FACTORS ASSOCIATED WITH CHOLERA OUTBREAK IN KUSADA, LGA, KATSINA STATE, NIGERIA

AMADU, L.[1,2]*, ZAKARIYAU, U.[1], BAWALE, L. [3], SULEIMAN, K.[3], ALIYU, A.A.[2], SUFIYAN, M.B.[2], OLORUKOOBA, A.A.[2], ABDULLAHI, M. [1] AND UMAR, A.A.[1,2]

[1]Nigeria Field Epidemiology and Laboratory Training Programme, Abuja, Nigeria
[2]Department of Community Medicine, Ahmadu Bello University, Zaria, Nigeria
[3]Katsina State Primary Health Care Agency, Nigeria

ABSTRACT

Cholera remains a public health problem in sub-Saharan Africa despite availability of an effective intervention for prevention and control. We investigated a suspected cholera outbreak in Yashe, Mawashi and Bauranya wards, Kusada LGA, Katsina state, Nigeria. The study aimed to characterize the outbreak, identify the risk factors and institute control measures. We conducted an unmatched case-control study. A case was defined as any resident of Yashe and Bauranya wards in Kusada LGA two years and above with acute watery diarrhea with or without vomiting from 15th May to 2nd July 2018. While a control was any resident of the affected wards of Kusada LGA two years and above without acute watery diarrhea and vomiting. Data was collected on socio-demographic characteristics, potential risk factors using structured interviewer administered questionnaire. We calculated frequencies and proportions to characterize the outbreak in time, place and person. Bivariate and Multivariate analysis were done to identify factors associated with the outbreak by using the adjusted odd ratio (AOR) and 95% confidence intervals (CI). A total of 86 cases were line listed of which 55(64%) were males. Median age was 12 (2-70) years for cases and 21 (2-70) years for controls; the overall attack rate was 63.6/100,000 and CFR was 9.3%. History of close contact with case (OR=14.0; 95% CI: 2.4-79.7), history of eating vegetable Tafasa (*Senna occidentallis*) (OR=27.76; CI: 5.1-149.3) and drinking water from unprotected well (OR=5.8; CI: 1.1-29.4) were risks for cholera. *Vibrio cholerae* 01 was isolated in 8/10 (80%) from culture samples. Unhygienic preparations of vegetables, unprotected wells and close contact with a case were the risk factors for developing cholera. Public health education on proper handling of vegetables and Provision of sanitary wells were recommended.

Keywords: Cholera, Kusada, Katsina State, Risk Factors
***Correspondence**: lawalkuki@gmail.com, lamadu@abu.edu.ng

INTRODUCTION

Cholera is an acute bacterial disease characterized by sudden onset of profuse, watery diarrhea and vomiting. It is caused by Gram negative organism *Vibrio cholerae* with over 200 serogroups, serogroup O1 and O139 are mostly the cause of outbreaks [1]. The disease is acquired through ingestion of contaminated food or water (faeco-oral route) and is transmitted through several mechanisms [1]. The incubation period ranges from a few hours to 5 days. Cholera can cause diarrhea, severe dehydration and death within few hours in the absence of an intervention. In many cholera outbreaks, at least 90% of the cases are mild or go unnoticed [2]. The case fatality rate (CFR) may reach up to 50% in untreated patients; with proper case management CFR is usually less than 1% [1, 2].

Cholera remains a global public health threat and has been described as one of the key indicators of social development.[3] Although, the disease is no longer an issue in developed countries where environmental hygiene standards are practiced, it remains a threat in almost every developing country. The typical environment for cholera are rural and peri-urban slums where basic urban infrastructure and social needs are missing [4]. In endemic countries, about 2.8 million cholera cases occur each year with an average global annual incidence rate of two cases per 1000 at risk population [5]. In 2019, 923 037 cholera cases were reported to World Health Organization from 55 countries with 1911 deaths, representing an increase of 46% compared with the number of cases reported in 2018 (499447) [6]. The increased in number of cases is a step backwards in cholera control. However, the total number of reported deaths from cholera decreased by 36%, from 2990 in 2018 to 1911 in 2019. Nigeria has been witnessing recurrent cholera outbreaks. The first outbreak of cholera was reported in Nigeria in 1972 [7]. Only a few cases of cholera were reported between 1970 and 1990. However, from 1990 to date, cholera cases have been reported almost yearly in Nigeria according to surveillance data obtained from the Epidemiology Division, Federal Ministry of Health, between January 2004 and December 2008, outbreaks of cholera have been reported in 12 out of the 36 states in the country with 74,881 cases and 1,387 reported deaths [7]. Within the last three years (2018 -2021), cholera outbreaks have

been reported in Benue, Sokoto, Katsina, Kano and Zamfara states, all in northern Nigeria [7].

On the 19th of June 2018, the Epidemiology Unit of Katsina State PHCDA was notified of suspected cases of Cholera in Mawashi settlement, of Kusada LGA. The State Rapid Response Team (RRT) was immediately deployed to the affected community for outbreak response and management. However, it is worth noting that before this present outbreak, the State has recorded some cholera cases in some wards in Funtua LGA which were adequately responded to and brought under control. By the 20th of June, 2018, a total of 46 cases of cholera have been reported with 8 deaths, CFR = 8.8%. Cholera was confirmed using both Cholera Rapid Test kits and laboratory culture. The worst hit is in Bauranya settlement with a total of 46 cases. We investigated the outbreak to assess the magnitude of the outbreak, identify risk factors associated with cholera, the agent and the source of infection, and institute control and preventive measures.

METHODS

Study design

The study was both descriptive and analytical (an unmatched case control) with 1:1 of cases to neighborhoods controls

Study site

The outbreak occurred in Kusada LGA, the LGA is located in Longitude $12^{0}28$N and Latitude $7^{0}58$E (Fig. 3) about 98kilometers away from Katsina State capital in north western Nigeria. Kusada LGA has ten wards Dudunni, Dangamau, Yashe A & B, Mawashi, Boko, Kafarda, Kusada, Kaikai, and, Bauranya. The study area has an estimated projected population of 199,267. Majority of the inhabitants are Hausa and Fulani with Islam as their main religion. The people of Kusada local government are mostly farmers and herdsmen. The main sources of drinking water for most inhabitants were open wells, shallow streams and few bore holes, which were distributed in some of the communities. Pit-latrine is the main toilet facility in most of the households and many households' members practiced open defaecation. The members of the community disposed the Refuse in backyard and farms lands. The community has been experiencing recurrent outbreak of cholera annually since 2017.

Study population

The study participants constituted 86 identified cases for descriptive study and 36 selected cases and 36 controls in Kusada LGA. The cases and controls were recruited into the study using adapted integrated diseases surveillance and response (IDSR) case definition

Descriptive methods

In this outbreak, a total of 86 suspected cholera cases were detected across all the 10 wards of the LGA. We adapted the integrated disease surveillance and response (IDSR) recommended case definition for cholera to identify suspected cases [8]. A suspected cholera case was any resident of Kusada LGA, two years and above, with acute watery diarrhea with or without vomiting from 15th May to 2nd July 2018 [7]. Active case search was conducted at the health facilities and within the communities. All identified cases line listed. We also searched for additional suspected cases in the community and patent medicine vendors. The line-listed data was analyzed to characterize the outbreak in time, place and person and to develop a plausible hypothesis for cholera transmission in the community.

Analytical methods

We conducted an unmatched case-control with 1:1 of cases to neighborhoods controls, the study was conducted to determine the risk factors associated with infection. The study population was defined as persons residing in the affected areas from 15th May to 2nd July 2018, 2 years old and above and presenting with acute watery diarrhea with or without vomiting, while a control was defined as any person age 2 years or more residing in Kusada LGA without acute watery diarrhea and vomiting. The study enrolled 36 cases and 36 controls using an odds ratio of 3 (for a risk factor on which intervention would have a significant impact), assuming 30% prevalence of exposure among control with 95% confidence interval and power of 80%.[9] The sample size was determined using the Statcal function of Epi-Info Software version 7.1.3.10 [10].

Data collection method

The cases were sourced and recruited consecutively from among the patients that presented at the health facility and also those identified within the settlements. The controls were sourced from the family and neighborhoods. An interviewer administered semi-structured questionnaires was used to collect data on Socio-demographic characteristics, exposures and associated risk factors from both cases and controls, and clinical information from the cases only.

Laboratory methods

Water samples were collected from wells and households within the affected settlements. Ten (10) rectal stool specimens from suspected cases were also collected before the commencement of case management. The specimens were transported in Cary Blair transport medium to a tertiary health facility in the State where laboratory analysis was performed using thiosulfate-citrate-bile sucrose (TCBS) agar to

culture *vibrio* organism and polyvalent antisera to determine the serotypes.

Sanitary survey

The research team inspected the water source used for drinking (wells). We examined the wells and collected water samples under aseptic conditions from households were cases were reported. We also inspected the houses to observed environmental sanitation and hygiene of the settlements and waste management practices in the affected community.

Data management

We entered data into Epi-Info statistical software version 7.1.3.10. and performed Univariate analysis to obtain frequencies and proportions, and bivariate analysis to obtain odds ratios and determine associations, p-value < 0.05 was considered statistically significant. Also, unconditional logistic regression was done to adjust for possible confounders and identify the independent factors for contracting cholera infection. Factors that were significant at $p < 0.05$ in the bi-variate analysis were then included in the model.

RESULTS

Descriptive epidemiology

A total of 86 suspected cases were line listed, and 8 out of 10 stool samples collected confirmed positive for gram negative *Vibrio cholerae* of serogroup 01. The water samples from wells and households were negative for *Vibrio cholerae*. Among the line listed cases 55 (64.0%) were males. Median age was 12 (2-70) years for cases and 21 (2-70) years for controls; the overall attack rate was 63.6/100,000. There were 8 deaths (CFR: 9.0%) recorded, the affected age group 2-9 years was the most affected and 30-39years was the least affected. Cumulatively, the highest number of cases was recorded in the age group 2 - 29 years in both sexes (61cases). However, age group 2-9 years had the highest attack rate (Figure 1). The index case, and the primary case in this outbreak, developed symptoms on 20th May, 2018. The epidemic curve has a propagated pattern with three peaks, and a period of about 10 days between the peaks. The outbreak spanned over a period of one month, with most deaths recorded toward the end of the outbreak (Figure 2).

The result of bivariate analysis shows that those in contact with suspected case were 7 times more likely to develop diarrhea than those who did not have any contact. Also, those that ate vegetables were 18times more likely to come down with diarrhea than those who did not. These were all statistically significant. While, washing hand before eating and after using toilets were protective. Those who had contact with suspected case and history of eating vegetables were independent risk factors, and hand washing before eating and after using toilets was independent protective factors.

Environmental assessment

There was generally poor environmental sanitation at all the communities where the cases reside. We observed backyard dumping of refuse in most places with people openly defaecating all over the surroundings, even though the main toilet facilities in the communities were pit latrines. The main source of water for the communities were unsanitary wells and shallow streams, and people normally fetch with buckets and gallons and further stored in rubber bowls, and gallons for use. We observed inadequate hand washing facilities.

DISCUSSION

This community-based, case-control study identified three risk factors independently associated with the occurrence of the 2018 cholera outbreak in four settlements in Kusada LGA, Katsina State.

These factors were eating unhygienic prepared vegetables, absence of hands washing with soap and close contact with a case. The outbreak most likely, resulted following importation of the disease by the index case from Funtua, an area with ongoing cholera transmission. The outbreak has affected all age groups in this community (Figure 1), but age group 2–9 years had the highest proportion of cases and 30-39 years have least proportion of cases. These findings are consistent with the reports from in Northcentral, Northwestern Nigeria, Wardha India and reports from Nepal [11, 12]. The epi-curve of the outbreak (Figure 2) revealed a propagated epidemic pattern which shows that the disease was transmitted from person to person. The Person to person transmission of cholera has been documented in previous cholera outbreaks, in Jigawa State, Nigeria, Zambia and Ethiopia [13, 14, 15].

The practice of visiting relations whenever they are sick either at home or in the hospital in Kusada and in fact in rural communities in northern Nigeria, also facilitated the person to person transmission. Moreover, the case-control study has also supported the person-to-person transmission hypothesis generated from the epidemic curve. (Figure 2). The outbreak of cholera in Kusada LGA, in which 86 cases were reported, was strongly related to orofaecal exposures. The case-control study identified significant independent associations between contact with a case of cholera. The protective effect for hand hygiene was seen in this outbreak, but statistical significance is within border line by looking at the 95% CI. There was a wide confidence interval pointing out either there was lack of significant difference in the hand hygiene practice between the

cases and the controls or most likely the sample size was small. In addition, there was generally poor environmental sanitation at all the communities where the cases reside. These included open defaecation, backyard dumping of refuse in most places, and inadequate hand washing facilities. The major toilet facility and source of water in the communities were pit latrine, unsanitary wells and shallow streams. Consumption of raw vegetables was associated with cholera in Kusada. Raw vegetables have been associated with cholera in previous outbreaks. In Israel, the use of raw sewage for fertilizer on vegetable farms was implicated in cholera transmission. The consumption of raw produce was strongly associated with cholera in a Peruvian city where fruits and vegetables were splashed with sewage-contaminated river water during transport to markets. *Vibrio cholerae* can survive on raw produce for five days. Transmission of V. cholerae O1 has been associated with eating of unwashed raw vegetables or fruits and with poor hygiene practices during meal preparation, as observed in fish gutting processes [16, 17, 18]. The practice of open defaecation in the affected communities was the main driver of cholera outbreak in the community. The faeces are usually washed away by rain leading to contamination of the vegetables and produce can be exposed to these organisms at any time between the farm and the consumer's mouth.

The isolation of pathogenic strain of cholera organisms in 80% (8/10) of the collected rectal swabs and stool samples from various health facilities in the region confirm that the outbreak was caused by *Vibrio cholera* 01. The high case fatality rate (9.0%) observed in the outbreak could be attributed to the fact that most health facilities were not prepared with logistics to manage the overwhelming numbers of cases and also the risk factors are multiple. Furthermore, a weak diarrhea disease surveillance system, the late notification of the outbreak to higher levels and inadequate multi-sectorial (State Water supply and State Environmental sanitation Agency etc.) preparedness and response mechanisms in the LGA were some of the major contributory factors for the high fatality rate of the cholera outbreak.

The study revealed that, the cholera outbreak affected all age groups in the region and more especially among young ones and elderly, however people in age 2-9 years from both sexes were most affected. Having more male cases was largely a function of male behavior since males are more likely to eat outside home. Finding more male case than female agrees with the findings in Wardha in India and contrast the findings in Assam India and Observation by Singh *et al* where more females were affected [12, 25].

The significant association observed between contact with diarrhea cases and also between consuming vegetables suggest that are possible vehicles of the cholera transmission in the LGA which is similar to findings of Baffa *et al.* [19, 18, 20]. Contamination of human water or food sources are factors that greatly accelerate cholera spread[21]. Water source contamination remains the most common risk factor for cholera outbreaks both in Africa and worldwide, incriminated in 29 % of 306 risk factor reports during the 1995–2005 period [22]. Transmission may occur by drinking from contaminated water sources, such as lakes, rivers, estuaries, irrigation canals, or ponds [23, 24]. Studies in Africa have associated cholera transmission with river bathing and use of water for domestic purposes [24]. Shallow, uncovered hand-dug wells, which constitute the main source of drinking water for many people in Africa have been repeatedly associated with cholera outbreaks in sub Saharan Africa [23].

The major strength of this study was the use of both descriptive and analytical study designs in the outbreak investigation. The identification of contact with the suspected case and eating of vegetables as risk factors allowed the use of evidence-based interventions to control the outbreaks. The findings and conclusion should be interpreted with some limitations encountered during the case control study. The stools from the control group were not tested for *Vibrio cholerae* to determine their appropriate control status. In many outbreaks of cholera 90% of cases are either mild or asymptomatic. The study participants might have been misclassified.

CONCLUSION

A protracted multiple source propagated cholera outbreak was established in Mawashi and Bauranya wards in Kusada LGA. The independent risk factors were unsanitary prepared vegetables and contact with a suspected case. Inadequate multi-sectorial intervention, weak disease surveillance and inadequate case management were the major contributory factors to the high case fatality rate. During the outbreak investigation prompt appropriate case management, restricting visiting cases by relatives, risk communication activities on preventive measures involving LGA's influencers forum, traditional and religious leaders as well as intersectoral collaboration with RUWATSAN, and MSF WASH team, were carried out. Improving access to safe water, environmental sanitation and enhanced surveillance are the definitive preventive measures to stem cholera outbreaks.

RECOMMENDATIONS

- The State Ministry of Health should continue with training and retraining of healthcare workers on cholera case management to

decrease case fatality rate and to also continue public awareness on hand hygiene and proper disposal of waste.

- The State Ministry of Water resources to improve community access to safe drinking water by sinking boreholes in the affected settlements
- The Health promotion unit should continue to conduct behaviours change communication activities in the affected communities on the importance of minimizing contacts with suspected cholera cases at home and avoid visiting cases in hospitals.
- The community leaders and WASH official should discourage open defaecation and encourage use of pit latrines in the affected communities to meet the 2025 target of free open defaecation.

ACKNOWLEDGEMENTS

We wish to acknowledge the following for their contributions to the outbreak investigation and response:

1. Nigeria Field Epidemiology and Laboratory Training Program (NFELTP), Abuja
2. Katsina State Primary Healthcare Agency, Katsina
3. Department of Primary Healthcare Kusada LGA
4. RUWATSAN and MSF WASH team

REFERENCE

1. AKYALA, A.I., SHADRACK, B.E., AJUMOBI, O., OLAYINKA, A. & NGUKU, P. (2014). Investigation of Cholera Outbreak in an Urban North Central Nigerian Community-The Akwanga Experience. *Public Health Research*, **4**(1): 7–12.
2. ACOSTA C.J., GALINDO CM, KIMARIO J, SENKORO K, URASSA H, CASALS C, ET AL. (2001). Cholera outbreak in southern Tanzania: risk factors and patterns of transmission. *Emergence Infectious Diseases*, **7**(3): 583–587.
3. 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):1–13.
4. GLEEN, J., MORRIS, J.R. & DAVID ACHESON (2003). Cholera and Other Types of Vibriosis: A Story of Human Pandemics and Oysters on the Half Shell *Clinical Infectious Diseases*, **37**(2): 272–280.
5. BAFFA, S.I.,YAHAYA, M., RABI U., UBONG A. O., UCHE I.K., ABAYOMI A.O., ET AL. (2017). Outbreak of cholera at Dutsen-Abba Ward Zaria local government Area, Kaduna State Nigeria 2015: the importance of hygienic practices. *International Journal of Community Medicine and Public Health*, **4**(5): 1–5.
6. CENTRES FOR DISEASES CONTROL AND PREVENTION. (2020). Epi Info version 7.2.1.7.
7. DAN-NWAFOR, C.C., OGBONNA, U., ONYIAH, P., GIDADO, S., ADEBOBOLA, B., NGUKU, P. & NSUBUGA, P. (2019). A cholera outbreak in a rural north central Nigerian community: An unmatched case-control study. *BMC Public Health*, **19**(1). https://doi.org/10.1186/s12889-018-6299-3
8. GRIFFITH, D.C., KELLY-HOPE, L.A., MILLER, M.A. & GRIFFITH, D.C. (2006). Review of Reported Cholera Outbreaks Worldwide, 1995–2005. *The American Journal of Tropical Medicine and Hygiene*, **75**(5): 973–977.
9. JARRED, B.M., SYDNEY, D., TONDERAI, N., PAUL, M., TONDERAI, P., ANDREW, T., ET AL. (2018). Outbreak of Vibrio cholerae Associated with Attending a Funeral-Chegutu District, Zimbabwe, 2018. *Morbidity and Mortality Weekly Report (MMWR)*, **67**(18): 560–561.
10. KORTHUIS, P.T., JONES, T.R., LESMANA, M., CLARK,S.M.,OKOSERAY,M.,INGKOKUS UMO, G., ET AL. (1998). An outbreak of el tor cholera associated with a tribal funeral in Irian Jaya, Indonesia. Southeast Asian. *Outheast Asian J Trop Med Public Health.*, **29**(3): 550–554.
11. LAWOYIN, T.O., OGUNBODEDE, N.A. & OLUMIDE, O.M. (1999). Outbreak of cholera in Ibadan, Nigeria. *European Journal Epidemiolog*, **15**(4): 367-370. doi: 10.1023/a:1007547117763. PMID: 10414378.
12. MAHANTA, B.N., MAHANTA, T.G., SINHA, R., DUTTA, A., PAYENG, D. & JAWED, Q. (2013). Investigation of a Cholera Outbreak in a tea Garden of Sivasagar District of Assam. *Indian Journal Community Medicine*, **38**: 340-243.
13. MORRIS, J.G. (2011). Cholera-modern pandemic disease of ancient lineage. *Emerging Infectious Diseases*, **17**(11): 2099–2104. https://doi.org/10.3201/eid1711.111109
14. NANBEN, O.V., EMMANUEL, M., ONYEMOCHO, A., JULIUS, G. & ELISHA, P. (2017). A Retrospective Investigation of a Measles Outbreak in a District in North-western Nigeria. *World Journal of Public*

Health, **2**(3): 96. https://doi.org/10.11648/J.WJPH.20170203.12

15. NNAJI, R.N., AJUMOBI, O., BALA, U., OLADIMEJI, A., SARKI, M., USMAN, R. & NGUKU, P. (2016). Cholera outbreak investigation, Gajala community, Birnin Kudu Local Government Area, Jigawa State, Nigeria, September 2015. *International Journal of Infectious Diseases*, **45**. https://doi.org/10.1016/j.ijid.2016.02.351.
16. OPARE, J., DER, J., AFAKYE, K., BONSU, G., OLUBUMMO, C., AFARI, E. & SACKEY, S. (2011). Outbreak of cholera, East-Akim Municipality, Ghana, November 2010. *Journal of Epidemiology and Community Health*, **65**(Suppl 1(Suppl 3): A448–A448.
17. REBAUDET, S., SUDRE, B., FAUCHER, B. & PIARROUX, R. (2013). Environmental determinants of cholera outbreaks in inland africa: A systematic review of main transmission foci and propagation routes. *Journal of Infectious Diseases*. https://doi.org/10.1093/infdis/jit195.
18. ROSEWELL, A., ADDY, B., KOMNAPI, L., MAKANDA, F., ROPA, B., POSANAI, E., ET AL. (2010). Cholera risk factors, Papua New Guinea,. *BMC Infectious Disease*, **2012**(12–15).
19. SCHEELBEEK, P., TREGLOWN, S., REID, T., PSCHEELBEEK, P., TREGLOWN, S., REID, T. & MAES, P. (2009). Household fish preparation hygiene and cholera transmission in Monrovia, Liberia. *Journal of Infection in Developing Countries*, **3**(9): 727–731.
20. SCHÜRMANN, D., EBERT, N., KAMPF, D., ET AL. (2002). Domestic Cholera in Germany Associated with Fresh Fish Imported from Nigeria. *European Journal Clinical Microbiology Infectious Diseases 2x*, **21**(1): 827–828. https://doi.org/10.1007/s10096-002-0832-z
21. SINYANGE, N., BRUNKARD, J.M., KAPATA, N., MAZABA, M.L., MUSONDA, K.G., HAMOONGA, R. & MUKONKA, V.M. (2018). Cholera Epidemic-Lusaka, Zambia, October 2017–May 2018. *MMWR. Morbidity and Mortality Weekly Report*, **67**(19): https://doi.org/10.15585/mmwr.mm6719a5
22. SOURAV, G., ANUPRIYA, J., SARINKUMAR, P.S., DAMBARE, D. & GUPTA, S.S. (2019). Investigation of Cholera Outbreak in a Slum Area of Urban Wardha India. *An Interventional Epidemiological Study Journal of Family Medicine and Primary Care*, **8**: 1112-6.
23. SUR, D., SARKAR, B.L., MANNA, B., DEEN, J., DATTA, S., NIYOGI, S.K., ET AL. (2006). Epidemiological, microbiological & electron microscopic study of a cholera outbreak in a Kolkata slum community. *The Indian Journal of Medical Research*, **123(**1): 31–36.
24. TADESSE, T. & ZAWDIE, B. (2020). Cholera Outbreak Investigation in Four Districts of Kirkos Sub-city in Addis Ababa, Ethiopia: A Case-Control Study. *Pathology and Laboratory Medicine*, **4**(1): 7. https://doi.org/10.11648/j.plm.20200401.12
25. WORLD HEATH ORGANIZATION.(2020). Cholera, 2019. *Weekly Epidemiological Report*, **37**(9537), 441–448.
26. YVAN HUTIN & STEPHEN LUBY, C.P. (2003). A large cholera outbreak in Kano City, Nigeria: the importance of hand washing with soap and the danger of street-vended water. *Journal of Water Health*, **1**(1): 45–52.

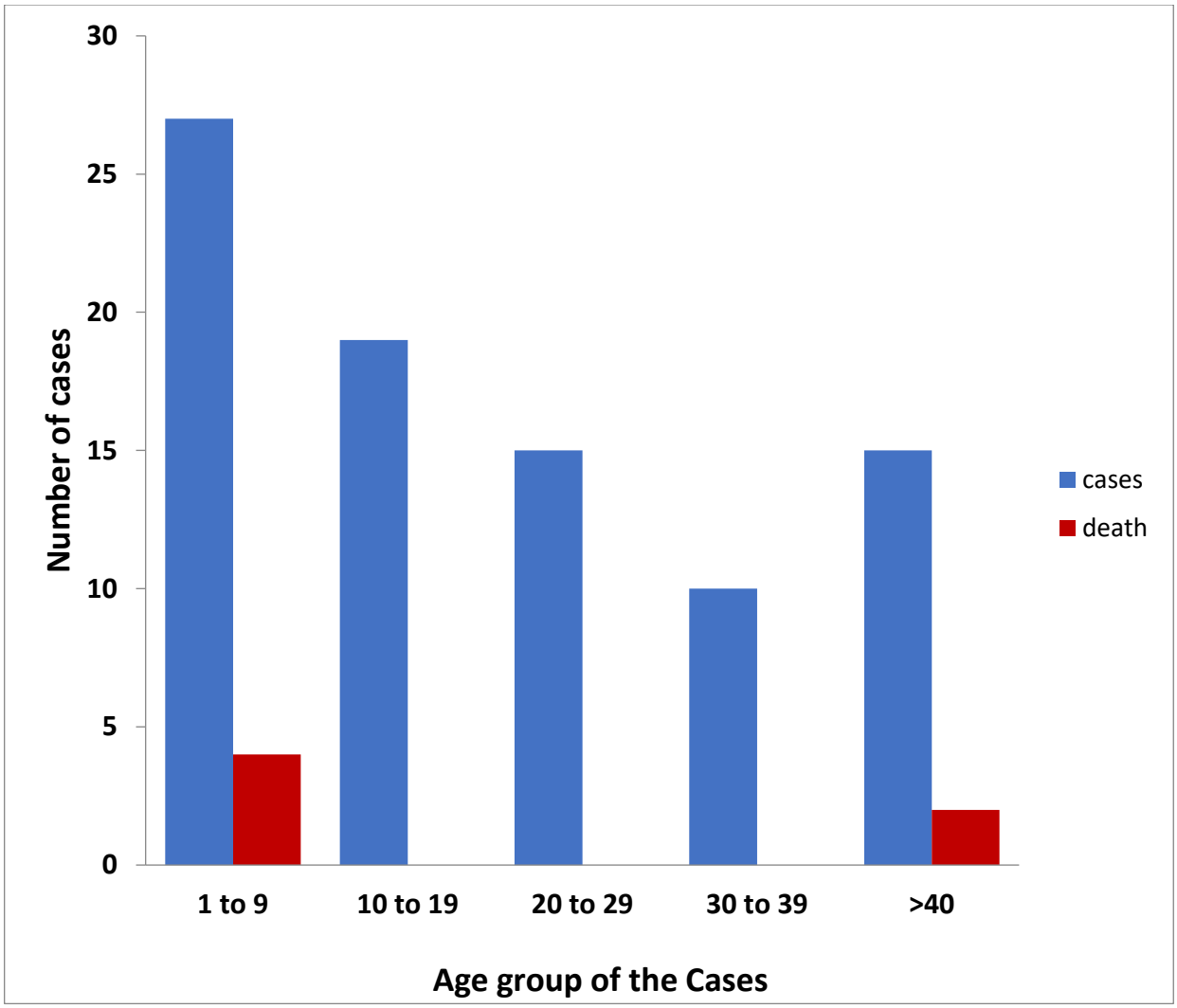

Figure 1: Age distribution of cases and deaths of Cholera in Kusada LGA Katsina State 2018

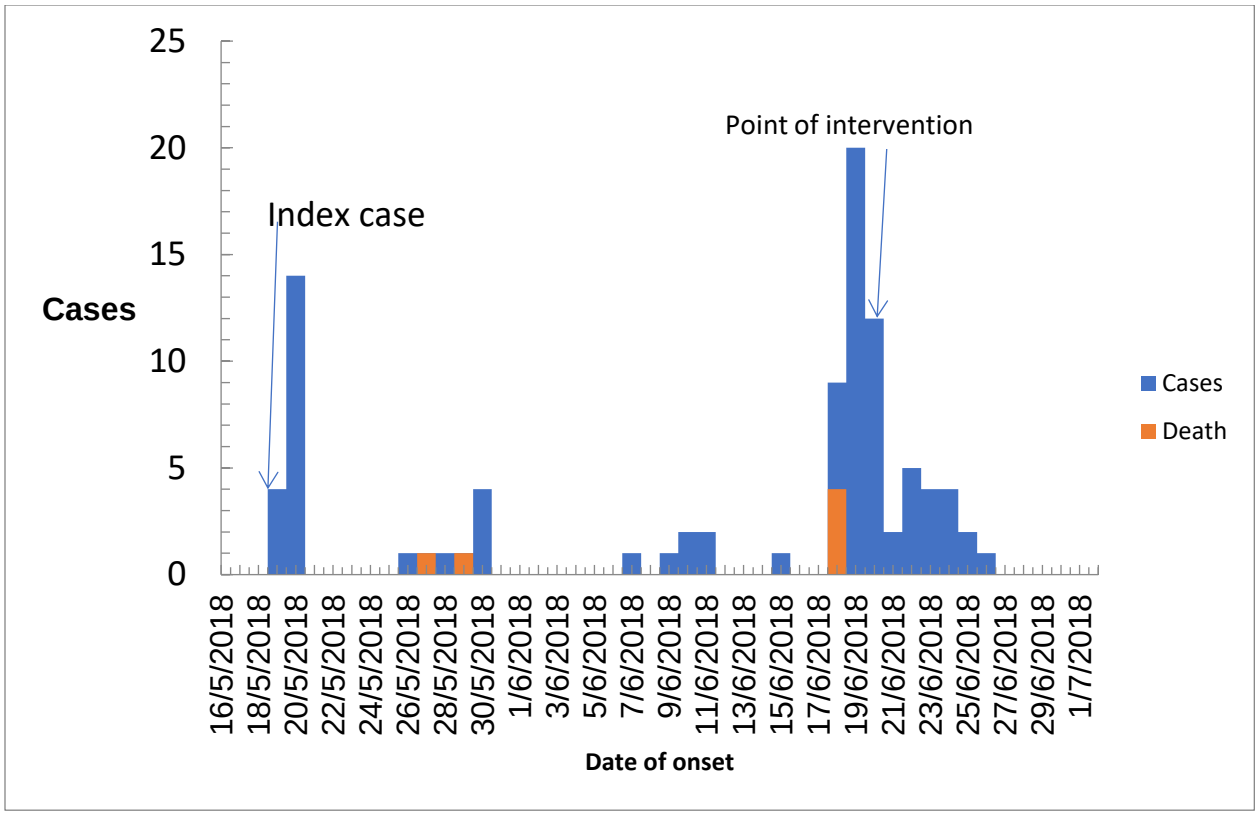

Figure 2: Epidemic curve of suspected cholera cases in Kusada LGA, Katsina State, May/June 2018

Table 1: Association of exposure factors to the risk of Developing cholera infection in Kusada LGA, Katsina State, June 2018

Exposure Risk Factors	Cases n=36(%)	Controls n=36(%)	Odd ratios 95%(CI)
Contact with diarrhea case	31 (86)	16(44.5)	7(2.5-28)
History of eating vegetables	25(69)	4(11.1)	18(5.0-63)
Washing of hand before eating	7(19.5)	9(25)	0.72(0.2-2.2)
Washing of hand after using toilets	11(30.8)	13(36.5)	0.77(0.2-2.0)

Table 2: Unconditional logistic regression of risk factors for cholera infection in Kusada LGA, Katsina State, June 2018

Exposure factors	Odd ratios (95% CI)	P-value
Contact with suspected case	7(2-24)	<0.001
History of eating vegetables	13.6(10-17)	<0.001
Washing hands with soap & water after using toilets	0.73(0.55-0.98)	0.04

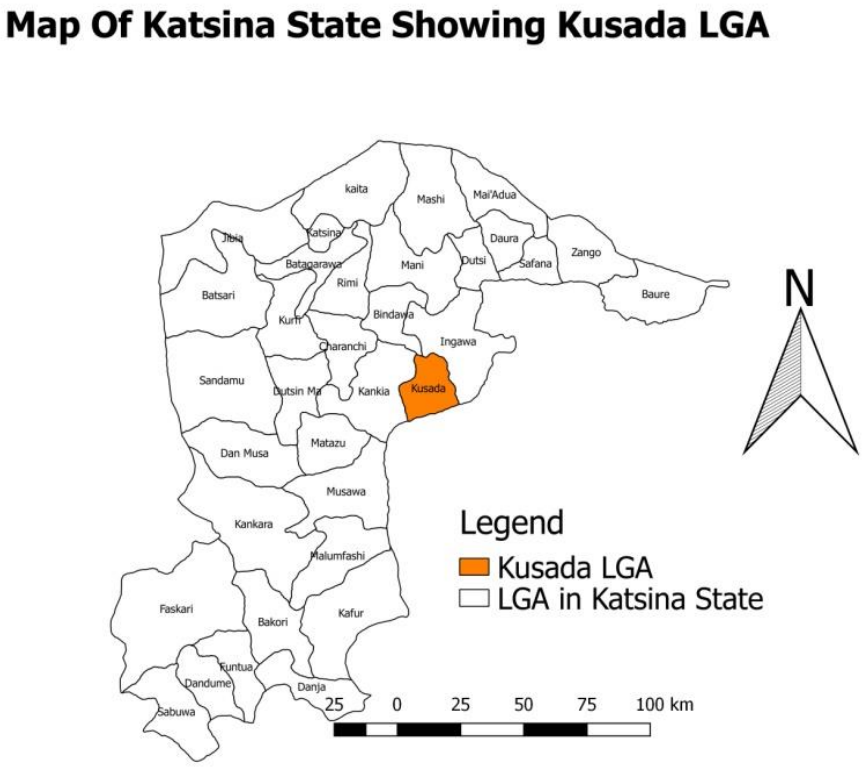

Figure 3: Map of Katsina state showing Kusada LGA