Assessment of potential factors that support the endemicity of cholera in Nigeria from food handlers, health workers and the environment

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Ethical approval: Ethical approval of the proposal and the study tool was obtained from the Nigerian Institute of Medical Research Institutional Review Board (IRB) with approval number IRB/17/001. There are minimal risks associated with the collection of stool and swabs from participants. Anonymity, confidentiality, and privacy of the participants were maintained. All samples and data did not bear any participant's name but labeled with the participant's identification (ID) number. Furthermore, the results generated were not labeled to any of the population where the samples were collected and as such, was not traceable to source. All participants consented before enrolment in the study.

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Informed consent: Anonymity, confidentiality, and privacy of the participants were maintained. All samples and data did not bear any participant's name but labeled with the participant's identification (ID) number. Furthermore, the results generated were not labeled to any of the population where the samples were collected and as such, was not traceable to source. All participants consented before enrolment in the study.

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Summary

Background and Aims. Diarrheal diseases caused by bacterial pathogens are widespread and they result in morbidity and mortality of a lot of people yearly. The aim of this study was to assess the role of the environment, health workers and food handlers as reservoirs of *Vibrio cholerae,* and other diarrhea causing bacteria.

Methods. Healthcare workers were proportionally selected and multistage sampling technique was adopted in selecting food handlers for the study. A total of 374 participants consisting of health workers and food handlers were recruited. Socio-demographic and clinical information were collected using questionnaires, while stool and environmental samples were also collected.

Results. More female 55.9% than male 44.1% participated in the study and the mean age of participants was 38.7±10.9. A significant number of participants identified poor hygiene practices as the major cause of diarrhea. *V.cholerae* O1 serotype was not detected in any of the environmental samples nor stool samples of both food handlers and health workers. However, *V.cholerae* (Non O1/Non O139) was isolated from the stool samples of food han-

dlers and health workers in Kano State implying that they could serve as a source of the continuous dissemination of the pathogen. Other diarrheal causing bacterial pathogens isolated from this study include *Salmonella* spp. *Escherichia coli*, *Klebsiella oxytoca*, and *Enterobacter* spp.

Conclusions. It is therefore imperative that food handlers and health workers undergo periodic health checks to ensure they are free of pathogens that could easily be transmitted through food or to patients.

Introduction

Diarrheal diseases caused by bacterial pathogens are widespread and *Vibrio cholerae,* the causative agent of cholera, is endemic in Nigeria, with recurrent outbreaks recorded yearly (1). Majorly, poor hygiene remains a factor among other factors that promote the transmission of *V. cholerae* as well as other etiology of diarrhea. In Buea Health District of Cameroon contaminated water sources and poor hygiene practices have been identified as the main transmission routes of cholera (15). Other risk factors that were independent were irregular water supply, lack of home toilet and poor food preservation. Food is a basic necessity needed to sustain life but when not properly processed or handled can be a source of infection. Food handlers infected with *V. cholerae* serve as a major source of transmission of the pathogen within the community (19,17). In a report in northwest Thailand food handlers were implicated as vehicles of transmission of *V. cholerae* in two consecutive outbreaks of food-borne cholera associated with the consumption of chicken rice (20). Health workers could also be a source of the continuous transmission of *V. cholerae* in the community due to their responsibility of caring for infected patients. Cholera as an occupational infection among health workers have been reported in Limpopo province of South Africa in which 10.7% of the 56 infectious diseases among health workers was cholera (13). Awareness and knowledge of a pathogen and its dynamics of transmission among populations including food handlers and health workers is key to preventing and controlling outbreaks. In a preliminary study on caretakers' (those that seek and provide treatment for cholera within households) knowledge on what is cholera in Bangladesh revealed that there was need for reformulation of cholera and diarrhea communication as nearly a third of the caretakers could not associate diarrhea with cholera and its accompanying symptoms (21). The environment also serves as a persistent source of *V. cholerae* transmission to humans. Dan-Nwafor *et al.* (6) during an outbreak of cholera in a rural community in north-central Nigeria, reported water source and environment polluted by indiscriminate defecation as factors that mediated the outbreak. Similarly, Akoachere *et al*. (3) investigated water sources in New Bell-Douala, Cameroon where cholera is endemic and reported the isolation of *V. cholerae* O1 from streams and well samples in both wet and dry seasons. The persistence of the pathogen in the environment fuels recurrent outbreaks. In Africa, several factors have been identified as drivers of recurrent outbreaks of cholera which include but not limited to cross border migration, environmental reservoirs, conflicts, climate change and socioeconomic factors (1). In Nigeria the outbreak of cholera cuts across inland, coastal and arid regions of the country. Information on factors that contribute to this trend is limited. Hence, this study assessed the potential role healthcare workers, food handlers and the environment might be playing in supporting the endemicity of cholera in Nigeria.

Materials and Methods

This study was a multicenter study that involved data and sample collection from consented individuals in states that had previously experienced cholera outbreak but was not experiencing outbreak at the time of sample collection. The study site consisted of primary, secondary, and tertiary healthcare facilities, hotspot communities, and the surrounding environment in local government areas (LGAs) of 3 states in Nigeria as shown in Figure 1. The study population comprised two groups A and B. Group A was made up of health workers including: doctors, nurses, laboratory personnel, pharmacists and ward attendants. While group B were food handlers. Samples were also collected from environmental sources such as: water, soil, and sewage that support growth and transmission.

Asymptomatic healthcare workers from public health care facilities and food handlers in the study sites were included in the study. While participants with cholera or diarrhea in the study sites were excluded from the study. Healthcare workers were proportionally selected. Multistage sampling technique was also adopted in selecting the food handlers for the study. Data on demographic characteristics, health, and predisposing factors to cholera risk were collected using a semi-structured questionnaire.

Sample size determination for study group A and B were calculated using the sample size expression for prevalence as described by Pourhoseingholi *et al.* (18) using the formula:

$$N=Z^2 (P(1-P)) / D^2$$

The expected prevalence (P) for study group A was 32% (16) and for study group B was 4% (9). The sample size thus calculated for group A and B was 286 and 174 respectively making a total of 460 samples. However, a total of 374 participants that were willing and gave consent were recruited for the study.

Stool and environmental samples were collected into sterile screw-capped universal containers, capped, labeled, and placed in an ice – pack sample box and transported to the laboratory for bacterial analysis.

A gram from each stool and soil sample was inoculated into alkaline peptone water (APW) for *V. cholerae* and selenite F medium for the isolation of *Salmonella*. The liquid cultures were incubated at 37ºC for 6 hours for APW and 24 hours for selenite F for *V. cholerae* and *Salmonella* respectively.

A loopful of 6 hours broth of APW was inoculated onto thiosulfate citrate bile salts sucrose (TCBS) agar (Oxoid, Basingstoke, UK) and incubated at 37 ºC for 24 hours. A loopful of selenite F broth culture was also streaked on sterile *Salmonella-Shigella* Agar (SSA) (Oxoid) and incubated at 37ºC for 24 hours.

Discrete yellow colonies on TCBS and translucent discrete colony with black pigmentation on SSA were subcultured on sterile Muller Hinton Agar (MHA) (Oxoid) and incubated at 37ºC for 24 hours. Suspected *V. cholerae* and *Salmonella* colonies were then characterized by standard biochemical tests using analytical profile index (API) 20E (BioMérieux, Marcy-l'Étoile, France) test kit. Serotyping of identified *V. cholerae* isolates was done using polyvalent and monovalent and antisera (BioMérieux).

Data analysis

Data entry and analysis was done using the Statistical Package for Social Sciences (SPSS) version 22. Discrete variables were presented as percentages while continuous variables were expressed as mean ± standard deviation. Proportions were compared using Pearson Chi-square, while the different means were compared using the students t-test. The level of significance was

predetermined at a p-value of 0.05. Variables attaining significance were further subjected to multivariate analysis using logistic regression. Results were expressed with 95% confidence intervals.

ResultsThe overall mean age of participants was 38.7±10.9. More females (55.9%) participated in the study. About 90% of the participants had either primary, secondary, or tertiary education while only 7% had Quranic education and 4 % had no form of formal education. More married persons and Muslims participated in the survey with the majority from Kano state (Table 1.).

Forty (11%) participants reported that they had household members who had diarrhea related sickness in the past week, while 19 (5.1%) respondent reported diarrhea related death of a household member. Assessment of the perception and knowledge of respon-

Table 1. Socio-demographic characteristics for all states.

Variables	Abia Number (%)	Kano Number (%)	Lagos Number (%)	All participants Number (%)
Sex				
Male	13(16.3)	136(71.6)	16(15.4)	165(44.1)
Female	67(83.8)	54(28.4)	88(84.6)	209(55.9)
Total	80(100)	190(100)	104(100)	374(100)
Level of education				
None	—	1(0.6)	3(3.0)	4(1.2)
Primary	3(4.1)	14(8.9)	12(12.1)	29(8.8)
Quranic	—	22(13.9)	1(1.0)	23(7.0)
Secondary	31(42.5)	13(8.2)	28(28.3)	72(21.8)
Tertiary	38(52.1)	103(65.2)	55(55.6)	196(59.4)
Other	1(1.4)	5(3.2)	—	6(1.8)
Total	73(100)	158(100)	99(100)	330(100)
Religion				
Christianity	68(97.1)	5(3.6)	72(77.4)	145(47.9)
Islam	2(2.9)	135(96.4)	21(22.6)	158(52.1)
Total	70(100)	140(100)	93(100)	303(100)
Marital status				
Married	50(70.4)	123(78.9)	67(73.6)	240(75.2)
Single	17(23.9)	31(19.7)	19(20.9)	67(21.0)
Widowed/separated/divorced	4(5.6)	3(1.9)	5(5.5)	12(3.8)
Total	71(100)	157(100)	91(100)	319(100)

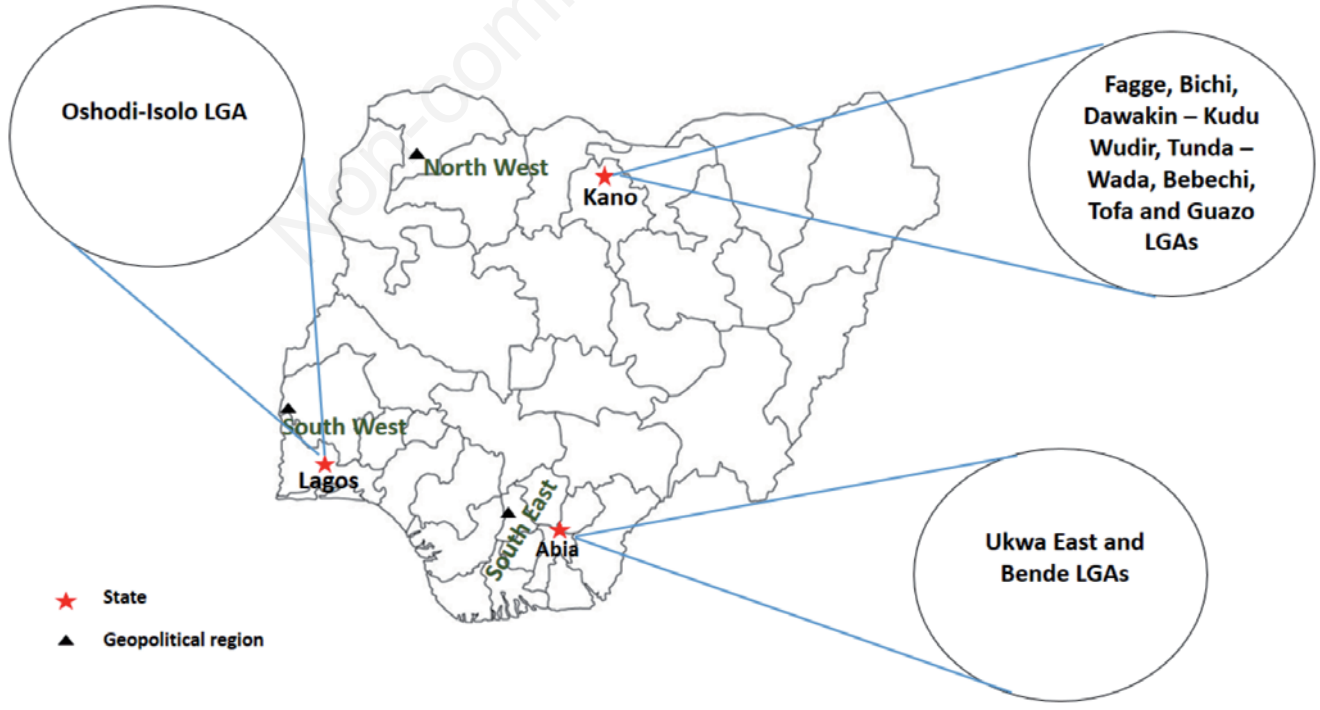

Figure 1. Sampling sites in different local government areas of 3 state in various geopolitical regions of Nigeria. LGAs: Local government areas.

dents on the causes, prevention and treatment of diarrhea revealed that a significant number of participants (85.3%) identified thorough cooking of food and proper hand washing with soap and water as a means of preventing diarrhea. There was varied opinion on treatment options adapted by participants in managing diarrhea as shown in Table 2. In terms of source of information on the prevention and treatment of diarrhea, 59.6% reported that they had heard information about prevention and treatment of diarrhea in the past six months with the majority of them (64.2%) stating that they heard from health care workers. A total of 39.3% of respondents indicated radio/television as their source of information on the treatment and prevention of diarrhea as shown in Table 3. Majority of the respondents, when assessed on their source of drinking and cooking water stated they drank sachet water (56.7%) and used pipe borne water to cook (46.8%) (Table 4). However, 29.7% of the participants reported that they did not have access to water during

Table 2. Information assessment on diarrhea causes, prevention and treatment of all participants.

	Abia n=80 Number (%)	Kano n=190 Number (%)	Lagos n=104 Number (%)	$\chi 2$ test p value
Causes				
Drinking bad water	71(88.8)	151(79.5)	90(86.5)	0.501
Eating bad food	67(83.8)	154(81.1)	89(85.6)	0.553
Eating unwashed fruits/vegetables	55(68.8)	145(76.3)	81(77.9)	0.086
Flies/insects	48(60.0)	137(72.1)	81(77.9)	0.189
Poor hygiene/not washing hands	67(83.8)	150(78.9)	91(87.5)	0.147
Cook food thoroughly	9(11.3)	29(15.3)	13(12.5)	0.870
Wash vegetables/fruits	11(13.8)	19(10.0)	12(11.5)	0.213
Prevention				
Wash hands with soap and water	63(78.8)	183(96.3)	86(82.7)	0.033
Cook food thoroughly	62(77.5)	164(86.3)	93(89.4)	0.035
Wash fruits/vegetables	63(78.8)	174(91.6)	87(83.7)	0.228
Properly dispose human waste	57(71.3)	162(85.3)	84(80.8)	0.383
Boil water	51(63.8)	144(75.8)	76(73.1)	0.187
Clean cooking utensils/vessels	60(75.0)	164(86.3)	84(80.8)	0.378
Treat water with chlorine products	38(47.5)	126(66.3)	64(61.5)	0.255
Cover food to keep away flies	56(70.0)	161(84.7)	79(76.0)	0.464
Cholera vaccine	22(27.5)	95(50.0)	38(36.5)	0.726
Unpreventable	4(5.0)	19(10.0)	8(7.7)	0.651
Other(specify)	-	1(0.5)	3(2.9)	0.505
Treatment				
Go to clinic	59(73.8)	173(91.1)	92(88.5)	0.210
Use ORS	59(73.8)	170(89.5)	72(69.2)	0.227
Salt and sugar solution	49(61.3)	125(65.8)	67(64.4)	0.765
Take zinc tablet	44(55.0)	138(72.6)	62(86.1)	0.054
Go to a traditional healer	4(5.0)	17(8.9)	4(3.8)	0.154
Home remedy	5(6.3)	38(20.0)	8(7.7)	0.039
Do not treat	2(2.5)	5(2.6)	2(1.9)	0.594
Others (such as using flagyl, tetracycline, paracetamol, chew dry garri, agbo-jedi, infusion)	12(15.00)	1(0.5)	13(12.5)	0.003

Table 3. Source of information on prevention and treatment of diarrhea.

	Abia n=80 Number (%)	Kano n=190 Number (%)	Lagos n=104 Number (%)	All study participants n=374 Number (%)
Heard about the prevention and treatment of diarrhea in the past 6 months				
Yes	53(66.3)	107(56.3)	63(60.6)	223(59.6)
No	18(22.5)	29(15.3)	32(30.8)	79(21.1)
Source of information on prevention and treatment of diarrhea in the past 6 months				
Family member	9(11.3)	29(15.3)	9(8.7)	47(12.6)
Neighbor/friend	10(12.5)	28(14.7)	10(9.6)	48(12.8)
Clinician/health worker	52(65.0)	131(68.9)	57(54.8)	240(64.2)
Chemist	6(7.5)	32(16.8)	6(5.8)	44(11.8)
Radio/TV	35(43.8)	74(38.9)	38(36.5)	147(39.3)
Internet/Badoo, etc	9(11.3)	31(16.3)	9(8.7)	49(13.1)
Community meeting	7(8.8)	40(21.1)	7(6.7)	54(14.4)
Community health worker visiting home	19(23.8)	60(31.6)	10(9.6)	89(23.8)
Religious leader	5(6.3)	31(16.3)	6(5.8)	42(11.2)
Others (such as handbills, seminar, school, posters, patients)	5(6.3)	1(0.5)	4(4.0)	10(2.9)

power outages or dry seasons. A total of 211(56.4%) participants cared about the safety of their water, with the majority of them (86.3%) stating that they made their water safe by boiling. Ninety-one (28.6%) of the participants indicated that they treated their water regularly before consumption, while 83 (26.1%) did not treat their water at all. Furthermore, 40.1% reported that their source of water did not require treatment before consumption while 1.1% lacked awareness of the need to treat their water. Hand washing after using the toilet was a regular practice of 94.9% of the respondents with 65.2% of participants reporting that they had flush toilet facility, while 27.5% use pit latrine with 4.0% having no toilet facility at all (practiced open defecation) as shown in Table 5.

The need to keep up good hygiene practice after receiving a cholera vaccine was expressed by 46.8% through regular hand washing with soap and water, 41.7% through adequate cooking of food, 44.9% through thorough washing of fruits or vegetables and 42.5% through boiling of water before consumption as shown in Table 6. Also, some (47.3%) of the participants identified health workers as their source of information on the availability and administration of cholera vaccine (Table 7).

Table 4. Source of drinking water/cooking water.

	Abia n=80 Number (%)	Kano n=190 Number (%)	Lagos n=104 Number (%)	All study participants n=374 Number (%)
Water source				
Piped borne water	35(43.8)	95(50.0)	29(27.9)	159(42.5)
Covered well	15(18.8)	105(55.3)	30(28.8)	150(40.1)
Uncovered well	1(1.3)	28(14.7)	4(3.8)	33(8.8)
Water truck	6(7.5)	49(25.8)	4(3.8)	59(15.8)
River/stream/lake/irrigation canal	24(30.0)	13(6.8)	1(1.0)	38(10.2)
Sachet water	42(52.5)	107(56.3)	63(60.6)	212(56.7)
Bottled water	19(23.8)	52(27.4)	44(42.3)	115(30.7)
Rainwater	20(25.0)	69(36.3)	7(6.7)	96(25.7)
Springwater	6(7.5)	27(14.2)	3(2.9)	36(9.6)
Other (bore-hole water)	11(13.8)	6(3.2)	14(13.5)	31(8.3)
Source of cooking water				
Piped water in the house	38(47.5)	92(48.4)	45(43.3)	175(46.8)
Piped water in court	4(5.0)	19(10.0)	2(1.9)	25(6.7)
Piped water in public	17(21.3)	67(35.3)	10(9.6)	94(25.1)
Communal standpipe	7(8.8)	26(13.7)	2(1.9)	35(9.4)
Well, protected	19(23.8)	103(54.2)	38(36.5)	160(42.8)
Well, unprotected	6(7.5)	32(16.80	5(4.8)	43(11.5)
Well with pump	7(8.8)	66(34.7)	13(12.5)	86(23.0)
Water truck/vendor	5(6.3)	54(28.4)	6(5.8)	65(17.4)
River/stream/lake/irrigation canal	33(41.3)	29(15.3)	1(1.0)	63(16.8)
Bottled water	13(16.3)	31(16.3)	8(7.7)	52(13.9)
Rainwater	40(50.0)	72(37.9)	11(10.6)	123(32.9)
Springwater	8(10.0)	22(11.60	1(1.0)	31(8.3)
Springwater, unprotected	1(1.3)	8(4.2)	1(1.0)	10(2.7)
Other (bore-hole water)	11(13.8)	4(2.1)	20(19.2)	35(9.4)

Table 5. Regular hand washing habits and type of toilet facility available.

	Abia n=80 Number (%)	Kano n=190 Number (%)	Lagos n=104 Number (%)	All study participants n=374 Number (%)
Regularly wash hands				
After toilet use	79(98.8)	174(91.6)	102(98.1)	355(94.9)
Before eating	79(98.8)	175(92.1)	101(97.1)	355(94.9)
After eating	79(98.8)	174(91.6)	100(96.2)	350(93.6)
Before cooking	74(92.5)	156(82.1)	90(86.5)	320(85.6)
After cleaning baby diapers/stool	70(87.5)	152(80.0)	61(58.7)	283(75.7)
After cleaning the home	76(95.0)	153(80.5)	90(86.5)	319(85.3)
Whenever hands are dirty	75(93.8)	162(85.3)	91(87.5)	328(87.7)
Others (after returning from work/market, after treating patients, after cooking, ablution)	6(7.5)	1(0.5)	17(16.3)	24(6.4)
Type of toilet facility				
Water flush	66(82.5)	82(43.2)	96(92.3)	244(65.2)
Pit latrine, ventilated and ameliorated	5(6.3)	34(17.9)	5(4.8)	44(11.8)
Pit latrine with cement slab	11(13.8)	90(47.4)	2(1.9)	103(27.5)
Bucket toilet	1(1.3)	7(3.7)	2(1.9)	10(2.7)
Hanging toilet/hanging latrine	-	11(5.8)	1(1.0)	12(3.2)
No toilet/canal/bush or field	5(6.3)	9(4.7)	1(1.0)	15(4.0)

Several bacterial strains were detected in samples obtained from health workers, food handlers and the environment. *V. cholerae* Non-O1/Non-O139 and *Salmonella* spp. were only isolated from samples that originated from Kano State and both bacteria had an occurrence of 1.6 % and 2.1% respectively. Other bacteria including *Proteus* spp., *Edwardsiella* spp., *Klebsiella oxytoca*, *Enterobacter* spp., *Citrobacter freundii*, and *Escherichia coli* were also isolated from samples obtained from the three states.

Discussion

The transmission of *V. cholerae* and other diarrheal causing pathogens in the community is driven most often by the contamination of water sources and food products with feces due to improper disposal of fecal matter and poor personal hygiene practice (5,7). Food handlers and health workers have been identified as potential transmission portals through which other persons in the community get infected with pathogens of public health significance (2,11). In this study the awareness of the causes, prevention and treatment of diarrhea was high. Among the 374 respondents, more females participated in the study than males, this could be due to the fact that females are more involved in food handling as well as primary health care than males. Ninety percent of them had one form of formal education or the other which might suggest the high level of awareness observed. Also, over 90% of the respondents in all three states showed good hand washing practice, which can be attributed to the fact that the majority of them were educated. However, in the observation of Akabanda *et al*. (2) satisfactory knowledge of food and personal hygiene did not cumulate into scrupulous hygiene practice by institutional food handlers. Participants in the study population had different sources of water for drinking as well as cooking, but the majority had access to pipe borne water and water sold in sachets across all the states. A greater percentage of respondents reported that they used pipe borne water for cooking and drinking. Also, over a half of the study population had modern water flush type of toilet indicating proper disposal of feces compared to a few who had no toilet facility at all reducing the spread of *V. cholerae* and risk of infection amongst members with modern toilet facility.

Administering cholera vaccines has been found to be effective in curbing transmission (8), making the knowledge of the availability of cholera vaccine vital. In this study, the majority of the participants (47.3%) who indicated that they had knowledge of the availability of cholera vaccine stated that they got to know through a health worker, while 31.8% reported that they got to know via mass media (television and radio) and those that gained awareness in school represented about 11.8%. The knowledge gap is still not encouraging as this

Table 6. Assessment of participants opinion on the importance of observing good hygiene practice even after taking cholera vaccine.

	Abia n=80 Number (%)	Kano n=190 Number (%)	Lagos n=104 Number (%)	All study participants n=374 Number (%)
Wash hands with soap and water				
Still important	43(53.8)	83(43.7)	49(47.1)	175(46.8)
Less important	-	1(0.5)	-	1(0.3)
No opinion	15(18.8)	1(0.5)	5(4.8)	21(5.6)
Cook food				
Still important	38(47.5)	73(38.4)	45(43.3)	156(41.7)
Less important	-	1(0.5)	-	1(0.3)
Not important	-	1(0.5)	-	1(0.3)
No opinion	14(17.5)	1(0.5)	5(4.8)	20(5.3)
Wash vegetables/fruits				
Still important	43(53.8)	78(41.1)	47(45.2)	168(44.9)
No opinion	14(17.5)	1(0.5)	5(4.8)	20(5.3)
Boil water before drinking				
Still important	40(50.0)	76(40.0)	43(41.3)	159(42.5)
Less important	14(17.5)	1(0.5)	4(3.8)	5(1.3)
No opinion	-	1(0.5)	5(4.8)	20(5.3)
Clean cooking utensils/vessels				
Still important	37(46.3)	77(40.5)	47(45.2)	161(43.0)
No opinion	14(17.5)	1(0.5)	5(4.8)	20(5.3)
Treat water with chlorine products				
Still important	29(36.3)	70(36.8)	32(30.8)	131(35.0)
Less important	4(5.0)	7(3.7)	5(4.8)	16(4.3)
Not important	-	-	1(1.0)	1(0.3)
No opinion	15(18.8)	1(0.5)	5(4.8)	21(5.6)
Safely dispose of feces				
Still important	31(38.8)	75(39.5)	46(44.2)	152(40.6)
Less Important	2(2.5)	1(0.5)	-	3(0.8)
Not important	-	1(0.5)	-	1(0.3)
No opinion	14(17.5)	1(0.5)	5(4.8)	20(5.3)
Give ORS to a person ill with diarrhea				
Still important	31(38.8)	76(40.0)	41(39.4)	148(39.6)
Less important	-	-	1(1.0)	1(0.3)
No opinion	14(17.5)	3(1.6)	5(4.8)	22(5.9)

Table 7. Source of information on the availability of cholera vaccine.

	Abia n=80 Number (%)	Kano n=190 Number (%)	Lagos n=104 Number (%)	All study participants n=374 Number (%)
Sources of information about cholera vaccine				
Health worker	31(38.8)	90(47.4)	56(53.8)	177(47.3)
Friend/family	9(11.3)	16(8.4)	7(6.7)	32(8.6)
Village leader	5(6.3)	10(5.3)	4(3.8)	19(5.1)
Radio	15(18.8)	33(17.4)	15(14.4)	63(16.8)
Television	15(18.8)	26(13.7)	15(14.4)	56(15.0)
Cell phone messages	8(10.0)	11(5.8)	7(6.7)	26(7.0)
Megaphones	5(6.3)	8(4.2)	4(3.8)	17(4.5)
School	11(13.8)	26(13.7)	7(6.7)	44(11.8)
Religious leader	5(6.3)	11(5.8)	3(2.9)	19(5.1)
Other (Invited speaker at church, training, from patients who came to ask for the vaccine)	-	-	4(4.0)	4(1.1)
How many doses are needed for a complete course of vaccine				
Number of doses	4(5.0)	12(6.3)	14(13.5)	30(8.0)
Don't know	67(83.8)	66(34.7)	73(70.2)	206(55.0)
Specify how many doses				
0	-	-	1(1.0)	1(4.0)
1	2(2.5)	2(1.0)	2(2.0)	9(36.0)
2	-	-	7(6.7)	7(28.0)
3	-	4(2.1)	1(1.0)	5(20.0)
4	-	1(0.5)	-	1(4.0)
5	-	1(0.5)	-	1(4.0)
6	1(1.3)	-	-	1(4.0)
Ever been given the cholera vaccine				
Yes	5(6.3)	7(3.7)	4(3.8)	16(4.3)
No	57(71.3)	95(50.0)	80(76.9)	232(62.0)
Don't know	11(13.8)	11(5.8)	12(11.5)	34(9.1)

data was collected from people with a large percentage having some form of medical education. There has also been a poor rate of cholera vaccination, as only 4% of respondents had received the vaccine. This further supports the study by Ali *et al*. (4) on the fact that cholera vaccines are still not commonly used in Nigeria.

V. cholerae O1 serotype was not detected in any of the environmental samples nor stool samples of both food handlers and health workers. However, *V. cholerae* (Non O1/Non O139) was isolated from the stool samples of food handlers and health workers in Kano State implying that they could be serve as a source of the continuous dissemination of the pathogen. In the study of Marin *et al*. (14) *V. cholerae* (Non O1/Non O139) was reported to have been isolated from cholera-like diarrhea cases in Nigeria during 2009-2010 cholera outbreak in which over 40,000 cases of cholera were recorded. Elsewhere, the transmission of *V. cholerae* O1 by food handlers has been reported. Llanes *et al*. (12) reported the carriage of *V. cholerae* O1 serotype Ogawa in food handlers that were catering for Cuban health workers in Haiti during a cholera outbreak in the country. In this study other bacterial pathogens including *Salmonella* spp. *Escherichia coli*, *Proteus* spp., *Citrobacter freundii*, *Klebsiella oxytoca*, and *Enterobacter* spp. were isolated from the three states from which samples were collected. Some of these bacterial pathogens have been implicated in diarrhea that could be fatal most especially in immunocompromised individual (10,22).

Conclusions

This study assessed the role that food handlers, healthcare workers and the environment might play in the endemicity of cholera in Nigeria. The results indicated that both food handlers and healthcare workers were well informed of the causes, prevention and treatment of diarrhea. Their practice of hygiene including hand washing and use of treated water was high. However, *V. cholerae* Non-O1/Non-O139 and other bacterial pathogens that are diarrhea etiologies were isolated from some of them. Although *V. cholerae* O1 was not isolated from any of the participants or the environment, it is imperative that food handlers and health workers undergo periodic health checks to ensure they are free of pathogens they could easily transmit through food or to patients they care for respectively.

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