ASSESSING HOUSEHOLD AND COMMUNITY LEVEL RISK FACTORS FOR CHOLERA OUTBREAKS IN KATSINA STATE, NIGERIA

[1&2] Balarabe, A.A, [3]Zakari, N. & [2]Dardau, H.

[1]Save the Children, Katsina field office
[2]Department of Geography, Umar Musa Yaradua Univesity, Katsina
[3]Departement of Environmental Management. Federal University, Dutse.

Correspondence: Zakari, N.
Department of Environmental Management. Federal University, Dutse, Nigeria.
E-mail: nafiufagge@gmail.com or zakari.n@fud.edu.ng
DOI: https://doi.org/10.5281/zenodo.15705448

Abstract

This study investigated factors contributing to cholera outbreaks in Katsina State, Nigeria. The study employed a community-based cross-sectional design and surveyed 108 households across five urban and rural communities using a structured questionnaire administered through the Kobocollect digital platform. The data was analyzed descriptively and inferentially (Chi-square tests) in SPSS to examine associations between cholera occurrence and demographic, socioeconomic, water, sanitation, and household characteristics. Key findings showed that children and adolescents (6–17 years) accounted for 54.2% of cholera cases, demonstrating their heightened vulnerability. Larger-sized households (21+ persons) experienced significantly higher cholera incidents (55.6–60%) compared to smaller-sized households (13.2%), revealing the impact of overcrowding. Although households accessed improved water sources, 41.7% of those using pipe-borne water reported cholera cases, indicating contamination risks. However, statistical analysis found no significant association between water source type and cholera incidence (p = 0.255). Spatial analysis identified disparities, with BCG Village recording the highest cholera incidents (50%) and Katoge reporting no cases, emphasizing the role of localized environmental and infrastructural differences. While most households expressed willingness to improve water and sanitation, income level showed only marginal association with willingness (p = 0.053). The study concluded that multiple factors influenced cholera risk, including age, household size, and inconsistent water infrastructure maintenance. Study recommended targeted hygiene education for children and adolescents, household-level interventions to reduce overcrowding, and improved maintenance of water infrastructure.

Keywords: Cholera, Household, Sanitation, Demographic

INTRODUCTION

Cholera remains a significant public health threat, particularly in low-resource settings where access to clean water and adequate sanitation is limited. Caused by the bacterium *Vibrio cholerae*, the disease is transmitted primarily through contaminated water and food, leading to severe acute watery diarrhea and dehydration, which can be fatal if untreated (Ali *et al.,* 2015; World Health Organization [WHO], 2024). Despite advances in prevention and treatment, cholera continues to cause outbreaks in vulnerable populations, with an estimated 1.3 to 4 million cases and 21,000 to 143,000 deaths annually, worldwide (WHO, 2024). The persistence of cholera is closely linked to socioeconomic disparities, inadequate infrastructure, and demographic factors that influence exposure and susceptibility (Deen *et al.,* 2020).

Demographic and socioeconomic factors play a critical role in shaping cholera risk. Studies have shown that age, gender, household size, income, and education level significantly impact vulnerability to cholera (Sack *et al.,* 2004). For instance, children and adolescents are disproportionately affected due to weaker immune systems and higher exposure to contaminated environments (Fung *et al.,* 2013). Similarly, larger households often face greater challenges in maintaining hygiene, which increase the likelihood of disease transmission (Camacho *et al.,* 2018). Socioeconomic status further exacerbates disparities, as low-income households may lack resources to invest in improved water and sanitation facilities (Gaffga *et al.,* 2007). Education also influences health-seeking behaviors and the adoption of preventive measures, with lower literacy rates correlating with higher cholera incidence (Reyburn *et al.,* 2011). Understanding these factors is essential for designing targeted interventions. Community-level variations in water sources, sanitation practices, and healthcare access further complicate cholera dynamics, necessitating localized approaches to outbreak prevention (Azman et al., 2012). This study examines the interplay of demographic and socioeconomic factors in cholera outbreaks within high-risk populations, aiming to identify actionable strategies for reducing disease burden. By analyzing household and community-level data, this research contributes to the growing body of evidence on cholera determinants and informs public health policies aimed at achieving sustainable cholera control.

MATERIAL AND METHOD

The Study Area

Katsina State is in the North-Western part of Nigeria and lies between latitudes $11^{0}.08^{'}$N and $13^{0}.22^{'}$ N and from longitudes $6^{0}.25^{'}$ E to $6^{0}.15$' E (Figure 1).

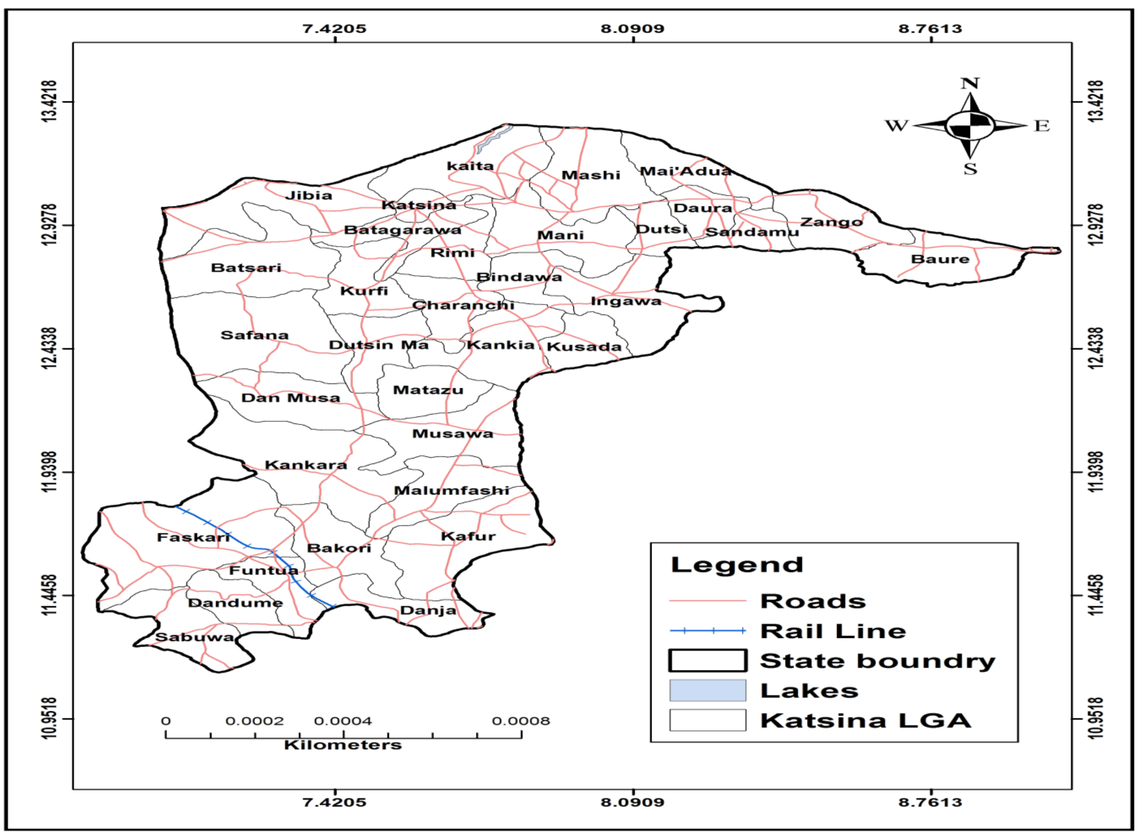

Figure 1: Katsina State, Nigeria (study area).
Source: Department of Environmental Management, Federal University, Dutse (FUD, 2023)

The State is bounded by Niger Republic to the north, Jigawa and Kano State to the east, Kaduna State to the south, and Zamfara State to the west. It is worthy of note that there are 4 Federal Health Institutions, 23 General Hospitals and over 1700 primary Health care Centers across the state (Katsina State Investment Promotion Agency, 2023). Katsina State has a Population of 9,861,476 people, this was projected from the 2006 census, out of with 1,804,930 was under 5 population, in an area of 24,235 KM square, the population density is 323.1 KM square with a 3.0% annual population changes (NPC, 2016). The climate of the study area is the 'Aw' type as determined by Koppen with distinctive wet and dry seasons. The total annual rainfall figures range from 1000mm around Funtua to over 800m around DutsimMa, while the North of Katsina State (from around Kankia to the extreme northeast) has total rainfall figures ranging from 600 to 700mm annually. The maximum temperature range in Katsina is between 290C and 380C but Harmattan season (November to February) lowers the temperature to between 180C and 270C in the noon. The daily temperature range is greater in the north and decreases southward where daily ranges are almost the same as in parts of Katsina area. The temperature in the Katsina area is more extreme during the dry season reaching over 420C. (Dardau, 2021).

A multi-stage sampling approach selected 108 households across 5 communities (Urban/rural) based on: historical records of cholera outbreaks, representation of different settlement types (urban/rural), and accessibility for data collection. From these communities, a total of 108 households were selected using a systematic random sampling technique. Urban Areas: Katsina Gabas (Katsina Local Government Area): 29 households and Katoge (Batagarawa Local Government Area): 15 households. Rural Areas: Dan Kauye (Safana Local Government Area): 20 households, Kofar Yamma (Kafur Local Government Area): 24 households, and BCG Village (Funtua Local Government Area): 20 households. A structured questionnaire covered demographic characteristics (age, gender, education, and occupation), household water sources and sanitation facilities, cholera history and health-seeking behavior, and socioeconomic indicators (income, household size). Data were collected via Kobocollect app. Data was analysed in SPSS (IBM Corp. V23) using descriptive Statistics (Frequency, mean, median, and standard deviation) and inferential Statistics (Chi-square and Spearman's correlation at 95% confidence level ($\alpha = 0.05$).

Verbal informed consent was obtained from all participants, with special attention to interviewing household heads or most knowledgeable adults regarding health and sanitation matters.

RESULT AND DISCUSSION

Demographic Characteristics of the Respondents

The results from the Table 1 show that the mean age of respondents is approximately 39.4, SD=13.3; 52.8% male, 84.3% married). The education level of respondents shows that a significant portion have Qur'anic (tsangaya) education (35.2%), followed by secondary education (32.4%). The largest employment group is housewives (34.3%), followed by farmers (22.2%) and self-employed individuals (13.9%). The income distribution shows that the majority of respondents fall within the ₦6,000-₦49,000income bracket (59.3%), others ≥ 50,000 (34.3%) indicating some level of income disparity. This disparity is important because it influences the willingness and ability of households to invest in improving their water and sanitation conditions. The data show an average household size of 9.8 people (SD=7.98), with 33.3% of households containing 6-10 members and 31.5% exceeding 10 members. These crowded conditions increase disease transmission risks and challenge households' ability to improve water and sanitation facilities, particularly given that 59.3% of respondents earn ≤ ₦49,000 monthly.

Table: 1 Demographic Characteristic of the Respondents

Age Group (years)	Frequency	Percentage (%)	Mean	Standard Dev
Below 20	5	4.6	39.4	13.3
20-29	19	17.6		
30-39	22	20.4		
40-49	24	22.2		
50-59	13	12.0		
60 and above	7	6.5		
Not indicated	18	16.7		
	Sex			
Female	51	47.2		
Male	57	52.8		
	Marital Status			
Divorced	1	0.9		
Married	91	84.3		
Single	8	7.4		
Widow	5	4.6		
Not indicated	3	2.8		
	Education Level			
Primary	14	13.0		
Qur'anic (tsangaya)	38	35.2		
Secondary	35	32.4		
Tertiary	19	17.6		
Vocational	2	1.9		
	Employment Status			
Civil Servant	8	7.4		
Employed by Private Business	7	6.5		
Farmer	24	22.2		
Housewife	37	34.3		
Labourer	1	0.9		
Professional	1	0.9		
Retired/Pensioner	3	2.8		
Self employed	15	13.9		
Student	5	4.6		
Unemployed	7	6.5		
	Estimated Monthly Income (₦)			
6,000-19,000	27	25.0		
20,000-49,000	37	34.3		
50,000-99,000	14	13.0		
100,000 and above	23	21.3		
Recent Cholera Case				
I don't know	5	4.6		

No	44	40.7		
Yes	59	54.6		
Household Size (persons)				
1-5	38	35.2	9.8	7.98
6-10	36	33.3		
11-15	10	9.3		
16-20	10	9.3		
21-25	9	8.3		
26 and Above	5	4.6		

Source: fieldwork (2024)

Resources Availability and Accessibility

The results from the Table 2 show that the mean water-fetching time is 18.2 minutes (SD= 27.7), highlighting disparities. The standard deviation is high, indicating significant variability in access to water, with some respondents having very convenient access and others facing considerable challenges. In terms of water usage per day, the mean is 511.3 liters, the variability in water usage by household stems from differences in household size, access to water, and socioeconomic status. Households with limited water access may struggle to maintain hygiene, increasing their risk of cholera, while those with ample water may have better health outcomes. Health care accessibility was considered in term of distances from the households, with the mean the distance from hospitals being 86.48 meters, (SD= 304.7). The extreme variability as indicated by the standard deviation highlights disparities that could impact the timely treatment of cholera cases. Those living farther from hospitals may face delays in receiving medical care, exacerbating the severity of outbreaks.

Table: 2 Resources availability and accessibility

Variable	Mean	Median	Mode	Standard Deviation (SD)
Distance from water source (**Minutes**) to and pro	18.2	11	1	27.7
Water usage per day (**Liters**)	511.3	150	100	1282
Distance from Hospital (**Meters**)	86.48	3	0	304.7

Source: fieldwork (2024)

Demographic and Cholera Cases in the Communities

The results from Table 3 show that the children and adolescents (6-17 years) accounted for 54.2% of cholera cases, and 25% in adults, Females (52.1%) were slightly more affected, but boys aged 0-5 had higher cases (16.7%) than girls 4.2%). This indicates that children and adolescents are more vulnerable to cholera compared to adults. The higher prevalence of cholera among children and adolescents (6-17 years) could be attributed to several factors, including poorer hygiene practices, higher exposure to contaminated water sources, or lower immunity compared to adults. The significant number of cases in the 0-5 years age group also highlights the vulnerability of young children, who are often more susceptible to waterborne diseases due to their developing immune systems. Children and adolescents are more susceptible due to weaker immunity and higher exposure to contaminated water (Fung *et al.,* 2013). Studies in sub-Saharan Africa confirm higher cholera rates among children, linked to poor hygiene practices (Camacho et al., 2018), adults are equally at risk in high-transmission settings (Lessler *et al.,* 2018).

The gender distribution of cholera cases suggests that while females are slightly more affected overall, the vulnerability varies by age group. This could be due to differences in exposure risks, such as girls being more involved in activities like fetching water or caring for younger siblings, which increases their exposure to contaminated water sources. A gender disparity arises from girls' roles in water collection, increasing exposure (Graf *et al.,* 2022). But Rebaudet *et al.,* (2019) revealed that gender differences are context-specific; in some outbreaks, males are more affected due to occupational exposure.

Table: 3 Demographic and Cholera cases of the Communities

	No of Households		Cholera Cases		No in Households		Cholera Cases					
Age Group	Female	%	Female	%	Male	%	Male	%	Total (HH)	%	Total (Cases)	%
0-5years	111	10.5	2	4.2	97	9.1	8	16.7	208	19.6	10	20.83
6-17years	175	16.5	15	31.3	193	18.2	11	23	368	34.7	26	54.17
18 and above	269	25.4	8	16.7	216	20.4	4	8.3	485	45.7	12	25.00
Total	555	52.3	25	52.1	506	47.7	23	47.9	1061	100	48	100

Source: fieldwork (2024)

Community-Level Insights of Cholera Cases

At the community level, BCG Village had the highest households with cholera cases (50%) (Table 4). Pearson Chi-Square value of 12.443 with a significance level of 0.014 indicates a statistically significant association between community and cholera cases. There is evidence to suggest that the community a household belongs to affects the likelihood of cholera cases. The significant results suggest that community differences are linked to cholera incidence. Spatial clustering of cholera is well-documented due to environmental and infrastructural differences (Deen *et al.,* 2020). Areas with better drainage and sanitation report fewer cases (Rebaudet *et al.,* 2019). Some outbreaks appear random due to transient contamination (Lessler *et al.,* 2018). Underreporting in low-case areas may bias results (Azman *et al.,* 2012).

Table 4 Community and household with cholera cases

Community	Household with Cholera case (Yes)	Total Household	Percentage (%) of Cholera cases
BCG	10	20	50
Dan Kauye	4	20	20
Gabas II	6	29	20.7
Katoge	0	15	0
Kofar Yamma	7	24	29.2

Source: fieldwork (2024)

Water Sources and Sanitation

From Table 5, the type of water source and sanitation facilities significantly impacts cholera incidence. Most studies show protected water sources reduce cholera risk (WHO, 2024). Incidentally, pipe-borne water into apartment/compound has the highest percentage of households with cholera cases (41.7%). The Pearson Chi-Square value of 7.771 with a significance level of 0.255 indicates that the type of water source does not significantly affect cholera incidence. This however still suggests that even improved water sources can be associated with cholera if they are not properly maintained or if there is contamination in the distribution system. Even "improved" water sources can be contaminated post-distribution (Wright *et al.,* 2004), which the lack of maintenance in piped systems leads to recontamination (Ercumen *et al.,* 2015).

Table 5 Water sources and cholera cases

Water Source	Household with Cholera cases (Yes)	Total Households	Percentage (%) of Cholera case
Hand pump borehole	12	58	20.7
Motorised borehole	2	5	40
Piped water into apartment/compound	10	24	41.7
Protected dug well with hand pump	1	11	9.1
Public Standpipe	0	2	0
Public Standpipe Hand pump borehole	2	6	33.3
Others	0	2	0

Source: fieldwork (2024)

In terms of sanitation, Por Flush Toilets have the highest percentage of households with cholera cases (47.1%), This indicates that the type of sanitation facility alone is not sufficient to prevent cholera; proper maintenance and hygiene practices are also crucial (Table 6). The Chi-square analysis explores the relationship between the type of excreta disposal and cholera cases where the Pearson Chi-Square value was 7.297 with a significance level of 0.199, indicating that the type of excreta disposal does not significantly affect cholera incidence.

Table 6 Defecation facility type and Cholera case

Defecation facility type	Household with Cholera case (Yes)	Total Household	Percentage (%) of Cholera cases
Improved Pit Toilet	2	7	28.6
Open Defecation	0	1	0
Por Flush Toilet	8	17	47.1
Traditional Pit Toilet	16	62	25.8
VIP Toilet	1	2	50
Water Closet	0	3	0

Source: fieldwork (2024)

Cholera Cases and Household Characteristics

The analysis of household characteristics shows that larger households (21-25 persons and 26 and above) have the highest percentages of cholera cases (55.6% and 60%, respectively) (Table 7). This could be due to the increased difficulty of maintaining hygiene and sanitation in larger households, as well as the higher likelihood of exposure to contaminated water sources. The Chi-square value of 12.072 with a significance level of 0.034 indicated that household size is significantly associated with cholera incidence. According to Azman *et al.* (2012) overcrowding increases transmission risk due to shared sanitation and water sources. Debes *et al.* (2016) some research suggest household size alone is less predictive than water and sanitation quality. Studies in Bangladesh found household density strongly correlated with cholera (Ali *et al.,* 2015). Similarly, cultural hygiene practices may mitigate transmission even in large households (Taylor *et al.,* 2015).

Table 7 Household sizes and Cholera cases

Household sizes (persons)	Household with Cholera case (Yes)	Total Household	Percentage (%) of Cholera cases
1-5	5	38	13.2
6-10	10	36	27.8
11-15	1	10	10
16-20	3	10	30
21-25	5	9	55.6
26 and Above	3	5	60

Source: fieldwork (2024)

Willingness to Improve Water and Sanitation

Willingness to improve water sources and excreta types (table: 8) by the respondent reveals that the majority (85-91%) across all income brackets are willing to improve water/sanitation. However, the Pearson Chi-Square value indicates no significant association between income level and willingness to improve water and sanitation with a significance level of 0.237 and with a marginal association significance level of 0.053 for defecation facility type. Middle-income groups often invest in health improvements when basic needs are met (Gaffga *et al.,* 2007). Willingness may depend on education rather than income alone (Sack *et al.,* 2004). Other studies find income strongly predicts sanitation investment (Whittington *et al.,* 2002). The marginal significance (p = 0.053) for defecation facility type improvement suggests possible underpowered analysis (Debes *et al.,* 2016).

Table: 8 Estimated Income and Willingness to improve on Water Sources and Excreta Type

Estimated Monthly Income (₦)	Total Household	Willingness to improve on Water sources (Yes)	Willingness to improve on Excreta Type (Yes)
6,000-19,000	27	23 (85.2%)	18 (66.7%)
20,000-49,000	37	34 (91.1%)	30 (81.1%)
50,000-99,000	14	11 (78.6%)	11 (78.6%)
100,000 and above	23	20 (87%)	18 (66.7%)
Not indicated	7	5 (71.4%)	2 (28.6%)

Source: fieldwork (2024)

CONCLUSION

This study identified key risk factors for cholera outbreaks, emphasizing the vulnerability of children, large households, and communities with inconsistent water infrastructure. Despite access to improved water sources, contamination risks persist, suggesting that infrastructure alone is insufficient without proper maintenance and hygiene practices. The lack of a significant income-cholera link contrasts with global trends but aligns with studies emphasizing education and behavior over economic status in disease prevention. Spatial disparities (e.g., BCG and Katoge) highlight the role of localized environmental and governance factors in outbreak dynamics. Overall, the findings reinforce that cholera is a multidimensional problem requiring integrated interventions targeting water quality, sanitation, household density, and community engagement.

REFERENCES

Ali, M., Nelson, A. R., Lopez, A. L., & Sack, D. A. (2015). Updated global burden of cholera in endemic countries. *PLoS Neglected Tropical Diseases*, 9(6), e0003832. https://doi.org/10.1371/journal.pntd.0003832

Azman, A. S., Rudolph, K. E., Cummings, D. A., & Lessler, J. (2012). The incubation period of cholera: A systematic review. *Journal of Infection*, 66(5), 432–438. https://doi.org/10.1016/j.jinf.2012.11.013

Camacho, A., Bouhenia, M., Alyusfi, R., Alkohlani, A., Naji, M. A. M., de Radiguès, X., ... & Luquero, F. J. (2018). Cholera epidemic in Yemen, 2016–18: An analysis of surveillance data. *The Lancet Global Health*, 6(6), e680–e690. https://doi.org/10.1016/S2214-109X(18)30230-4

Dardau Hafiz (2021) Social Justice, Distibution and the utilization of Health care services in Katsina State, Nigeria. A PhD thesis submitted to the Department of geography BUK

Debes, A. K., Ateudjieu, J., Guenou, E., Ebile, W., Sonkoua, I. T., Njimbia, A. C., ... & Sack, D. A. (2016). Clinical and environmental surveillance for Vibrio cholerae in resource constrained areas: Application during a cholera outbreak in Cameroon. *International Journal of Infectious Diseases*, 48, 97–101.

https://doi.org/10.1016/j.ijid.2016.05.010

Deen, J., Mengel, M. A., & Clemens, J. D. (2020). Epidemiology of cholera. *Vaccine*, 38(Suppl 1), A31–A40. https://doi.org/10.1016/j.vaccine.2019.07.078

Ercumen, A., Arnold, B.F., Kumpel, E., Burt, Z., Ray, I., Nelson, K., et al. (2015) Upgrading a Piped Water Supply from Intermittent to Continous Delivery and Association with Waterborne Illness: AMatched Cohort Study in Urban India. PLoS Med 12(10): e1001892. Doi:10.1371/journal.pmed.1001892

Fung, I. C. H., Fitter, D. L., Borse, R. H., Meltzer, M. I., & Tappero, J. W. (2013). Modeling the effect of water, sanitation, and hygiene and oral cholera vaccine implementation in Haiti. *American Journal of Tropical Medicine and Hygiene*, 89(4), 617–627. https://doi.org/10.4269/ajtmh.13-0201

Gaffga, N. H., Tauxe, R. V., & Mintz, E. D. (2007). Cholera: A new homeland in Africa? *The American Journal of Tropical Medicine and Hygiene,* 77(4), 705–713. https://doi.org/10.4269/ajtmh.2007.77.705

Ibrahim1 and M. Aliyu (2018), Relief, Drainage and Associated Riverine Landforms in Katsina: A Regional overview *Katsina Journal of Natural and Applied Sciences* 7(2) September 2018

Katsina State Investment Promotion Agency, (2023) information on infrastructural facilities. Katsina State Government https://katsinastate.gov.ng>upload>2024/01

Lessler, J., Moore, S. M., Luquero, F. J., McKay, H. S., Grais, R., Henkens, M., ... & Azman, A. S. (2018). Mapping the burden of cholera in sub-Saharan Africa and implications for control: An analysis of data across geographical scales. *The Lancet*, 391(10133), 1908–1915. https://doi.org/10.1016/S0140-6736(17)33050-7

NPC (2006) National Population Commission of Nigeria.

Oxfam (2013). Gender and Vulnerability to Cholera in Sierra Leone. Oxfam Research Report, June 2013

Rebaudet, S., Gazin, P., Barrais, R., Moore, S., Rossignol, E., Barthelemy, N., ... & Piarroux, R. (2013). The dry season in Haiti: A window of opportunity to eliminate cholera. *PLoS Currents,* 11, ecurrents.outbreaks.aa63a458b9237a484e629a5f6ef5e6a7. https://doi.org/10.1371/currents.outbreaks.aa63a458b9237a484e629a5f6ef5e6a7

Reyburn, R., Deen, J. L., Grais, R. F., Bhattacharya, S. K., Sur, D., Lopez, A. L., ... & Clemens, J. D. (2011). The case for reactive mass oral cholera vaccinations. *PLoS Neglected Tropical Diseases,* 5(1), e952. https://doi.org/10.1371/journal.pntd.0000952

Sack, D. A., Sack, R. B., Nair, G. B., & Siddique, A. K. (2004). Cholera. *The Lancet,* 363(9404), 223–233. https://doi.org/10.1016/S0140-6736(03)15328-7

Taylor, D. L., Kahawita, T. M., Cairncross, S., & Ensink, J. H. (2015). The impact of water, sanitation, and hygiene interventions to control cholera: A systematic review. *PLoS ONE*, 10(8):e0135676. https://doi.org/10.1371/journal.pone.0135676

Whittington, D., Pattanayak, S. K., Yang, J., & Bal Kumar, K.C. (2002). Household demand for improved piped water services: Evidence from Kathmandu, Nepal. *Water Policy Research*, 4(6), https://doi.org/10.1016/S1366-7017(02)00040-5

World Health Organization. (2024). Cholera. Retrieved from https://www.who.int/news-room/fact-sheets/detail/cholera

Wright, J., Gundry, S., & Conroy, R. (2004). Household drinking water in developing countries: A systematic review of microbiological contamination. *Tropical Medicine & International Health*, 9(1), 106–117. https://doi.org/10.1046/j.1365-3156.2003.01160.x