and multivariate analysis was used to identify predictors of cholera in Niger State at a significance level of $p<0.05$. **Results:** A total of 2,051 cases were reported with a CFR of 6.5%. Wushishi LGA had the highest CFR (40.0%) while Bosso LGA had the highest AR of 127.3/100,000 population. Children aged 0 to 9 years comprised 25.8% (530/2051) accounting for the largest proportion of the affected population. Consumption of water stored in an uncovered wide-mouthed container (AOR: 2.81; 95% CI: 1.36-5.76) and being less than 20 years of age (aOR: 0.34, 95%CI: 0.14-0.82) were independently associated with cholera. *Vibrio cholerae* was cultured from 47(70.1%) stool, 6(60%) salads, and 14(38.9%) water samples. **Conclusion:** We confirmed the presence of a cholera outbreak in Niger State with a high CFR. Storing water in uncovered open-mouthed containers and being aged 20 plus years were risk factors. We educated the community on the proper treatment and storage of water.

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Introduction

Cholera is an ancient infectious disease that is caused by the ingestion of food or water contaminated with the toxigenic strains of *Vibrio cholerae* serogroups O1 or O139 [1]. It is often characterized by a rapid onset of watery diarrhea, with or without vomiting, with mild to extensive dehydration [2-3]. Cholera is usually fatal when prompt rehydration therapy is not administered in severe cases; it can result in severe clinical outcomes such as confusion, unconsciousness, low blood pressure, and circulatory shock [4-5]. Although the case fatality rate (CFR) from untreated cholera cases can be as high as 30-50%, with prompt and adequate treatment, the CFR can be reduced to 1% [6].

Cholera outbreaks tend to occur because of contamination of food or drinking water sources with *Vibrio cholera* organisms due to poor personal hygiene, and poor environmental sanitation conditions worsened by a lack of potable water supply [6]. Natural and man-made disasters that result in the internal displacement of persons from their original habitation leading to overcrowded and unstable living conditions with contamination of food and water sources have also been linked to many cholera outbreaks [7].

Cholera is an important public health problem worldwide, affecting an estimated 1.3 to 4.0 million cases of cholera, and 21,000 to 143,000 deaths worldwide. [8]. Although most cholera infections are not detected, large outbreaks can occur, such as those seen in Vietnam and Zimbabwe in recent years [9]. Industrialized countries have not reported cholera cases for over a century due to their advanced water and sewage treatment infrastructure. However, cholera remains prevalent in areas with crowded housing and inadequate water and sanitation facilities [10]. Cholera was one of the three diseases mandated for notification to the WHO under the 1969 International Health Regulations (IHR). Even after the 2005 revision of the IHR, cholera outbreaks still necessitate notification. [10].

Cholera is endemic in Africa, parts of Asia, the Middle East, and South and Central America. However, Africa has experienced recurrent cholera outbreaks, characterized by a large disease burden and high case-fatality rates [11]Sub-Saharan Africa is one of the high cholera burden regions, with an estimated 140000 suspected cases occurring each year in both endemic and epidemic settings. According to a 2010 - 2019 report, 1,080,778 of the 4,426,844 (24%) cholera cases reported to the World Health Organization (WHO) came from sub-Saharan Africa [12]. The actual burden is higher because many people who get infected don´t present to health facilities because they show mild symptoms while others die before getting to health facilities [12]

In Nigeria, the link between rainfall and cholera according to some studies was attributed to flooding which exposes the population to the bacterium. In the northern part of Nigeria, the beginning of the rainy season is usually associated with heavy downpours and flooding, thereby increasing the risk of contaminating sources of drinking water through sewage collapse in slum areas, where most of the residents are using unimproved sanitation facilities [13]. In Nigeria, populations living in urban slums are more at risk of contracting the disease, because these areas are mostly densely populated by low-income earners and basic sanitation infrastructure is not readily available, which results in many people defecating in the open and usually practising poor hygiene [14]. The highest cholera death rate in Nigeria was in 1991 with a CFR of 12.9%. As at March 28, 2021, a total of 1,746 suspected cases including 50 deaths (CFR = 2.9%) had been reported from eight states [15]

Niger State in north-central Nigeria is also known for recording regular outbreaks of cholera. On 14 May 2021 the first case of cholera was reported from Gurara LGA of Niger State and a Rapid Response Team (RRT) was deployed immediately to the affected community. Based on the initial assessment and report of the state´s RRT, the Nigeria Center for Disease Control (NCDC) deployed a 4-man team to describe the outbreak, determine its source and determine the associated risk factors.

Methods

Outbreak area

Niger is a state in the North Central region of Nigeria and the largest state in the country by landmass. The state's capital is at Minna. Other major cities are Bida, Kontagora and Suleja (**Figure 1**). The estimated population as of 2020 was 5,556,200 [16]. It has three tertiary health facilities, 24 secondary facilities, and 1,093 primary health care centers.

About 57.7% of people in Niger state still practice open defecation, 39.0 % lack access to potable water[17] and long queues of women and children at water wells is a common site; there are densely populated slums with environmental problems, uncollected refuse, and inadequate drainage facilities. Niger State has a rural water supply and sanitation agency [18].

Descriptive Epidemiology

Case definition: We defined a case of cholera as "any person or patient with acute watery diarrhea with or without vomiting living in Niger State from May 14 to August 30, 2021. We also defined a confirmed case as any of the suspected cases in which *vibrio cholera* have been isolated from their specimen or RDT positive for cholera in the laboratory.

Active case search: We reviewed routine surveillance data obtained from the Integrated Disease Surveillance and Response (IDSR) and carried out active case searches in health facilities and communities in affected LGAs, updated and cleaned the state cholera line list.

Analytic Epidemiology

A review of the descriptive epidemiology findings led us to suspect drinking unsafe water from wells was associated with being a cholera case.

Study design

To test the above hypothesis, we conducted an unmatched case-control study of both confirmed and suspected cases in the 6 most affected LGAs with a case-to-control ratio of 1:2.

Sample size

Using Epi Info version 7.2.4.0 StatCalc, the minimum Sample size was calculated as 67 cases and 134 controls to identify an odds ratio of 4.0, with an estimated 15.0% prevalence of exposure among controls from a previous outbreak [19], 95% two-sided confidence level, controls to cases ratio of 2, an alpha risk of 5%, 80% power and we selected the Kelsey output.

Sampling Strategy

We included all current and recovered cholera cases from the line list. Using established case definitions, we conducted an active case search within the affected communities and reviewed health records at local health facilities. All individuals meeting the case definition were enrolled. We collected data on socio-demographic characteristics (sex, age, residence), the date of illness onset, the date of clinic presentation, presenting signs and symptoms, treatment history, and outcomes.

Controls were selected from family members (26%), friends (14.5%), and neighbors (59.5%) of the recruited cases. These groups were selected for ease of recruitment and were more accessible and cooperative compared to strangers. Given also the limited time and resources for the study during the response.

Eligible controls were those who had lived in the communities for at least 10 days before the outbreak began and had no symptoms matching the case definition during the specified period.

Data collection

An electronic interviewer-administered questionnaire was developed on the Open Data Kit (ODK) and used to obtain information on participants' socio-demographic characteristics, general knowledge of cholera, source of water, method of water storage, prevention of cholera, and hygiene practice.

Laboratory Investigation

Stool samples were taken from the 67 cases and transported using the Cary-Blair medium. Rapid diagnostic tests and cultures were conducted on the samples in the laboratory. In addition, 10 salad samples were taken from street vendors and cultured in the laboratory. Food vendors were selected based on their proximity to the outbreak locations, six samples from Wushishi LGA and four from Bosso LGA.

Data analysis

Data was cleaned using Microsoft Excel and exported to Epi Info version 7.2.4.0 for analysis. Univariate analysis was conducted to summarize the data in person, place, and time. Frequencies and proportions were generated and tabulated. An epidemic curve was generated, and CFR and attack rate were computed. Bivariate analysis was conducted to determine factors associated with cholera at $p<0.05$. Statistically significant variables from bivariate analysis were fitted into a multivariate regression model to control for confounding at $p<0.05$ and adjusted odds ratios were calculated.

Environmental assessment

An observational checklist was administered to all the 201 study participants to assess accessibility to water, water safety, sanitary facilities, and waste disposal. Thirty-six water samples were taken from 15 uncovered wells, 8 from boreholes, and 13 from household water storage facilities within the affected communities.

Ethical considerations

Informed verbal consent was obtained from the participants and confidentiality of the respondents was maintained. Ethical approval was obtained from the Niger State Ministry of Health ethical review committee with approval number ERC PAN/2021/08/17.

Results

Descriptive epidemiology

As of August 30, 2021, there were 2051 cases and 134 deaths with an overall CFR of 6.53%. A proportion of 52.1% (1068/2051) were female and 25.8% (530/2051) were children aged 0-9 years accounting for a large proportion of the affected population (**Table 1**).

21 LGAs were affected during the period of this investigation. Bosso LGA recorded the highest attack rate of 127.3 per 100,000 population while Wushishi LGA had the highest CFR of 40%. The case fatality and attack rates for other affected LGAs can also be seen in **Table 2**.

From the age-sex pyramid, 0-9 age group has a male-to-female ratio of 0.96:1 (ie. 222:231). The only age groups that have a 1:1 male-to-female ratio were: 50-59 years (48:48), and 40-49 years (72:72) (**Figure 2**). **Figure 3** shows the spatial distribution of cases and deaths in the affected LGAs of Niger state, with a higher number of cases and deaths clustered in most affected LGAs, particularly Bosso, Chanchaga, Magama, and Kontagora. However, four LGAs reported no case during the period of investigation.

The epicurve shows index case was reported in week 24 however further retrospective investigations revealed the incidence of cases from week 21 and three peaks in weeks 27, 29, and 30 (**Figure 4**).

Our analysis also showed that 53.2% (107/201) of the respondents were males 53.7% (36/67) of cases and 53% (71/134) of controls were males. While more than one-third (36.8%, 74/201) of all respondents were living in a multi-dwelling type of household, 50.7% (34/67) cases and only 29.8% (40/134) controls lived in such households (**Table 3**).

Laboratory findings

Out of the 67 stool specimens tested, 70.1.% (47/67) were positive for *Vibrio cholerae. Vibrio cholera* was isolated from 38.9% (14/36) of water specimens as follows: 3/15 (20.0%) from uncovered wells, 9/13 (69.2%) from wide open-mouth containers from households, and 2/8 (25.0%) from boreholes. Six (60%) of ten salad specimens were also positive for *vibrio cholera*.

Environmental findings

The environmental assessment revealed that 50% (101/201) of respondents did not have adequate containers for storing water, and 55% (111/201) used a well as their source of drinking water (**Table 4**). Widespread open defecation, absence of toilets or latrines, presence of salad vendors, blocked drainages, and open waste dumping sites were observed. Waste is typically discharged into the surrounding environment/streams by almost all the households visited.

Analytical epidemiology

At bivariate analysis, the factors that were statistically significantly associated with cholera infection were: consumption of water stored in an uncovered wide-mouthed container (Crude OR[cOR]=4.4; 95% CI:2.3-8.4), consumption of salad (cOR=3.1; 95% CI:1.56-6.25), living in a multi-dwelling household (cOR=2.4; 95%CI:1.3-4.4), age group 0-19 years (cOR=2.9; 95% CI:1.3-6.5) and not washing hands with soap water after use of toilet (cOR=1.9; 95% CI:1.1–3.6) (Table 4). Notably drinking water from unprotected wells was negatively associated with cholera but not statistically significant (cOR: 0.8; 95%CI:0.4-1.4).

After multivariate analysis, only consumption of water stored in uncovered wide-mouthed containers, (adjusted odd ratio [aOR]: 2.81; 95% CI: 1.36-5.76), and persons below 20 years of age (aOR: 0.34; 95%CI: 0.14-0.82) were independently associated with cholera infection in Niger state. The association between consumption of salad and developing cholera was borderline (aOR: 2.28, 95%CI: 1.00-5.19). Drinking water from unsafe wells remained non-significant (aOR:0.75; 95%CI: 0.33-1.69) (Table 4).

Discussion

Results from laboratory cultures of human stool, salad, and water samples confirmed a cholera outbreak in Niger State. Our epidemiological findings revealed that consumption of water stored in uncovered wide-mouthed containers was a risk factor and significantly associated with the disease. Contrary to our hypothesis, drinking water from unprotected wells was negatively associated with cholera though not statistically significant. Hence, we reject our hypothesis that drinking from unsafe wells is associated with cholera infection. Laboratory results from the environmental specimen also showed the presence of Vibrio cholerae in salad and water samples from wide-mouth containers. The results agree with similar studies in Kenya and Nigeria [20-21]. The link between using water from open wells and cholera is a major public health concern.

Our findings that 69% of water samples from the wide open-mouthed containers tested positive for cholera compared to only 20% of water samples from uncovered wells and consumption of water stored in uncovered wide-mouthed containers was a risk factor for cholera, seem to imply that water got contaminated at household level by being stored poorly in uncovered open-mouthed containers.

Research from Nigeria and other parts of the world highlights the need to enhance water quality by improving sanitation infrastructure, water treatment methods, and community awareness. Tackling these issues can greatly decrease the risk of cholera and other waterborne illnesses.

This cholera outbreak affected all age groups, but older people seem to have been most affected. Findings from this study show that being younger than 20 years of age was an independent protective factor which is consistent with a previous study from Nigeria [22]. This may be because younger individuals might have been exposed to cholera or related bacteria earlier in life, leading to partial immunity or adhering more to hygiene practices taught in schools or through public health campaigns. Younger individuals might have better nutritional status, which can enhance immune function and provide protection against infections. and most times families might prioritize protecting their children from known health risks, leading to more stringent preventive measures for younger individuals. However, some studies showed the contrary with a higher number of cholera cases in children than adults and vice versa [23-24]. Community education programs should therefore target all age groups, ensuring that older populations are equally informed about cholera prevention and control measures.

Bosso LGA recorded the highest attack rate of 127.3 per 100,000 population. Bosso LGA has settlements like Sabon Gari, Angwan Daji, and Dutsen Kura which are slums with limited access to water and sanitation infrastructure. This may have accounted for the high attack rate in Bosso LGA.

A case fatality rate (CFR) of 6.5% was recorded as of 30th August during the response in Niger State. This CFR is higher than the WHO-recommended threshold of < 1%. According to other studies, this might be because of inadequate clinical case management or quality of care, access to available cholera treatment centers, and poor management of large outbreaks, however, these factors were not assessed during the study as such we cannot categorically say that these factors were responsible for the high CFR. The Higher CFR recorded in Wushishi local government may be because of the security challenges in the area which has grossly affected surveillance activities as such most of the cases reported were few cases that could access health facilities and deaths. Also, the four local government areas that were not reporting may be a result of the security challenges in those areas, though the surveillance officers in the LGAs were contacted during the response.

The occurrence of this cholera outbreak in Niger State falls within the already established period when cholera outbreaks are expected to occur in the State and Northern Nigeria as well [25]. Cholera exists as a seasonal disease in most countries. In Nigeria, cholera infections have been reported in both rainy and dry seasons, although the burden of cholera tends to increase during the beginning of rainy and dry seasons [25].

During the investigation, unreported cases were uncovered in the communities whose incidents happened weeks before that of the reported index case. This calls for an enhanced community-based surveillance system in the state.

The lack of improved water sources forces households to use less safe water sources. It is worthy of note that the population generally does not treat their water before consumption. Transporting drinking water in uncovered basins and storing it in wide-mouthed containers uncovered were common among the people. This should not downplay other factors that were explored during the study such as consumption of unhygienic prepared salad, open defecation, indiscriminate human waste disposal, and lack of potable water in the affected areas which are also responsible for the outbreak. Consumption of poorly prepared salad was also common among the people infected [26]. This indicates the need to scale up health communication and community sensitization on the health benefits of storing water in clean closed-mouthed containers and good hand hygiene, particularly after using the toilet, adequately washing vegetables, and drinking water from safe sources to reduce the disease incidence. There were also many multi-dwelling households which according to previous studies contributed to the spread of cholera disease [27]. Waste is typically discharged into the surrounding environment/streams by almost all the households visited. The total absence of water sanitation and hygiene reflects the lack of attention to this problem, and waste management is a major concern in the communities visited. Open defecation is frequently practiced by most of the households. This is evidenced by the absence of latrines, probably because of the low economic level of most households.

Study Limitations

Our study is not without limitations. The use of household, friends, and neighborhood controls might have resulted in selection bias and inadvertent matching on some variables. Also, controls were not tested for cholera, raising the possibility that some could have been asymptomatic cholera cases hence a misclassification bias.

Conclusion

We confirmed the presence of a cholera outbreak in Niger State with a high CFR. Consumption of water stored in uncovered wide-mouthed containers was revealed as a possible risk factor for the infection. Therefore, we rejected our hypothesis for this study. Our findings indicate that people need to be aware of the importance of safe storage of drinking water in well-covered containers and proper hand hygiene to avoid contaminating the water, and salad vendors need to be educated through their appropriate bodies on the safe preparation and handling of the salad. Considering many people have poor access to safe drinking water there is a need to intensify risk communication and community engagement on treatment of water before use and hand hygiene.

As part of our immediate intervention, we educated the community on the proper treatment and storage of water. We recommended to the Niger State government the provision of safe water and the construction of sanitation facilities; enhanced awareness creation on the dangers of cholera infection using commonly spoken local languages, training of surveillance officers particularly at the community level for timely reporting, advocacy to partners for the provision of cholera treatment centers for quick, accessible, and adequate clinical case management or quality of care and enhanced water sanitation and hygiene activities including chlorination of water points in the affected communities.

What is known about this topic

- Cholera is endemic in Niger State and northern Nigeria due to poor hygiene, open defecation, and lack of potable water and waste disposal facilities
- Transmission occurs mainly through contaminated water, food, and produce
- During outbreaks, the case fatality rate (CFR) often exceeds the WHO benchmark of <1% because many patients rely on home care, seek treatment late, or face delayed establishment of free cholera treatment centers

What this study adds

- Consuming drinking water stored in uncovered wide mouthed containers led to the transmission of cholera. This highlighted the need for effective enlightenment of the public on proper storage of drinking water
- The laboratory results from this study revealed presence of *vibro cholera* in drinking water and prepared salad confirming the fact that bacteria can be found in anything edible

Competing interests

The authors declare no competing interest in this study.

Authors' contributions

EA conducted the outbreak investigation and produced the first draft of the manuscript. AS, AU, MB, and OO reviewed the methodology and data analysis and YY, OE, and AE reviewed the manuscript. All authors agreed with the final version of the manuscript.

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Tables and figures

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Table 1: Case fatality rate by age group of cholera cases in Niger State, Nigeria, May to August 2021 (N=2051)				
Age group(years)	**Cases**		**Deaths**	**CFR %**
	Frequency	**Percentage**		
0-9	530	25.8	32	6.0
10-19	427	20.8	33	7.7
20-29	417	20.3	16	3.8
30-39	329	16.1	18	3.4
40-49	159	7.8	8	5.5
50-59	102	4.9	16	15.7
60-69	53	2.6	7	13.2
70 and above	34	1.7	4	11.8
Total	2051		134	6.5

Table 2: Number of cases and deaths per LGA in Niger State, Nigeria May to August 2021					
LGA	**Cases**	**Death**	**LGA Population**	**AR/ 100,000 pop**	**CFR %**
Agwara	78	0	80600	96.8	0.0
Borgu	111	11	242800	45.7	9.9
Bosso	265	11	208100	127.3	4.2
Chachanga	58	2	284000	20.4	3.4
Gurara	39	1	127700	30.5	2.6
Kontagora	254	14	213500	118.9	5.5
Lapai	15	0	164400	9.1	0.0
Magama	266	28	255000	104.3	10.5
Mariga	83	4	280400	29.6	4.8
Mashegu	77	13	215197	35.8	17.1
Mokwa	164	3	341200	48.1	1.8
Munya	67	3	145400	19.6	4.5
Paikoro	24	1	222200	10.8	4.2
Rijau	63	2	247600	25.4	3.2
Shiroro	216	22	331100	65.2	10.2
Suleja	125	2	302200	41.4	1.6
Tafa	68	5	117800	57.7	7.4
Wushishi	10	4	114900	8.7	40.0
Lavun	48	6	294700	16.3	12.5
Bida	8	0	260700	3.1	0.0
Agaie	15	2	185600	8.1	13.3
Total	**2051**	**134**	**5556200**	**36.9**	**6.5**

Table 3: Socio-demographic characteristics of respondents in the cholera case-control study in Niger State, Nigeria, May to August 2021			
Variable	**Cases N=67 Frequency (%)**	**Control N=134 Frequency (%)**	**Total N= 201 Frequency (%)**
Sex			
Male	36 (53.7)	71 (53.0)	107 (53.2)
Female	31 (46.3)	63 (47.0)	94 (46.8)
Age group (years)			
0–19	16 (23.9)	13 (9.7)	29 (14.4)
20–39	30 (44.8)	70 (52.2)	100 (49.8)
40–59	18(26.9)	42 (31.3)	60 (29.9)
60–79	3 (4.48)	9 (6.72)	12 (5.97)
Occupation			
Civil servant	3 (4.48)	12 (8.95)	15 (7.46)
Trader	3 (4.48)	11 (8.21)	14 (6.96)
Farmer	17 (25.4)	38 (28.4)	55 (27.4)
Artisan	4 (5.97)	3 (2.24)	7 (3.48)
Health care worker	1 (1.49)	10 (7.46)	11 (5.47)
Student	21 (31.3)	25 (18.7)	46 (22.9)
Housewife	13 (19.4)	28 (20.9)	41 (20.4)
Unemployed	5 (7.46)	7 (5.22)	12 (5.97)
Religion			
Islam	58 (86.6)	108 (80.6)	166 (82.6)
Christianity	9 (13.4)	26 (19.4)	35 (17.4)
Type of household			
Multi-dwelling	34 (50.7)	40 (29.8)	74 (36.8)
Single family-dwelling	33 (49.3)	94 (70.2)	127 (63.2)

Table 4: Factors associated with cholera infection in Niger State, Nigeria, May to August 2021					
Variable	**Cases (N=67)**	**Control (N=134)**	**Bivariate results**		**Adjusted Odds Ratio (95%CI)**
			Crude Odds ratio (95%CI)	**P-value**	
Age group(years)					
0-19	16	13	**2.9 (1.3–6.5)**	**0.007**	**0.34 (0.14-0.82)**
>19	51	121	1		1
Sex					
Female	31	63	0.9 (0.5–1.7)		
Male	36	71	1	0.920	
Ate salad					
Yes	116	41	**3.2(1.6-6.6)**	<0.001	2.23 (0.95-5.25)
No	18	22	1		1
Drank Kunu/koko					
Yes	50	21	1.3 (0.7–2.5)		
No	82	46	1	0.403	
Drink water from unprotected wells					
Yes	71	40	0.8 (0.4-1.4)	0.3667	0.75 (0.33-1.69)
No	63	27	1		1
Multi-dwelling household					
Yes	94	33	**2.4 (1.3–4.4)**	**0.003**	0.54 (0.27-1.09)
No	40	34	1		1
Not washing hands with water after use of toilet					
Yes	43	65	**1.9 (1.1–3.6)**	**0.024**	0.57 (0.27-1.27)
No	24	72	1		1
Visited patient with diarrhea and vomiting					
Yes	29	72	1.6 (0.4–1.2)	0.163	
No	38	62	1		
Consumption of water stored in wide mouthed container					
Yes	83	18	**4.4 (2.3-8.4)**	**<0.001**	**2.90(1.40-6.01)**
No	51	49	**1**		1

Figure 1: **M**ap of Niger state with local government areas (LGAs)

Figure 1: Map of Niger state with local government areas (LGAs)

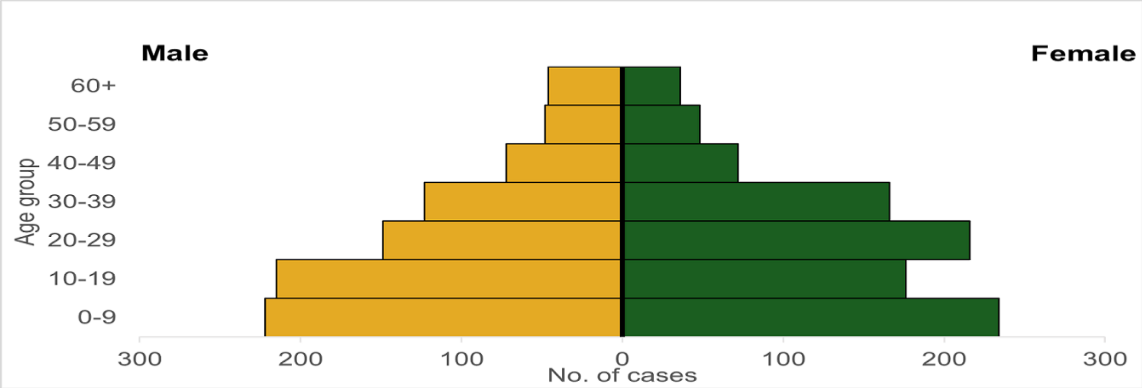

Figure 2: Age-sex distribution of cholera cases in Niger State, Nigeria May to August 2021

Figure 2: Age-sex distribution of cholera cases in Niger State, Nigeria May to August 2021

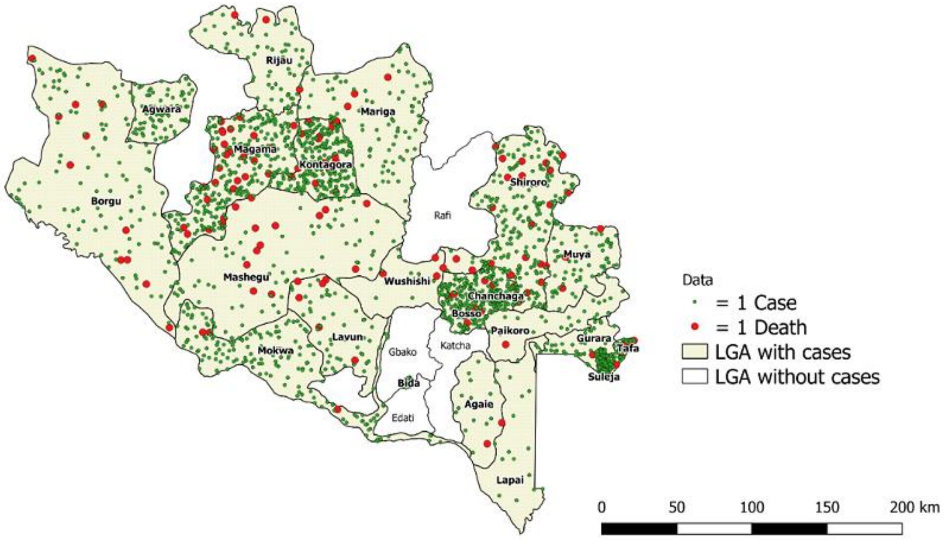

Figure 3: A spot map of Cholera cases in affected LGAs

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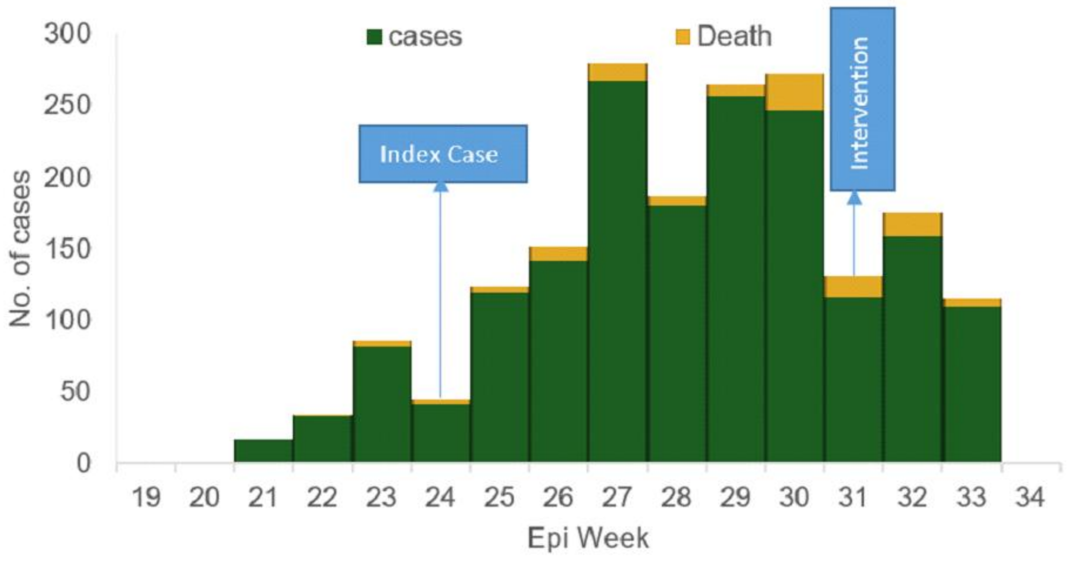

Figure 4: Epidemic curve of cholera cases in Niger State, Nigeria May to August 2021

Figure 4: Epidemic curve of cholera cases in Niger State, Nigeria May to August 2021