ABSTRACT

Aims: In 2014, a cholera outbreak occurred in Greater Accra region, affecting more than 1733 people, and 20 individuals died. We investigated to verify the diagnosis, identify risk factors and recommended control measures.

Study Design: The study was both descriptive and un-matched community-based 1:2 case control study.

Place and duration of study: The investigations were done between 24th July and 3rd August 2014 in the Greater Accra region of Ghana.

Methods: We conducted a descriptive investigation, active case-search and conducted risk factor
assessment of the cases and environmental assessment of the communities. Standardized questionnaire was used to collect demographic, clinical and exposure history from the cases and controls and described the outbreak by place, age and sex. Rectal swabs from patients admitted in the Cholera Treatment Centres at health facilities were collected and tested by culture and antimicrobial sensitivity. Bivariate analysis was used to compare cases and controls and calculated odds ratio and 95% confidence interval.

**Results:** We found 1733 cases with 20 deaths (CFR=1.2%) with an overall attack rate of approximately 25 per 100,000 population with sex specific attack rates of 31.2% and 19.6% for males and females respectively. The most affected districts were Osu Klottey Sub-Metropolis of the Accra Metropolis with an attack rate of 111 per 100,000 and La Dadekotopon with an attack rate of 76 per 100,000. Ninety stool samples yielded *V. cholera* O1 Ogawa with Ciprofloxacin and Tetracycline being sensitive to the cholera strains. Epidemiologic data suggested that the outbreak was due to drinking of vended sachet water [odds ratio = 6; 95 confidence interval: 1.7-20.9, p-value: 0.00].

**Conclusion:** The lack of personal hygiene, safe drinking water, open defecation, poor sanitation and consumption of street vended sachet water and food were some of the causes of the recent cholera outbreak in Greater Accra. We recommend the Ministries of Local Government and Rural Development, Works and Housing and Water Resources to ensure proper liquid and solid waste disposal systems and provide adequate potable water to the populace.

**Keywords:** Cholera; outbreak; Greater Accra; Ghana.

1. **INTRODUCTION**

Cholera is an acute secretory diarrhoea caused by the Gram-negative bacterium *Vibrio cholera* (*V. cholera*) serogroup O1 or O139 [1-4]. Cholera has claimed many lives throughout history and it continues to pose a serious health risk for those residents of countries where the public health infrastructure is compromised [5-8]. Globally, 47 countries reported a total of 129,064 cases of cholera including 2102 deaths, with a case-fatality rate (CFR) of 1.63% in 2013. The disease represents an estimated burden of 1.4 to 4.3 million cases, and 28 000 to 142 000 deaths per year worldwide [9,10].

Historically, seven main cholera pandemics have been recorded globally. The seventh and current pandemic started in Indonesia in 1961 and affected countries including Mexico, Zimbabwe, Haiti, Malawi, Peru [11-13]. The pandemic reached Sub-Saharan Africa in 1970. In 2010, a total of 110,115 cases were reported from sub-Saharan African countries. Four countries in Central Africa around the Lake Chad Basin (Cameroon, Chad, Niger and Nigeria) accounted for 62,762 cases, including 2,610 deaths. Nigeria earlier on reported 38% of cases from Africa with 44,456 cases and a CFR of 3.9%. However, a recent descriptive analysis of the 2010 cholera outbreak in Nigeria reported overall attack rate and CFR of 47.8 cases/100,000 population and 5.1% respectively [12,14].

In Ghana, the first case of cholera occurred on September 1, 1970 following the seventh pandemic that started in Indonesia in 1961 [15]. Infected Togolese national on transit to Conakry, Guinea collapsed at the Kotoka International Airport in Accra, Ghana and was found to have cholera [16]. The epidemic actually began when infected Ghanaian fishermen in Togo, Liberia and Guinea brought the disease to the country. The two worst hit areas were Akplabanya (the then Ada District) and Nyanyano near Kasoa. By July 1971, the Ashanti region began to report cases, indicating that cholera had spread across the country [17]. Since then cholera has become endemic with cyclical epidemics. This has led to focal outbreaks every 4 to 6 years, however, in recent years outbreaks have become more frequent and protracted. A total of 26,924 cases and 620 deaths were officially reported to the WHO [18,19] from 1999 to 2005. In 2012 most regions in Ghana except for Upper West experienced outbreaks which were linked to poor socio-economic status, inadequate sanitation and poor access to safe drinking water in many cities of Ghana [20].

The epidemics of cholera have been increasing in intensity, duration, and frequency, showing the need for more effective approaches to prevention and control. Effective interventions combining surveillance, treatment, and improving water, sanitation, and hygiene measures are paramount. Vaccination can complement these
preventive and control strategies in areas of endemic disease or areas at risk for outbreak [21]. Nevertheless, poor detection and delayed response to cholera outbreaks can result in geographical spread of the disease and consequently high attack rates and case fatality rates [22-24]. Failure to control local outbreaks and prevention of between-region transmission could result in spread of cholera outbreaks to neighbouring regions [25].

In 2014, Ghana was hit by a massive cholera outbreak which recorded the highest number of cases in the past 30 years claiming many lives. We used investigation team comprising local health authorities, experts from local referral hospitals, and public health personnel from Disease Surveillance Department to investigate and explore possible reasons for the outbreak in Greater Accra, determine epidemiological linkages and risk factors, describe the outbreak by time, place, and person and formulate recommendations for the control and future response of outbreaks.

2. MATERIALS AND METHODS

The outbreak occurred in the Accra metropolitan area, La Dadekotopon, Lodzokuku kurowor, Ga South, Ga West and Tema Metropolis in the Greater Accra Region. Meetings were held by teams from the Disease Surveillance Department and the Greater Accra Regional Health Directorate to develop and design the outbreak investigation tools.

2.1 Location and Demography of the Study Area

The Greater Accra Region is located in the southern belt of Ghana. The region is bordered on the north by the Eastern Region, on the east by the Lake Volta, on the south by the Gulf of Guinea, and on the west by the Central Region. It is the smallest region made up of 16 administrative areas and has a land area of 3,245 square kilometres or 1.4 per cent of the total land area of Ghana. It is the second most populated region, after the Ashanti Region, with a population of 4,010,054 in 2010, accounting for 15.4 per cent of Ghana’s total population. The region harbours the seat of government in Accra which is the national capital. It is currently the most urbanized region in the country (90.5%) with overcrowding conditions due to high housing cost. This has led to the creation of lots of slummy and/or squatter settlements with poor sanitation systems perceived to be niches where cholera outbreaks begin.

2.2 Study Design

The study was both descriptive and un-matched community-based 1:2 case control study. The participants of the study included all persons living in Greater Accra Region confirmed with cholera or had epidemiological linkage with confirmed cholera cases detected during the outbreak and randomly selected community controls from the same neighborhood where the cases live. The investigations were done between 24th July and 3rd August 2014 by a team from Disease Surveillance Department, Ghana Field Epidemiology and Laboratory Training Programme (GFELTP) and Greater Accra Regional Health Directorate.

2.3 Selection of Cases and Controls

We defined a case as any person reporting to a facility in the Greater Accra Region from June to August 2014 with diarrhoea with or without vomiting and diagnosed as cholera by clinician [26]. Health facilities were conveniently sampled and cases were randomly selected from cholera treatment centres in the health facilities visited.

Controls were defined as any person living in Greater Accra Region from June to August 2014 without diarrhoea or vomiting and coming from same community and neighbourhood of a case. Two controls were selected for each case and interviewed on the same day as the case interviewed. A bottle was spun in the approximate centre of the house of the case, selected the immediate household to the direction of the bottle and randomly selected the first control. The second control was also randomly selected from the immediate household following the first control in the same direction. Random selection of controls was done by numbering all persons met in a household on pieces of paper, mixed them and selected one. We visited as many households as needed to find appropriate controls for all the 46 cases.

2.4 Data Collection Method

We engaged and interviewed, Regional, Metropolitan and Sub-Metropolitan Health Management Teams, Hospital management Teams, clinicians, Municipal Disease Control Officer (MDCO), the Public Health Nurse, the Hospital Management Teams, the Environmental...
Health Officer and the Municipal Chief Executive, and Laboratory staff at all places visited to obtain information on the outbreak and preliminary data on those affected. We reviewed surveillance data and the initial line-list generated by the MDCO, reviewed records of cases (line list, OPD and admission folders) and conducted risk factor assessment of the cases. We followed-up cases into their residence and conducted environmental assessment of the communities.

Standardized questionnaire was used to collect demographic, clinical and exposure history from the cases and controls. Questionnaire was administered to the cases as they were detected in the cholera treatment centres by trained data collection officers. Communities and neighbourhoods of the cases were visited to randomly select and interview the controls. If a case or control was a child the questionnaires was administered to their parents or care givers. Questions were asked about age, sources of drinking water, main source of food (whether home prepared or vended foods), hand washing practices, type of toilet use and household waste disposal practices between June and August 2014.

2.5 Laboratory Investigations

We collected rectal swabs from patients admitted in the Cholera Treatment Centres at health facilities. We tested those by culture and antimicrobial sensitivity at the National Public Health Reference Laboratory, Korle-Bu. The specimens were incubated in alkaline peptone water enrichment media for 6 hours. Enriched cultures were inoculated in thiosulphate-citrate-bile salts-sucrose (TCBS) agar for *V. cholerae* and in *Salmonella* and *Shigella* agar for other enteropathogens. Subcultures were done after 18 hours at 37°C on nutrient agar. Typical colonies were confirmed by standard biochemical and slide agglutination with *V. cholerae* serogroup O1 polyvalent antiserum, followed by Ogawa and Inaba antisera [27]. Antimicrobial sensitivity was determined by the Kirby-Bauer disc diffusion method. Results were recorded as resistant, intermediate, or sensitive following the guidelines of the Clinical and Laboratory Standard Institute (CLSI).

2.6 Environmental Investigations

We conducted environmental survey of households of cases and control. The water supply pipelines, crude dumping of refuse and refuse containers, drainage system, sewage pipes and sanitation situation were reviewed.

2.7 Data Management and Analysis

Data was cleaned manually and necessary correction(s) made during collection. Data was entered into Epi-info version 7 and Excel statistical software packages for descriptive analysis. Univariate and bivariate analyses were expressed as frequency distributions, percentages, mean ± SD, odds ratio, rates and 95% confidence interval.

2.8 Ethical Considerations

Participants of the study were informed about the study verbally to solicit their consent to participate in the study. We sought permission from the health facilities to use their data. Children were recruited in the study after obtaining informed consent from their parents or care-givers. We protected the confidentiality of participants through use of codes. However, ethical committee review did not apply as this was a public health response to an outbreak.

3. RESULTS

3.1 Descriptive Epidemiology

The Cholera outbreak in Greater Accra Region started during epidemiological week 24 of 2014 (9th – 15th June 2014) when six suspected cholera cases were reported to the Ussher polyclinic in the Asiedu Keteke Sub-Metropolis of the Accra Metropolis. One out of the five samples investigated at the National Public Health Reference Laboratory (NPHRL) at Korle-Bu was confirmed positive for *Vibrio cholerae*. The index case was a 10 year old girl from Agbado community in Ashiedu Keteke Sub-Metropolis. The date of onset of diarrhoea was 9th June 2014 and was admitted on 10th June 2014 at Ussher Polyclinic. She survived the infection after being managed with intravenous infusions, oral rehydration salt (ORS), and tetracycline antibiotics. Stool specimen taken from her on the date of reporting tested positive for *Vibrio cholerae*. The index case was a 10 year old girl from Agbado community in Ashiedu Keteke Sub-Metropolis. The date of onset of diarrhoea was 9th June 2014 and was admitted on 10th June 2014 at Ussher Polyclinic. She survived the infection after being managed with intravenous infusions, oral rehydration salt (ORS), and tetracycline antibiotics. Stool specimen taken from her on the date of reporting tested positive for *Vibrio cholerae*.

As of 20th June 2014 no case was reported to the Ussher polyclinic. However, on the 26th June
2014 ten cases with profuse watery diarrhoea were reported at Ridge hospital OPD and five tested positive by Cholera Rapid Diagnostic test (RDT) but three of the stool samples sent to NPHRL tested negative by culture. All the cases reported from Odorna area in the Osu-Klottey Sub-Metro of Accra Metropolis. As of 4th July 2014 no cases have been reported to the Ridge hospital cholera bay.

The second positive vibrio cholera case in the Greater Accra region was a 53 years old male, residence of Maamobi in Ayawaso Sub-Metropolis of the Accra Metropolis. He was admitted to the Maamobi Polyclinic on 30th June 2014 with diarrhoea which started 28th June 2014.

After the report of the second positive case in week 26, there was sudden upsurge of the cholera cases during week 29 in the Accra Metropolis and further spread of the outbreak to other districts in the region. The epidemic curve (Fig. 1) shows a protracted propagating multiple source outbreak with increasing peaks starting in week 24 of 2014 (9th – 15th June 2014) reaching the highest peak in week 31 with the number of cases slightly declining in week 32 of the outbreak.

Of the 1,733 suspected cholera cases collected, 90 were confirmed with 20 deaths (CFR=1.2%) between 9th June and 3rd August 2014. The overall attack rate was approximately 25 per 100,000 population with sex specific attack rates of 31.2% and 19.6% for males and females respectively. The most affected districts were Osu Klottey Sub-Metropolis of the Accra Metropolis with an attack rate of 111 per 100,000 and La Dadekotopon with an attack rate of 76 per 100,000.

### 3.2 Distribution of the Cholera Cases by Place

The majority of cases clustered in the Ablekuma Sub-Metropolis (20.7%). Of the 98.7% (1126/1141) of cases from Greater Accra Region, 20.7% (233/1126) were from Ablekuma Sub-Metropolis, 13.9% (157/1126) from Osu Klottey Sub-Metropolis and 12.3% (138/1126) from Okaikoi Sub-Metropolis of Accra metropolis whilst 15.5% from La Dadekotopon Municipal. Cases from Accra metropolis formed 59.4% (669/1126) of the total cases from Greater Accra Region and 0.2% (2/1126) were from Shai Osu Doku district. There was no case recorded from Ada East, Ada West and Ningo Prampram districts (Fig. 2).

### 3.3 Age and Sex Distribution of Cases

The affected ages ranged from 3 months to 90 years with a median of 28 years, mean 31.1 years and standard deviation of 14.5 years. The age group 20 - 29 years was the most affected; 426 (37.3%). The least (0.1%) affected age group was ninety years and above. As shown in Fig. 3, more males than females were affected by the outbreak but the difference was statistically not significant (P>0.05).

![Fig. 1. Epidemic curve: Cholera outbreak, Greater Accra Region, 2014](image-url)
3.4 Laboratory Results
Out of the 184 suspected cases investigated by Culture at the National Public Health Reference Laboratory, Korle-Bu, 90 were confirmed positive for *Vibrio cholerae*, Ogawa subtype. Of the confirmed cases, 64 were from Accra Metropolis, 9 from La Dadekotopon, 11 from Tema metro and 2 from Ga South, 2 from Ga East and 2 from Shai Osu Doku Districts.

3.5 Antibiotic Susceptibility of *V. cholerae* Isolates
All isolates (100%) were sensitive to the Ciprofloxacin and Tetracycline. Chloramphenicol and Erythromycin showed low to moderate activities respectively while Ampicillin and Cotrimoxazole were completely resistant (Table 1). Isolates also showed multiple resistances (resistance to 2 or more drugs) to antibiotics.

3.6 Environmental Assessment
There was generally poor environmental sanitation at all the communities where the cases reside. We observed crude dumping of refuse in most places and refuse containers full and overflowing, drains were chocked with people openly defecating in them, and some water pipe lines laid directly through some of the drains (Fig. 4). We observed broken sewage pipes with
sewage leaking into the environment at some places. There were inadequate water supply from the Ghana Water Company; taps were closed and people normally fetch water with buckets and gallons and further stored in rubber bowls, gallons and polytanks for use. We observed inadequate hand washing facilities (<7% of the households have hand washing facilities). Few people use the water closet toilet facility in their homes but majority of them use the public pit latrines (KVIP) with dirty premises and liquid waste dislodged by cesspit emptier. Many food vendors were observed selling food along the open gutters.

3.7 Epidemiological and Clinical Characteristics of Cases and Controls

Our case control study involved 138 participants of which 46 were cases and 96 were controls giving a case control ratio of 1:2. The median age for both cases and controls was 32 years. Among cholera cases, age ranged from 12 to 70 years, with the most affected age group 21-30 years;17 (37%) and the least affected age group being below 10 and above 60 years; (Table 2). The age range among controls was from 10 to 89 years. The most common symptoms among Cholera cases were diarrhoea 46 (100%), vomiting 34(73%) and abdominal cramps 30 (65%) (Table 2). Of the 46 cases 42 (91%) were hospitalized.

3.8 Risk Factors

In a bivariate analysis, the study found that as compared to the controls, the cholera cases were six times more likely to have drunk vended sachet water [odds ratio = 6; 95% confidence interval (CI): 1.7-20.9, p-value: 0.00] (Table 3), suggesting sachet water as a possible vehicle of transmission. Drinking pipe and borehole water were protective although not significantly associated with the illness.

Eating food prepared outside home was found to be significantly associated with cholera. Cholera cases were six times more likely to have eaten food prepared outside as compared to the controls [OR=5.6; CI 2.5-13.5; p-value 0.00] (Table 3). Similarly, it was found that, cases were three times more likely to have eaten street vended food compared to controls (OR= 2.7; 95% CI: 1.3-5.7; p-value 0.01). Eating home prepared food was found to be protective against acquiring cholera [OR=0.1; 95% CI: 0.06-0.29], p value: 0.00].

The odds of acquiring cholera were reduced by 70%, comparing hand washing after defecating in controls to cases (OR = 0.3; 95% CI: 0.1-0.8).
Knowledge of the mode of cholera transmission significantly reduces the risk of acquiring cholera by almost 60% (OR = 0.4; 95% CI: 0.2-0.8; p-value: 0.01). Other variables tested included places food eaten, attending ceremonies (funerals, parties, outdooring, and festivals), water storage were not associated with the risk of cholera in the region.

4. DISCUSSION

Cholera has remained one of the most predominant diarrhoeal diseases in Ghana since 1972 and it is generally connected to the rainy season and contamination of drinking water either due to sewage or polluted water and food. In this study, the epidemic started in two districts following the downpour in June and eventually spread throughout the Greater Accra region. We found 72% (100/137) of the collected rectal swabs and stool samples from various health facilities in the region to be caused by *Vibrio cholerae* 01 Ogawa. Past surveillance suggests that very few or no cases are reported between weeks 19 and 35. Therefore the abnormal number of cases observed during this period is a clear indication of an outbreak.

The study revealed that, the cholera outbreak affected more males in the region similar to the findings of Opare et al. [20] in Ghana and Sur et al. [28] in India. The majority of male cases observed may largely be a function of male behaviour since males are more likely to eat outside home foods. Young adult populations of age group 21–30 years were highly infected accounting for 17% as compared to all other aged groups. The studies by Kansakar et al. [29] and Yadav et al. [30] found similar results in which most of the infected patients were adults aged 20 to 29 years and 15 to 29 years respectively. Contrary to this, other studies found children and elderly people mostly affected by cholera [31-33].

According to the 2010 population, housing and census data from the National Statistics Office, 46.5% of households in Ghana use piped-borne water as their main source of drinking water, while 29.1% use borehole or protected well. In addition, 9.4% rely on sachet or bottled water. In Greater Accra however, 64.7% and 28% of the people respectively use pipe borne water and sachet water as their source of drinking water. In spite of this, water does not flow in some of the pipe-lines making people to draw drinking water from unsafe sources (rivers and unprotected wells). We found that the water supply system in these areas had visible leakages in the pipes with some laid in open drains suggesting possible water contamination. The significant association observed between eating vended foods and also between consuming vended sachet water suggest that sachet water and street food vending are possible vehicles of the cholera transmission in the region which is similar to findings of Hutin et al. 2003. The vended items are most likely contaminated from the environment and poor handling.
Table 2. Bivariate analyses of clinical symptoms and characteristics of hospitalized patients tested for *Vibrio cholerae*, Greater Accra region, 2014

| Age group | No. of cases (%) | No. of controls (%) |
|-----------|------------------|---------------------|
| 0-10      | 0 (0%)           | 1 (1%)              |
| 11-20     | 8 (17%)          | 8 (8%)              |
| 21-30     | 17 (37%)         | 30 (32%)            |
| 31-40     | 7 (15%)          | 20 (21%)            |
| 41-50     | 6 (13%)          | 17 (18%)            |
| 51-60     | 4 (9%)           | 11 (12%)            |
| 61-70     | 4 (9%)           | 3 (3%)              |
| 71-80     | 0 (0%)           | 1 (1%)              |
| 81-90     | 0 (0%)           | 1 (1%)              |

| Signs and symptoms | No. of cases (%) | No. of controls (%) |
|--------------------|------------------|---------------------|
| Diarrhoea          | 46 (100%)        |                     |
| Vomiting           | 34 (73%)         |                     |
| Abdominal cramps   | 30 (65%)         |                     |
| Headache           | 17 (37%)         |                     |
| Chills             | 16 (35%)         |                     |
| Nausea             | 15 (33%)         |                     |
| Fever              | 13 (28%)         |                     |
| Blood in stool     | 0 (0%)           |                     |

Furthermore, the sudden outbreak of severe diarrhoea especially among residents living at La Dadekotopon, Osu Klottey, Okai Koi, and Ablekuma sub metros in the Greater Accra Region could be attributed to visible disposal of untreated sewage into open drains, open defecation, poor sanitary conditions and bad eating habits of these residents. Though majority of the household use the public toilet, 48.5% of households have their solid waste collected from their homes and 25.7% dump their solid waste in containers according to the National Statistics office. The collected solid waste and proportion dumped into containers are all disposed directly into the sea without treatment. Educating the people in the communities on sanitation and personal hygiene to completely eliminate open defecation and keep their surroundings clean could improve sanitation coverage and use.

Our findings are subject to several limitations. First, stool samples were only collected by convenience method which limits the generalizability of the results to the rest of the region. Second, tracing of cases to respective homes were at times not possible due to poor addressing systems. Third, we were unable to collect food/environmental samples from the communities for laboratory investigation. Hence the possibility of recall bias cannot be ruled out.

Isolates exhibited 100% susceptibility to Ciprofloxacin and Tetracycline. Chloramphenicol and Erythromycin which showed 80% susceptibility may be effective substitute drugs for the treatment of cholera. Studies from Shrestha et al. [34] and Akoachere et al. [35] also found high level sensitivity to these two antibiotics in Kathmandu city and Douala respectively. Our study found Ampicillin and Cotrimoxazole (100%) and Ampicillin (20%) resistant to the clinical isolates which are contrary to high-level resistance of chloramphenicol reported by Garg et al. [36] but similar to the findings of Shrestha et al. [34]. Resistance to these antibiotics and other antimicrobial agents among *V. cholerae* isolates can be acquired through selected mutations over time, or due to indiscriminate use of antibiotics for treatments of cholera in asymptomatic individuals [37]. Studies in other parts of the world [36] have reported varying susceptibilities of the organism to these antibiotics. Changes in susceptibility pattern have been attributed to isolation time, source and geographical location [38]. From our results it would be necessary to investigate drug resistant *V. cholerae* from Greater Accra for these resistance markers.

Table 3. Statistically significant exposures among cholera cases and controls, Greater Accra region, 2014

| Potential exposures            | Cases       | Control     | OR         | 95% CI     | P-value |
|--------------------------------|-------------|-------------|------------|------------|---------|
| Street vended sachet water     | 43/46 (93.5%) | 65/92 (70.7%) | 6.0        | 1.7-20.85  | 0.00    |
| Food prepared home             | 19/46 (41.3%) | 78/92 (84.8%) | 0.1        | 0.06-0.29  | 0.00    |
| Food outside home              | 37/46 (80.4%) | 38/92 (41.3%) | 5.8        | 2.53-13.51 | 0.00    |
| Street food vendor             | 25/46 (54.4%) | 28/92 (30.4%) | 2.7        | 1.31-5.65  | 0.01    |
| Hand washing after defecating  | 35/46 (72.4%) | 84/92 (91.3%) | 0.3        | 0.11-0.82  | 0.03    |
| Knowledge of cholera transmission | 20/46 (43.5%) | 62/96 (67.4%) | 0.4        | 0.18-0.78  | 0.01    |
5. CONCLUSION

The intermittent outbreak of cholera in Greater Accra still makes the disease a public health concern. The lack of personal hygiene, safe drinking water, open defecation, poor sanitation and consumption of street vended sachet water and food were some of the causes of the recent cholera outbreak. Mass community education and social mobilization with announcements on cholera prevention with the following key messages: drinking of safe water, avoid drinking of street vended sachet water, preparation and consumption of food under hygienic conditions, avoid eating street vended food, avoid open defecation and washing of hands with soap and water after using toilet and before meals will help eliminate or minimize cholera outbreaks in the region. There is also the need for Ministries of Local Government and Rural Development and Works and Housing and Water Resources to ensure proper liquid and solid waste disposal systems and provide adequate potable water to the populace.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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