Analysis of the Risk Factors to Cholera Outbreaks in Parts of Minna, Niger State

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Most people in Minna, Niger State rely on untreated water from wells for their daily supply and intake while some have no or limited access to water and adequate sanitation facilities. These residents live under the threat of cholera. Approximately one hundred and ninety-nine cases of cholera were recorded during epidemic outbreak in Minna between 2010 and 2021. Hence, the thrust of this study is to analyse the risk factors to Cholera Outbreak in parts of Minna. Purposive sampling was used to select the neighbourhoods in Minna. This study also designed a well-structured questionnaire to collect information on the risk factor causing Cholera outbreak in Minna. Field reconnaissance survey was used to identify the risk causing cholera in the study area. The risks were ranked on the field from severity 1 to 5. The risk factor causing cholera epidemic was determined by multiplying risk frequency with its severity level. Monthly cholera cases were also collected from General Hospital Minna between 2010 and 2021 and Pearson correlation coefficient was used to determine the relationship between cholera epidemic and average rainfall events from 2010 to 2021. The study revealed that the risk factors causing cholera epidemic were source of drinking water with mean risk value of 3.13, followed by mode of water treatment (3.04), refuse disposal /defecation (2.99) and source of food/fruits (2.95); implying that untreated well (open) water is the major cause of cholera epidemic in Minna. The study revealed that positive correlation (0.76) existed between cholera cases and monthly rainfall; implying that the spread of cholera is more during the rainy season and is high. The untreated well (open) water is the major factor causing cholera epidemic across in Minna and its severity is high. The study recommend that the well water should be treated with water guard at source before drinking especially during rainy season.
Keyword: Cholera, Water Sources, Risk factor, Rainfall, Pearson Correlation, Minna

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Introduction

Cholera is caused by the bacterium (*Vibrio cholera*) primarily transmitted through the consumption of contaminated water or food (World Health Organization, 2014). This disease can lead to severe diarrhoea, dehydration, and even death if left untreated. Cholera, a highly contagious and potentially life-threatening waterborne disease, remains a significant global health concern, particularly in areas with inadequate sanitation and limited access to clean water. Understanding the vulnerability of a community to a cholera outbreak is crucial for implementing effective preventive measures and designing appropriate intervention strategies (Mohammad *et al.,* 2012). The infection is transmitted through contaminated faecal matter, which can be consumed through tainted food and water sources or because of poor hygiene and sanitation and unwashed hands according to International Medical Corps, 2011 (Nsagha *et al., 2015)*. As from 2000, the incidence of cholera has increased steadily, culminating in 317,534 reported cases worldwide, including 7543 deaths with a case-fatality rate of 2.38 % in 2010 (WHO, 2014) The disease is now considered to be endemic in many countries and the pathogen causing cholera cannot currently be eliminated from the environment (WHO, 2018).

In Nigeria, the burden of cholera has increased during the past two decades (Mohammed *et al.,* 2012). Cholera is endemic in Nigeria, and there has been an increase in reported cases since June 2021. Following this rise in cholera infections across the country, the Nigeria Centre for Disease Control (Elimian *et al.,* 2022) activated a comprehensive Cholera Emergency Operations Centre on 21 June. As at 24 October 2021, there have been 93,932 suspected cases and 3,293 associated deaths in Nigeria. These numbers put the case fatality rate at 3.5%, which is higher than the previous annual outbreaks in the past four years. The outbreak has affected 32 of the 36 states of the country, including the federal capital Abuja. While in Niger State, in 2021, the commissioner for Health, Muhammad Makusidi stated that the state recorded 100 deaths from cholera outbreak are attributed the outbreak to open defecation and indiscriminate waste disposal by the dwellers. Community awareness and preparedness are vital in preventing and managing a cholera outbreak (Ncube *et al.,* 2016).

Numerous studies have assessed the awareness, knowledge, and risk factors responsible for cholera outbreak. Most of these studies reported that the level of awareness and knowledge of cholera is low (Anetor & Abraham 2020) in Abuja. Risk factors of that result to cholera outbreak such as open flow of sewage water within the surrounding, food and water supplies contaminated by parasites and bacteria when essential systems like those for water and sewage are destroyed, lack of resources, infrastructure and disaster preparedness system among others were reported (Denue *et al.*, 2018; WHO, 2019). Dan-Nwafor *et al.* (2019) revealed in a study on cholera carried out in a district in North central Nigeria, the lack of sufficient knowledge and awareness of cholera. Denue *et al.* (2018) and Elimian *et al. (*2019) reported that despite the huge public health impact of cholera there is a dearth of information about this preventable disease in Nigeria especially the northern part as most outbreaks are either underreported or not thoroughly investigated.

The factors contributing to a cholera outbreak in Minna, like in many other regions, can be multifaceted. Some of the common factors include poor sanitation and hygiene practices, contaminated water sources, overcrowding and poor waste management. Lack of access to clean drinking water and inadequate sanitation facilities can facilitate the spread of the cholera-causing bacteria. Improper disposal of waste, especially in densely populated areas can contaminate water sources and lead to the transmission of the disease. Inadequate public health infrastructure and limited healthcare services can also contribute to the severity of a cholera outbreak in Minna. Lack of awareness about preventive measures and delayed response to suspected cases can further exacerbate the situation. In Minna neighbourhood, the risk factors of cholera outbreak between 2020 and 2022 have not been analysed hence the need for this study. In this study, the following answer the following question: (i) what are the risk factors contributing to cholera outbreaks in the Minna? (ii) what is the relationship between cholera outbreak and monthly rainfall events in Minna?

Description of the Study Area

This study was carried out on six Minna neighbourhoods. Minna is bounded by Tudun Fulani in the Northern part, Maitumbi in the East, Chanchaga in the South and Dutsen Kura in the Western axis. Minna is located between latitude 09^{o} 39`18" N and 09$^{o}$ 38`42" N of the equator and longitude 06^{o} 30`54" E and 6$^{o}$ 32`6" E of the Greenwich meridian. Bosso is one of the ten (10) wards that make up Bosso Local Government Area and also one of the oldest wards; later on, Bosso was divided into two (2) wards (Bosso Central Ward I and Bosso Central Ward II). The residents of Bosso are mostly Gwari speaking people and other tribes like Hausa, Nupe, Igbo and Yoruba. Figure 1 shows the map of Niger state indicating the different local government areas in Niger state. The green coloured area indicates Bosso and Chanchaga local government areas which are within Minna and were used for this study. Figure 2 shows the map of Minna and environs. The map shows the different neighbourhoods within Minna, Niger State. Figure 3 also shows the map of the study areas. The map shows Tundun Fulani, Bosso 1, Bosso 11, Maitumbi, Tunga and Chanchaga neighbourhoods coloured green.
There are two main seasons, the rainy season which is between April and September, and with September recording the highest rainfall of 300m. It has the minimum temperature of 22^{o}C and the maximum of 40^{o}C. Minna metropolis is drained by many rivers with the main course of River Dutsen Kura flowing towards River Kaduna at a point south west of Minna (Adeola *et al.*, 2022). The river main tributaries include Rivers Wanna, Shaho, Godina and Dunalape, which are flowing from their respective highlands and isolated compounds such as Gwar, Kpewi, Zuru and Tsauran Nabi hills (Sadauki *et al.*, 2017).

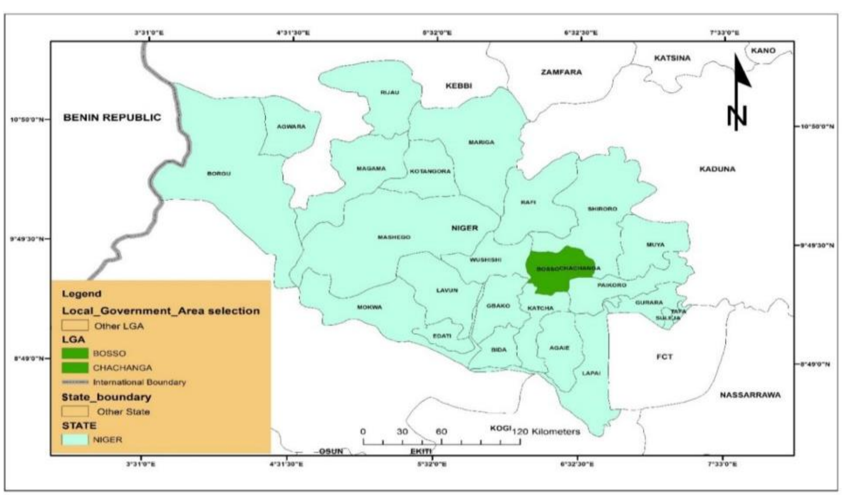

Figure 1: Niger State
Source: Department of Geography FUT, Minna

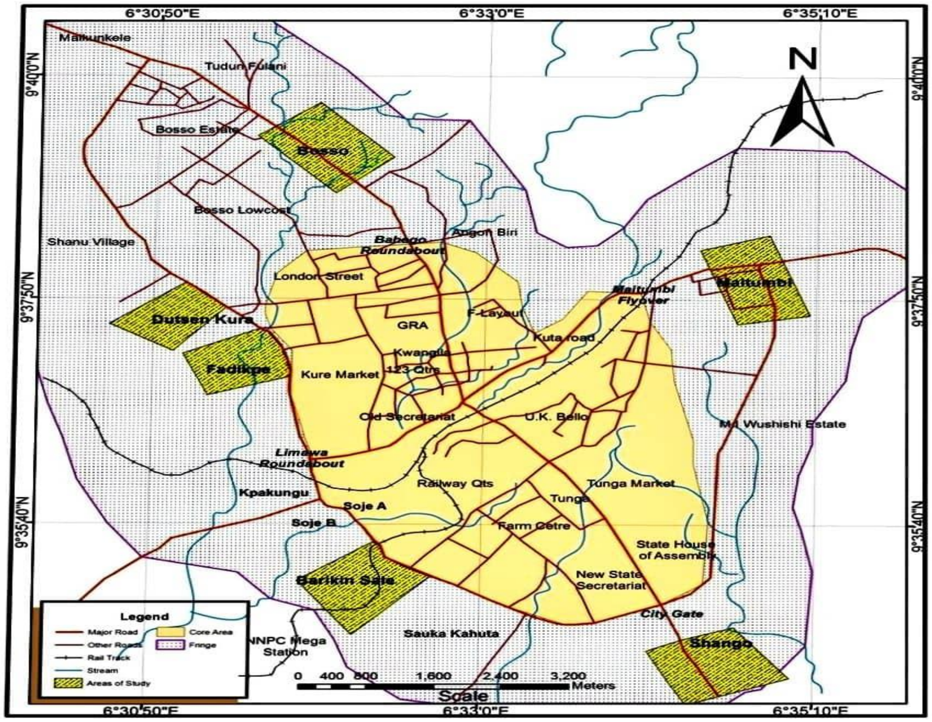

Figure 2: Minna and Environs
Source: Niger State Ministry of Lands and Housing, Minna (2020).

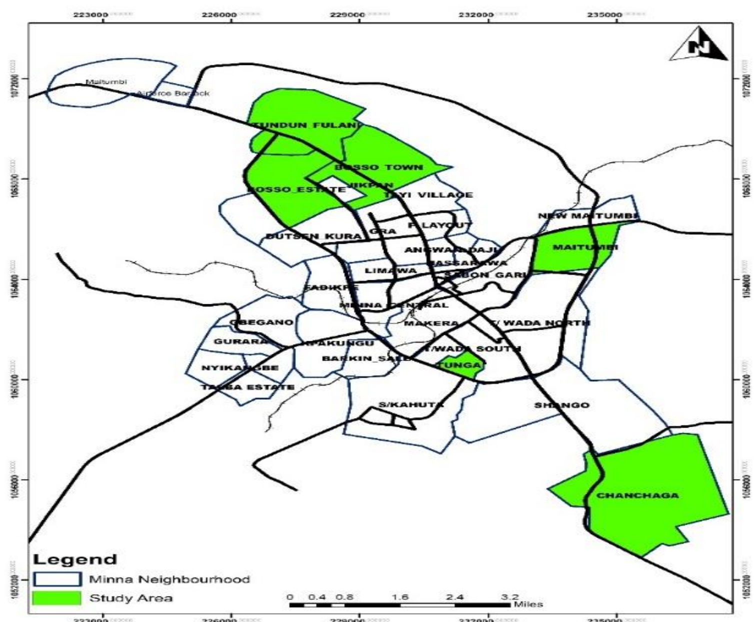

Figure 3: The study Area
Source: Department of Geography FUT, Minna

Research Methodology

Research design

The study adopted mixed methods design that enabled data to be collected using observation and survey methods which focused on the level of awareness, knowledge and risk factors that expose the respondents to cholera epidemic in Minna. In a related development, data were collected from archival records which involved yearly cases of cholera recorded sourced from General Hospital, Minna. This design was chosen to collect reliable and usable data.

These were the data sourced directly from the field. A 5-point Likert scale was adopted in the data collection process. The data were analysed using frequency count, percentile, mean score values and Pearson product moment correlation which formed the basis for the conclusion reached and the recommendations made.

The mean risk value was calculated by dividing the frequency risk factor (RF) by the total frequency of respondents (384) as shown in equation 1.

$$Mean\ risk\ value = \frac{\sum risk\ factor\ X\ frequency}{total\ frequency} \quad (1)$$

Sampling technique and sample size

Purposive sampling technique was adopted in selecting the study area; the areas selected were Bosso I and II, Tudun Fulani, Chanchaga, Maitumbi and Tunga as shown in Table 1. Population of the areas were extracted from National Population Commission 2006 projected a total number of 153,877 and a total number of 19177 households were identified in the study area (NPC, 2020). For equal representative, 2% of the household size which is approximately 384 respondents were picked for questionnaire administration.

Table 1: Sample size of the respondents

S/N	Neighbourhood	Number of Household	Sampled Size (2%)
1	Bosso I	3335	67
2	Tudun Fulani	2570	51
3	Bosso II	3205	64
4	Chanchaga	3057	61
5	Maitumbi	3529	71
6	Tunga	3481	70
	Total	19177	384

Source: National population commission (2020)

Results and Discussion

Analysis of the risk factors contributing to cholera outbreak in Minna

Table 2 shows the risk factors contributing to cholera outbreak within the study area. The sources of drinking water had a mean risk value of 3.13. The study therefore revealed that the sources of water such as well (open) and stream when contaminated by open/collapsed sewage, refuse dumpsites less than 5m largely contributed to cholera outbreak in the study area. The mean risk value for the mode of water treatment was 3.04. The modes of water treatment mostly used in the study area were settling, boiling, alum use and water guard use while some do not treat. The study found that respondents that use water settling and those that do not treat are at high risk of contracting cholera. However, the use of alum was discovered to be less risky when used to treat water in the study area. The source of food/fruits had a mean risk valve of 2.95. The study found that food/fruits sourced from the market, road side, household, neighbours and personal gardens could be contaminated when washed with polluted or contaminated water. The means of refuse disposal had a mean risk value of 2.99 in the study area. This indicated that poorly disposed refuse dumps especially refuse thrown in the backyards and bushes contributed largely to cholera outbreak within the study area. The pattern of the risk factors in the neighbourhoods were similar.

Table 2: Risk Factors contributing to Cholera outbreak in Minna

Sources of drinking water	Frequency (F)	Risk Factor (RF)	F*RF	Mean
Well(open)	162	3	486	
Borehole	22	1	22	
Tap water	62	3	124	Risk value = 3.13
Water vendor	120	3	480	
Stream	18	5	9	
Total	384		1202	
Mode of water treatment				
Settling	84	3	252	
Boiling	45	2	90	

Uses of Alum	87	1	87	Risk value = 3.04
Uses of water guard	25	1	25	
None	143	5	715	
Total	384	S	1169	
Sources of food/fruits				
Market	196	3	588	
Road side	102	4	408	Risk value =2.95
House hold neighbour	54	2	108	
Personal garden	32	1	32	
Total	384		1136	
Means of Refuse disposal				
Backyard	148	4	592	
Bush	83	3	249	
Personal latrine	62	2	124	Risk value =2.99
Govt allocated area	92	2	184	
Total	384		1149	

The plates show some of the risk factors seen within the study area. Plate I show waste dumps in open space within the study area. This waste dumps could be washed to water sources thereby contaminating the water source and this could result to increased cholera outbreak in the study area. Plate II depicts waste dumps into river channel in the study area. This study found that refuse dumpsites and collapsed sewages were less than 5m from the water source. This implies that contamination of water sources could result to cholera outbreak within the study area. Plate III shows water sourced from open sewage disposal area, this study therefore found that sources of water close to open sewages could result to contamination of the water sources and food sources thereby resulting to cholera outbreak in the study area. Plate IV shows open sewage disposal or drainage which could be linked to a water source thereby contaminating the water source which could in turn result to cholera outbreak in the study area.

Plate I: Waste dump in open space in Tunga

Plate II: Presence of open dump space in Maitumbi

Plate III: Contamination of water source

Plate IV: Open sewage disposal in Chanchagafrom open drainage in Bosso 1

Appendix I shows a field analysis of the epidemic risk in the study area carried out using GPS. The level of severity (1-5) was rated in the study area. These risks include dumpsite in water channel, poorly built abattoir, improper water channel, dumpsites with open defecations and poor drainage systems within the study area. This study therefore found that waste dump was the most rampant risk factors identified with severity five (5) in the study area. Improper sewage and drainage had severity 5 and open soak away close to market also had severity 5 in the study area. This imply that constant waste dumps and improper drainage/sewage could result to cholera outbreak in the study area.

Table 3 shows the cases of cholera reported from General Hospital Minna, over the past decade by gender within the study area. The study revealed that more men (109) were affected with cholera compared to women (90) within the study area. The year 2021 had the highest number of cholera cases (143) in the Minna. This implies that cholera cases had increased in recent times.

Table 3: Data on Cholera cases for both male and female from 2009-2021

Year	Male	Female	Total
2009	6	1	7
2010	2	2	4
2011	12	3	15
2012	5	1	6
2013	0	0	0
2014	9	4	13
2015	0	0	0
2016	0	0	0
2017	1	0	1
2018	0	0	0
2019	5	4	9
2020	1	0	1
2021	68	75	143
Total	109	90	199

Source: General Hospital Minna, Niger State

Relationship between cholera outbreak and monthly rainfall

Monthly analysis of cholera epidemic was carried out from data obtained from General Hospital, Minna. Figure 4 shows that maximum cases were recorded in the month of May, August and September within the study area. Medium cases were recorded in the months of April, June and October, while lower cases were recorded in the month of January and March in the study area. No cases were recorded in the month of February, July, November and December over the last 10 years in the study area. This revealed that the months with higher rainfall events had more cholera cases recorded within the study area over the last 10 years as shown in Appendix II.

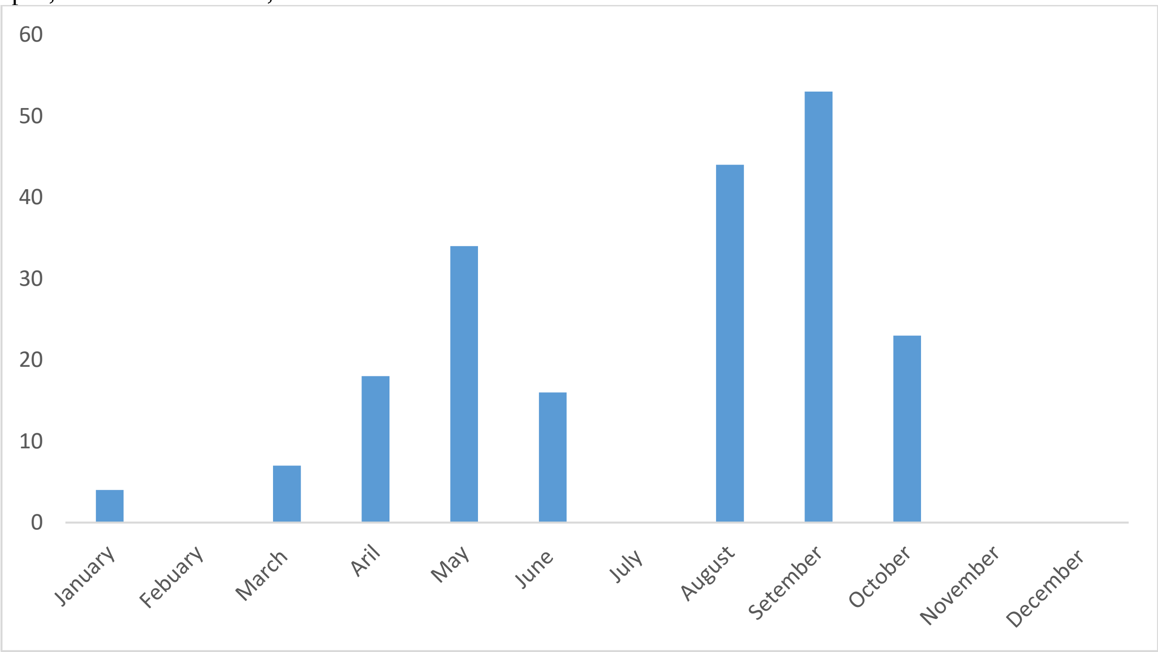

Figure 4: Monthly Analysis of Cholera Outbreak Cases (2009-2021)
Source: General Hospital Minna, Niger State

Table 4 shows correlation of cholera cases with rainfall. The cholera cases recorded had a positive correlation with rainfall at 0.76. This implies that the higher the rainfall the more chances of cholera epidemic in the study area.

Table 4: Correlation of cholera cases recorded with rainfall

	Cholera	Rainfall
Cholera	1	0.756735
Rainfall	0.756735	1

Discussion

The risk factors contributing to cholera outbreaks in Minna source of drinking water had a mean risk value of 3.13, mode of water treatment 3.04, source s of food/fruits 2.95, refuse disposal 2.99. These high-risk values indicated that sources of drinking water, mode of water treatment, source of foods and refuse contributed to cholera outbreak within the study area. The most vulnerable include those without clean water, with lack of access to soap and sanitation, the displaced, the food insecure and the impoverished they are most at risk of being infected (Usman *et al.*, 2005). They become very ill and likely to die (Gidado, 2018). In relation to these works, the current study has also demonstrated that mode of water treatment and sources of drinking 3.15, 3.04 has been the major contributing risk factors of cholera epidemic in Minna. This finding is in line with the suggestion of Adeneye *et al.* (2016) who opined that factors associated with high cholera cases are poor sanitation/hygiene and poor food hygiene.

The study found that maximum cases of cholera were recorded in the months of May, August and September within the study area. Medium cases were recorded in the months of April, June and October, while lower cases were recorded in the month of January and March. No cases were recorded in the month of February, July, November and December over the last 10 years. This demonstrated that the months with higher average rainfall events as indicated in appendix III had more cholera cases recorded within the study area. Kibria *et* *al.* (2008) established the effect of rainfall on the incidence of cholera in northern Nigeria that the weekly number of cholera cases increased by 14% (95%) confidence interval = 10.1%-18.9%) for each 10-mm increase above the threshold of 45 mm for the average rainfall, over lags 0 to 8 weeks. These cholera cases recorded had a positive correlation with rainfall at 0.76. This implied that there is relationship between cholera and rainfall. Conversely, Baker *et al.* (2005) reported that the number of cholera cases increased by 24% (10.7%-38.6%) for a 10-mm decrease below the same threshold of average rainfall, over lags 0 to 16 weeks.

Conclusion

The risk factors causing cholera epidemic was assessed with the aim of identifying the variables that makes the Minna people vulnerable to Cholera outbreak. The study revealed that the major risk factors causing cholera are source of drinking water with mean risk factor of 3.13, mode of water treatment (3.04), sources of food/fruits (2.95) and means of refuse disposal (2.99). Therefore, the sources of water are ranked as the highest mean risk value and is responsible for the cholera outbreak in Minna. These risk factors are also high. This study implies that the respondents who use open well, water settling and/or consumed foods from markets may be at high risk of contracting cholera. The research discovered that the relationship between cholera outbreak and monthly rainfall in the last decade has a positive correlation (0.76). These correlation between cholera outbreak and monthly rainfall is high. The study revealed that the rate of cholera epidemic is 19.9% per year and is low.

The hazards causing cholera outbreak in Maitumbi, Bosso 1, Bosso 11, Tunga, Tudun Fulani and Chanchaga neighbourhoods were identified to be sources of water, mode of water treatment, sources of food/fruits and means of refuse disposal. This study enables the people to identify the risks associated with sewage (open or contaminated) that pre-dispose the residents to cholera outbreak. It also informs the residence on the impacts of indiscriminate refuse disposals. It enlightens the residents on the status of the food/fruits sold in the market that they could have been washed with contaminated water.

The following recommendations were based on the findings of the study: (i) sensitization and organization of regular health talks on proper environmental and hand hygiene, (ii) chlorination of existing wells should be encouraged by various stakeholders and the community, (iii) Oral Cholera Vaccines should be provided in our health facilities as well as recruitment of more Environmental Health workers to enforce that hygiene and sanitation laws are obeyed, (iv) Future studies should analyse the risk factors for cholera outbreaks in the remaining neighbourhoods of Minna, Niger State, Nigeria.

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Appendix I

Risk Factors contributing to Cholera Outbreak within the Study Area

S/NO	TYPES OF HAZARD	COORDINATES	SEVERITY LEVEL (1 to 5)
1	Dumpsite in water channel	N 9^0 33'10.95012", E6^0 34' 52.176"	3
2	Illegal dumpsite	N9^0 32' 41.20188", E6^0 34' 47.761588"	3
3	Poorly built ranch close to an illegal dumpsite	N 9^0 32' 11.26104", E6^0 34' 43.76172"	4
4	Poorly built abattoir	N 9^0 32' 11.26104", E6^0 34' 42.76172"	5
5	Improper water channel	N9^0 32' 17.6064", E6^0 34' 41.664"	5
6	Open soak away close to market area	N9^0 32' 15.12096", E6^0 34' 41.58732"	3
7	Improper water channel in residential area	N9^0 32' 17.6064", E6^0 34' 43.77172"	5
8	Improper water channel	N9^0 32' 17.48212", E6^0 34' 42.86388"	3
9	Improper water channel and open soak away	N9^0 32' 16.28988", E6^0 34' 43.90212"	4
10	Dumpsite and open defecation in front of residence	N9^0 32' 16.28988", E6^0 34' 45.43211"	3
11	Poor drainage system	N9^0 32' 10.83804", E6^0 34' 45.43104"	5

Appendix II

Correlation of Cholera Cases with Average Rainfall

Months	Cholera Cases	Ave. Rainfall (mm)
January	4	0.5
February	0	4
March	7	7.7
April	18	44.5
May	34	121.7
June	16	129.8
July	0	225
August	44	333.7
September	53	283.6
October	23	102.7
November	0	3
December	0	0