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Cholera in Syria, a crisis following crises: Assessment of knowledge, attitude, and practice in a cohort of syrian population

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ABSTRACT

Cholera is an acute bacterial disease caused by intestinal infection with *Vibrio cholerae*. It is one of the major re-emerging communicable diseases in Syria following the Syrian crisis and the Covid-19 pandemic. The current study was undertaken to explore the level of awareness in a cohort of the Syrian population by testing their knowledge and investigating their attitudes and practices. An internet-based survey that queried knowledge of cholera transmission, prevention, risk factors, and treatment was designed. Of particular interest was revealing sources of information associated with higher knowledge. Furthermore, individual attitudes and practices towards the disease were collected and analyzed. Participants were 1521, mostly females (68.3%), 18–25 years old (56.4%), single (72.7%), and college degree holders (75.9%). The main sources of information on cholera were school/college (31.7%), social media (28.7%), family and friends (13.2%), and online search engines (11.3%). The average total knowledge of the cohort was 40.39%. The participants >40 years old, highly educated, living in urban areas, and females demonstrated higher knowledge of cholera. Schools/colleges and online search engines were associated with better knowledge. Most of the cohort showed serious attitudes and considered cholera a very dangerous disease. They were very concerned about cholera resurfacing in the country and were worried about getting infected. The majority of the cohort were leading their lives favorably by eating out/takeaway <5 times a month; however, their practices regarding handling raw produce were suboptimal. Succeeding cholera re-emergence, females, highly educated, and >40 years old participants were more committed to changing practices and taking stricter safety measures. As cholera imposes a health threat not only to Syrians but to the people of the whole Middle East, preventive strategies were suggested, mainly raising awareness with more focused media means and vaccination of people at high risk in the affected areas of the governorates.

1. Introduction

Cholera is an acute bacterial disease caused by intestinal infection with *Vibrio cholerae*. It is endemic to certain countries and turns epidemic when outbreaks affect multiple countries around the world [1]. The origin of the disease is thought to be in the areas around the Bay of Bengal and Ganges river in India where the first outbreak was reported in the early 19th century [2]. Even though WHO has

Abbreviations: GI, Gastrointestinal; MOH, Ministry of Health; UN, United Nations; WHO, World Health Organization.

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cholera on its 2030 roadmap to minimize death by 90%, up to four million cases of cholera are reported annually with close to 150,000 associated deaths worldwide [1]. To date, there have been seven cholera pandemics with the seventh outbreak has been going since 1961; 1.3 billion people are at risk in countries where the disease is endemic [3,4].

Cholera is a fecal-oral disease transmitted between humans at any age. The infection is spread to healthy individuals when feces of an infected patient contaminate their drinking water and food such as unpeeled fruits and vegetables that are eaten raw and cooked meals that are left exposed [1]. Additionally, consuming undercooked shellfish that are contaminated with *Vibrio cholera* may spread the disease [5].

The infection is often mild or asymptomatic, but can sometimes be severe and life-threatening in which ~ one out of 10 infected people get very sick and may need to be hospitalized. In up to 50% of untreated cases and when rapid treatment with intravenous fluids and antibiotics is not provided on time, cholera can be fatal causing death within hours [1,5]. The disease is extremely dangerous because during the infection incubation time (12 h to five days) symptoms may not be obvious, and patients may spread the disease to a large extent in their environment [1].

The most common symptom associated with cholera is watery diarrhea referred to sometimes as "rice-water stools". Patients may lose 10 L of body fluids within hours and become dehydrated rapidly. The disease got its nickname "blue death" from the appearance of dying dehydrated patients with dark bluish skin [1]. Other symptoms include: nausea and vomiting, thirst, muscle-cramps, and irritability [5]. Confirmation of the diagnosis is achieved by detecting *Vibrio cholerae* in stool samples from affected individuals [1,6]. Many complications are associated with cholera infection such as dehydration, low blood pressure, hypoglycemia, electrolyte imbalance, renal failure, shock, coma, and death [1,5]. Prevention of infection can be reached through securing clean drinking water and food, maintaining sanitation and hygiene, and providing oral cholera vaccines [1,7]. Risk factors comprise poor sanitary and hygiene conditions, achlorhydria or reduced stomach acid, household exposure, and type O blood. Immunocompromised patients or affected individuals who lack access to rehydration and medical therapy contract more severe disease and suffer poorer outcomes after getting infected with cholera [1,4].

Cholera is one of the major re-emerging vaccine preventable diseases that resurfaced very recently in most Syrian governorates. In this study, we aspired to explore the level of awareness in a cohort of the Syrian population. Our objectives were to test their knowledge of cholera and to investigate their attitudes and practices that may help avert the infection.

2. Methods

2.1. Study design

A cross-sectional internet-based survey using Google form platform was designed based on the information provided by WHO and CDC [1,5] and launched September 16 to 27, 2022 (Supplement A). The survey questions were in Arabic and were multiple-choice and closed-end questions mainly; however, for some questions, participants were given the choice to add other answers. Questions were evaluated by two experts for relevance and clarity and a draft of the survey was piloted on 30 participants to assess the survey's ease to understand and answer. The validated survey was uploaded to professional and private groups on social media namely Facebook and WhatsApp. Group members were asked to participate and forward the survey. It included a brief introduction on the purpose of the study followed by general questions to collect demographics of the participants. The survey queried personal experience with cholera in addition to general knowledge of the disease including ways of transmission, symptoms, treatment, prevention and complications. Furthermore, participants' attitudes and practices towards the disease were collected. Participation was voluntary; however, signing informed consent was required to participate in the study.

2.2. Sample size and percentage of participation

The required sample size for the study was calculated using the equation [$n = z^2p(q)/d^2$], which allows calculating the sample size with a desired level of confidence, precision, and estimated proportion of the attribute. In the equation: n is the sample size, z is the score for different significance levels, p is the estimated proportion of the population that presents the characteristic (when unknown $p = 0.5$), $q = 1\text{-}p$, and d is the margin of sample error]. The minimum required sample size for the current study with 95.5% confidence ($z = 2$) and 5% margin error was 400 {$n = [(2)\ [2]*0.5*0.5]/(0.05)\ [2]$}. 1562 individuals replied to the invitation to participate in the survey, 1521 agreed and 41 declined (response rate = 97.4%).

2.3. Statistical analysis

The statistical analyses were accomplished using Statistical Package for Social Sciences (SPSS–V.25). For assessing knowledge, one point was assigned for each correct answer and zero for each incorrect answer. The correct answers were calculated as sums of knowledge and proportions of the average knowledge and deviations were measured. A five-point scale was used where indicated to assess the respondents' knowledge (self-evaluation), attitudes, and practices. Moreover, a five-point scale was used to assess the respondents' worrisome as follows: 1 = not worried at all, 2 = somewhat worried, 3 = medium worried, 4 = very worried, and 5 = extremely worried. Additionally, nonparametric tests [Chi-Square, Mann-Whitney, Independent T-test, One Way ANOVA, and Kruskal-Wallis] were employed where applicable. For all tests, p-value < 0.05 was considered statistically significant.

Role of the funding **source:** Not applicable as there was no funding for this work.

3. Results

3.1. General description of the participants

The survey was open for 12 days (September 16–27, 2022) and 1521 individuals participated. They were mostly females (68.3%), 18–25 years old (56.4%), single (72.7%) and college degree holders (75.9%). Participants from 14 governates responded but the majority were from Damascus (48.1%) and Rif Dimashq (18.8%). Most participants had type A (34.5%) or O (27.9%) blood (Supplement B). Before participating in the study, 94.6% have heard of the cholera disease and 0.6% (nine participants) have been infected with *Vibrio cholerae*.

3.2. Assessment of the participants' knowledge

The main sources of the cohort's knowledge were school/college (31.7%), social media (28.7%) family and friends (13.2%) and online search engines (11.3%). Remarkably, only a minority of the cohort (8.9%) gathered knowledge of the disease from traditional mass media (Television, radio, and newspaper). Large percentages of the cohort were able to identify the route of infection (oral) (63.5%) and the infectious agent (bacteria) (71.6%) (Fig. 1). The vast majority of participants knew that all ages were vulnerable (91.2%), cholera spread through ingestion of contaminated water (93.1%) and contaminated produce (vegetables and fruits) (90.9%); however, lesser percentages thought of other spreading channels such as contaminated undercooked seafood (55.3%) or exposed cooked food (53%). Only 37.2% of the cohort knew all ways of transmission (Fig. 1). Regarding signs and symptoms, the majority of

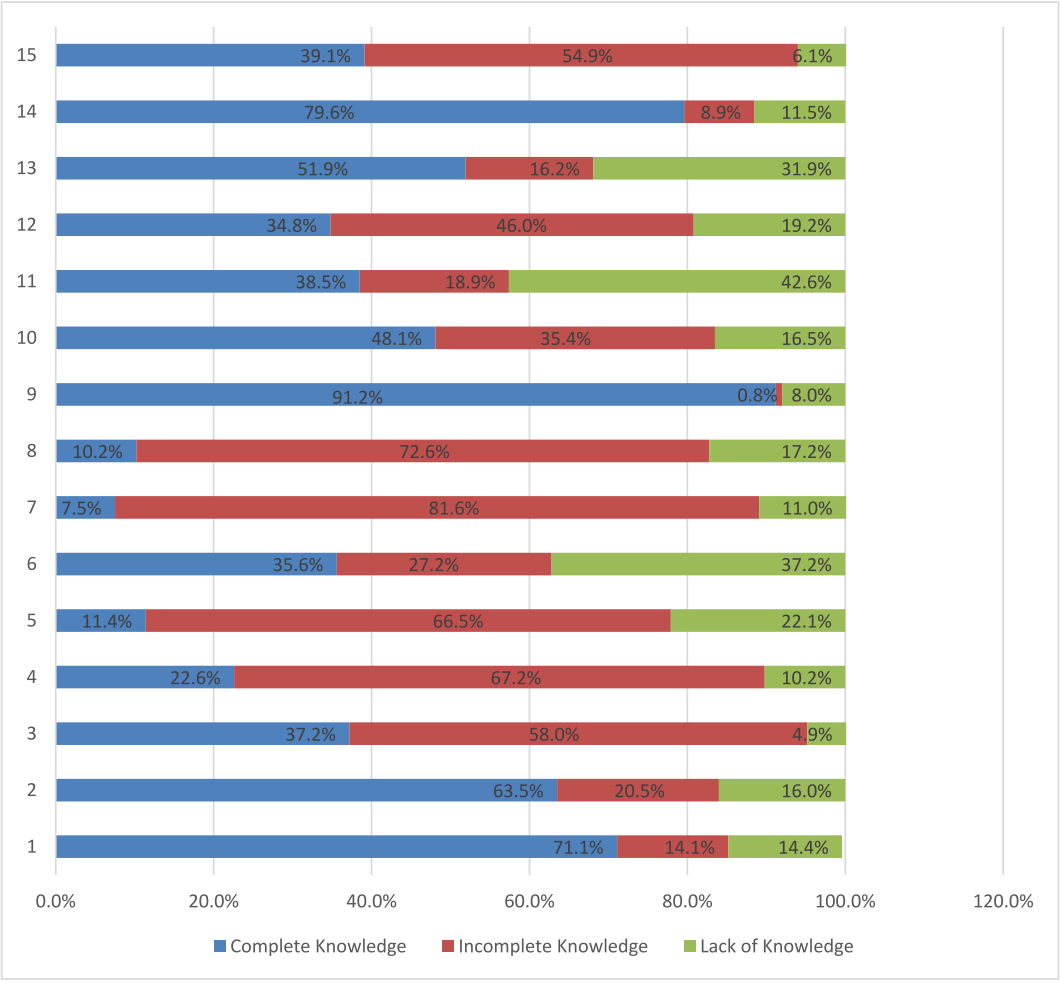

Fig. 1. Distribution of participants by their complete (correct answer), incomplete (wrong or partial answer) or lack (do not know the answer) of knowledge of cholera disease.
1. Infectious agent; 2. Route of infection; 3. Ways of infection transmission; 4. Signs and Symptoms; 5. Symptoms intensity; 6. Incubation time before symptoms appear; 7. Risk factors; 8. Complications of infection; 9. Age of affected individuals; 10. Treatment; 11. Vaccine; 12. Transmission between species; 13. Confirmation of diagnosis; 14. The affected body system; 15. Prevention.

the cohort knew one or more including watery diarrhea (95.7%), vomiting (80.1%), and dehydration (76.4%). Nevertheless, only 22.6% had complete knowledge of all disease-associated symptoms (Fig. 1). A considerable percentage of the cohort (23%) did not know the intensity of the symptoms while the rest knew that the disease could be asymptomatic (25.8%), mild (50.5%), medium (56.2%), or severe (68.1%). Only 11.4% had complete knowledge of the disease different intensities (Fig. 1). Only 35.6% of the cohort distinguished the right answer for the incubation time between getting infected and the symptoms appearance. The majority (37.2%) acknowledged the lack of knowledge, while the rest of the cohort picked wrong answers (Fig. 1). One-third of the cohort (34.8%) knew that human was the only host for *Vibrio cholerae* and that transmission occurred human to human via different means, while the majority selected wrong answers (Supplement A). Most of the cohort (79.6%) knew the main affected organ/system in the body (GI) while 51.9% knew the test employed for confirmation of diagnosis (stool-test) (Fig. 1). The cohort knew that treatment was mainly by rehydration and electrolytes replacement (93.1%), or antibiotics (63%), and 48.1% selected both answers as possible treatment (Fig. 1). The cohort was familiar with one or more of the major complications of cholera including death (80.9%), decrease of body electrolytes (77.8%), and renal failure (44.6%). Nevertheless, only 10.2% of the cohort had complete knowledge and knew all complications. Regarding risk factors, the cohort was aware of the impact of personal hygiene practices (88.9%), household exposure (74.5%), and immunodeficiency (56.8%) on getting infected with cholera. Smaller percentages could identify low stomach acid (30%) and type O blood (14.2%) as risk factors. Only 7.5% had complete knowledge and could identify all associated risk factors (Fig. 1). The cohort was familiar with one or more preventive measures against the spread of cholera disease including washing hands with soap well and frequently (92.2%), sterilizing raw produce before eating (92.2%), and drinking only water that was bottled or disinfected by boiling (88.9%). However, only 39.1% had complete knowledge of all preventive approaches (Fig. 1). Only 38.5% of the cohort knew there was a vaccine against *Vibrio cholerae* while the remaining of the cohort either did not know (42.6%) or thought an anti-*Vibrio cholerae* vaccine did not exist (18.9%) (Fig. 1). The percentage of the cohort who took the vaccine before the study was 10.2%.

3.3. Assessment of personal attitude

Most of the cohort (94.5%) thought cholera was a very dangerous disease and chose five (29.8%), four (37.4%), and three (27.3%) on the five-point scale of dangerousness with five being extremely dangerous. Most of the cohort (85.1%) was concerned about cholera resurfacing in the country and chose five (16.8%), four (25.4%), and three (42.9%) on the five-point scale with five corresponding to extremely concerned. Only a minority felt unconcerned (4.3%) towards the new wave of endemic disease. When asked to entertain the idea of becoming infected, most of the cohort (62%) felt worried and chose five (10.3%), four (13.8%), and three (37.9%) on the five-point scale with five matching extremely worried.

3.4. Assessment of personal practice

Most of the cohort (74.3%) were eating out/takeaway less than five times a month. Only 1.9% of the cohort were eating out/takeaway more than 20 times a month. Comparable percentages stated eating fresh fruits (pears, apples, peaches, plums) and raw vegetables (tomatoes, cucumbers) after just washing them with water (78.8% and 78.1%, respectively). Substantial percentages stated eating fruits and vegetables after washing and peeling (17.4 and 17.9%, respectively). Only minorities of the cohort sterilized fruits and vegetables before eating (0.5% and 1.3%, respectively).

Nevertheless, after cholera resurfaced in the country the majority of the cohort affirmed changing one or more practices to healthier measures: 82.6% committed to washing fresh fruits and vegetables more thoroughly; 65.3% selected washing hands with soap more frequently; 61.4% chose to pay more attention to sources of drinking water; and 60.4% picked minimizing eating out/takeaway. Only 8% chose not to change their habits.

3.5. Significant associations in the study

1) Sum of knowledge and cohort demographics:

Fifteen questions were incorporated into the survey to evaluate the knowledge of the participants (Supplement A). Data showed significant associations with 95% confidence and $p < 0.05$ between knowledge and each of the following: gender in favor of females, age in favor of >40 years old, and education in favor of highly educated participants (college, M.S. and Ph.D. degree holders) reflecting better knowledge in all these groups (Table 1).

2) Self-assessed knowledge and study variables:

At the beginning of the survey, participants were asked to self-assess their knowledge of cholera using a five-point scale with five indicating excellent knowledge. The aim was to explore the ability of the participants to correctly evaluate their knowledge by comparing self-evaluation with actual performance in the survey. Data showed a significant difference with 95% confidence and $p < 0.05$ between self-assessed knowledge and gender in favor of females. Compared to male participants (2.72 ± 1.2), females assessed their knowledge of cholera higher (2.97 ± 1.2). Females also demonstrated better knowledge of the disease in the survey (6.59 ± 2.9) compared to males (6.22 ± 3.2) (Table 2, A). Similarly, a significant difference was revealed between self-assessed knowledge and age in favor of participants >40 years old. Participants 41–60 and > 60 years old chose higher scores for their knowledge by self-assessment compared to the remaining cohort. Both age groups were correct in their evaluation and showed superior knowledge in

Table 1
Correlations between participants' demographics (gender, age, and education) and knowledge of cholera disease.

		Gender		Age					Education (Degree)					
		Male (%)	Female (%)	<18 (%)	18-25 (%)	26-40 (%)	41-60 (%)	>60 (%)	Elementary School (%)	Middle School (%)	High School (%)	College (%)	M.S. (%)	Ph.D. (%)
1	I	328 (68.6)	748 (72.9)	31 (64.6)	603 (70.9)	291 (70)	138 (81.2)	16 (66.7)	0 (0)	15 (51.7)	99 (71.2)	814 (71.5)	120 (75.9)	24 (85.7)
	II	58 (12.1)	153 (14.9)	8 (16.7)	120 (14.1)	65 (15.6)	14 (8.2)	6 (25)	2 (33.3)	7 (24.1)	21 (15.1)	157 (13.8)	21 (13.3)	2 (7.1)
	III	92 (19.2)	125 (12.2)	9 (18.8)	128 (15)	60 (14.4)	18 (10.6)	2 (8.3)	4 (66.7)	7 (24.1)	19 (13.7)	168 (14.7)	17 (10.8)	2 (7.1)
	P-value	0.001*		0.109					0.002*					
2	I	293 (61.6)	662 (64.6)	20 (40.8)	526 (61.9)	268 (64.4)	130 (77.8)	13 (54.2)	0 (0)	13 (48.1)	81 (57.9)	716 (63)	116 (72.5)	25 (92.6)
	II	94 (19.7)	215 (21)	11 (22.4)	183 (21.5)	82 (19.7)	24 (14.4)	10 (41.7)	1 (16.7)	4 (14.8)	35 (25)	236 (20.8)	29 (18.1)	0 (0)
	III	89 (18.7)	148 (14.4)	18 (36.7)	141 (16.6)	66 (15.9)	13 (7.8)	1 (4.2)	5 (83.3)	10 (37)	24 (17.1)	184 (16.2)	15 (9.4)	2 (7.4)
	P-value	0.109		<0.001*					<0.001*					
3	I	165 (34.4)	396 (38.4)	19 (38.8)	350 (41)	125 (29.9)	62 (36.5)	7 (29.2)	1 (16.7)	11 (37.9)	38 (27.1)	450 (39.4)	56 (34.8)	5 (17.9)
	II	276 (57.6)	599 (58.1)	23 (46.9)	458 (53.6)	276 (66)	105 (61.8)	16 (66.7)	2 (33.3)	14 (48.3)	94 (67.1)	638 (55.9)	99 (61.5)	23 (82.1)
	III	38 (7.9)	36 (3.5)	7 (14.3)	46 (5.4)	17 (4.1)	3 (1.8)	1 (4.2)	3 (50)	4 (13.8)	8 (5.7)	53 (4.6)	6 (3.7)	0 (0)
	P-value	0.001*		<0.001*					<0.001*					
4	I	99 (20.7)	244 (23.7)	9 (18.4)	187 (21.9)	89 (21.2)	50 (29.6)	8 (33.3)	1 (16.7)	7 (24.1)	28 (20)	250 (21.9)	47 (29.2)	7 (25)
	II	301 (63)	711 (69)	30 (61.2)	561 (65.8)	299 (71.4)	110 (65.1)	16 (66.7)	3 (50)	18 (62.1)	90 (64.3)	768 (67.4)	110 (68.3)	21 (75)
	III	78 (16.3)	76 (7.4)	10 (20.4)	105 (12.3)	31 (7.4)	9 (5.3)	0 (0)	2 (33.3)	4 (13.8)	22 (15.7)	122 (10.7)	4 (2.5)	0 (0)
	P-value	<0.001*		0.001*					0.005*					
5	I	56 (11.7)	117 (11.4)	6 (12.5)	106 (12.4)	43 (10.3)	14 (8.3)	4 (16.7)	1 (16.7)	2 (6.9)	9 (6.5)	118 (10.4)	37 (23)	2 (7.1)
	II	294 (61.6)	706 (68.6)	30 (62.5)	537 (63)	283 (67.7)	135 (79.9)	19 (79.2)	2 (33.3)	19 (65.5)	94 (67.6)	760 (66.8)	104 (64.6)	20 (71.4)
	III	127 (26.6)	206 (20)	12 (25)	209 (24.5)	92 (22)	20 (11.8)	1 (4.2)	3 (50)	8 (27.6)	36 (25.9)	260 (22.8)	20 (12.4)	6 (21.4)
	P-value	0.012*		0.002*					<0.001*					
6	I	173 (36.3)	362 (35.3)	11 (22.4)	301 (35.5)	136 (32.6)	81 (48.2)	9 (37.5)	0 (0)	12 (41.4)	37 (26.6)	408 (35.9)	59 (37.1)	17 (60.7)
	II	122 (25.6)	287 (28)	19 (38.8)	218 (25.7)	121 (29)	43 (25.6)	9 (37.5)	3 (50)	7 (24.1)	42 (30.2)	305 (26.8)	46 (28.9)	4 (14.3)
	III	182 (38.2)	376 (36.7)	19 (38.8)	330 (38.9)	160 (38.4)	44 (26.2)	6 (25)	3 (50)	10 (34.5)	60 (43.2)	423 (37.2)	54 (34)	7 (25)
	P-value	0.614		0.003*					0.063					

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Table 1 (*continued*)

		Gender		Age					Education (Degree)					
		Male (%)	Female (%)	<18 (%)	18-25 (%)	26-40 (%)	41-60 (%)	>60 (%)	Elementary School (%)	Middle School (%)	High School (%)	College (%)	M.S. (%)	Ph.D. (%)
7	I	34 (7.1)	79 (7.7)	4 (8.3)	68 (8)	26 (6.2)	13 (7.6)	2 (8.3)	1 (16.7)	0 (0)	5 (3.6)	81 (7.1)	20 (12.4)	4 (14.3)
	II	382 (79.9)	846 (82.3)	36 (75)	680 (79.8)	345 (82.7)	150 (88.2)	22 (91.7)	3 (50)	24 (82.8)	111 (80.4)	935 (82.1)	128 (79.5)	23 (82.1)
	III	62 (13)	103 (10)	8 (16.7)	104 (12.2)	46 (11)	7 (4.1)	0 (0)	2 (33.3)	5 (17.2)	22 (15.9)	123 (10.8)	13 (8.1)	1 (3.6)
	P-value	0.227		0.047*					0.010*					
8	I	46 (9.7)	109 (10.6)	2 (4.2)	94 (11)	38 (9.1)	17 (10.1)	4 (16.7)	2 (33.3)	0 (0)	8 (5.8)	117 (10.3)	24 (14.9)	3 (10.7)
	II	328 (68.9)	764 (74.2)	34 (70.8)	593 (69.6)	319 (76.3)	131 (77.5)	19 (79.2)	1 (16.7)	20 (71.4)	101 (73.2)	823 (72.2)	119 (73.9)	23 (82.1)
	III	102 (21.4)	157 (15.2)	12 (25)	165 (19.4)	61 (14.6)	21 (12.4)	1 (4.2)	3 (50)	8 (28.6)	29 (21)	200 (17.5)	18 (11.2)	2 (7.1)
	P-value	0.013*		0.034*					0.002*					
9	I	417 (88)	952 (92.8)	41 (85.4)	772 (91)	381 (91.4)	156 (92.9)	22 (91.7)	2 (33.3)	22 (75.9)	122 (88.4)	1043 (91.9)	146 (91.8)	27 (96.4)
	II	4 (0.8)	7 (0.7)	1 (2.1)	3 (0.4)	5 (1.2)	2 (1.2)	1 (4.2)	1 (16.7)	0 (0)	1 (0.7)	7 (0.6)	3 (1.9)	0 (0)
	III	53 (11.2)	67 (6.5)	6 (12.5)	73 (8.6)	31 (7.4)	10 (6)	1 (4.2)	3 (50)	7 (24.1)	15 (10.9)	85 (7.5)	10 (6.3)	1 (3.6)
	P-value	0.008*		0.203					<0.001*					
10	I	218 (45.8)	506 (49.3)	16 (34)	399 (46.9)	202 (48.6)	97 (57.4)	12 (50)	0 (0)	10 (34.5)	57 (41.3)	551 (48.5)	87 (54.4)	14 (50)
	II	153 (32.1)	377 (36.7)	19 (40.4)	300 (35.3)	145 (34.9)	56 (33.1)	12 (50)	4 (66.7)	9 (31)	57 (41.3)	398 (35)	49 (30.6)	13 (46.4)
	III	105 (22.1)	143 (13.9)	12 (25.5)	152 (17.9)	69 (16.6)	16 (9.5)	0 (0)	2 (33.3)	10 (34.5)	24 (17.4)	187 (16.5)	24 (15)	1 (3.6)
	P-value	<0.001*		0.012*					0.017*					
11	I	175 (36.7)	404 (39.5)	20 (41.7)	323 (38.1)	158 (37.8)	68 (40.2)	10 (43.5)	2 (33.3)	12 (41.4)	49 (35.3)	419 (37)	76 (47.5)	16 (57.1)
	II	79 (16.6)	203 (19.8)	4 (8.3)	131 (15.5)	96 (23)	42 (24.9)	11 (47.8)	1 (16.7)	4 (13.8)	31 (22.3)	204 (18)	36 (22.5)	5 (17.9)
	III	223 (46.8)	416 (40.7)	24 (50)	393 (46.4)	164 (39.2)	59 (34.9)	2 (8.7)	3 (50)	13 (44.8)	59 (42.4)	510 (45)	48 (30)	7 (25)
	P-value	0.069		<0.001*					0.034*					
12	I	150 (31.6)	371 (36.4)	17 (35.4)	273 (32.3)	140 (33.7)	81 (48.8)	10 (41.7)	1 (16.7)	12 (41.4)	51 (37)	373 (33)	65 (40.6)	14 (51.9)
	II	213 (44.8)	474 (46.5)	19 (39.6)	405 (47.9)	187 (45)	66 (39.8)	13 (54.2)	3 (50)	8 (27.6)	63 (45.7)	537 (47.6)	67 (41.9)	8 (29.6)
	III	112 (23.6)	174 (17.1)	12 (25)	167 (19.8)	89 (21.4)	19 (11.4)	1 (4.2)	2 (33.3)	9 (31)	24 (17.4)	219 (19.4)	28 (17.5)	5 (18.5)
	P-value	0.009*		0.002*					0.169					
13	I	229 (48.3)	547 (53.6)	21 (44.7)	415 (49.1)	217 (52.4)	107 (63.3)	19 (79.2)	1 (16.7)	11 (37.9)	69 (50)	574 (50.7)	95 (60.5)	20 (71.4)

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Table 1 (*continued*)

		Gender		Age					Education (Degree)					
		Male (%)	Female (%)	<18 (%)	18-25 (%)	26-40 (%)	41-60 (%)	>60 (%)	Elementary School (%)	Middle School (%)	High School (%)	College (%)	M.S. (%)	Ph.D. (%)
	II	79 (16.7)	162 (15.9)	7 (14.9)	157 (18.6)	51 (12.3)	22 (13)	5 (20.8)	2 (33.3)	7 (24.1)	22 (15.9)	198 (17.5)	12 (7.6)	2 (7.1)
	III	166 (35)	312 (30.6)	19 (40.4)	274 (32.4)	146 (35.3)	40 (23.7)	0 (0)	3 (50)	11 (37.9)	47 (34.1)	360 (31.8)	50 (31.8)	6 (21.4)
	P-value	0.144		<0.001*					0.020*					
14	I	364 (76.8)	833 (81)	32 (66.7)	658 (77.5)	345 (82.7)	142 (84)	23 (95.8)	1 (16.7)	24 (82.8)	102 (73.4)	899 (79.2)	138 (86.3)	26 (92.9)
	II	32 (6.8)	100 (9.7)	5 (10.4)	82 (9.7)	28 (6.7)	17 (10.1)	1 (4.2)	2 (33.3)	0 (0)	16 (11.5)	107 (9.4)	9 (5.6)	0 (0)
	III	78 (16.5)	95 (9.2)	11 (22.9)	109 (12.8)	44 (10.6)	10 (5.9)	0 (0)	3 (50)	5 (17.2)	21 (15.1)	129 (11.4)	13 (8.1)	2 (7.1)
	P-value	<0.001*		0.006*					0.001*					
15	I	181 (38.5)	396 (39.4)	17 (35.4)	334 (39.9)	146 (35.8)	74 (45.1)	9 (39.1)	2 (33.3)	11 (39.3)	50 (36)	437 (39.3)	70 (44)	6 (22.2)
	II	241 (51.3)	569 (56.6)	26 (54.2)	444 (53)	242 (59.3)	86 (52.4)	13 (56.5)	2 (33.3)	13 (46.4)	78 (56.1)	608 (54.7)	83 (52.2)	21 (77.8)
	III	48 (10.2)	41 (4.1)	5 (10.4)	60 (7.2)	20 (4.9)	4 (2.4)	1 (4.3)	2 (33.3)	4 (14.3)	11 (7.9)	67 (6)	6 (3.8)	0 (0)
	P-value	<0.001*		0.116					0.020*					

*. Significant at the 0.05 level. Chi-Square test.

[I. Complete knowledge**(correct answer)**; II. Incomplete knowledge**(wrong or partial answer)**; III. Lack of knowledge **(do not know the answer)**].

1. Infectious agent; 2. Route of infection; 3. Ways of infection transmission; 4. Signs and Symptoms; 5. Symptoms intensity; 6. Incubation time before symptoms appear; 7. Risk factors; 8. Complications of infection; 9. Age of affected individuals; 10. Treatment; 11. Vaccine; 12. Transmission between species; 13. Confirmation of diagnosis; 14. The affected body system; 15. Prevention.

the survey (Table 2, B). A significant difference was discovered between self-assessed knowledge and marital status in favor of married participants. Married participants chose higher scores for their knowledge by self-assessment compared to singles. However, data did not show differences in the knowledge of married and single participants in the survey (Table 2, C). A significant difference was uncovered between self-assessed knowledge and education in favor of higher education (college, M.S., Ph.D.). They rated personal knowledge of cholera higher than the remaining cohort and their total knowledge verified in the survey indicated superior performance (Table 2, D). A significant difference was revealed between self-assessed knowledge and residential area in favor of urban. Participants living in urban areas rated personal knowledge of cholera higher than participants living in rural areas of the governorates and their performance in the survey was also better (Table 2, E). A significant difference was discovered in the study between self-assessed knowledge and previous knowledge in favor of the participants who have heard of cholera before the study; they rated personal knowledge of cholera higher and their actual performance in the survey was better (Table 2, F). A significant difference was uncovered between self-assessed knowledge and source of information. Participants who got their information about cholera from search engines and school/college evaluated their knowledge higher compared to the remaining cohort. Remarkably, the sum of their knowledge confirmed in the survey was superior to the remaining cohort who gathered information from other sources (Table 2, G).

3) Attitudes and cohort demographics:

No significant difference was detected between cholera dangerousness and gender; however, a significant difference with 95% confidence and $p < 0.05$ was revealed between attitude towards cholera and gender in favor of females. Female participants, were more concerned about cholera disease resurfacing in the country and were more worried about getting infected compared to male participants (Table 3, A). Furthermore, a significant difference was uncovered between cholera dangerousness and age. In comparison to younger respondents, participants 41–60 and > 60 years old viewed cholera as a more serious disease. Additionally, the same age groups felt more concerned about cholera disease resurfacing in the country and were more worried about getting infected compared to other age groups (Table 3, B). Moreover, a significant difference was discovered between attitude towards cholera and marital status. Married participants thought that cholera was a more serious disease and were more concerned about the disease spreading in Syria compared to single participants (Table 3, C). Similarly, a significant difference was revealed between attitude towards cholera and sources of information. Participants who gathered information about cholera from online search engines were both more concerned about the disease spreading in Syria and more worried about getting infected compared to participants who gathered information from other sources (Table 3, D). No significant differences were detected between education and concern towards cholera spreading in the country or worrisome of getting infected, reflecting equal attitudes across the cohort. A significant difference was discovered between cholera dangerousness and education. Participants with an education level of elementary school thought cholera dangerousness was less serious in comparison to the remaining groups (Table 3, E).

4) Practices and cohort demographics:

Significant associations with 95% confidence and $p < 0.05$ were revealed between healthy practices and gender in favor of females. Compared to males (64.2%), a higher percentage of female participants (79.1%) ate out or ordered takeaway <5 times a month; a lower percentage of females ate out/takeaway five times or more (Table 4). Similarly, a significant association was uncovered between handling fruits before eating and gender. Higher percentages of males (81.5%) ate fruits after just washing them with water compared to females (77.6%). While, higher percentages of females (18.8%) ate fruits after peeling compared to males (14.3%) (Tables 4 and I). Significant associations were found between changing practices after cholera re-emerged in Syria and gender in favor of females. Higher percentages of females committed to washing raw produce (fruits and vegetables) more thoroughly (85.2%), washing hands with soap more frequently (67.3%), paying more attention to sources of drinking water (64.1%), and minimizing eating out/takeaway (62.4%) compared to males (77.4%, 61%, 56.2%, and 56.6% respectively). Additionally, a higher percentage of males (11.3%) chose not to change their habits compared to females (6.3%) after cholera resurfaced in the country (Tables 4 and II). These practices emphasized higher awareness of health-maintaining practices in female participants.

Significant associations were revealed between healthy practices and age. Compared to the remaining age groups, higher percentages of participants >60 years and 41–60 years old ate out/takeaway <5 times a month (91.7% and 84.1%, respectively), ate vegetables after washing and peeling (54.2% and 23.8%, respectively), and ate fruits after washing and peeling (41.7% and 22.5%, respectively) (Tables 4 and I). Moreover, significant associations were found between changing practices after cholera resurfaced in Syria and age. Compared to the remaining age groups, higher percentages of 41–60 and > 60 years old participants committed to washing raw produce more thoroughly (88.2%, 83.3% respectively), avoiding eating undercooked seafood (34.7%, 37.5% respectively), and minimizing eating out/takeaway (69.4%, 62.5% respectively) (Tables 4 and II). These good practices of participants >40 years old reflect higher awareness of health-maintaining practices and contribute to averting cholera infection.

Significant associations were found between healthy practices and education (Tables 4 and I). Compared to the remaining cohort, higher percentages of participants with higher education ate out/takeaway <5 times a month, and ate raw produce after washing and peeling. A significant association was found between education and changing practices after cholera re-emerged in Syria. Higher percentages of college degree, M.S., and Ph.D. holders (84%, 80.6%, and 78.6%, respectively) committed to washing raw produce more thoroughly. These good practices reflect higher awareness of health-maintaining practices in the indicated groups. Interestingly, there were no significant associations between changing other practices and education (Tables 4 and II).

Table 2
Self-assessed knowledge versus actual knowledge demonstrated in the survey: Correlations with gender, age, marital status, education, residential area, previous knowledge, and source of information.

A. Gender	Male		Female		*P*-value (Mann-Whitney)	
	N	Mean ± SD	N	Mean ± SD		
I	480	2.72 ± 1.2	1031	2.97 ± 1.2	<0.001*	
II	479	6.22 ± 3.2	1033	6.59 ± 2.9	0.049*	
B. Age	**Age in years**	**N**	**Mean ± SD**	***P*-value[a]**	**Mann-Whitney Test**	
					I – J	***P*-value**
I	1. <18	49	2.45 ± 1.2	<0.001*	1–2	0.058
					1–3	0.016*
	2.18–25	856	2.79 ± 1.2		1–4	<0.001*
					1–5	<0.001*
	3.26–40	418	2.89 ± 1.2		2–3	0.101
					2–4	<0.001*
	4.41–60	169	3.34 ± 1.1		2–5	<0.001*
					3–4	<0.001*
	5. >60	24	4.13 ± 0.9		3–5	<0.001*
					4–5	0.001*
II	1. <18	48	5.57 ± 3.2	0.001*	1–2	0.052
					1–3	0.086
	2.18–25	845	6.41 ± 3		1–4	0.001*
					1–5	0.053
	3.26–40	415	6.28 ± 2.8		2–3	0.375
					2–4	0.001*
	4.41–60	168	7.33 ± 2.9		2–5	0.392
					3–4	<0.001*
	5. >60	24	7.25 ± 3.1		3–5	0.307
					4–5	0.594
C. Marital Status	**Married**		**Single**		***P*-value (Mann-Whitney)**	
	N	**Mean ± SD**	**N**	**Mean ± SD**		
I	403	3.03 ± 1.2	1092	2.82 ± 1.2	0.002*	
II	405	6.57 ± 3	1091	6.43 ± 3	0.744	
D. Education	**Degree**	**N**	**Mean ± SD**	***P*-value[a]**	**Mann-Whitney Test**	
					I – J	***P*-value**
I	1. Elementary School	6	2.67 ± 2	<0.001*	1–2	0.982
					1–3	0.818
	2. Middle School	29	2.55 ± 1.2		1–4	0.657
					1–5	0.364
	3. High school	139	2.7 ± 1.2		1–6	0.304
					2–3	0.621
					2–4	0.251
	4. College	1143	2.84 ± 1.2		2–5	0.006*
					2–6	0.004*
					3–4	0.194
	5. M.S.	161	3.28 ± 1.2		3–5	<0.001*
					3–6	0.001*
					4–5	<0.001*
	6. Ph.D.	28	3.5 ± 1		4–6	0.003*
					5–6	0.361
II	1. Elementary School	6	2.5 ± 1.9	<0.001*	1–2	0.026*
					1–3	0.005*
	2. Middle School	29	5.72 ± 3.2		1–4	0.001*
					1–5	0.001*
	3. High school	140	5.86 ± 2.9		1–6	0.001*
					2–3	0.926
					2–4	0.397
	4. College	1143	6.42 ± 2.9		2–5	0.052
					2–6	0.077
					3–4	0.021*
	5. M.S.	161	7.26 ± 3.2		3–5	<0.001*
					3–6	0.003*
					4–5	0.003*
	6. Ph.D.	28	7.68 ± 3.2		4–6	0.036*
					5–6	0.515
E. Residential area	**Urban**		**Rural**		***P*-value (Mann-Whitney)**	
	N	**Mean ± SD**	**N**	**Mean ± SD**		
I	1093	2.99 ± 1.2	416	2.63 ± 1.2	<0.001*	

(*continued on next page*)

Table 2 (*continued*)

A. Gender	Male		Female		*P*-value (Mann-Whitney)	
	N	Mean ± SD	N	Mean ± SD		
II	1094	6.63 ± 2.9	416	6.04 ± 3.1	0.003*	
F. Previous Knowledge	**Have heard of cholera**		**Have not heard of cholera**		***P*-value (Mann-Whitney)**	
	N	**Mean ± SD**	**N**	**Mean ± SD**		
I	1434	2.96 ± 1.2	83	1.66 ± 1.2	<0.001*	
II	1436	6.62 ± 2.9	83	3.69 ± 3.4	<0.001*	
G. Source of information	**Source**	**N**	**Mean ± SD**	***P*-value[a]**	**Mann-Whitney Test**	
					I – J	***P*-value**
I	1. Family & friends	200	2.33 ± 1	<0.001*	1–2	<0.001*
					1–3	<0.001*
	2. School/college	480	3.39 ± 1.1		1–4	<0.001*
					1–5	<0.001*
	3. Online search engines	172	3.33 ± 1		2–3	0.340
					2–4	<0.001*
	4. Traditional mass media	134	2.91 ± 1.1		2–5	<0.001*
					3–4	0.001*
	5. Social media	436	2.78 ± 1		3–5	<0.001*
					4–5	0.129
II	1. Family & friends	201	5.22 ± 2.9	<0.001*	1–2	<0.001*
					1–3	<0.001*
	2. School/college	480	7.71 ± 2.8		1–4	<0.001*
					1–5	<0.001*
	3. Online search engines	172	7.49 ± 2.7		2–3	0.348
					2–4	<0.001*
	4. Traditional mass media	135	6.39 ± 2.5		2–5	<0.001*
					3–4	0.001*
	5. Social media	436	6.07 ± 2.5		3–5	<0.001*
					4–5	0.209

*:Significant at the 0.05 level; a: Kruskal-Wallis Test.
[I. Self-assessed knowledge; II. Actual knowledge].

4. Discussion

The Syrian crisis extended over a decade during which most of the health infrastructures in many governorates got destroyed. Additionally, the immigration of large numbers of healthcare providers and health-related professionals especially medical doctors debilitated the struggling health system. Cutaneous leishmaniasis, hepatitis, typhoid, and polio resurfaced [8]. Then, the Coronavirus pandemic emerged and presented more challenges. As the Covid-19 pandemic intensity started to fade with the year 2022 coming to an end, cholera began to re-emerge in Syria. The deadly disease can turn a healthy body into a blue corpse within hours and deserves its nickname "the blue death". Cholera is not new to Syria, one of the earliest documented reports on a cholera outbreak dates back to 1889 [9,10]. The disease became endemic in the country and many other countries. The first outbreak was followed by six more worldwide in the last century. The newest outbreak was declared by the Syrian Ministry of Health (MoH) on September 10, 2022 [11]. The majority of cases were in the governorates of Aleppo, Deir-ez-Zor, Ar-Raqqa and Al-Hasakeh. In less than a month, close to 6000 cases of infection and 36 associated deaths have been reported in nine of the 14 Syrian governorates. All ages were affected and the diagnosis was confirmed in many stool specimens [11]. According to the UN humanitarian relief coordinator for the country, the current cholera outbreak represents a serious threat not only to Syrians but also to the people of the whole Middle East region [12].

We aimed to evaluate the awareness level of Syrians by exploring their knowledge of cholera and investigating their attitudes and practices that may help defeat the odds and protect them from cholera infection. 1521 individuals responded to our survey within 12 days. The majority were females, young adults, single, and college degree holders. The cohort depended mostly on school/college, social media, family and friends, and online search engines for information on the disease. Participants knew some important information on cholera's ways of transmission, symptoms, management, risk factors, and complications but their knowledge was incomplete. Our data showed that 95.7% of participants knew the most common and characteristic symptom of cholera "watery diarrhea". This is comparable to previous studies where cholera is endemic [13]. The average total knowledge in the current study was 40.39%; it is suboptimal. In comparison to studies conducted in other cholera-affected countries, the average knowledge in our study is comparable to some studies [14] and inferior to others [15,16]. Participants with higher education, >40 years old, from urban areas, and females demonstrated superior knowledge. The significant positive impact of the level of education on knowledge of cholera reported in our study agrees with studies conducted in neighboring countries [15,17].

Participants who sought information from school/college and online search engines were more knowledgeable, which distinguished these sources as more dependable. Interestingly, less than one-tenth of the cohort sought information from formal mass media including television, radio, and newspaper. This is of high importance because in Syria the main vehicle for communicating with the public and raise awareness is still the traditional mass media. Educating the public is a critical element in combating the transmissible

Table 3
Correlations between participants' attitudes towards cholera and their gender, age, marital status, source of information, and education.

A. Gender	Male		Female		*P*-value (Mann-Whitney)	
	N	Mean ± SD	N	Mean ± SD		
I	471	3.82 ± 1	1024	3.94 ± 0.9	0.065	
II	474	3.2 ± 1.1	1022	3.49 ± 1	<0.001*	
III	473	2.65 ± 1.2	1025	2.86 ± 1.2	0.001*	
B. Age	**Age in years**	**N**	**Mean ± SD**	***P*-valuea**	**Mann-Whitney Test**	
					I – J	***P*-value**
I	1. <18	48	4 ± 1	<0.001*	1–2	0.110
					1–3	0.490
	2.18–25	845	3.82 ± 0.9		1–4	0.689
					1–5	0.091
	3.26–40	415	3.94 ± 0.9		2–3	0.019*
					2–4	<0.001*
	4.41–60	168	4.12 ± 0.9		2–5	<0.001*
					3–4	0.046*
	5. >60	24	4.38 ± 1		3–5	0.008*
					4–5	0.086
II	1. <18	48	3.35 ± 1	0.019*	1–2	0.905
					1–3	0.868
	2.18–25	845	3.36 ± 1		1–4	0.217
					1–5	0.026*
	3.26–40	415	3.37 ± 1		2–3	0.920
					2–4	0.031*
	4.41–60	168	3.57 ± 0.9		2–5	0.008*
					3–4	0.049*
	5. >60	24	3.92 ± 1.1		3–5	0.007*
					4–5	0.062
III	1. Under 18	48	2.81 ± 0.9	0.196		
	2.18–25	845	2.85 ± 1.2			
	3.26–40	415	2.74 ± 1.2			
	4.41–60	168	2.76 ± 1.2			
	5. Over 60	24	2.29 ± 1.2			
C. Marital Status	**Married**		**Single**		***P*-value (Mann-Whitney)**	
	N	**Mean ± SD**	**N**	**Mean ± SD**		
I	400	4.07 ± 0.9	1079	3.84 ± 0.9	<0.001*	
II	401	3.53 ± 1	1079	3.34 ± 1	0.001*	
III	402	2.76 ± 1.2	1080	2.82 ± 1.2	0.369	
D. Source of information	**Source**	**N**	**Mean ± SD**	***P*-valuea**	**Mann-Whitney Test**	
					I – J	***P*-value**
I	1. Family & friends	196	3.92 ± 0.9	0.871		
	2. School/college	476	3.93 ± 0.9			
	3. Online search engines	172	3.97 ± 0.8			
	4. Traditional mass media	133	3.83 ± 1			
	5. Social media	433	3.95 ± 0.9			
II	1. Family & friends	199	3.29 ± 1.1	0.022*	1–2	0.411
					1–3	0.005*
	2. School/college	474	3.37 ± 1		1–4	0.499
					1–5	0.079
	3. Online search engines	170	3.58 ± 0.9		2–3	0.003*
					2–4	0.881
	4. Traditional mass media	135	3.36 ± 1		2–5	0.148
					3–4	0.044*
	5. Social media	433	3.45 ± 1		3–5	0.095
					4–5	0.425
III	1. Family & friends	199	2.72 ± 1.2	0.040*	1–2	0.486
					1–3	0.015*
	2. School/college	475	2.77 ± 1.1		1–4	0.707
					1–5	0.202
	3. Online search engines	171	3.01 ± 1.1		2–3	0.015*
					2–4	0.286
	4. Traditional mass media	135	2.64 ± 1.1		2–5	0.333
					3–4	0.007*
	5. Social media	433	2.84 ± 1.2		3–5	0.118
					4–5	0.100

(*continued on next page*)

Table 3 (*continued*)

A. Gender	Male		Female		*P*-value (Mann-Whitney)	
	N	Mean ± SD	N	Mean ± SD		
E. Level of Education	**Level**	**N**	**Mean ± SD**	***P*-valuea**	**Mann-Whitney Test**	
					I – J	***P*-value**
I	1. Elementary School	6	2.5 ± 1.5	<0.001*	1–2	0.004*
					1–3	0.009*
	2. Middle School	28	4.43 ± 0.9		1–4	0.011*
					1–5	0.012*
	3. High School	137	4.01 ± 0.9		1–6	0.013*
					2–3	0.016*
					2–4	<0.001*
	4. College	1131	3.88 ± 0.9		2–5	0.001*
					2–6	0.212
					3–4	0.063
	5. M.S.	160	3.89 ± 0.9		3–5	0.186
					3–6	0.385
					4–5	0.848
	6. Ph.D.	28	4.14 ± 1		4–6	0.060
					5–6	0.091
II	1. Elementary School	6	3.67 ± 1.6	0.913		
	2.Middle School	28	3.57 ± 1.2			
	3. High School	138	3.38 ± 1.2			
	4. College	1131	3.39 ± 1			
	5. M.S.	160	3.41 ± 1			
	6.Ph.D.	28	3.32 ± 0.9			
III	1.Elementary School	6	3.17 ± 1.6	0.265		
	2.Middle School	29	3 ± 1.4			
	3.High School	138	2.73 ± 1.2			
	4.College	1132	2.79 ± 1.2			
	5.M S.	160	2.9 ± 1.2			
	6.Ph.D.	28	2.36 ± 0.9			

*:Significant at the 0.05 level; a: Kruskal-Wallis Test.
[**I.** Dangerousness of cholera; **II.** Concern towards cholera spreading in the country; **III.** Worrisome of getting infected].

fatal disease and reducing cholera-associated morbidity and mortality. In this regard and taking into consideration that the vast majority of Syrians are not seeking information from mass media, a shift to targeted and personalized media (mobile, SMS) may serve the purpose better.

Remarkably, the groups that chose higher scores for their knowledge through self-assessment, achieved better in the survey (except for married participants). This shows that these participants were precise in their assessments, confident in their knowledge, and knew exactly their abilities. This is critical as with proper motivation and efficient means of communication, the knowledge of Syrians can be elevated from the current inadequate level to the optimal level.

The cohort's attitude towards the disease showed seriousness. The majority recognized cholera as a dangerous disease, especially >40 years old and married participants. Data showed that the cohort was concerned about cholera spreading in the country, especially females, >40 years old, and married participants reflecting maturity and a high sense of responsibility. Furthermore, participants who used online search engines as the main source of information were more concerned, which may indicate that the search engine was more informative and detailed. The majority of the cohort were worried about getting infected, in particular females, >40 years old, and participants who used online search engines as the main source of information.

Unfortunately, the practices of the cohort were inadequate during the time of the cholera outbreak even though females, participants >40 years, and participants with higher education had better practices. Furthermore, they were more committed to changing some of their practices after cholera resurfaced towards better practices especially washing raw produce more thoroughly.

Therefore, the study demonstrated that even though the participants had serious attitudes towards cholera, their knowledge and practices were not at similar levels, unfortunately. Their knowledge of the disease was suboptimal and their practices were insufficient to prevent the cholera infection. More serious was the unwillingness to change bad practices expected to contribute to cholera further expansion in the country. Changing practices seems inevitable to win the battle against cholera. Raising awareness, providing medical support and vaccinating Syrians at high risk in the affected areas of the governorates are equally important.

4.1. Strengths and limitations of this study

In combating endemic disease, public awareness is critical for planning and implementation of preventive measures. Higher awareness and good adherence to precautionary measures lead to control outbreaks faster and better. The study is one of a few to investigate the level of awareness of cholera amongst Syrians and their attitudes and practices. Some of the main strengths of the current study are revealing gaps in the knowledge of cholera and shedding light on unsafe practices that may contribute to getting infected. The study adds value by exploring the impact of the source of information on the level of the cohort's knowledge. Important

Table 4
Correlations between Participants' demographics and their practices.

I. Practices of the cohort:														
	Gender		Age					Education						
	Male (%)	Female (%)	<18 (%)	18-25 (%)	26-40 (%)	41-60 (%)	>60 (%)	Elementary School (%)	Middle School (%)	High School (%)	College degree (%)	M.S. (%)	Ph.D. (%)	
1	<5	307 (64.2)	815 (79.1)	37 (77.1)	633 (74.1)	289 (69.3)	143 (84.1)	22 (91.7)	4 (66.7)	22 (75.9)	114 (82.6)	844 (74)	109 (67.7)	22 (78.6)
	5–10	107 (22.4)	179 (17.4)	9 (18.8)	168 (19.7)	90 (21.6)	21 (12.4)	1 (4.2)	0 (0)	4 (13.8)	17 (12.3)	227 (19.9)	34 (21.1)	6 (21.4)
	10–20	46 (9.6)	25 (2.4)	1 (2.1)	36 (4.2)	29 (7)	5 (2.9)	0 (0)	0 (0)	2 (6.9)	5 (3.6)	51 (4.5)	13 (8.1)	0 (0)
	>20	18 (3.8)	11 (1.1)	1 (2.1)	17 (2)	9 (2.2)	1 (0.6)	1 (4.2)	2 (33.3)	1 (3.4)	2 (1.4)	19 (1.7)	5 (3.1)	0 (0)
	P-value	<0.001*		0.026*				<0.001*						
2	A1	384 (80.7)	789 (77)	34 (70.8)	676 (79.3)	340 (82.1)	119 (70.8)	8 (33.3)	3 (50)	18 (62.1)	104 (75.4)	903 (79.4)	124 (78)	17 (63)
	A2	71 (14.9)	197 (19.2)	12 (25)	146 (17.1)	58 (14)	40 (23.8)	13 (54.2)	1 (16.7)	10 (34.5)	28 (20.3)	197 (17.3)	24 (15.1)	7 (25.9)
	A3	14 (2.9)	18 (1.8)	2 (4.2)	20 (2.3)	8 (1.9)	2 (1.2)	0 (0)	1 (16.7)	0 (0)	5 (3.6)	20 (1.8)	6 (3.8)	0 (0)
	A4	4 (0.8)	15 (1.5)	0 (0)	5 (0.6)	6 (1.4)	6 (3.6)	2 (8.3)	0 (0)	1 (3.4)	1 (0.7)	10 (0.9)	4 (2.5)	3 (11.1)
	A5	1 (0.2)	4 (0.4)	0 (0)	4 (0.5)	0 (0)	1 (0.6)	0 (0)	0 (0)	0 (0)	0 (0)	4 (0.4)	1 (0.6)	0 (0)
	A6	2 (0.4)	2 (0.2)	0 (0)	1 (0.1)	2 (0.5)	0 (0)	1 (4.2)	1 (16.7)	0 (0)	0 (0)	3 (0.3)	0 (0)	0 (0)
	P-value	0.156		<0.001*				<0.001*						
3	B1	388 (81.5)	798 (77.6)	35 (72.9)	678 (79.7)	337 (80.8)	126 (74.6)	13 (54.2)	2 (33.3)	18 (62.1)	99 (72.3)	913 (80.2)	127 (79.4)	21 (75)
	B2	68 (14.3)	193 (18.8)	10 (20.8)	145 (17)	59 (14.1)	38 (22.5)	10 (41.7)	2 (33.3)	9 (31)	35 (25.5)	186 (16.3)	23 (14.4)	6 (21.4)
	B3	17 (3.6)	26 (2.5)	2 (4.2)	24 (2.8)	17 (4.1)	1 (0.6)	0 (0)	1 (16.7)	1 (3.4)	2 (1.5)	31 (2.7)	9 (5.6)	0 (0)
	B4	0 (0)	7 (0.7)	0 (0)	1 (0.1)	2 (0.5)	4 (2.4)	0 (0)	0 (0)	1 (3.4)	1 (0.7)	3 (0.3)	1 (0.6)	1 (3.6)
	B5	0 (0)	3 (0.3)	0 (0)	2 (0.2)	1 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (0.3)	0 (0)	0 (0)
	B6	3 (0.6)	1 (0.1)	1 (2.1)	1 (0.1)	1 (0.2)	0 (0)	1 (4.2)	1 (16.7)	0 (0)	0 (0)	3 (0.3)	0 (0)	0 (0)
	P-value	0.017*		<0.001*				<0.001*						
II. Changing Practices after cholera re-emerged in the country														
	Gender		**Age**					**Education**						
	Male (%)	Female (%)	<18 (%)	18-25 (%)	26-40 (%)	41-60 (%)	>60 (%)	Elementary School (%)	Middle School (%)	High School (%)	College degree (%)	M.S. (%)	Ph.D. (%)	
4	Yes	369 (77.4)	878 (85.2)	30 (61.2)	704 (82.7)	345 (82.3)	150 (88.2)	20 (83.3)	3 (50)	22 (75.9)	107 (76.4)	958 (84)	129 (80.6)	22 (78.6)
	No	108 (22.6)	153 (14.8)	19 (38.8)	147 (17.3)	74 (17.7)	20 (11.8)	4 (16.7)	3 (50)	7 (24.1)	33 (23.6)	182 (16)	31 (19.4)	6 (21.4)
	P-value	<0.001*		0.001*				0.044*						
5	Yes	99 (20.8)	239 (23.2)	10 (20.4)	190 (22.3)	85 (20.3)	46 (27.1)	9 (37.5)	0 (0)	5 (17.2)	35 (25)	256 (22.5)	37 (23.1)	5 (17.9)
	No	378 (79.2)	792 (76.8)	39 (79.6)	661 (77.7)	334 (79.7)	124 (72.9)	15 (62.5)	6 (100)	24 (82.8)	105 (75)	884 (77.5)	123 (76.9)	23 (82.1)
	P-value	0.293		0.168				0.686						
6	Yes	150 (31.4)	349 (33.9)	17 (34.7)	302 (35.5)	112 (26.7)	59 (34.7)	9 (37.5)	3 (50)	11 (37.9)	42 (30)	388 (34)	48 (30)	4 (14.3)
	No	327 (68.6)	682 (66.1)	32 (65.3)	549 (64.5)	307 (73.3)	111 (65.3)	15 (62.5)	3 (50)	18 (62.1)	98 (70)	752 (66)	112 (70)	24 (85.7)
	P-value	0.356		0.035*				0.198						

(*continued on next page*)

Table 4 (*continued*)

I. Practices of the cohort:														
	Gender		Age					Education						
	Male (%)	Female (%)	<18 (%)	18-25 (%)	26-40 (%)	41-60 (%)	>60 (%)	Elementary School (%)	Middle School (%)	High School (%)	College degree (%)	M.S. (%)	Ph.D. (%)	
7	Yes	270 (56.6)	643 (62.4)	25 (51)	494 (58)	263 (62.8)	118 (69.4)	15 (62.5)	2 (33.3)	16 (55.2)	72 (51.4)	693 (60.8)	109 (68.1)	17 (60.7)
	No	207 (43.4)	388 (37.6)	24 (49)	357 (42)	156 (37.2)	52 (30.6)	9 (37.5)	4 (66.7)	13 (44.8)	68 (48.6)	447 (39.2)	51 (31.9)	11 (39.3)
	P-value	0.033*		0.032*				0.052						
8	Yes	268 (56.2)	661 (64.1)	25 (51)	541 (63.6)	244 (58.2)	102 (60)	17 (70.8)	2 (33.3)	16 (55.2)	76 (54.3)	713 (62.5)	101 (63.1)	17 (60.7)
	No	209 (43.8)	370 (35.9)	24 (49)	310 (36.4)	175 (41.8)	68 (40)	7 (29.2)	4 (66.7)	13 (44.8)	64 (45.7)	427 (37.5)	59 (36.9)	11 (39.3)
	P-value	0.003*		0.151				0.279						
9	Yes	291 (61)	694 (67.3)	30 (61.2)	570 (67)	256 (61.1)	116 (68.2)	16 (66.7)	3 (50)	18 (62.1)	91 (65)	759 (66.6)	101 (63.1)	14 (50)
	No	186 (39)	337 (32.7)	19 (38.8)	281 (33)	163 (38.9)	54 (31.8)	8 (33.3)	3 (50)	11 (37.9)	49 (35)	381 (33.4)	59 (36.9)	14 (50)
	P-value	0.017*		0.253				0.445						
10	Not changing	54 (11.3)	65 (6.3)	10 (20.4)	69 (8.1)	34 (8.1)	7 (4.1)	1 (4.2)	1 (16.7)	4 (13.8)	19 (13.6)	88 (7.7)	8 (5)	1 (3.6)
	Changing	422 (88.7)	965 (93.7)	39 (79.6)	781 (91.9)	384 (91.9)	163 (95.9)	23 (95.8)	5 (83.3)	25 (86.2)	121 (86.4)	1051 (92.3)	151 (95)	27 (96.4)
	P-value	0.001*		0.007*				0.062						

*. Significant at the 0.05 level.

I. **Practices of the cohort according to gender, age, and education:1. Eating out/Takeaway** (# of times per month); **2. Handling raw vegetables** (A1. Wash with water only; A2. Wash and peel; A3. Do not eat vegetables; A4. Wash and sterilize (with soap, vinegar, salt … etc); A5. Wash or peel; A6. Eat without washing or peeling); **3. Handling fresh fruits** (B1. Wash with water only; B2. Wash and peel; B3. Do not eat fresh vegetables; B4. Wash and sterilize (with soap, vinegar, salt, …etc); B5. Wash or peel, B6. Eat without washing or peeling).

II. Changing Practices after cholera re-emerged in the country: 4. Washing fresh produce (vegetables and fruits) more thoroughly; 5. Peeling vegetables and fruits before eating; 6. Avoiding eating undercooked seafood; 7. Minimizing eating out/takeaway; 8. Paying more attention to sources of drinking water; 9. Washing hands with soap more frequently; 10. Not changing practices.

associations have been revealed in the study including correlations with gender, age, and education. This may assist in preventive strategies in which control efforts can be focused on the most vulnerable groups to educate and raise awareness. However, the study has some important limitations including the restricted number of participants with the majority coming from Damascus (48.1%, Supplement B). These limitations do not allow the results to expand to the whole Syrian population. The survey was conducted online; only people with access to the interest could participate. Therefore, more widespread studies with much larger participation are needed to conclude the KAP of Syrians. Efforts should also focus on lower socioeconomic populations with no access to the internet in the affected governorates. The length of the survey with the complexity of some questions (with multiple-answers) seemed also challenging; participants needed to choose all correct answers to get the point allocated for the question, which required deep knowledge of the tested topic.

5. Conclusions

A sequence of crises in Syria left the country struggling with innumerable health concerns. Several infectious diseases, which once thought were eradicated, re-emerged in Syria during and succeeding the Syrian war; lastly, it was the blue death. Cholera re-emerging is posing a significant health problem to a delicate health system. Awareness of cholera amongst Syrians is mirrored in their knowledge of the disease, especially ways of transmission, symptoms, risk factors, and prevention. Partial knowledge of cholera was demonstrated in the study by the vast majority of participants; however, the average total knowledge of the cohort was only 40.39%, which is deficient. Schools/colleges and online search engines were associated with better knowledge; therefore, were regarded as more reliable sources of information. The cohort's attitude towards cholera showed seriousness: The cohort considered cholera very dangerous and viewed cholera re-emerging as a source of concern. Additionally, the cohort was worried about getting infected. However, several practices were risky and part of the cohort was not willing to change to stricter hygiene measures. As cholera imposes a health threat not only to Syrians but to the people of the whole Middle East, preventive strategies were suggested, mainly raising awareness with more focused media means and vaccination of people at high risk in the affected areas of the governorates.

Ethics approval and consent to participate

This study was approved by the ethics committee of the Arab International University (#8/10). All methods were carried out in accordance with the Declaration of Helsinki. All participants were fully informed about the study, and informed consent was obtained from each participant before answering the survey.

Author contribution statement

Lina Albitar: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Imad Addin Almasri: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Data availability statement

Data included in article/supplementary material/referenced in article.

Declaration of interest's statement

The authors declare no conflict of interest.

Key questions

What is already known about this topic?

Cholera is a communicable disease caused by *Vibrio cholerae* and is endemic to many countries in the world including Syria.

Cholera outbreaks and re-emergence are associated with poor sanitary and hygiene conditions thus reflective of public health.

Successive crises in Syria left the country struggling with innumerable health concerns.

What are the new findings?

Partial knowledge of cholera was demonstrated by the vast majority of the participants; however, the complete knowledge of the cohort was only 40.39%, which is suboptimal.

The cohort considered cholera very dangerous and viewed cholera re-emerging as a source of high concern. The cohort was worried about getting infected as well.

Sources of information including schools/colleges and online search engines were associated with better knowledge.

Cholera resurfacing invoked stricter hygiene measures and changes in practices of participants mainly females and >40 years old.

How this study might affect research, practice or policy

Educating the public is a critical element in combating the transmissible fatal cholera. Health-education activities and campaigns with a focus on transmission, symptoms, and prevention should be implemented.

A shift from mass media to targeted and personalized media (mobile and SMS) should be more effective and helpful in raising the awareness of the public.

Cholera may cause another humanitarian crisis in Syria after a decade of war that demolished major vital infrastructures in the country. Efforts must be rigorous in preventing cholera from spreading across borders and reaching other countries in the Middle East.

Cholera vaccination should be considered one of the most cost-effective preventive strategies and should be provided to people at high risk in the affected areas in governorates (especially Aleppo, Deir-ez-Zor, Ar-Raqqa and Al-Hasakeh).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e18278.

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