

Assessment Risk Factors for Cholera Epidemic Transmission among Females Employees at Sana'a City –Yemen.

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Abstract

Background: Yemen recently experienced the largest cholera outbreak in the world, which started at the end of 2016. Cholera causes an estimated 1.3–4.3 million illnesses and 30,000–140,000 deaths worldwide each year, Cholera is caused by toxigenic *Vibrio cholera* serogroup O1 or O139 and is transmitted through fecal oral route. Infection is usually associated with drinking contaminated water and poor hygiene and sanitation (**World Health Organization, 2019**). **Objective:** This study aimed to identify the risk factors for cholera transmission in the city of Sana' a, Yemen. **Methods:** We conducted an unmatched case control study. Cases were identified from the health unit records of Sana'a University and 230 participants were interviewed on socio-economic, household hygiene, food, and water exposure practices using a semi-structured questionnaire. Data were analyzed using SPSS version 22, and statistical significance was set at $P < 0.05$. **Results:** The 230 participants included 45 cholera cases (19.5 %) and 185 controls (80.5 %). Ages ranged from 15 to 65 years, with a mean of (20.0±47.0) years. According to the WHO, the cholera attack rate was 0.16 %, with no fatalities. Report 2017. Most participants 206 (89.5 %) had heard of cholera. Poor hygienic practices 199 (85.5.2 %) and contaminated water sources 159 (69.1 %) were the main reported transmission routes for cholera. Good hygienic practices 211 (91.7 %) were the main preventive methods for cholera in both cases, 45 (84.6 %) and controls, 185 (89.0 %). The risk factors for cholera in the study population analysis showed Most participants 186 (80.8 %) practiced good food preservation methods. Moreover, 108 (46.9 %) ate outside their homes, such as in restaurants. Those with cholera were 11.2 times more likely to practice poor food preservation methods than those without the disease ($p < 0.0001$). **Conclusions:** Cholera transmission risk factors in Sana'a City were related to water and sanitation hygiene, and not washing khat before chewing is a specific risk factor for cholera; therefore, increasing awareness of the population on the importance of water chlorination and washing fruits, khat, and vegetables through a health education campaign is strongly recommended.

Key Words: Assessment, Cholera, Epidemic Risk Factors.

Introduction

Cholera is an extremely virulent disease that can cause severe acute watery diarrhea. Cholera is mainly transmitted by the ingestion of food or water contaminated with the bacterium *Vibrio cholera* O1 or O139 and is a serious threat to global public health. An estimated 3-5 million cases and over 100,000 deaths from cholera occur each year worldwide (Nsgha et al.,2019). The disease is now considered endemic in many countries, and the pathogen that causes cholera cannot be eliminated from the environment (World Health Organisation.,2019). This disease is particularly widespread in countries where people have unfavorable living conditions, such as poor access to safe water and sanitary toilets (Alkhalidi., 2017).

The infection is transmitted through contaminated fecal matter, which can be consumed through tainted food and water sources or poor hygiene and sanitation, such as unwashed hands (Federspiel &Ali, 2018). Different risk factors have been reported in previous research, such as drinking contaminated water, eating dried fish, not boiling drinking water, living with people who had acute diarrhea, traveling and eating outside the home, and consumption of unrefrigerated leftover food (Ishaku ., 2014)

Yemen has experienced the largest cholera outbreak in the world in recent years, with symptoms ranging from

mild to severe, and large amounts of watery diarrhea lasting a few days. Vomiting and muscle cramps may also occur, and diarrhea can be so severe that it leads to severe dehydration and electrolyte imbalance within hours, which may result in sunken eyes, cold skin, decreased skin elasticity, and wrinkling of hands and feet (Al-Gheethi et al.,2018).

A recent study performed in Sana'a identified the following risk factors of cholera transmission: a history of traveling and having visitors from outside the Sana'a governorate; eating outside the house; not washing fruits, vegetables, and khat (a local herbal stimulant) before consumption; using common-source water; and not using chlorine or soap in the household (Deb et al., 2012). Nursing interventions for patients diagnosed with cholera include monitoring intake and output; noting the number, character, and amount of stools; estimation of insensible fluid losses such as diaphoresis; measurement of urine specific gravity; and observation of oliguria. Daily weight monitoring is an indicator of overall fluid and nutritional status. Maintain hydration. Replace the ongoing fluid loss until diarrhea stops. Administer medications, as indicated. Give an oral antibiotic to patients with severe dehydration as prescribed (Gallandat et al.,2020).

Methods

Study Area and Setting

Sanaa is one of the oldest continuously inhabited cities in the world, the capital of Yemen, Located in the western part of the country. It is the 2nd largest city in Yemen, with a population of 4000,000 inhabitants.

We performed a case-control study matched by age and sex. Cases included female employees who presented at Sana'a University with acute watery diarrhea (three or more watery stools in 24 hours) and moderate or severe dehydration during the study period. Cases were included if they were at least five years of age, had a positive result for a rapid diagnostic test for cholera, and agreed to participate in the study. Patients were excluded if they lived outside Al Hudaydah City after the start of the outbreak. Controls were selected from the same neighborhood of cases among houses that had not reported any cases of cholera since the start of the outbreak. Female employees who had lived in the same neighborhood as the cases since the start of the outbreak up to August 27, 2018, did not have three liquid watery stools within 24 hours at any time since the start of the outbreak, and agreed to participate in the study were included. Controls were specifically selected from among female employees living in the house to the left of a case's house. If no control was found in that house, the data collectors moved to the next house on the left. Controls were excluded if they lived outside Sana, a city, at any time after the start of the outbreak.

Cholera risk factors were defined as any event or behavior related to water and food consumption and hygiene practices of female employees living in Sana, a city that could potentially increase the chance of becoming infected with cholera.

Sample Size

The sample size was calculated by assuming that 30% of the controls were exposed. To detect an odds ratio (OR) of 2 between any of the studied exposure factors and the disease with a margin of error of 5%, the minimum sample size was estimated as 45 cases and 185 controls (using a ratio of cases to controls of 1:2) at a significance level of .05, and a power of 80%. A total of 45 patients were recruited from the five CTCs in Sana, a city, from December 1, 2018, to January 10, 2019.

Results:

Table 1. Demographic characteristics of study participants in Sana'a and Yemen.

Socio-demographic characteristics	No. (230)	%
	Case (45)	Control (n=185)
Age: (years)		
< 30	12 (26.7%)	43 (23.2%)
30 - ≤35	20 (44.4%)	105 (56.8%)
> 35	13 (28.9%)	37 (20%)
Mean ± SD (Range)	32.85 ± 5.84 (36.0+47.0)	
Residence:		
Urban	32 (71.1%)	158 (85.4%)
Rural	13 (28.9 %)	27 (14.6%)
Marital status:		
Single	9 (20%)	36 (19.5%)
Married	31 (68.9%)	124 (67.02%)
Divorced	3 (6.7%)	13 (7.02%)
Widowed	2 (4.4%)	12 (6.5%)
Level of education:		
Illiterate	2 (4.4%)	10 (6 %)
Basic education	3 (6.7%)	16 (8.6%)

Data Collection

Data was collected from December 1, 2018, to January 10, 2019. Well-trained health workers collected data using a semi-structured questionnaire. The questionnaire was translated into Arabic and distributed to five healthcare providers who were included in the pilot test. The questionnaire was modified accordingly, and the final version was used to collect responses through face-to-face interviews with cases and controls. The interviewers collected data from cases or their caretakers at CTCs after reviewing the registers of admitted patients. Houses were also visited to collect data related to water, sanitation, hygiene, and food consumption. The interviewers searched for controls at neighboring houses and selected two controls for each case.

The questionnaires were used to collect demographic characteristics such as age, clinical details, address, neighborhood, sex, and occupation, including the date of diarrhea onset, symptoms, and diagnosis. Information on travel history, contact with infected persons, hygiene practices, eating outside the home, and attending gatherings was also collected. The sources of water in the home (e.g., public well, truck water, private well/borehole water, and water containers), water used for drinking, preparing food, and washing, as well as the source of food, were assessed.

Ethics

This study was performed as one of the requirements for ethical approval for collecting data from the Faculty of Nursing, Assiut University, Egypt. Verbal consent was obtained from all female employees. They were strictly voluntary, and the confidentiality of the participants was maintained throughout the study.

Data Analysis

Data were entered into SPSS version 24 and summarized using frequency distributions. Percentages were compared using OR. Univariate and multivariate binary logistic regression analyses were used to determine the factors associated with cholera. ORs with 95% CIs were calculated; a P-value <.05 was considered statistically significant.

Socio-demographic characteristics	No. (230)	%
	Case (45)	Control (n=185)
Secondary	12 (26.7%)	47 (25.4%)
University	25(55.6%)	100(54.05%)
Postgraduate	3 (6.7%)	12(6.5%)
Number of bedrooms:		
One	7 ()	17(9.2%)
Two	27	102(55.1%)
Three	10	44 (23.8%)
Four	1	22 (11.9%)
A number of family members:		
2 – 3	7 (15.6%)	78 (42.1%)
4 – 5	18 (40%)	83 (44.9%)
> 5	20 (44.4%)	24 (13%)
Crowding index:		
One per room	9 (20%)	45 (24.3%)
Two per room	12 (26.7%)	65(35.1%)
Three or more per room	24 (53.3%)	75(40.5%)
Source of Water		
Shallow wells	15 (33.3%)	30 (16.2%)
Lake	12 (26.7%)	21 (11.4%)
Running water	13 (28.9%)	98 (53%)
water barriers	5 (11.1%)	36(19.4%)

Table 2: Distribution of Cholera Risk factors:

Cholera Risk Factors	Case N=45		Control N=185		X ²	P.value
	Yes	No	Yes	NO		
Eating raw vegetables and fruit every day	(15.6%) [∧]	38 (84.4%)	65(35.1%)	120 (64.9%)	14.69	0.293
Washing vegetables and fruit before eating	71.1%) ^{∧∧} (13 (29.9%)	(55.7%) [∧] ∙ √	82 (44.3%)	2.015	0.006*
Eating outside the house	17(37.8%)	28 (62.2%)	75 (40.5%)	110 (59.5%)	26.46	0.030*
Drinking or eating dairy products before the onset of cholera	32(71.1%)	13 (28.9%)	73 (39.5%)	112 (60.5%)	1.395	0.001*
Chewing khat	41(91.1%)	4 (8.9%)	161 (87%)	24 (13%)	54.37	0.000*
Washing khat before eating	2(4.4%)	43 (95.6%)	21 (11.4%)	164 (88.6 %)	21.44	0.000*
Drinking from household tap water	40 (88.9%)	5 (11.1%)	69 (37.3%)	116 (62.7%)	24.82	0.000*
Drinking from common-source municipal tap water	32 (71.1%)	13 (28.9%)	38 (20.5%)	147 (79.5%)	8.49	0.000*
Drinking from private/well/borehole water	36 (80%)	9 (20%)	41 (22.2%)	144 (77.8%)	70.46	0.000*
Using chlorine in the household	2 (4.4%)	43 (95.6%)	151 (81.6%)	34 (18.4%)	21.44	0.000*
Soap available at the toilet	12(26.7%)	33 (73.3%)	180 (97.3%)	5 (2.7%)	14.69	0.000*
Travel history to other provinces	16 (35.6%)	29 (64.4%)	2 (1 %)	183(99 %)	2.015	0.393
History of attending any gathering	23 (51.1%)	22 (48.9%)	11 (5.9%)	174 (94.1%)	40.53	0.000*
History of contact with a cholera patient	19 (42.2%)	26 (57.8%)	21 (11.4%)	164 (88.6%)	1.395	0.000*
Having had visitors from other provinces	7 (15.6%)	38 (84.4%)	31 (16.8%)	154 (83.2 %)	9.167	0.000*
Total score of Mean ± SD	6.63± 3.62		9.86±3.19		-----	0.000*

*Statistically significant difference

 X²= chi-square

Table 3. Risk of cholera infection in Sana'a Province, Yemen using logistic regression mod OR odds ratio; CI, confidence interval; a OR, adjusted odds ratio

Variables	Univariate analysis	Multivariate analysis
	OR (95% CI)	a OR (95% CI)
Drinking from indoor municipal tap water	0.38 (0.31, 0.83)	2.30 (0.37, 5.74)
Drinking from common-source municipal tap water	4.23 (2.08, 28.61)	6.27 (1.16, 45.64)
Using chlorine in the household	0.32 (0.05, 0.10)	0.25 (0.05, 1.13)
Washing khat before chewing it	0.08 (0.05, 0.62)	0.14 (0.05, 0.46)
Eating outside the house	3.57 (2.43, 8.69)	2.95 (1.61, 7.16)

Results

Demographic and socioeconomic characteristics of the study participant

The whole study population consisted of 230 participants: 45 cases (20 %) and 185 (80%) controls. The distribution by the district is presented in **Table 1**: The demographic and socioeconomic characteristics of the study female's employees are presented in Table 1. The mean age of cases was not very different from the mean age of controls (32.85 years vs. 36.0 years), The majority of the female employees lived in the Urban region. Almost more of them had a university education, Overall, the cases and controls were well-matched for most characteristics.

Cholera risk factors

Table 2 shows the distribution of the risk factors for cholera by study group. Among the risks within dietary behavior, eating outside the household was significantly associated with a case, as was eating raw vegetables and fruits and not washing them before eating. Chewing khat was significantly associated with being a case; however, not washing the khat before use was significantly associated with being a case. Concerning water and sanitation, using indoor municipal tap water was significantly associated with being a control, whereas using common-source water was significantly associated with being a case. Moreover, using chlorine in the household was significantly associated with being controlled, but the availability of soap in toilets was not significantly associated with being control. Concerning travel history and contacts, we found that traveling to another governorate, having had a visitor from another city, or having had contact with a potential cholera case were not significantly associated with being a case.

Table 3 shows the non-adjusted and adjusted findings from the logistic regression analysis of the factors associated with cholera cases. In the bivariate analysis, cases were less likely to use indoor municipal tap water as their main source of drinking water (OR, 0.38, 95% CI (0.31 to 0.83)) and to use chlorine to treat household water (OR, 0.32; 95% CI (0.05 to 0.10)). However, they were more likely to use common-source water as their primary source of drinking water (OR, 4.23, 95% CI (2.08, 28.6)). Washing the khat before chewing was significantly less prevalent in cases (OR, 0.08; 95% CI, (0.05 to 0.62)). Eating outside of the house was significantly associated with being a case (OR, 3.57; 95% CI, (2.43 to 8.69)).

In the multivariate analysis, only the practice of not washing khat before chewing it (OR, 0.14; 95% CI, (0.05 to 0.46)) and drinking from common-source water (OR, 6.27; 95% CI, (1.16 to 45.64)) were significantly associated with cholera.

Discussion

Cholera remains a global threat to public health and is an indicator of inequity and a lack of social development. Our study revealed that most of the cholera cases in Sana'a, Yemen, were in the Maeen district, which is the poorest in the city. This finding is in agreement with that of a study performed in an urban north-central Nigerian community (**Ishaku., 2014**).

This study aimed to identify risk factors for cholera outbreaks among female employees in Sana'a Yemen based on a case-control study of 45 cases and 185 controls in Sana'a Province in northern Yemen. In the bivariate analysis, several factors were shown to be associated with being a cholera case: a history of traveling; having had visitors from outside the province; eating outside the house; not having washed fruits, vegetables, and khat before use; use of common-source water; and not using chlorine or soap in the household. Two studies in Iran and Nigeria reported similar findings (**Moradi, 2016, Hutin., 2003**). Storing water in containers is usually associated with a higher level of bacterial contamination if it is not treated (**Hutin., 2003**).

In the multivariate analysis, only not washing khat and using common-source water (private common borehole water, donated water tanks, and purchased water) remained significant factors, whereas a history of traveling and eating outside the house was not significantly associated with being a case. These results support findings from other studies that have identified similar risk factors (**Al-Mekhlafi, M., 2018**).

People in Yemen regularly chew khat daily, and this has been proposed to be a risk factor for cholera because many people chew khat without washing it properly. The findings of this study support the hypothesis that eating unwashed vegetables or fruits is also significantly associated with an increased risk of cholera transmission, as reported in a previous study performed in Yemen (**Siddiqui., 2006**). Studies in Aden reported similar findings (**Camacho 2016**). Some

studies have reported that contact with a person with diarrhea and the presence of a cholera case at home is significantly associated with cholera transmission, which has some limitations. First, it was conducted in conditions of war and insecurity, which made the study logistics and data collection rather complicated. Second,

However, we did not find evidence to support these associations. Sharing a toilet was also a significant predictor of cholera transmission in this and other studies.

The main limitation of this study is that it was performed in Sana'a city and not in all governorates; therefore, the results cannot be generalized to the whole country.

In conclusion, cholera transmission risk factors in Sana'a City, Yemen, were mainly related to water and sanitation hygiene. Increasing public awareness of the importance of daily water chlorination and washing fruits and vegetables prior to consumption through a health education campaign is strongly recommended.

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