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Cholera knowledge, socioeconomic and WaSH characteristics in Aden - Yemen, 2017: a community-based comparative survey

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Keywords

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Summary

Objectives. *To improve prevention and control response to the cholera outbreak, we sought to assess and compare the community's cholera awareness and needs in high and low epidemic areas in Aden.*
Methods. *A community-based comparative survey was conducted in 2017. We used multi-stage cluster sampling. Eligible household heads in high and low epidemic areas were interviewed. The data collected from both areas using a pretested questionnaire.*
Results. *Cholera cases and mortality were higher in high epidemic areas compared with low epidemic areas. Socioeconomic, water, sanitation, and hygienic conditions were poorer in high epidemic areas compared with low epidemic areas. Knowledge of cholera transmission and prevention was sub-optimal in both areas. We found a mismatch between the delivered education and distributed preventive materials.*
Conclusions. *Stakeholders should tailor the design, content, and implementation of future cholera prevention and control methods to meet the needs of the community. Future educational camping should focus on the transmission prevention, including vaccination. Education and sustainable interventions should be implemented to improve the water, sanitation, and hygiene.*

Introduction

Cholera is a fatal dehydrating diarrheal disease caused by *Vibrio cholera.* The disease acquired through the ingestion of an infective dose of contaminated food or water and spread through many mechanisms [1]. The improvement in water and sanitation system has eliminated the cholera transmission in Europe and other developed countries since the late nineteenth century. However, most developing countries failed to implement such measures [2, 3], and cholera remains a significant public health problem. Ali and colleagues have estimated about 2.86 million cholera cases and 95,000 associated deaths had occurred annually between 2008-2012, in 69 endemic countries [4]. However, only 5-10% of the actual cases reported to the World Health Organization (WHO) due to social, economic and political sensitivities, and inadequacies of laboratory and epidemiological surveillance systems of cholera-endemic countries [4].
Cholera is a synonym of poverty, inequity, and lack of social development. Risk factors for cholera – lack of safe water, poor hygiene, overcrowding, poor infrastructure, and improper environmental sanitation – exist in the underprivileged areas of many developing countries. The massive population displacements imposed by complex humanitarian emergencies also increase the risk of disease transmission, if the pathogen is present or introduced into the population [2, 5]. Yemen is one of the poorest countries in the Middle East. The country suffered from protracted political conflict for nearly a decade, which escalated into conflict in 2015. The violence displaced 3.34 million people and disrupted the fragile services of water, sanitation, and health. More than half of the 30.5 million Yemeni people lack safe drinking water and sanitation, and two-third of people have no or limited access to basic health care [6]. Cholera in Yemen became reportable to the WHO since the 1970s. Several outbreaks have been declared since then [7]. More recently, the cholera outbreak began first in October 2016 in the capital, Sana'a [8]. During this wave, over 70% of cases were reported from five governorates, including Aden [9]. By mid-March 2017, the outbreak was in decline [10]. The resurgence of cholera cases after 27 April 2017 marked the second wave with the unprecedented spread in 22 out of 23 governorates. By January 2019, almost 1.5 million cases and 2,906 associated deaths were reported [11], making the worst recorded cholera epidemic. More than half of the cases were among children under 15 years. The cases-fatality rate was as high as 0.76% in the elderly above 60 years [6].
As a response to the outbreak, the Yemen Ministry of Public Health and Population (MoPHP) along with "Health and Water, Sanitation, and Hygiene (WaSH)" clusters, developed an integrated cholera preparedness and response plan in October 2016 [12]. The plan was based on the WHO strategy for cholera prevention and control, a combination of surveillance, water, sanitation and hygiene, social mobilization, treatment, and oral cholera vaccines [12, 13]. Although the first release of the plan missed important components, including infection preventions, the following iterations of the plans were more comprehensive [12]. However, how to implement these interventions remains a

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challenge in the context of Yemen. In August 2017, MoPHP and its partners initiated a cholera awareness campaign as a strategy to control the outbreak. However, the oral cholera vaccine was not administrated until May 2018 [12].

To design community-tailored educational messages and methods for prevention and control activities, it is important to understand the community awareness and needs. This study assessed and compared cholera knowledge, socioeconomic, and WaSH characteristic between high epidemic areas (HEAs) and low epidemic areas (LEAs) in Aden city. We also suggest recommendations for stakeholders to prioritize future preventive actions and mobilization effort.

Methods

Study design, setting and target population

We conducted a community-based comparative cross-sectional survey between September-October 2017, in the southern port city of Aden. Aden – the officially Yemen's temporary capital – divided into 8 administrative urban districts. It has about 1.14 million inhabitants, in addition to 60,000 internally displaced (IDPs) and 138,000 refugees [6]. For a meaningful comparison, we targeted population in areas with the highest and the lowest suspected cholera cases. A suspected cholera case defined as *"a patient aged 5 years or more develops acute watery diarrhea, with or without vomiting"* [14]. We used the cholera case attack rate (AR), and the caseload to indicate the epidemic level in districts, and blocks within districts, respectively.

Sample size and sampling strategy

The multi-stage cluster sampling method was applied to reach the eligible households [15]. Based on the 34th epidemic week report – obtained from the Primary Health Care Directorate and WHO – the two districts with highest, and the two with lowest suspected cholera AR were selected purposively in the first stage (Fig. 1). In the second stage, blocks with the highest cumulative number of suspected cholera [high-epidemic areas (HEAs)] were selected from the two districts with the highest suspected cholera AR. In low AR districts [low-epidemic areas (LEAs)], blocks with the lowest caseload were included purposefully [16]. In the third stage, 30 clusters were selected with probability proportionate to the population size in each area. Finally, a random selection of the seven households within each of the 30 clusters was targeted. This resulted in a minimum sample size of 210 households in each area.

The questionnaire was administered either to the head of the household or in his absence to a responsible adult above 18 years of age, after obtaining their informed consent.

Study tool and data collection

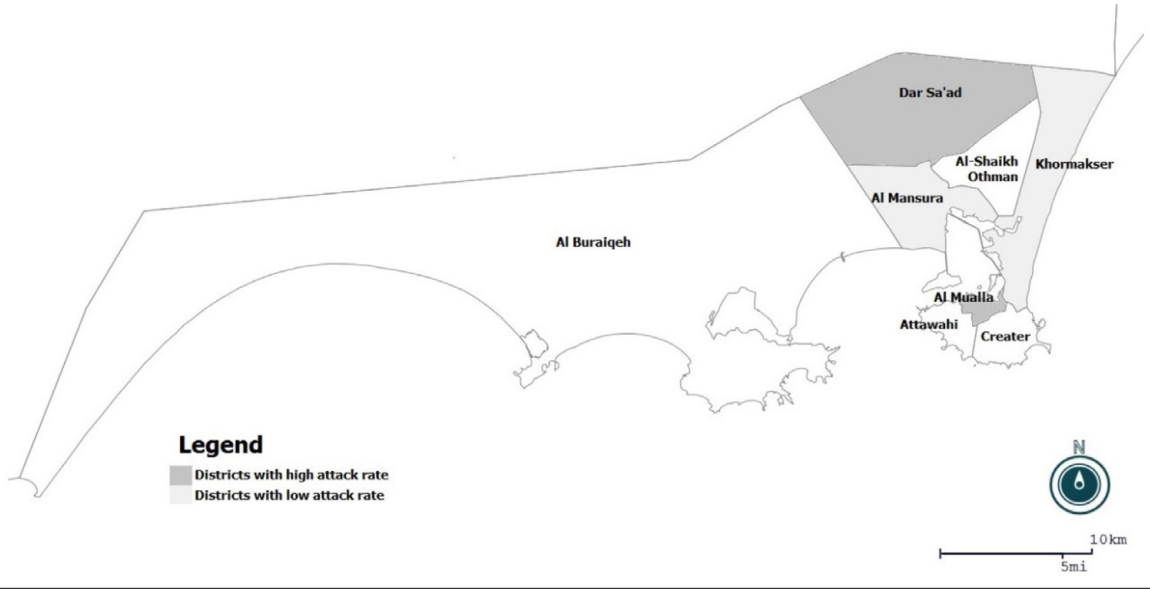
A translated version of a semi-structured questionnaire adapted from a previous study about cholera in Bangladesh [17] was administrated to the eligible household members through face-to-face interviews. Interviewers were trained before the survey through classroom and field training to ensure the questionnaire was well understood by the surveyors, avoiding the difference in the definitions and interpretations of concepts used.

Pre-testing of the questionnaire was also conducted on a small number of participants (n = 10) in a district not included in the study and their responses were not used in the final analysis. The final version of the questionnaire consists of six sections: 1) socio-demographic characteristics; 2) illness in the family; 3) water sources, storage and handling practices; 4) Hand-washing and sewage disposal; 5) cholera-related knowledge, and exposure to health communication message, and intervention.

Analysis of data

Data were entered and analyzed using the Statistical Package for Social Sciences software version 22 (SPSS

Fig. 1. Aden administrative map showing selected districts, drawn using Epi Info™ version 7.3.2. Data source: UN Office for the coordination of humanitarian affairs, 2019. The humanitarian data exchange. https://data.humdata.org/dataset/yemen-admin-boundaries



Incorporation, Chicago, IL, USA). Variables were presented as proportions or means. To measure knowledge of the respondents about cholera, a scoring system was used. Correct and incorrect answers for knowledge were given scores of "one" and "zero", respectively. Fourteen items were used in the calculation of the knowledge score, with a total score ranged from 0 to 14, as shown in Table I. The poor knowledge was defined as a score of ≤ 7, while good knowledge defined as a score of ≥ 8 [18]. The comparison between HEAs and LEAs characteristics was done by using the Chi-Square test or Fisher's exact (FE) test as appropriate. To identify the predictors of a high level of cholera epidemicity, a multivariate logistic regression for the relevant socioeconomic and WaSH variables, which were also significant by chi-square test, was done. Relevant socioeconomic variables are low educational level [18], low income, and crowding [19]. Relevant WaSH variables are water sources, water treatment, sanitation facilities and sanitary system, and handwashing. Crude and adjusted odds ratio (OR), 95 % confidence interval (CI) and P-value were reported. The statistical significance of all tests was considered when the P-value was < 0.05.

Ethical consideration

Approval for conducting the study was obtained from the MoPHP, and the ethical clearance was issued from the Ethics Research Committee, Faculty of Medicine and Health Sciences, University of Aden before conducting the study. Verbal consent was obtained from participants before conducting the interview. The agreement to take part in the study indicates participant's consent.

Tab. I. Knowledge score items.

Items	Given score
Cholera symptoms	
Watery diarrhoea	1
Vomiting	1
Dehydration	1
Transmission of cholera	
Eating polluted food	1
Drinking polluted water	1
Poor hygienic practices	1
Flies and insects	1
Person-to-person contact	1
Cholera prevention	
Adequate food safety: wash fruits and vegetables, cooking food thoroughly, cover food and keep it away from flies and insects, clean cooking utensils	1
Use of safe water treat water with chlorine tablet or boiling	1
Basic hygienic practice: washing hands with soap	1
Proper sanitation: adequate disposal of human wastes	1
Vaccine	1
Cholera treatment	
Diarrhoea treatment centre, hospital, clinic and ORS	1
Total score	**14**

Results

We interviewed members of 440 households in four targeted districts, 228 *vs* 212 in HEAs and LEAs, respectively. The self-reported prevalence of suspected cholera in the six months preceding the survey was high (44.8%). HEAs respondents reported a statistically significant higher prevalence of suspected cholera (49.6%) than LEAs respondent did (39.6%). Additionally, all five deaths attributed to suspected cholera were reported from the HEAs.

Socioeconomic characteristics

The age of respondents was similar in both areas with significantly more female from HEAs. HEAs and LEAs were significantly different in the other socioeconomic characteristics, except for family size, with the least favourable conditions such as low educational level, unemployment, low income are striking features for the HEAs respondents (Tab. II).

Tab. II. Socioeconomic characteristics.

Characteristic	Total (n = 440)	HEAs (n = 228)	LEAs (n = 212)	P-value
	%	%	%	
Sex				
Male	46.4	38.6	54.7	P < 0.001*
Female	53.6	61.4	45.3	
Age				
18-24	17.0	18.4	15.6	P = 0.842
25-34	22.7	23.2	22.2	
35-44	23.9	24.1	23.6	
45-54	18.9	17.1	20.8	
≥ 55	17.5	17.1	17.9	
Family size				
< 5	19.8	16.2	23.6	P = 0.059
5-10	69.1	70.2	67.9	
> 10	11.1	13.6	8.5	
Educational level				
Illiterate, read and write	23.9	36.8	9.9	P < 0.001*
Basic school	26.8	28.5	25.0	
Secondary school	21.8	19.7	24.1	
University	27.5	14.9	41.0	
Job				
Housewife	37.3	45.2	28.8	P < 0.001*
Public work	20.7	12.7	29.2	
Private work	18.4	12.7	24.5	
Unemployed	8.0	10.1	5.7	
Work on daily basis	5.7	9.6	1.4	
Students	5.7	3.9	7.5	
Others	4.3	5.7	2.8	
Monthly per capita income (YR)[a]				
< 5,000	20.9	35.1	5.7	P < 0.001*
5,000 - < 10,000	27.3	28.1	26.4	
10,000 - < 15,000	25.0	20.6	29.7	
≥ 15,000	26.8	16.2	38.2	

[a] YR: Yemeni Riyal; *: statistically significant.

Water, sanitation and hygiene (WaSH) related characteristics

More than 77% respondents drank untreated water, 66.2% of them claimed their current water source was safe. However, HEAs and LEAs had a significant difference in water sources and management. The LEAs respondents reported safer water sources for drinking and domestic use. For example, the piped water system is prevalent in 98% of LEAs households compared with 71.5% in HEAs households. The more efficient way of water treatment, such as filters was also significantly higher in LEAs. Similarly, LEAs respondents had reported significantly improved sanitary and sewerage system compared with HEAs respondents. In HEAs, although respondents claimed washing their hands significantly more than respondents from LEAs did (92.5% versus 84.9% respectively), a significantly higher percentage from LEAs respondents wash their hands before eating (98.1% *vs* 93.8%) and after using the toilet compared to HEAs respondents (93.4% *vs* 73.9%). More details about WaSH characteristics are shown in Table III.

Education about cholera prevention and treatment

Eighty-four percent of the respondents were exposed to education regarding cholera in the last six months.

Tab. III. Households' WaSH characteristics.

Characteristic	Total (n = 440)	HEAs (n = 228)	LEAs (n = 212)	P-value
	%	%	%	
Water characteristics				
Main source of drinking water for the household				
Piped water in house	53.9	51.3	56.6	P = 0.001*
Bottled water	38.6	36.4	41.5	
Others	7.3	12.3	1.9	
Main source of water used for other purposes such as cooking and handwashing				
Piped water in house	84.3	71.5	98.1	P = 0.001*
Others	15.7	28.5	1.9	
Using procedures to make water safer to drink	23.4	19.3	27.8	P = 0.035*
Procedures used to make water safer to drink (total = 103, HEAs = 44, LEAs = 59)				
Use water filter	68.9	43.2	88.1	P < 0.001*
Add chlorine tablets	18.4	29.5	10.2	P = 0.012*
Boil the water	11.7	22.7	3.4	P = 0.002*
Strain it through cloth	7.8	15.9	1.7	FEP = 0.020*
Others	3.9	9.1	0.0	FEP = 0.031*
Reasons for not treating drinking water before use (total = 337, HEAs = 184, LEAs = 153)				
Current water source is safe	66.2	68.5	63.4	P = 0.326
No money	13.1	17.4	7.8	P = 0.010*
No time	11.9	7.1	17.6	P = 0.003*
No chlorine	3.0	5.4	0.0	FEP = 0.002*
Cannot tolerate chlorine taste/smell	2.4	0.5	4.6	FEP = 0.018*
Other reasons	3.6	2.2	5.2	P = 0.113
Treatment of water tanks	53.9	53.7	54.1	P = 0.921
Sanitation characteristics				
Having flush toilet	44.6	28.2	62.3	P < 0.001*
Having public sewerage network	76.1	61.8	91.5	P < 0.001*
Hygiene characteristics				
Practising regular hand washing	88.9	92.5	84.9	P = 0.011*
Hand washing occasions				
Before eating	95.9	93.8	98.1	P = 0.023*
After eating	94.5	92.0	97.2	P = 0.018*
After using the toilet	83.3	73.9	93.4	P < 0.001*
Before cooking	36.3	37.6	34.9	P = 0.556
After cleaning the home	18.7	15.5	22.2	P = 0.073
After washing/cleaning tables	15.1	22.6	7.1	P < 0.001*
After cleaning the child	11.0	14.2	7.5	P = 0.027*
Others	8.7	5.3	12.3	P = 0.010*

*: statistically significant.

Community health workers (CHWs) (71.2%), mass media (32.3%), and health care providers (14.4%) were the main sources of information in both areas. Reporting CHWs and media varied significantly between HEAs and LEAs respondents. While most HEAs and LEAs respondents mentioned CHWs (80.0% and 60% respectively), LEAs respondents mentioned Radio and TV (49.1%) more frequently compared with HEAs respondents (17.4%). Respondents mentioned they were educated about many preventive ways against cholera, top of which were washing hands (81.2%) and washing fruits/vegetables (50.3%). A statistically significant difference between both localities was observed only for washing fruits/vegetables and covering food in favour of LEAs. Respondents from HEAs received more soap and oral rehydration solution (ORS). It is noteworthy respondents received chlorine more than they have been educated about it. Respondents also received printed educational materials, but fewer numbers reported it as a source of information as illustrated in Table IV.

Cholera knowledge

Most of the respondents (97.9%) claimed they heard about cholera, with a statistically insignificant difference between the two localities. Of them, 87% mentioned two symptoms for cholera, 72.7% mentioned two causes of cholera, and 75.7% mentioned two preventive methods correctly. However, 15.9% mentioned three symptoms, 0.5% mentioned five causes, and 4.3% mentioned five preventive measures against cholera.

Table V shows the respondents' knowledge about cholera.

Less than half of the respondents have an overall good knowledge score. Watery diarrhoea was the most recognized symptom of cholera by the participants (93.4%). Polluted food (65.5%) was the most frequently mentioned cholera causes. Similarly, adequate food safety (79.5%) was the most frequently mentioned preventive method. However, only 15.2% mentioned using safe water and 1.1% mentioned vaccines as methods of cholera prevention.

Tab. IV. Education received about cholera prevention.

Characteristic	Total (n = 440)	HEAs (n = 228)	LEAs (n = 212)	P-value
	%	%	%	
Exposed to education about cholera prevention and treatment in the last 6 months (total = 440, HEAs = 228, LEAs = 212)	83.6	85.5	81.6	P=0.266
Source of information about cholera (total = 368, HEAs = 195, LEAs = 173)				
Community health worker	71.2	80.0	61.3	P < 0.001*
Radio/TV	32.3	17.4	49.1	P < 0.001*
Healthcare providers	14.4	11.3	17.9	P = 0.070
Community meetings	3.8	3.1	4.6	P = 0.439
Internet/social media	3.5	3.6	3.5	P = 0.950
Neighbour/friend	3.0	4.1	1.7	P = 0.183
Printed materials	2.4	0.5	4.6	FEP = 0.015*
Family member	2.2	2.6	1.7	P = 0.586
Religious people	0.5	0.0	1.2	P = 0.132
Ways of preventing cholera they were educated about (total = 368, HEAs = 195, LEAs = 173)				
Wash hands with soap and water	81.2	79.0	83.8	P = 0.235
Wash vegetables/fruits	50.3	43.6	57.8	P = 0.006*
Cover food to keep away from flies	49.7	43.6	56.6	P = 0.012*
Cook food thoroughly	26.1	24.1	28.3	P = 0.357
Dispose of human waste properly	23.6	20.5	27.2	P = 0.134
Treat water with chlorine products	22.3	24.6	19.7	P = 0.254
Clean cooking utensils/vessels	20.4	23.6	16.8	P = 0.105
Boil water	10.6	11.8	9.2	P = 0.428
Personal and domestic hygiene	5.7	4.1	7.5	P = 0.159
Cholera vaccine	0.5	0.6	0.5	FEP = 0.720
ORS	3.3	2.1	4.6	P = 0.165
Received educational/preventive materials (total = 293, HEAs = 173, LEAs = 120)	66.6	75.9	65.6	P < 0.001*
Type of materials received (total = 293, HEAs = 173, LEAs = 120)				
Soap	66.9	71.7	60.0	P = 0.037*
Chlorine solution/tablets	48.8	47.4	50.8	P = 0.563
Printed materials (brochure, leaflet)	30.4	28.9	32.5	P = 0.510
ORS	18.4	27.7	5.0	P < 0.001*
Oral information	17.7	15.0	21.7	P = 0.144

*: statistically significant.

Tab. V. Knowledge about cholera.

Items	Total (n = 440)	HEAs (n = 228)	LEAs (n = 212)	P-value
	%	%	%	
Cholera symptoms				
Watery diarrhoea	93.4	93	93.9	P = 0.708
Vomiting	85.7	86.0	85.4	P = 0.860
Dehydration	18.2	14.9	21.7	P = 0.065
Causes of cholera				
Eating polluted food	65.9	64.5	67.5	P = 0.510
Drinking polluted water	61.6	59.6	63.7	P = 0.358
Poor hygienic practices	48.2	52.2	43.9	P = 0.081
Flies and insects	48.1	54.8	41.1	P = 0.005*
Person-to-person contact	6.6	6.1	7.1	P = 0.693
Cholera prevention				
Adequate food safety wash fruits and vegetables, cooking food thoroughly, cover food and keep it away from flies and insects, clean cooking utensils	79.5	77.6	81.6	P = 0.302
Basic hygienic practice: washing hands with soap	78.4	76.8	80.2	P = 0.382
Proper sanitation and adequate disposal of human wastes	24.5	28.5	20.3	P = 0.045
Use of safe water treat water with chlorine tablet or boiling	15.2	18.0	12.3	P = 0.095
Vaccine	1.1	0.9	1.4	P = 0.595
Cholera treatment				
Diarrhoea treatment centre, hospital, clinic and ORS	95.2	94.3	96.2	P = 0.343
Knowledge score				
Good knowledge score ≥ 8	51.1	52.2	50.0	P = 0.646

*: statistically significant.

Predictors of a high level of cholera epidemicity

Table VI presents the results of logistic regression analysis of HAEs as an outcome variable with different independent variables, such as socioeconomic and WaSH characteristics. The relevant variables associated with the outcome variable through Chi-square tests were family size, education, monthly income per capita, water sources, water treatment, sanitation facilities and regular hands-washing. Therefore, these variables were included in the regression model. In the adjusted regression model, only the lack of piped water for domestic use, and the lack of sewerage systems were significant positive predictors of being HEAs, while higher income and regular handwashing were significant negative predictors of HEAs.

Discussion

Educational interventions are essential for community mobilization effort [18, 20]. To the best of our knowledge, this is the first community-based study that assessed the community's cholera knowledge in the context of Yemen's recent cholera outbreak. The comparison between the HEAs and LEAs illuminated the reasons for such spread of cholera. The result of this study will enable stakeholders to adapt prevention and control strategies to the local's needs.

This study identified the respondents' cholera knowledge gaps. Most respondents from both areas had good knowledge of symptoms and treatment, but poor knowledge of transmission and prevention. Additionally, respondents from HEAs were educated about cholera more than those in LEAs (85.5 % *vs* 81.6%). They also showed slightly better knowledge (52.2%) than LEAs respondents (50.0%). A better knowledge of HEAs respondents could be a result of education and communication campaign that were conducted later in the outbreak and targeted HEAs.

Additionally, behavioral change is not a direct result of the knowledge per se [21]. Despite the Somalians' very good knowledge of cholera, disrupted water and sanitation services limited their preventive practices. The protracted conflict and the ignorance of infrastructure investment resulted in limited access to water, sanitation, and health services despite the locals' high demands for them [23]. In Yemen, the ongoing conflict had a devastating impact on water and sanitation services. Additionally, the economic crisis led to an upsurge in food and fuel prices, which rendered people unable to pay for safe water and food. In similar situations, people prioritize water and food availability over their sources and safety [22, 23].

Socioeconomic and WaSH characteristics are major determinants of cholera morbidity and mortality [18, 19, 24]. This study showed safer water sources for both drinking and domestic uses, water treatment, effective water treatment methods such as filters, and improved sanitary and sewerage systems were significantly reported more by the LEAs respondents. Additionally, the adjusted regression model revealed poverty, lack of piped water system, and the lack of sanitary systems as significant positive predictors of HEAs. Indeed, a higher burden of diseases affected the

Tab. VI. Logistic regression findings of cholera epidemicity by socioeconomic and WaSH characteristics.

	Crude			Adjusted		
Variable	**OR**	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Family size						
< 5 (reference)						
5-10	1.502	0.928-2.429	P < 0.001*	0.994	0.535-1.847	P = 0.986
>10	2.327	1.133-4.780	P < 0.001*	0.781	0.291-2.097	P = 0.624
Education						
Illiterate, read and write (reference)						
Basic school	0.307	0.168-0.559	P < 0.001*	0.571	0.277-1.178	P = 0.571
Secondary school	0.221	0.118-0.412	P < 0.001*	0.513	0.242-1.086	P = 0.513
University	0.098	0.052-0.182	P < 0.001*	0.299	0.140-0.635	P = 0.299
Monthly per capita income (YR)						
< 5,000 (reference)						
5,000 - < 10,000	0.171	0.085-0.347	P < 0.001*	0.213	0.093-0.488	P < 0.001*
10,000 - < 15,000	0.112	0.055-0.229	P < 0.001*	0.201	0.084-0.480	P < 0.001*
≥ 15000	0.0069	0.033-0.141	P < 0.001*	0.158	0.063-0.396	P < 0.001*
Main source of drinking water for the household						
Piped water in house (reference)						
Bottled water	0.967	0.653-1.434	P = 0.869	0.768	0.455-1.296	P = 0.323
Others	7.179	2.443-21.102	P < 0.001*	0.503	0.097-2.608	P = 0.413
Main source of water used for other purposes such as cooking and handwashing						
Piped water in house (reference)						
Others	20.736	7.401-58.100	P < 0.001*	14.770	3.941-55.356	P < 0.001*
Using procedures to make water safer to drink						
Yes						
No	1.613	1.033-2.518	P = 0.035*	1.197	0.660-2.168	P = 0.554
Having flush toilet						
Yes (reference)						
No	4.228	2.832-6.312	P < 0.001*	1.586	0.962-2.615	P = 0.070
Having public sewerage network						
Yes (reference)						
No	6.650	3.829-11.548	P < 0.001*	3.886	2.062-7.322	P < 0.001*
Practicing regular hand washing						
Yes (reference)						
No	0.453	0.244-0.843	P = 0.012*	0.198	0.077-0.511	P = 0.001*

*: statistically significant.

less privileged population more, continuing the cycle of disease, poverty, and inequity, and driving more conflict. In this study, although HEAs respondents reported slightly better cholera knowledge, higher self- reported incidence, and all the five cholera - related deaths were in this locality. Additionally, education becomes an insignificant predictor for cholera epidemicity in the adjusted regression model. The piped water for domestic use (and not for drinking), which indicated the availability of water network at home, suggest that water and sanitation facilities and infrastructures are the main determinants of cholera in urban settings. Still, the burden of cholera reported in this study was high in both areas.

The humanitarian response to control the ongoing cholera outbreak since 2016, focused on case management instead of early prevention [25]. The failure to contain the outbreak early in the first wave, where two-thirds of the cases were confined to five governorates [9], lead to widespread of the disease throughout the country. Moreover, no major intervention targeted the environmental determinants of the disease. Instead, water, sanitation, and hygiene interventions carried out were similar to those carried out to contain outbreaks in refugee camps, which is not suitable for a country wrapped up by protected conflict [25].

The study showed the respondents' lack knowledge about cholera vaccine [12, 25]. It is important to integrate vaccine education in future preventive activities to ensure public trust and intake.

The study also revealed discrepancies related to the current outbreak preventive and control measures. Examples include a higher number of respondents who received chlorine (48.8%) compared with those educated about (22.3%) or those who use it (18.4%). Besides, only 2.4% of the respondents considered the brochure as educative compared with those who received

it (30.4%). Such discrepancies necessitate improving the design, content, and implementation of education campaign, taking into consideration the educational/ cultural background of the beneficiaries. Stakeholders must understand and invest in the community accepted methods and materials for education and prevention. Thus, formative research to inform the design of the materials is required.

The study site was limited to Aden, so the representativeness is limited. Yet, the findings of this study could be relevant to similar settings. We could not attribute the respondents' knowledge to the educational camping as the population's baseline data were lacking. The study design is vulnerable to response bias. The respondents' knowledge may not represent their actual practices without validating that with observation method, is another limitation of this study.

Conclusions

We conducted this study on population from HEAs and LEAs in Aden city. We compared the knowledge level of cholera, socioeconomic, and WaSH characteristic between both areas. Findings revealed a strike difference between HEAs and LEAs economic level, and water and sanitary systems. It also identified knowledge gaps of both areas' respondents concerning cholera transmission and prevention. The study also identified a mismatch between education and prevention interventions.

The identified gaps must be addressed in future preventive activities and should be adapted to consider beneficiaries' needs without wasting resources. Future education camping should focus on community prevention and control methods, including detailed information on the cholera vaccine. The stakeholders should support the localities for sustainable water and sewerage systems, through long-term engagement rather than unsustainable WaSH activities. We also recommend further research to understand the community needs and stakeholder implementation barriers.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

KAZA and HOSB designed the study, train the data collectors, and designed and validated the questionnaire. KAZA and AASB supervised data collectors. HOSB and AASB analyzed data with the contribution of KAZA. AASB drafted the manuscript with the contribution of KAZA and HOSB. All authors reviewed and approved the final version of the manuscript.

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