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ENVIRONMENTAL FACTORS AND BEHAVIORAL RISK ASSOCIATED WITH CHOLERA OUTBREAK IN NGURU COMMUNITY, YOBE STATE NORTH EAST NIGERIA

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ABSTRACT: In this descriptive case control cohort study, we evaluated the environmental and behavioral factors associated with an outbreak of cholera that occurred in Nguru community from 3rd August to 8th October 2021. A total of 254 cholera cases were managed at Cholera Treatment Unit (CTU), at Federal Medical Centre, Nguru. Out of which 59 adult (28 males & 31 females) cholera cases aged ≥ 18 years that consented to participate in the study were recruited through systematic random sampling as cases. The control involved 60 adults aged ≥ 18 years that presented to hospital for different health conditions other than diarrheal diseases. They were also recruited through systematic random sampling as control. There was similar distribution of cholera cases and control cohort based on gender $\chi^2 = 2.466$, $P = 0.116$ and defined aged groups $\chi^2 = 0.917$, $P = 0.916$. Literacy level was significantly lower in cholera cases than controls ($\chi^2 = 19.063$, $P = 0.001$). Potential risk factors associated with cholera includes low literacy level below secondary education, Odd Ratio (95% Confidence Interval); OR 95% (CI) 1.97 (0.96 – 4.82), $P = 0.042$, pond and water purchased from water vendors as a source of drinking and domestic use 67.231 (21.25 – 756.45), $P < 0.001$. Suboptimal hand hygiene such as not washing hand before and after eating food was associated with significant risk of cholera disease, 39.871 (14.32 – 233.04), $P < 0.001$. Other personal hygiene practices associated with significant risk of the disease includes; not always washing fruits and vegetables before consumption 68.49 (23.13 – 494.26), $P = 0.001$ and not always washing hand after visiting toilet 0.01 (0.00 – 1.53), $P = 0.043$. Visiting/attending to sick person/relative with diarrheal disease during the outbreak was significantly associated with risk of cholera 64.12 (17.43 – 290.35), $P = 0.001$. Provision of portable drinking water, optimizing personal hygiene such as hand washing after visiting the toilet, before and after eating food, washing of fruits and vegetables before consumption are necessary preventive measures. Optimal hand hygiene is also required during visit or attending to a sick person with diarrheal disease such as cholera.

Keywords: Environmental Hygiene, Behavioral Risk, Cholera Outbreak, Nguru

1. INTRODUCTION

Cholera is a disease that is associated with consumption of food or water contaminated with fecal matter from infected person or from sewage facility (Gwenzi and Sanganyado 2019). Epidemiologic report indicates that Cholera has a worldwide distribution. Globally, World Health Organization (WHO), estimated about 1.3 to 4.0 million cases and 21,000 to 14,300 deaths occur annually (Ali, *et al.*, 2015). The incidence is higher in low- and middle-income countries such as sub-Saharan Africa, South East Asia and southern America (Mintz and Tauxe 2013). Large cholera outbreak is seldom seen

in developed countries except during natural or Man-made disasters such as earth quake, tsunami, wars and civil unrest due to internal displacement, overcrowding, destruction of sewage and sanitation facilities (WHO, 2017). Of the 58 Cholera endemic countries, 27 are on the African continent and 23 out of the 33 countries that frequently report high death from cholera are located in sub-Saharan Africa (Ali, *et al.*, 2015; WHO, 2017). Nigeria contributes significant number of both global cases and death from cholera (WHO, 2017). The frequent occurrence of Cholera in a locality often reflects underdevelopment and low socioeconomic indices (Mintz, and Tauxe 2013).

Spatio temporal distribution of cholera in Nigeria shows that although cholera is endemic and therefore could occur throughout the year, largest outbreak occurs during raining season (Abdulssalam, 2017; Luckebusch, & Abdulssalam, 2015). Lack of pipe borne water and use of shallow wells, dams and ponds for domestic consumption has been linked with cholera epidemic (Lessler, *et al.*, 2018). Other determinant of frequent occurrence of the disease in the environment is lack of or improperly constructed drainage system. During raining season, improperly constructed pit latrines and drainages overflow and discharge their content into the environment and also contaminate shallow wells, dams and ponds that are used for domestic consumption (Lessler, *et al.*, 2018; Rebaudet, *et al.*, 2013). The practice of open defecation, poor personal hygiene such as hand washing after eating and defecation has been shown to be a risk factor disease that are acquired and transmitted through consumption of food and water contaminated with effluent from sewage and fecal matter in the environment (Ali, *et al.*, 2017).

It is against this background that we evaluated the environmental and personal hygiene behaviors that is associated with cholera outbreak that began from 3rd August to 8th October 2021. Information obtained from this study will be shared with the community health extension workers, hospital administration of the hospital located within the locality and community leaders.

2. MATERIALS AND METHODOLOGY

2.1. Study Area

Nguru local government area (LGA) has its headquarters at Nguru town. It has a total land area of 826.63 km². It is bounded in the North and North-East by Yusufari LGA, at the West by Karasuwa LGA, at the South and West by Jigawa State and Machina LGA in the North-West (Fig. 1).

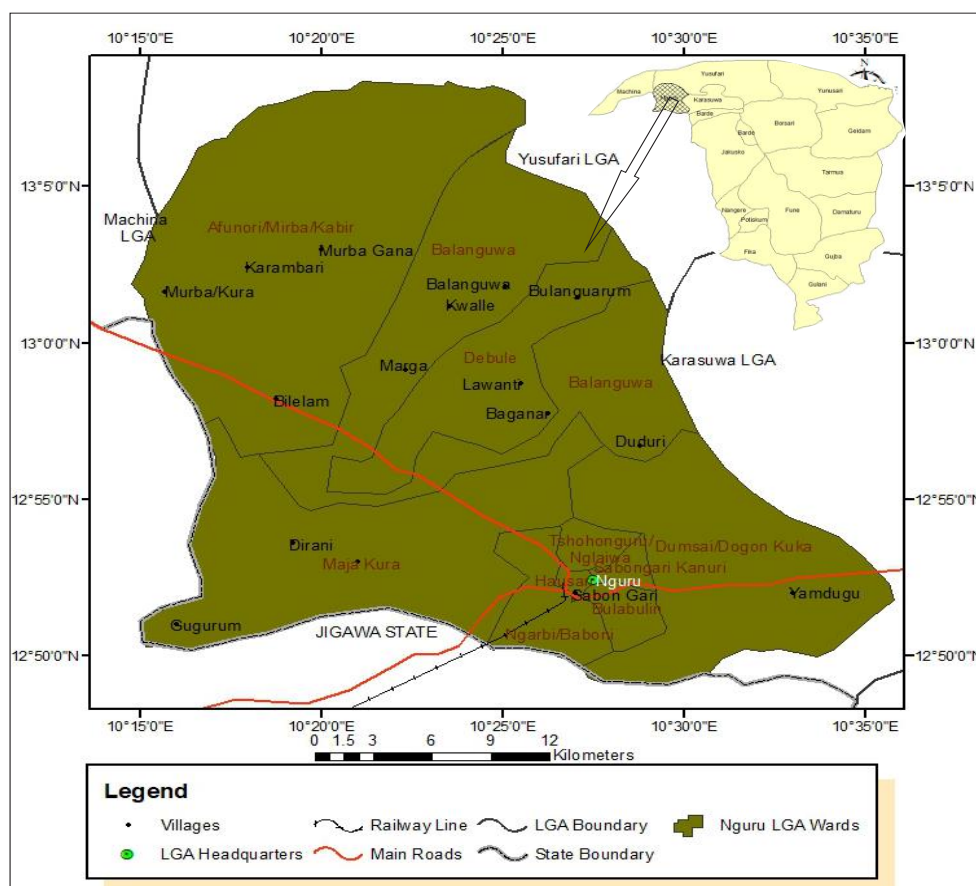


Figure 1. The Study Area

The entire LGA is located within the floodplains of River Hadejia with elevation ranging from 333 to 370 m

above sea level (Tiway and Nuhu (2014). According to the National Population Commission (NPC, 2009),

based on the population and census figures of 2006, Nguru LGA had a population of 150,632 people consisting of 54% males and 46% females. Therefore, with the land area of the LGA as 916 km², the population density of the LGA is 165 people per km². According to Tiwary and Nuhu (2014), the three main ethnic groups in the LGA include; Kanuri, Bedde and Manga with Kanuri and Hausa as the most common spoken languages. Karkarna and Adamu (2021) opined that Nguru LGA has hot and dry climate throughout the year. March, April and May are the hottest months in the LGA with temperature ranging from 39°-42°C. However, Manpower Nigeria (2022) stated that the average temperature in the LGA is about 33°C. The period of rainy season starts in the month of June and lasts for about 120 days. Annual rainfall ranges from 500mm-1000mm and the rainy season is normally from June to September in the town (Tiwary and Nuhu (2014).

The vegetation cover of Nguru is Sahel savannah. There are numerous water bodies within the LGA, among which are Nguru lake, River Nguru and Hadejia/Nguru wetlands. All these perennial water bodies are possible domicile for water borne diseases. The northern parts of the LGA registered the presence of sand dunes. The main occupation of the inhabitants is farming (cultivation of crops like groundnuts, millet, sorghum, cotton and cowpea), processing of hides and skin, petty trading, fishing and leather works. The main health facility in the LGA is Federal Medical Center, Nguru (Manpower Nigeria 2022).

2.2. Methodology

A pre-evaluated questionnaire was administered to cholera cases that were admitted to cholera treatment unit (CTU) at Federal Medical Centre Nguru during the disease outbreak that lasted for nine weeks from 3rd August to 10th October 2022. The questionnaire was also administered to other patients and their relatives that presented to the hospital for different conditions as control through systematic random sampling. Participation in the study was voluntary; those that declined were assured that declining participation will not in any way affect the quality of services in the hospital. Verbal consent was obtained from participants that agreed to participate in the study. Permission was also obtained from the Federal Medical Centre to conduct this study. Socio- demographic characteristics of the participants were obtained. Information was also sourced on the environmental factors such as source of drinking water, waste disposal, type of toilet facilities and family size was obtained from the study participants. Behavioral practices and personal hygiene such as washing hand before and after eating, washing hand before eating fruits and vegetables, washing has after visiting the toilets, proper covering of leftover food was also evaluated. Stratification of the participants was done based on Revised Scoring Scheme for the Classification of Socio-economic status as detailed in the Table 1 (Abadin and Akpede, 2021).

Table 1. Revised Scoring Scheme for the Classification of Socioeconomic status in Nigeria

Assigned score/ Socio-Economic status	Revised scheme category
I	Postgraduate education (Diploma, Certificate, Masters and Doctorate
II	University degree or Higher National Diploma
III	National Certificate of Education/National Diploma/Advanced Level GCE & National Business and Technical Education Board
IV	School Certificate/National Examination Council/Teachers Grade II
V	Junior Secondary School Certificate/Primary leaving Certificate/Basic Quaranic Education
VI	Unable to read and Write

Source: Ibadin, 2021

2.3. Data Collection

The study questionnaire was administered to all participants that consented to participate in the study. The questionnaire had two sections; socio-demographic information and environmental and behavioral risk factors. Data was de-identified and stored on password protected electronic devices.

2.4. Statistical Analysis

The de-identified research data was transferred to the Statistical package for social sciences (SPSS) version 26 (IBM Corp., Armonk, NY, USA) template for initial statistical analysis. Quantitative data was summarized using means and standard deviation, while discrete data by frequencies and proportions. Environmental and behavioral risk was evaluated using Logistic regression

analysis. Data cleaning was done to remove errors. Statistical significance was set as $p < 0.05$.

2.5. Ethical consideration

Ethical approval was obtained from Federal Medical Centre before commencement of this study. Informed consent (written or verbal as appropriate) was sought from all study participants before commencement of the study.

3. RESULTS AND DISCUSSION

Cholera outbreak has been shown to occur in environment with sub optimal environment and personal hygiene. It often occurs in peri –urban slums, poor rural communities or overcrowded living conditions due to

shortage of sanitary and environmental waste disposal (Ngwa *et al.*, 2021). In agreement with this study, most cholera disease outbreak in Nigeria are reported during, at the onset and within the raining season due to contamination of drinking water with fecal matter from shallow wells, dams and ponds (Perez–Saez 2022; Adagbada *et al.*, 2012; Lemaitre *et al.*, 2019; Ngwa, *et al.*, 2016). The cholera disease outbreak started on the 3rd August 2021 to 8th October 2021, 254 cholera cases were managed at Cholera Treatment Unit located within Federal Medical Centre, Nguru from the total reported cases, 59 adult cholera cases aged ≥ 18 years that consented to participate in the study were recruited as case study. The control involved 60 adults aged ≥ 18 years that presented to hospital for different health conditions other than diarrheal diseases were recruited through systematic random sampling as control.

Table 2. Socio-demographic characteristics of the studied participants

Variable	Cases	Control	Statistical significance
Sex			
Female	31	40	$\chi^2 = 2.466, P = 0.116$
Male	28	20	
Age group (Years)			
< 20	07	06	$\chi^2 = 0.917, P = 0.916$
21 - 30	17	15	
31 - 40	13	14	
41 - 50	11	12	
≥ 50	07	04	
Educational Status			
Nil	22	18	$\chi^2 = 19.063, P = 0.001$
Primary	05	07	
Secondary	18	12	$\chi^2 = 10.142, P = 0.017$
Tertiary	03	20	
Quaranic	11	03	
01 - 04	17	10	
05 - 09	06	21	
10 - 14	05	11	$\chi^2 = 52.465, P < 0.001$
≥ 15	10	17	
Type of Toilet facilities			
Pit toilet	04	25	$\chi^2 = 33.670, P < 0.001$
Pit toilets/open defecation	32	-	
Water system	16	32	
Open defecation	01	-	
Occupation			
Farming	14	1	$\chi^2 = 33.670, P < 0.001$
Civil servant	00	7	
Trading	14	14	
Farming/Trading	10	-	
Student	06	3	
House wife	07	18	

Table 2 shows that there was a significant distribution of cholera cases and control cohort based on gender $\chi^2 = 2.466, P = 0.116$ and defined aged groups $\chi^2 = 0.917, P = 0.916$ (The reason for a higher infection in the

female gender was not fully established in this study but it could be attribute to their numerous activities and their patient care role during any disease outbreak). The practice of open defecation as observed among cholera cases in this study is associated with cholera outbreak. This is not surprising as rainfall dissolve fecal matter easily contaminate source of water, fruits and vegetables and other food items (Bwire *et al.*, 2017). Poor and blocked drainage system often overflows its banks during raining season causing flooding of contaminated water in the environment. Open defecation and use of pit latrines in homes often reflect under development and poor socioeconomic status. Shallow pit latrines have been shown to overflow and discharge fecal matter into the environment (Brick *et al.*, 2004). Proper waste disposal, avoiding dumping of refuse in drainage channels and prompt evacuation of drainage before blockage is necessary in optimizing environmental hygiene (Brick *et al.*, 2004; Anandan *et al.*, 2021). Use of pit latrines is common among cases in this study, in contrast to the use of water system in control ($\chi^2 =$

52.465, $P < 0.001$). This increases the risk of infectious diseases that are contacted through feco – oral route. The contaminated water could easily contaminate shallow wells, dams and ponds located within the peri – domestic environment. Most controls in this study use pipe borne water for drinking and domestic use ($\chi^2 = 23.138$, $P < 0.001$). The use of safe and portable pipe borne water is associated with lower risk of water borne diseases (Brick *et al.*, 2004; Anandan *et al.*, 2021; Bompange *et al.*, 2008). Unfortunately, most communities that report frequent cases of diarrheal diseases lack portable water for domestic consumption. Cholera outbreak rarely occurs in the setting of efficient sewage disposal, sanitation, and optimal personal hygiene except where there is damage to sewage lines. Damage to sewage facilities and pipe water supplies has been reported to have caused point source outbreak of cholera (Hutin *et al.*, 2013). However, such point source epidemic seldom results in large outbreak of cases (WHO, 2017).

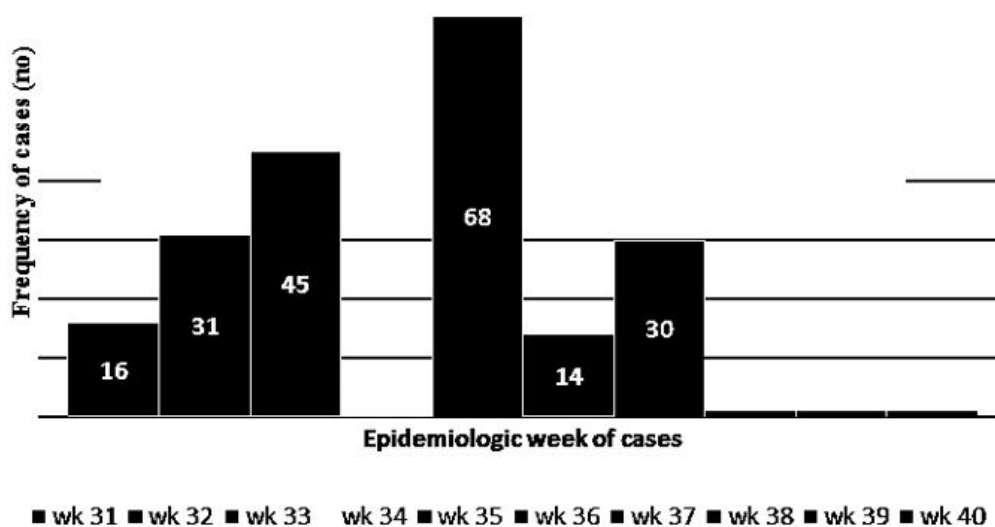


Figure 2. Cholera cases based on the epidemiologic week of presentation

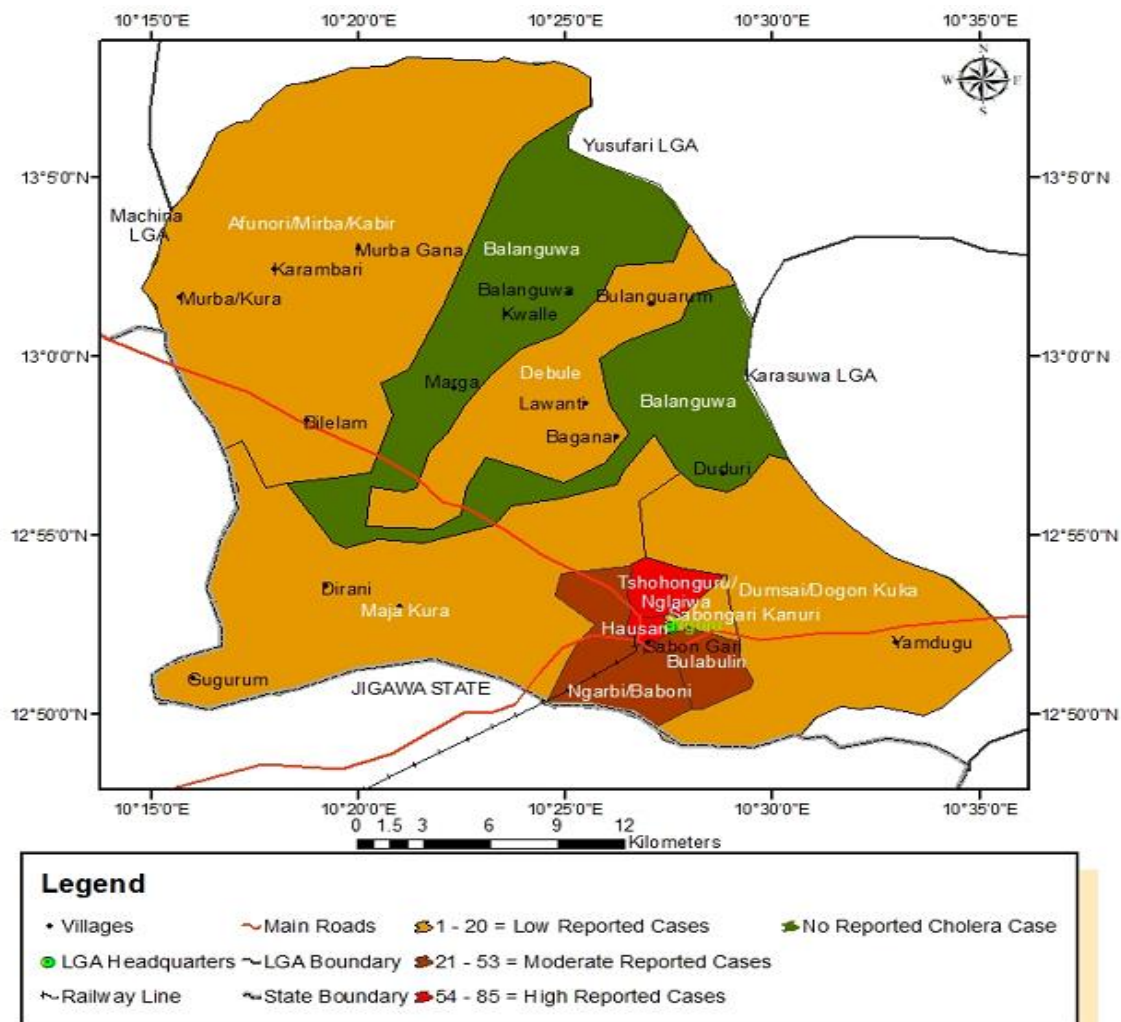
3.1. Spatial Pattern of Cholera Reported Cases

The distribution of cases of cholera based on the epidemiologic week of presentation is as depicted in Figure 2. The outbreak began in week 31 with 16 cases with a steady increase in cases/week through week 34 reaching a peak in week 35. The cases declined in week 36 but doubled in week 37. The epi-curve then flattened from week 38 to the end of the outbreak in week 40.

Figure 3, shows the spatial distribution of reported cases of cholera based on the wards in Nguru .8LGA in 2021. Tshohonguru/Nglaiwa and Hausari wards were reported to have the highest reported cases, moderate reported cases were reported in Ngarbi/Baboni and Bulabuni around Nguru urban which is the LGA headquarters. Being the LGA headquarters, Nguru urban has higher population with associated urban problems such as poor drainage system (Tiwary and Nuhu, 2014), poor sanitation and hygiene such as poor waste management and toilet facilities (Karkarna and Adamu, 2021). Infact,

(Karkarna and Adamu, 2021) reported that about 68% of the inhabitants of Nguru use pit latrines. The terrain of the area is also an added advantage for cholera endemic as the topography is mainly plains with the presence of stagnant water such as Hadejia/Nguru wetlands, River Nguru and Nguru Lake which help in the breeding of water borne diseases. Though, about 84% of the inhabitants have access to household toilets,

but open defecation practices and defecation in polythene bags after which they discarded into the bush or on a refuse dump are still widely practiced in the town. While Balanguwa wards had no record of cholera case throughout the year, the LGAs that are far northwards such as Afunori ward with extreme temperature, low rainfall and scanty population recorded low reported cases.



•
• Figure 3. Spatial pattern of reported cases of cholera based on the wards in Nguru

3.2. Environmental and Behavioral Risk Factors for Cholera

Cholera outbreak frequently occur in the setting of unhygienic environmental and behavioral factors especially during raining season. Environmental factors such as access to portable drinking water, waste and sewage disposal and sanitation has been associated with diarrheal diseases including cholera. Personal hygiene

such as washing of hands before eating, washing of fruits and vegetables and covering of food has been shown to reduce the risk of diseases that are transmitted via feco-oral route. Environmental and behavioral risk factors for cholera in this study are as depicted in Table 2. Potential risk factors associated with cholera includes low literacy level below secondary education, Odd Ratio (95% Confidence Interval); OR 95% (CI) 1.97 (0.96 – 4.82), $P = 0.042$. The level of education of the

respondents is inversely proportional to the rate of infection, these can be interpreted clearly that the less educated ones are more prone to infection compared to their educated counterparts. Pond and water purchased from water vendors as a source of drinking and domestic use 67.231 (21.25 – 756.45), $P < 0.001$. Street vented water has been shown to be associated with risk of cholera infection. Suboptimal hand hygiene such as not washing hand before and after eating food was associated with significant risk of cholera disease, 39.871 (14.32 – 233.04), $P < 0.001$. Other personal hygiene practices associated with significant risk of the disease includes; not always washing fruits and vegetables before consumption 68.49 (23.13 – 494.26),

$P = 0.001$ and not always washing hand after visiting toilet 0.01 (0.00 – 1.53), $P = 0.043$. Visiting/attending to sick person/relative with diarrheal disease during the outbreak was significantly associated with risk of cholera 64.12 (17.43 – 290.35), $P = 0.001$. Optimal personal hygiene has been shown to reduce the risk of cholera disease. Washing of hands before and after eating food, washing of hands after visiting the toilet and washing of fruits and vegetables was observed in controls than cases in this study. This underscores the importance of personal hygiene in preventing the disease. Poor adherence to personal hygiene has been reported to be associated with disease outbreak (Lemaitre *et al.*, 2019).

Table 3. Environmental and behavioral risk factors for cholera

Potential risk exposure		Odd Ratio (95% Confidence Interval)	p – value
Source of drinking water			
Tap/Well water	Reference		
Pond/water vendor		67.231 (21.25 – 756.45)	<0.001
Water storage in homes			
Water always covered	Reference	2.561 (0.60 131.89)	0.082
Water storage not always covered			
Hand Hygiene			
Always washing hand before and after eating food	Reference		
Not washing hand before and after eating food		39.871 (14.32 – 233.04)	
Always washing fruits and vegetables	Reference		
Not always washing fruits and vegetables		68.49 (23.13 – 494.26)	<0.001
Not always washing hand after visiting toilet		0.01 (0.00 – 1.53)	y0.043
Did not visited or attended to a sick person/relative with diarrheal disease during the outbreak	Reference		
Visited/Attended to sick person/relative with diarrheal disease during the outbreak		64.12 (17.43 – 290.35)	<0.001

Source: Research work 2021

4. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

1. In this study, we evaluated the environmental and behavioral factors associated with an outbreak of cholera that occurred in Nguru community from August to November 2021.
2. Cholera outbreak frequently occur due to unhygienic environmental and behavioral factors especially during raining season.
3. Environmental factors such as access to portable drinking water, waste and sewage disposal and sanitation has been associated with diarrheal diseases including cholera.
4. Personal hygiene such as washing of hands before eating, washing of fruits and vegetables and covering of food has been shown to reduce the risk of diseases that are transmitted via feco-oral route.

4.2. Recommendations

Educational programs aimed at promoting personal and environmental hygiene is necessary to prevent disease outbreak. This could be achieved through social mobilization and engagement with community, religious and political leaders. People should be encouraged to practice personal hygiene, washing of hands before and after using the toilet, multifaceted approach involving the combination of water sanitation and hygiene (WASH) should be encouraged and unsolicited visits to sick persons should be discouraged. The government should ensure the provision of portable water for domestic consumption, construction of efficient drainage systems and water ways, construction of adequate and functional toilets in public places such as schools, markets, mosques, churches and recreational and sport facilities and very importantly, western

education should be encouraged among the people of Nguru LGA

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