

RESEARCH

Open Access



Assessment of hand hygiene awareness and practice levels amid the COVID-19 period: a comparative study of the public in Jordan and the United Arab Emirates

Nisreen Alwan^{1*}, Rina Salhab², Fathima Hussain¹, Aseel A. Takshe² and Wissam Ghach^{2*}

Abstract

Background Hand hygiene is essential as a preventive measure in reducing healthcare-associated infections and infectious diseases such as COVID-19. While many studies have been conducted in clinical and educational settings, there has been a lack of research targeting hand hygiene awareness and practices in the general community within the Arab world. In the United Arab Emirates (UAE) and Jordan where various and heavily populated cities pose unique public health concerns, establishing strong hand hygiene habits is critical for protecting the population's health. The purpose of this study is to assess, for the first time, the public levels of awareness and practices of hand hygiene in the in UAE and Jordan during the spread of COVID-19 pandemic.

Methods The study was carried out between October 2022 and June 2023 via an online Google survey using a convenience sampling. Data from respondents in Jordan ($n=725$) and the UAE ($n=520$) were analyzed using SPSS (Version 28). ANOVA, Mann-Whitney, and Kruskal-Wallis tests were used to test if significant differences in awareness levels existed across different demographic groups in Jordan/UAE and between them. Pearson's chi-square test was applied to assess differences among the sample characteristics and participants' practice of hand hygiene.

Results The evaluation of hand hygiene awareness between the two populations demonstrated a slightly higher levels of awareness in UAE as compared to Jordan (average-to-good awareness: 87.8% vs. 82.5%). Significant differences in terms of age group, were revealed in both countries ($P < 0.05$). Regarding education level, there was a significant difference among the participants in Jordan only ($P < 0.05$) as shown by the Kruskal-Wallis test. The majority of the study populations demonstrated high commitment to WHO hygiene recommendations, with 98.2% of participants in the UAE and 92.4% in Jordan reported handwashing using soap and water. Statistical analyses revealed some gender, age, educational level, and regional differences.

Conclusions In Jordan and the UAE, awareness and practices around hand hygiene among various demographic groups show room for improvement, with overall awareness levels ranging from average to good during the

*Correspondence:

Nisreen Alwan
nisreen.alwan@adu.ac.ae
Wissam Ghach
wissam.ghach@cud.ac.ae

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

pandemic of COVID-19. Females, higher education level (Master's and Ph.D. degree holders), and age (50+ years old) were significant factors influencing awareness and hygiene practices. To further enhance hand hygiene awareness and practices, particularly among younger and less-educated individuals, awareness campaigns and health education programs are recommended. These findings can aid policymakers in designing effective, targeted strategies for promoting public health measures across diverse community sectors to prevent the spread of infectious diseases.

Keywords COVID-19, Hand hygiene, Public Community, UAE, Jordan

Background

Throughout history, infectious disease outbreaks and pandemics like COVID-19, the plague, cholera, and tuberculosis have caused significant mortality and morbidity in people all around the world [1, 2]. According to the WHO statistics, the global rate of COVID-19 infections reached over 777,000,000 cases including over 7 million death cases. In the UAE, over 1 million confirmed cases of COVID-19 were reported with 2,349 death cases while in Jordan, over 1,700,000 confirmed cases of COVID-19 with 14,122 deaths [3, 4]. Infectious diseases such as COVID-19 not only damage host tissues, but can also trigger exaggerated immune responses, aid in infection by other pathogens, and lead to enduring health outcomes like persistent infections and increased susceptibility to specific ailments, such as liver cirrhosis and cancer [2, 5, 6]. Therefore, understanding the complex relationships that exist between infectious agents and human health is essential to creating methods that effectively prevent and control infectious diseases.

With millions of documented cases and deaths, the recent COVID-19 pandemic, caused by the SARS-CoV-2 virus, serves as an alarming reminder of the disastrous impact that infectious agents may have on people's health [7, 8]. The emergence of novel SARS-CoV-2 strains, including Alpha, Beta, Gamma, Eta, and Delta, and many others indicates the continuing danger linked to infectious diseases and the necessity of implementing effective preventative measures [9, 10].

Vaccination, practicing good hygienic practices, adopting healthy lifestyle habits, and complying to public health guidelines and interventions are among the key strategies for preventing infectious diseases including COVID-19 [11, 12]. Hand hygiene, in particular, plays a vital role in infection prevention. Regular handwashing and the use of hand sanitizers are effective methods for reducing the spread of pathogens [11, 13].

Hand hygiene is essential in preventive measures as demonstrated by Issa et al. (2023) and Chakma et al. (2024), who highlighted its effectiveness in reducing healthcare-associated infections and infectious diseases [14, 15]. Studies conducted on hand hygiene have highlighted both the potential and challenges of expanding hand hygiene habits across various contexts pre-, and during COVID-19. Hand hygiene practices have been extensively researched in the past within clinical settings

in Bahrain, Egypt, Jordan, Lebanon, Qatar, Saudi Arabia, and United Arab Emirates (UAE) [16–22]. On the other hand, there have been some studies before, and during COVID-19 related to hand hygiene in schools and universities in Bahrain, Egypt, Jordan, Lebanon, Qatar, Turkey, Saudi Arabia, and United Arab Emirates [2, 23–27]. Although some studies have studied the prevalence and factors influencing hand hygiene behavior among the general populations in India, South Korea and Indonesia [28–30]. The research showed that there has been a significant increase in the hand hygiene awareness after the pandemic. Moreover, demographic factors were associated with hand hygiene behaviors.

The impact of good hygienic practices goes beyond such contexts, affecting the community in general. Effective hand hygiene not only decreases the spread of infectious illnesses but also minimizes medical costs and improves the community's health. Despite having many studies in the above mentioned educational and clinical settings, none have targeted hand hygiene awareness and practices in the community especially in Jordan and UAE where a high incidence of COVID-19 infections was expected as a result of religious activities (e.g. pilgrimages and regular prayers in mosques and churches), high cultural diversity in the UAE [31], and lack of humanitarian quality in Syrian refugee camps in Jordan [32]. Thus, establishing strong hand hygiene habits is critical for protecting the population's health in these countries. Building on this framework, the purpose of this study is to assess, for the first time, the levels of awareness and practices of hand hygiene in the public community in UAE and Jordan.

Methods

A cross-sectional study was carried out from October 2022 till June 2023 to assess the levels of awareness and practices regarding hand hygiene among public in Jordan and the UAE. Using a convenience sampling technique and google survey, study population were reached via social media platforms (Facebook, Instagram, Twitter, and LinkedIn) and through the research departments of the academic institutions in Jordan and UAE.

Study population

The study population was divided into two groups (A and B) according to the geographical location of the

respondents where population A included 725 respondents, aged 18 years or older, who participated from the twelve governorates of Jordan, and population B included 520 respondents, aged 18 years or older, who participated from the seven UAE emirates. Exclusion criteria included participants aged below 18 years old. Then, participants were further stratified by gender, age, educational level, and place of residence according to governorate or emirate.

Study tool

The validated questionnaire applied in this study was developed and validated (content validity) by Mahdi et al. (2021) [33]. The study tool was divided into several sections: (1) participants' profiles including gender, age, educational level, governorate/emirate, and previous experience with SARS-CoV-2 infection; (2) sources of information regarding preventive measures of COVID-19; (3) 12 awareness-related items (Yes/No) related to risks, practices, and common misconceptions about hand hygiene; and (4) 12 practice-related items related to the safe use of hand hygiene products (water only, soap and water, and alcohol-based hand rubs [ABHRs]).

To estimate awareness levels, each correct item was assigned 1 point (0 point for incorrect responses). For each respondent, the total awareness score was then calculated on a scale of 0 to 12. The average awareness score was divided into intervals: weak [0–5], moderate [6–9], and good [10–12].

Statistical analyses

The Statistical Package for the Social Sciences, version 28 (SPSS, IBM Corp., Chicago, IL, USA) was used to analyze the collected data. Percentage frequencies were calculated to present the participants' sociodemographic profiles. Continuous variables, including the total hand hygiene awareness score, were summarized using the mean $\pm$ standard deviation (SD) and median with interquartile range (IQR). Descriptive analyses in the study tables represented the levels and scores of awareness and the frequency distribution of hand hygiene practice methods. Regarding awareness, the Mann-Whitney test was employed to determine significant differences in mean scores by gender, while the Kruskal-Wallis test was used to assess mean differences across other variables. Prior to these tests, normality and homogeneity of variances were checked using Kolmogorov-Smirnov/Shapiro-Whilk and Levene's tests, respectively, with violations in assumptions observed for $P < 0.05$. Pearson's chi-square test was applied to assess differences among the sample characteristics and participants' practice of hand hygiene.

Additionally, univariate ANOVA was conducted to examine significant differences of awareness levels in the

studied variables between population A and population B (Gender, age group, and educational level only as the emirate and governorate cannot be compared). All data analyses were performed at a significance level of 0.05.

Ethical considerations

The study protocol received ethical approval from the Institutional Review Board (IRB) at Abu Dhabi University (ADU) (CAS-22-08-00023) and the Hashemite University (2/9/2021/2022). An informed consent form (first page of the google survey) outlined the aim of study, risks, benefits, and confidentiality measures. The form also included a statement emphasizing that participation was voluntary, and submission of the questionnaire signified the participant's consent to take part in the study.

Results

Demographics and sources of COVID-19 information

Table 1 shows the frequencies and percentage frequency of population demographics in Jordan and the UAE. The gender distribution shows a higher proportion of females with 62.6% in Jordan and 63.8% in the UAE. The majority of the study populations in Jordan (71.7%) and UAE (80.2%) was between 18 and 29 with an equal median age of 22. In terms of geographic distribution, the majority of the participants reside in Irbid-Jordan (59.0%) and Dubai-UAE (47.5%). Furthermore, the highest proportion of both populations held a bachelor's degree, with 76.4% in Jordan and 67.5% in the UAE with no illiterate participants in both countries. Regarding COVID-19 diagnosis, more than half of the study populations (57.0% Jordan, and 53.7% UAE) had claimed their previous infection with SARS-CoV-2 virus.

In terms of the preferred sources of COVID-19 information (Fig. 1), population B demonstrated a slightly higher frequency compared to population A in engaging with several information resources except for TV (Jordan: 39%; UAE: 35.6%) and Healthcare Professionals (Jordan: 38.8%; UAE: 31.2%). Social media platforms (Jordan: 56.7%; UAE: 66.5%) were the most utilized sources, followed by the Ministry of Public Health (Jordan: 49.4%; UAE: 62.1%), internet search engines (Jordan: 49.8%; UAE: 59.0%), and WHO/CDC webpages (Jordan: 31.2%; UAE: 38.5%). Personal experience was the least preferred source of information in Jordan (28.8%) compared to both personal experience and healthcare professionals in the UAE (31.2%).

Evaluation of awareness (A)

The evaluation of hand hygiene awareness between the two populations is represented in Table 2. Population B (UAE) demonstrated a slightly higher levels of awareness compared to population A (Jordan). This is particularly evident in the awareness of the recommended alcohol

Table 1 Frequencies and percent frequencies of participants' characteristics (gender, age group, governorate/emirate, and education level) in populations A (Jordan) and B (UAE)

Population A-Jordan (n = 725)			Population B-UAE (n = 520)		
Variables	Number	%	Variables	Number	%
Gender			Gender		
Male	271	37.4%	Male	188	36.2%
Female	454	62.6%	Female	332	63.8%
Age-Median (range, minimum, maximum)			Age-Median (range, minimum, maximum)		
22 (46, min.: 18; max: 64)			22 (51.00, min.: 18; max: 69)		
18–29	520	71.7%	18–29	417	80.2%
30–39	141	19.4%	30–39	36	6.9%
40–49	38	5.2%	40–49	41	7.9%
50–64	26	3.6%	50–64	24	4.6%
65–74	-	-	65–74	2	0.4%
Governorate			Emirate		
Ajloun	42	5.8%	Abu Dhabi	165	31.7%
Amman	108	14.9%	Dubai	247	47.5%
Aqaba	9	1.2%	Sharjah	59	11.3%
Balqa	11	1.5%	Ajman	20	3.8%
Irbid	428	59.0%	Fujairah	7	1.3%
Jarash	28	3.9%	Ras Al-Khaimah	20	3.8%
Karak	6	0.8%	Umm Al-Quwain	2	0.4%
Maan	1	0.1%			
Madaba	3	0.4%			
Mafrq	29	4.0%			
Tafleeh	4	0.6%			
Zarqa	56	7.7%			
Education level			Education level		
Illiterate	-	-	Illiterate	-	-
High school	24	3.3%	High school	92	17.7%
Bachelor's degree	554	76.4%	Bachelor's degree	351	67.5%
Master's degree	80	11.0%	Master's degree	59	11.3%
PhD	64	8.8%	PhD	15	2.9%
Pharm D	-	-	Pharm D	-	-
Post-doc	3	0.4%	Post-doc	3	0.6%
Have you been diagnosed with COVID-19?			Have you been diagnosed with COVID-19?		
Yes	413	57.0%	Yes	279	53.7%
No	312	43.0%	No	241	46.3%

% in the ABHR (A4: 56.9% UAE vs. 40.6% Jordan); in hand washing protocols (A5: 78.7% UAE vs. 75.9% Jordan); in transmission of HIV/AIDS through poor hand hygiene (A2: 70.4% UAE vs. 59.2% Jordan), and the risk of using bleach for hand disinfection (A12: 62.9% UAE vs. 39.9% Jordan). The highest awareness in both populations was evident in the understanding of COVID-19 transmission through poor hand hygiene (A1: 92.9% UAE vs. 92.3% Jordan). However, awareness of hand hygiene protocol was more accurately identified by population A (A6: 52.0% Jordan vs. 28.7% UAE). Similarly, population A demonstrated higher awareness of hand hygiene protocol (A7: 52.6% Jordan vs. 50.8% UAE) and UV use for hand disinfection (A11: 67.3% Jordan vs. 64.0% UAE). Both populations showed the lowest awareness of the effectiveness of antiseptic soap (A8: 23.7% Jordan vs.

26.3% UAE). By comparing the two study populations in Table 2, results indicate that a higher mean score of 7.48 ± 1.706 (Average-to-good awareness: 87.8%) compared to 6.96 ± 1.702 in Jordan (Average-to-good awareness: 82.5%) was recorded.

According to Table 3, both genders recorded no significant differences in both countries as revealed by the Mann-Whitney tests ($P > 0.05$). Another notable variable was age groups which had a significant difference ($P < 0.05$) without a clear relationship with the variation of age as shown by the Kruskal-Wallis tests. When considering geographical differences, Kruskal-Wallis tests revealed no significant differences in both populations ($P > 0.05$). Regarding education level, there was a significant difference among the participants in Jordan ($P < 0.05$) as shown by the Kruskal-Wallis tests, where the

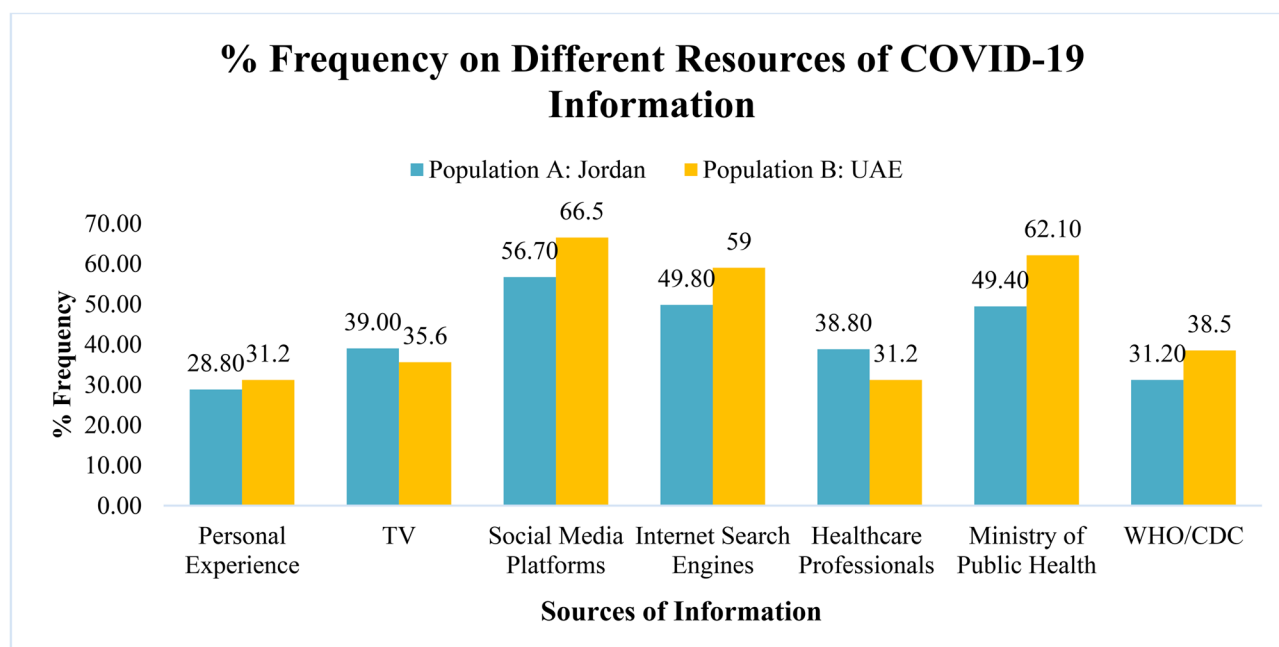


Fig. 1 Bar graph representing the respondents' reliance (% frequency) on different resources of COVID-19 information

Table 2 Frequencies and percent frequencies of the participants' awareness regarding hand hygiene in populations A (Jordan) and B (UAE)

Awareness	Correct Responses-Population A (Jordan)		Correct Responses-Population B (UAE)	
	Frequency	%	Frequency	%
A1 - Respiratory infections including "COVID-19" can be transmitted by poor hand hygiene (Yes, No).	669	92.3%	483	92.9%
A2 - HIV/AIDS can be transmitted by poor hand hygiene (Yes, No).	429	59.2%	366	70.4%
A3 - Always keeping your hands clean may lower your body defense mechanism (Yes, No).	346	47.7%	301	57.9%
A4- ABHR containing less than 60% of alcohol is sufficient for hands disinfection (Yes, No).	294	40.6%	296	56.9%
A5 - Washing off with soap and water from 20 to 40 s is sufficient for hands disinfection (Yes, No).	550	75.9%	409	78.7%
A6 - Hands should be held underwater while lathering with soap (Yes, No).	377	52.0%	149	28.7%
A7 - The temperature of the water does not make difference in terms of the cleansing effect of handwashing (Yes, No).	381	52.6%	264	50.8%
A8 - Antiseptic/antibacterial soaps are more effective at preventing illness than washing with plain soap and water (Yes, No).	172	23.7%	137	26.3%
A9 - Using ABHR may not be as effective as the use of soap and water when hands are visibly dirty (Yes, No).	512	70.6%	384	73.8%
A10 - There is no need to clean our hands after sneezing, coughing, or shaking hands (Yes, No).	545	75.2%	442	85.0%
A11 - Ultra-violet (UV) lamps should not be used to disinfect our hands or other areas of our skin (Yes, No).	488	67.3%	333	64.0%
A12 - Spraying and introducing bleach or another surface disinfectant into our hands is safe and it will protect us against COVID-19 and other infections (Yes, No).	289	39.9%	327	62.9%
Awareness levels				
Poor (score < 6 points)	127	17.5%	63	12.1%
Average (6 < score < 9 points)	548	75.6%	403	77.4%
Good (score ≥ 10 points)	50	6.8%	54	10.4%

Mean score of hand hygiene awareness ($\pm$ SD): 6.96 $\pm$ 1.702 (Jordan)

Mean score of hand hygiene awareness ($\pm$ SD): 7.48 $\pm$ 1.706 (UAE)

Table 3 Statistical tests showing awareness median scores with participants' characteristics (gender, age, governorate/emirate, education level) in populations A (Jordan) and B (UAE)

Variables	Awareness-Population A (Jordan)			Variables	Awareness-Population B (UAE)		
	Median	IQR	P-value*		Median	IQR	P-value*
Gender				Gender			
Male	7.0	2.00	0.173	Male	7.0	3.00	0.20
Female	7.0	2.00		Female	8.0	3.00	
Age group				Age group			
18-29	7.0	2.00	<0.001	18-29	8.0	3.00	0.034
30-39	7.0	3.00		30-39	8.0	2.75	
40-49	7.0	2.25		40-49	8.0	2.00	
50-64	8.0	2.25		50-64	8.0	1.75	
65-74	-	-		65-74	8.0	-	
Governorate				Emirate			
Ajloun	7.0	2.00	0.612	Abu Dhabi	8.0	3.00	0.217
Amman	7.0	2.00		Dubai	8.0	2.00	
Aqaba	6.0	2.00		Sharjah	7.0	3.00	
Balqa	7.0	2.00		Ajman	7.0	3.00	
Irbid	7.0	2.00		Fujairah	7.0	3.00	
Jarash	7.0	1.75		Ras Al-Khaimah	7.5	2.00	
Karak	7.5	2.25		Umm Al-Quwain	8.0	-	
Maan							
Madaba	7.0	-					
Mafrq	7.0	3.00					
Tafleh	7.0	4.25					
Zarqa	7.0	2.50					
Education level				Education level			
Illiterate	-	-	<0.001	Illiterate	-	-	0.097
High school	7.0	1.00		High school	8.0	3.00	
Bachelor's degree	7.0	2.00		Bachelor's degree	8.0	3.00	
Master's degree	8.0	3.00		Master's degree	8.0	2.00	
PhD	8.0	2.00		PhD	8.0	2.00	
Pharm D	-	-		Pharm D	-	-	
Post-doc	7.0	-		Post-doc	7.0	-	

*Values in bold indicate a significant value of $P < 0.05$

respondents with age group 50–64 years old recorded higher median scores of awareness (8.0 with IQR of 2.25) (Table 3). On the other hand, no significant difference existed among the participants of the UAE ($P > 0.05$).

Upon comparing if significant differences in the awareness levels occurred between the gender in the two populations, the results of the univariate ANOVA (Table 4) indicated an effect of the country on the mean awareness score ($P < 0.05$). Regarding the age group, there was an effect of country on the mean awareness scores and a difference in the mean awareness score among the age groups ($P < 0.05$). As for the educational level, the results of the univariate ANOVA (Table 4) indicated a significant effect on the interaction of educational level and country on the mean awareness score ($P = 0.008 < 0.05$).

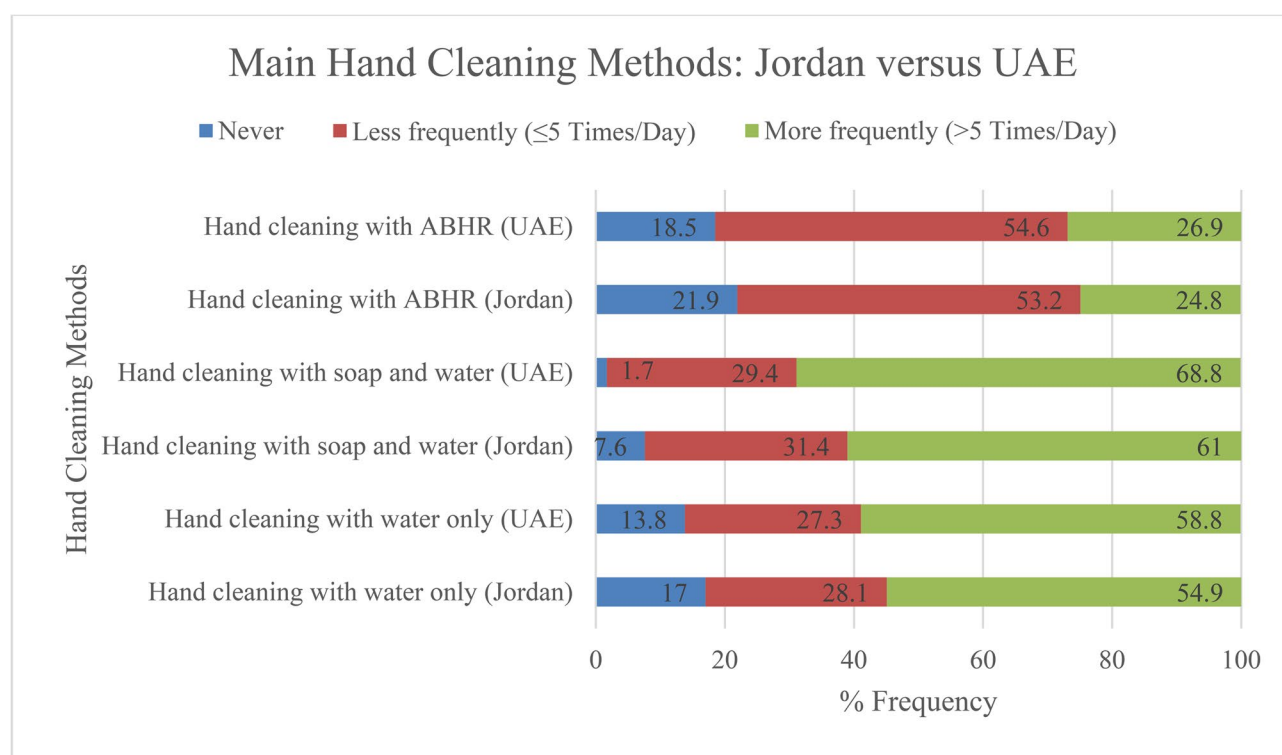
Evaluation of performance (P)

According to Fig. 2, the majority of the study population demonstrated high commitment to WHO hygiene recommendations (2021) [34], with 98.2% of participants in the UAE and 92.4% in Jordan reported handwashing using soap and water. Table 5 represents the statistical comparison of hand hygiene practices across genders. In Jordan, the study population showed statistical significance for all hand hygiene practices as revealed by the Pearson's chi-square tests ($P < 0.05$), with females more likely than males to use water alone, soap and water, and ABHR. However, in the UAE, statistical significance was found for soap and water use only ($P = 0.003 < 0.05$). Table 6 shows the frequency and percent frequency of hand hygiene practices across age. The statistical analysis in Jordan (Table 6) indicates the preference of using ABHR among almost all age groups ($P < 0.05$). However, there was no statistical significance for water alone and soap with water ($P > 0.05$). Surprisingly, statistical

Table 4 Univariate ANOVA results for the comparison of awareness levels of each of the tested variables between the two populations

Awareness levels			
Gender			
Source	F	P-value*	Conclusion
Country	60.44	<0.001	There is an effect of country on the mean awareness score of the public.
Gender	0.012	0.911	There is no difference in the mean awareness score of the public between males and females.
Country * Gender	3.60	0.058	There is no interaction of gender and country on the mean awareness score of the public.
Age group			
Source	F	P-value *	Conclusion
Country	7.16	0.008	There is an effect of country on the mean awareness score of the public.
Age group	7.95	<0.001	There is a difference in the mean awareness score of the public in terms of age group.
Country * Age group	0.87	0.46	There is no interaction of age group and country on the mean awareness score of the public.
Education level			
Source	F	P-value *	Conclusion
Country	0.43	0.51	There is no effect of country on the mean awareness score of the public
Education level	1.51	0.18	There is no difference in the mean awareness score of the public in terms of educational level
Country * Education level	6.97	0.008	There is interaction of education level and country on the mean awareness score of the public

*Values in bold show significant *P*-values less than 0.05

**Fig. 2** Percent frequency of hand cleaning methods applied by the study population in Jordan and UAE

significance was observed for water alone and soap and water use ($P < 0.05$), while no significant differences ($P > 0.05$) were found for ABHR use across age groups in the UAE. Table 7 shows the relationship between hand hygiene practices and education level. In Jordan, statistical significance was observed for soap and water use and ABHR use ($P < 0.05$). In the UAE, no statistically significant differences were found across education levels. As indicated in Table 8, there is no significant differences

among both governorates in Jordan/emirates in the UAE and hand hygiene practices.

Figure 3 represents the practices of hand hygiene reported by the study population using nine key actions in the two study populations. The findings reveal strong adherence to hand hygiene practices in compliance with CDC recommendation to use both soap and water [35]. The highest rate of washing with soap and water was recorded after meals (83.7% Jordan vs. 84% UAE), before

Table 5 Frequency and percent frequency of hand hygiene practice methods based on gender in population A-jordan ($n = 725$) and population B-UAE ($Nn = 520$)

Population A- Jordan					Population B-UAE				
Hand hygiene practices by gender	Never n (%)	Less frequently (≤ 5 times/day) n (%)	More frequently (> 5 times/day) n (%)	P -value*	Hand hygiene practices by gender	Never n (%)	Less frequently (≤ 5 times/day) n (%)	More frequently (> 5 times/day) n (%)	P -value*
Water only									
Male	32 (1.8)	79 (29.2)	160 (59.0)	0.016	Male	19 (10.1)	47 (25.00)	122 (64.9)	0.068
Female	91 (20.1)	125 (27.5)	238 (52.4)		Female	53 (16.0)	95 (28.6)	184 (55.4)	
Soap and water									
Male	17 (6.3)	105 (38.7)	149 (55.0)	0.004	Male	7 (3.7)	65 (34.6)	116 (61.7)	0.003
Female	38 (8.4)	123 (27.1)	293 (64.5)		Female	2 (0.6)	88 (26.5)	242 (72.9)	
ABHR									
Male	51 (18.9)	134 (49.4)	86 (31.7)	0.003	Male	40 (21.3)	99 (52.7)	49 (26.0)	0.460
Female	108 (23.8)	252 (55.5)	94 (20.7)		Female	56 (16.9)	185 (55.7)	91 (27.4)	

*Values in bold indicate a significant value of $P < 0.05$ **Table 6** Frequency and percent frequency of hand hygiene practice methods based on age group in population A-jordan ($n = 725$) and population B-UAE ($n = 520$)

Population A- Jordan					Population B-UAE				
Hand hygiene practices by age group	Never n (%)	Less frequently (≤ 5 times/day) n (%)	More frequently (> 5 times/day) n (%)	P -value*	Hand hygiene practices by age group	Never n (%)	Less frequently (≤ 5 times/day) n (%)	More frequently (> 5 times/day) n (%)	P -value*
Water only									
18–29	90 (17.3)	154 (29.6)	276 (53.1)	0.702	18–29	50 (12.0)	120 (28.8)	247 (59.2)	< 0.001
30–39	21 (14.9)	34 (24.1)	86 (61.0)		30–39	15 (41.7)	7 (19.4)	14 (38.9)	
40–49	8 (21.1)	10 (26.3)	20 (52.6)		40–49	5 (12.2)	11 (26.8)	25 (61.0)	
50–64	4 (15.4)	6 (23.1)	16 (61.5)		50–64	1 (4.2)	4 (16.7)	19 (79.2)	
65–74	-	-	-		65–74	1 (50.0)	-	1 (50.0)	
Soap and water									
18–29	47 (9.0)	170 (32.7)	303 (58.3)	0.158	18–29	5 (1.2)	123 (29.5)	289 (69.3)	< 0.001
30–39	6 (4.3)	40 (28.4)	95 (67.4)		30–39	2 (5.6)	8 (22.2)	26 (72.2)	
40–49	1 (2.6)	9 (23.7)	28 (73.7)		40–49	-	12 (29.3)	29 (70.7)	
50–64	1 (3.8)	9 (34.6)	16 (61.5)		50–64	1 (4.2)	10 (41.7)	13 (54.2)	
65–74	-	-	-		65–74	1 (50.0)	-	1 (50.0)	
ABHR									
18–29	137 (26.3)	275 (52.9)	108 (20.8)	< 0.001	18–29	80 (19.2)	220 (52.8)	117 (28.1)	0.694
30–39	13 (9.2)	73 (51.8)	55 (39.0)		30–39	6 (16.7)	21 (58.3)	9 (25.0)	
40–49	6 (15.8)	21 (55.3)	11 (28.9)		40–49	5 (12.2)	26 (63.4)	10 (24.4)	
50–64	3 (11.5)	17 (65.4)	6 (23.1)		50–64	4 (16.7)	16 (66.7)	4 (16.7)	
65–74	-	-	-		65–74	1 (50.0)	1 (50.0)	-	

*Values in bold indicate a significant value of $P < 0.05$

meals (75.3% Jordan vs. 76% UAE), and after toileting (77.2% Jordan vs. 90.6% UAE). Soap and water were also used when hands were visibly dirty (71% Jordan vs. 87.7% UAE) and after waste disposal (58.2% Jordan vs. 79.2% UAE). On the other hand, participants used ABHR after touching surfaces (26.2% Jordan vs. 31.5% UAE) and caring for a patient (39% Jordan vs. 31.7% UAE) and after shaking hands (28.6% Jordan vs. 33.5% UAE). Notably, a small percentage did not practice hand hygiene in certain

scenarios, with the highest non-compliance after hand-shaking (21.5% Jordan vs. 26.2% UAE).

Discussion

Awareness of hand hygiene

This study was conducted to examine the awareness and practices of hand hygiene within public communities in Jordan and the UAE, with an aim to provide insights for effective pandemic prevention strategies. The data highlights significant findings in hand hygiene awareness,

Table 7 Frequency and percent frequency of hand hygiene practice methods based on education level in population A-jordan ($n = 725$) and population B-UAE ($n = 520$)

Population A- Jordan					Population B-UAE				
Hand hygiene practices by education level	Never n (%)	Less frequently (≤ 5 times/day) n (%)	More frequently (> 5 times/day) n (%)	P -value*	Hand hygiene practices by education level	Never n (%)	Less frequently (≤ 5 times/day) n (%)	More frequently (> 5 times/day) n (%)	P -value*
Water only									
Illiterate	-	-	-	0.078	Illiterate	-	-	-	0.381
High school	8 (33.3)	8 (33.3)	8 (33.3)		High school	16 (17.4)	20 (21.7)	56 (60.9)	
Bachelor's degree	90 (16.2)	166 (30.0)	298 (53.8)		Bachelor's degree	42 (12.0)	104 (29.6)	205 (58.4)	
Master's degree	16 (20.0)	15 (18.8)	49 (61.3)		Master's degree	11 (18.6)	12 (20.3)	36 (61.0)	
PhD	8 (12.5)	15 (23.4)	41 (64.1)		PhD	3 (20.0)	4 (26.7)	8 (53.3)	
Pharm D	-	-	-		Pharm D	-	-	-	
Post-doc	1 (33.3)	0	2 (66.7)		Post-doc	-	2 (66.7)	1 (33.3)	
Soap and water									
Illiterate	-	-	-	0.005	Illiterate	-	-	-	0.060
High school	4 (16.7)	13 (54.2)	7 (29.2)		High school	1 (1.1)	26 (28.3)	65 (70.7)	
Bachelor's degree	45 (8.1)	181 (32.7)	328 (59.2)		Bachelor's degree	5 (1.4)	104 (29.6)	242 (68.9)	
Master's degree	2 (2.5)	16 (20.0)	62 (77.5)		Master's degree	1 (1.7)	16 (27.1)	42 (71.2)	
PhD	4 (6.3)	17 (26.6)	43 (67.2)		PhD	2 (13.3)	5 (33.3)	8 (53.3)	
Pharm D	-	-	-		Pharm D	-	-	-	
Post-doc	-	1 (33.3)	2 (66.7)		Post-doc	-	2 (66.7)	1 (33.3)	
ABHR									
Illiterate	-	-	-	0.002	Illiterate	-	-	-	0.743
High school	4 (16.7)	15 (62.5)	5 (20.8)		High school	15 (16.3)	48 (52.2)	29 (31.5)	
Bachelor's degree	139 (25.1)	287 (51.8)	128 (23.1)		Bachelor's degree	69 (19.7)	187 (53.3)	95 (27.1)	
Master's degree	4 (5.0)	44 (55.0)	32 (40.0)		Master's degree	9 (15.3)	37 (62.7)	13 (22.0)	
PhD	11 (17.2)	39 (60.9)	14 (21.9)		PhD	3 (20.0)	10 (66.7)	2 (13.3)	
Pharm D	-	-	-		Pharm D	-	-	-	
Post-doc	1 (33.3)	1 (33.3)	1 (33.3)		Post-doc	-	2 (66.7)	1 (33.3)	

*Values in bold indicate a significant value of $P < 0.05$

informed by WHO's preventive guidelines. The study aims to provide governmental and non-governmental authorities in both countries with evidence on hand hygiene awareness and practices, supporting efforts to develop educational campaigns that can reduce infection rates and promote health within both communities. These findings align with the UN's Sustainable Development Goal 3 (SDG 3), which focuses on promoting health and well-being.

The rapid global spread of COVID-19 posed a serious health threat. In response, government and non-government organizations launched numerous virtual campaigns during lockdowns to increase COVID-19 awareness [36, 37]. In this study, participants predominantly used social media platforms and internet search engines for information on COVID-19, while a less percentage of the study population got information from reliable sources such as government health departments or the WHO. This preference poses challenges, as unverified online information can spread misinformation [38, 39]. The study suggests that future educational and awareness campaigns, both virtual and in-person, could benefit from collaboration

with academic institutions and public health agencies to ensure accurate, verified information reaches various communities and broader public.

Both study populations showed moderate level of hand hygiene awareness where the study population in the UAE (mean score: 7.48 ± 1.706) exhibited a slightly higher awareness level compared to Jordan (mean score: 6.96 ± 1.702). Participants in both Jordan and the UAE demonstrated highest awareness level regarding COVID-19 transmission through poor hand hygiene, which is consistent with a previous study by Alwan et al. (2024) [23]. However, poor-to-average awareness was detected in numerous aspects associated with the misconceptions of hand hygiene and proper handwashing techniques as compared to the Lebanese study [23]. For example, a notable area of misconception in KSA was the low awareness of the alcohol concentration utilized for effective disinfection of hand sanitizers. Public communities were aware that antibacterial soaps would be more effective than plain soap and water [40]. Alarmingly, a very low percentage of participants were aware that bare hand skin should not be disinfected via bleach, other

Table 8 Frequency and percent frequency of hand hygiene practice methods based on governorates/emirates in population A-jordan (N= 725) and population B-UAE (N= 520)

Population A- Jordan					Population B-UAE				
Hand hygiene practices by governorate	Never <i>n</i> (%)	Less frequently (≤ 5 times/day) <i>n</i> (%)	More frequently (> 5 times/day) <i>n</i> (%)	<i>P</i> -value*	Hand hygiene practices by emirate	Never <i>n</i> (%)	Less frequently (≤ 5 times/day) <i>n</i> (%)	More frequently (> 5 times/day) <i>n</i> (%)	<i>P</i> -value*
Water only									
Ajloun	12 (28.6)	7 (16.7)	23 (54.8)	0.201	Abu Dhabi	20 (12.1)	40 (24.2)	105 (63.6)	0.265
Amman	16 (14.8)	41 (38.0)	51 (47.2)		Dubai	38 (15.4)	71 (28.7)	138 (55.9)	
Aqaba	-	5 (55.6)	4 (44.4)		Sharjah	8 (13.6)	12 (20.3)	39 (66.1)	
Balqa	3 (27.3)	2 (18.2)	6 (54.5)		Ajman	1 (5.0)	6 (30.0)	13 (65.0)	
Irbid	74 (17.3)	125 (29.2)	229 (53.5)		Fujairah	-	4 (57.1)	3 (42.9)	
Jarash	3 (10.7)	6 (21.4)	19 (67.9)		Ras Al-Khaimah	5 (25.0)	8 (40.0)	7 (35.0)	
Karak	-	1 (16.7)	5 (83.3)		Umm Al-Quwain	-	1 (50.0)	1 (50.0)	
Maan	-	-	1 (100.0)						
Madaba	-	1 (33.3)	2 (66.7)						
Mafrq	4 (13.8)	6 (20.7)	19 (65.5)						
Tafileh	1 (25.0)	1 (25.0)	2 (50.0)						
Zarqa	10 (17.9)	9 (16.1)	37 (66.1)						
Soap and water									
Ajloun	9 (21.4)	14 (33.3)	19 (45.2)	0.200	Abu Dhabi	2 (1.2)	54 (32.7)	109 (66.1)	0.514
Amman	8 (7.4)	34 (31.5)	66 (61.1)		Dubai	4 (1.6)	70 (28.3)	173 (70.0)	
Aqaba	-	3 (33.3)	6 (66.7)		Sharjah	1 (1.7)	15 (25.4)	43 (72.9)	
Balqa	1 (9.1)	4 (36.4)	6 (54.5)		Ajman	-	7 (35.0)	13 (65.0)	
Irbid	26 (6.1)	141 (32.9)	261 (61.0)		Fujairah	1 (14.3)	2 (28.6)	4 (57.1)	
Jarash	2 (7.1)	10 (35.7)	16 (57.1)		Ras Al-Khaimah	1 (5.0)	4 (20.0)	15 (75.0)	
Karak	2 (33.3)	-	4 (66.7)		Umm Al-Quwain	-	1 (50.0)	1 (50.0)	
Maan	-	-	1 (100.0)						
Madaba	-	1 (33.3)	2 (66.7)						
Mafrq	2 (6.9)	9 (31.0)	18 (62.1)						
Tafileh	-	1 (25.0)	3 (75.0)						
Zarqa	5 (8.9)	11 (19.6)	40 (71.4)						
ABHR									
Ajloun	8 (19.0)	25 (59.5)	9 (21.4)	0.541	Abu Dhabi	33 (20.0)	102 (61.8)	30 (18.2)	0.100
Amman	26 (24.1)	59 (54.6)	23 (21.3)		Dubai	41 (16.6)	123 (49.8)	83 (33.6)	
Aqaba	1 (11.1)	7 (77.8)	1 (11.1)		Sharjah	12 (20.3)	30 (50.8)	17 (28.8)	
Balqa	4 (36.4)	4 (36.4)	3 (27.3)		Ajman	4 (20.0)	14 (70.0)	2 (10.0)	
Irbid	87 (20.3)	223 (52.1)	118 (27.6)		Fujairah	1 (14.3)	3 (42.9)	3 (42.9)	
Jarash	8 (28.6)	11 (39.3)	9 (32.1)		Ras Al-Khaimah	5 (25.0)	10 (50.0)	5 (25.0)	
Karak	1 (16.7)	4 (66.7)	1 (16.7)		Umm Al-Quwain	-	2 (100.0)	-	
Maan	1 (100.0)	-	-						
Madaba	2 (66.7)	1 (33.3)	-						
Mafrq	7 (24.1)	15 (51.7)	7 (24.1)						
Tafileh	1 (25.0)	2 (50.0)	1 (25.0)						
Zarqa	13 (23.2)	35 (62.5)	8 (14.3)						

*Values in bold indicate a significant value of $P < 0.05$

household disinfectants, or ultraviolet lamps where these techniques may cause damage of skin tissues [37]. All the above-mentioned misconceptions highlight the potential risks of misinformation which could raise an additional concern during the spread of COVID-19.

Similar to a study conducted in Saudi Arabia by Al-Hanawi et al. (2020) [41], the findings showed no statistical association between awareness and gender in

both countries. This consistency may be explained by the fact that public health campaigns targeting COVID-19 in these countries may have addressed both genders simultaneously, reducing gender disparities in health education.

Unlike UAE, where awareness and age variable were not statistically significant, elderly population in Jordan demonstrated slightly higher awareness levels than young

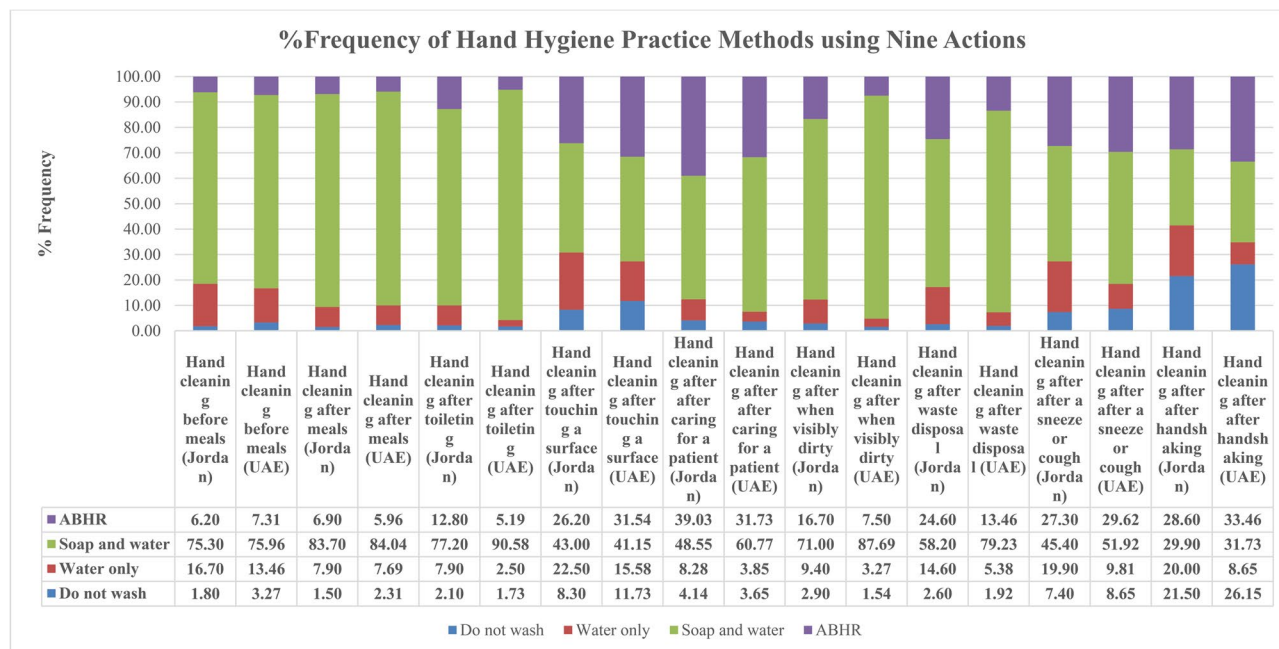


Fig. 3 Percent frequency of hand hygiene practice methods using the nine actions

participants [18–49]. This finding is consistent with other literature studies [23, 40, 41] where older individuals had stronger understanding of public health guidelines. Therefore, the higher awareness could be attributed to increased vulnerability to severe outcomes from COVID-19, which may have led them to prioritize learning about preventive measures [28, 42]. Similar to other literature studies [23, 41], the emirate/governorate was not an associated variable in this study thus confirming the uniformity of health education campaigns among the public community regardless of the geographical location.

The statistical association of awareness and education was highlighted in this study where highly educated participants recorded higher awareness levels compared to those with only a high school education in Jordan [43]. This finding is consistent with previous studies by [23, 41, 44, 45]. This finding could be explained by the fact that individuals with advanced education levels are more likely to access diverse information sources to get a deeper understanding of hygiene awareness [23]. However, education variable had no statistical association with awareness levels in the UAE.

Practice of hand hygiene

Focusing on practices towards COVID-19, the study populations in Jordan and UAE reported that both males and females primarily used soap and water, with females showing significantly higher adherence to more frequent usage. While water-only was common among both genders, ABHR was a secondary choice, with males in Jordan showing a higher reliance on ABHR than females. These

results are likely due to females' generally lower tolerance for uncleanness and greater concern for infection prevention, which may encourage more consistent hygiene habits [28, 46]. Surprisingly, while older age groups showed higher levels of hand hygiene awareness, there was no statistical association between practices and age groups in both study populations. This finding could be explained by the fact that awareness campaigns target all public communities to reinforce the importance of consistent hygiene habits regardless of the age variation. Similar to studies published in India [28], data reveals that individuals with higher education levels reported more frequent handwashing with soap and water than those with lower education levels. These findings suggest that higher education may foster greater awareness and adherence to hand hygiene practices, likely due to increased access to health information and a more profound awareness and understanding of disease prevention [28].

Furthermore, the results of the data collected reported that in high-risk situations, both populations most frequently used soap and water for hand hygiene, with ABHR as a secondary choice. This trend aligns with previous studies in Lebanon and Saudi Arabia [23, 33, 47–49] which reported that handwashing with soap and water was the predominant practice among both study populations using the nine key actions, particularly before meals, after meals, following toileting, when hands were visibly dirty, and after waste disposal. On the other hand, ABHR was used more frequently in certain situations such as when touching surfaces, or caring for elderly patients, after sneezing or coughing and handshaking

[23, 33, 47, 50–52]. Overall, the study population showed high compliance of hand hygiene recommendations of CDC to prevent the spread of the pandemic.

Limitations

This study protocol has several limitations. The self-responding nature of the tool used may introduce bias, and the uneven distribution of the study population, with a dominant number of females and an imbalanced age range. To overcome this limitation, participants were recruited through social media platforms, and the study tool was also distributed via research offices and centers at academic institutions in Jordan and the UAE. Electronic data collection may weaken the randomness of the sampling, especially because the lack of familiarity with the electronic devices and/or social media platforms is expected among the community. As a result, the age distribution of the sample population was affected by the electronic procedure of data collection where most of the participants were young participants (aged 18–29) who are expected to have more accessibility to the social media platforms. Based on the above findings and limitations, community-based interventions and research-based assessments are recommended to ensure comprehensive compliance with hand hygiene guidelines across public, academic, and occupational communities in Jordan and the UAE.

Conclusions

In Jordan and the UAE, awareness and practices around hand hygiene among various demographic groups show room for improvement, with overall awareness levels ranging from average to good. Although individuals with higher education and specific age groups displayed better awareness and adherence to safe practices, these findings highlight the need for targeted awareness campaigns. Interestingly, the UAE population's relatively younger demographic and the various initiatives and measures taken by the UAE government may contribute to their higher engagement with health awareness information, as well as an understanding of health and safety precautions embedded within the UAE's diverse culture. Gender, education level, and age were significant factors influencing awareness and hygiene practices. To further enhance hand hygiene awareness and practices, particularly among younger and less-educated individuals, awareness campaigns and health education programs are recommended. These could be implemented through a variety of accessible and appropriate channels to effectively reach different segments of the population. In particular, campaigns organized by the Ministry of Health, NGOs, and in collaboration with the Ministry of Education can play a crucial role in delivering consistent messaging across schools, health institutions, and communities. These findings can aid policymakers in designing effective,

targeted strategies for promoting public health measures across diverse community sectors.

Acknowledgements

This research study was hosted and resourced by the Canadian University Dubai and Abu Dhabi University. The authors are thankful to Dr. Mohammad Rababa from the Faculty of Nursing, Jordan University of Science and Technology (Jordan) and Dr. Sami Al-Rawashdeh from the Faculty of Nursing, the Hashemite University (Jordan) who participated in the data collection process.

Author contributions

"Conceptualization, methodology, data curation, project administration, supervision, formal analysis, and writing—original draft preparation and review and editing N.A. & W.G.; writing—original draft preparation R.S., A.A.T. & F.H. All authors have read and agreed to the published version of the manuscript."

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding authors on reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) at Abu Dhabi University (ADU) (CAS- 22-08-00023) and the Hashemite University (2/9/2021/2022). In the first page of the google survey, an informed consent was used to identify the purpose, risks, benefits, and confidentiality of the study. At the end of the informed consent, a statement was added to stress that participation is voluntary, and that the questionnaire submission indicates the individual's approval to participate in the study.

Consent for publication

In the consent form, participants informed and agreed to have their data information published, excluding any personal or identifiable details.

Competing interests

The authors declare no competing interests.

Author details

¹College of Health Sciences, Abu Dhabi University, Abu Dhabi, United Arab Emirates

²Department of Public Health, Canadian University Dubai, Dubai, United Arab Emirates

Received: 30 December 2024 / Accepted: 21 August 2025

Published online: 08 October 2025

6. References

1. Zhu N, Aylin P, Rawson T, Gilchrist M, Majeed A, Holmes A. Investigating the impact of COVID-19 on primary care antibiotic prescribing in North West London across two epidemic waves. *Clin Microbiol Infect.* 2021;27(5):762–8.
2. Noshili Al, Alharbi H, Hasan Z, Awaji NY. Assessment of hand-washing habits among secondary school students in Saudi Arabia.
3. World Health Organization. WHO Health Emergency Dashboard - UAE Situation [Internet]. 2023 [cited 2024 May 19]. Available from: <https://covid19.who.int/region/emro/country/ae>.
4. World Health Organization (WHO). WHO Health Emergency Dashboard - Jordan Situation [Internet]. 2023 [cited 2024 May 19]. Available from: <https://covid19.who.int/region/emro/country/jo>.

5. Newton AH, Cardani A, Braciale TJ. The host immune response in respiratory virus infection: balancing virus clearance and immunopathology. *Seminars in immunopathology*. Springer; 2016. p. 471–82.
6. Fauci AS, Lane HC, Redfield RR. Covid-19—navigating the uncharted. *N Engl J Med*. 2020;382:1268–9.
7. World Health Organization. Coronavirus disease (COVID-19): How is it transmitted? [Internet]. 2021 [cited 2023 May 17]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirus-disease-covid-19-how-is-it-transmitted?gclid=CjwKCAjw9pGjBhB-EiwAa5j3Ogbupslwg0UxEXbBYd_U5oKXCX78eqjk1NsC9QVs-ChrOFHXuR_RRoCjGsQAvD_BwE.
8. World Health Organization. State of the world's hand hygiene: a global call to action to make hand hygiene a priority in policy and practice. World Health Organization; 2021.
9. Singh H, Dahiya N, Yadav M, Sehrawat N. Emergence of SARS-CoV-2 new variants and their clinical significance. *Can J Infect Dis Med Microbiol*. 2022;2022(1):7336309.
10. Zhao Y, Huang J, Zhang L, Chen S, Gao J, Jiao H. The global transmission of new coronavirus variants. *Environ Res*. 2022;206:112240.
11. Centers for Disease Control and Prevention. Cleaning and Disinfection for Households. 2020. Available from: <https://www.cdc.gov/hygiene/cleaning-disinfecting/index.html>.
12. Rodrigues CMC, Plotkin SA. Impact of vaccines; health, economic and social perspectives. *Front Microbiol*. 2020;11:1526.
13. Bloomfield SF, Aiello AE, Cookson B, O'Boyle C, Larson EL. The effectiveness of hand hygiene procedures in reducing the risks of infections in home and community settings including handwashing and alcohol-based hand sanitizers. *Am J Infect Control*. 2007;35(10):S27–64.
14. Issa M, Dunne SS, Dunne CP. Hand hygiene practices for prevention of health care-associated infections associated with admitted infectious patients in the emergency department: a systematic review. *Ir J Med Sci*. 2023;192(2):871–99.
15. Chakma SK, Hossen S, Rakib TM, Hoque S, Islam R, Biswas T, et al. Effectiveness of a hand hygiene training intervention in improving knowledge and compliance rate among healthcare workers in a respiratory disease hospital. *Heliyon*. 2024;10(5):e27286. <https://doi.org/10.1016/j.heliyon.2024.e27286>.
16. Basurrah MM, Madani TA. Handwashing and gloving practice among health care workers in medical and surgical wards in a tertiary care centre in Riyadh, Saudi Arabia. *Scand J Infect Dis*. 2006;38(8):620–4.
17. Abd Elaziz KM, Bakr IM. Assessment of knowledge, attitude and practice of hand washing among healthcare workers in Ain- Shams university hospitals in Cairo. *J Prev Med Hyg*. 2009;50(1).
18. Lohiniwa AL, Bassim H, Hafez S, Kamel E, Ahmed E, Saeed T, et al. Determinants of hand hygiene compliance in Egypt: building blocks for a communication strategy. *East Mediterr Health J*. 2015;21(9):665–70.
19. Ng WK, Shaban RZ, van de Mortel T. Healthcare professionals' hand hygiene knowledge and beliefs in the United Arab Emirates. *J Infect Prev*. 2017;18(3):134–42.
20. Safadi S, Kavuran E, Al Nuqaidan H, Tassi A, Fawaz M. Knowledge, attitude and practice for healthcare workers and clinical students about infection control measures awareness at hospitals. *BAU Journal-Health Wellbeing*. 2019;2(1):6.
21. Saleh AM, Alrawaili SM, Abdelbasset WK. Hand hygiene practices among Jordanian nurses in Amman. *Afr Health Sci*. 2022;22(3):710–7.
22. Sower Sr SF, Acunin R, Cabanalan HC, Arisheh TTA, Alkhawaja S. Hand hygiene knowledge and perception survey for healthcare workers in government hospitals (GHs) in Bahrain. *Cureus*. 2023;15(12):e50126.
23. Alwan N, Safwan J, Kerek R, Ghach W. Hand hygiene during the spread of COVID-19: a cross-sectional study of awareness and practices among academic institutions in Lebanon. *Front Public Health*. 2024;11:1256433.
24. Ghanim M, Dash N, Abdullah B, Issa H, Albarazi R, Al Saheli Z. Knowledge and practice of personal hygiene among primary school students in Sharjah-UAE. *J Heal Sci*. 2016;6(5):67–73.
25. Ibrahim AA, Elshafie SS. Knowledge, awareness, and attitude regarding infection prevention and control among medical students: a call for educational intervention. *Adv Med Educ Pract*. 2016;7:505–10.
26. Almoslem MM, Alshehri TA, Althumairi AA, Aljassim MT, Hassan ME, Berekaa MM. Handwashing knowledge, attitudes, and practices among students in Eastern Province schools, Saudi Arabia. *J Environ Public Health*. 2021;2021(1):6638443.
27. Ayran G, Köse S, Saralıoğlu A, Çelebioğlu A. Hand hygiene and mask-wearing behaviors and the related factors during the COVID 19 pandemic: a cross-sectional study with secondary school students in Turkey. *J Pediatr Nurs*. 2022;62:98–105.
28. Hareesh PV, Rajkumar E, Gopi A, Sri Lakshmi KNV, Romate J. Prevalence and determinants of hand hygiene behavior among Indian population: a systematic review and meta-analysis. *Sci Rep* [Internet]. 2024;14(1):1–15. <https://doi.org/10.1038/s41598-024-52444-2>.
29. Dwipayanti NMU, Lubis DS, Harjana NPA. Public perception and hand hygiene behavior during COVID-19 pandemic in Indonesia. *Front Public Health*. 2021;9:621800.
30. Jung YH, Park YS, Park EC, Jang SI. Association between years with incidence of communicable diseases focused on COVID-19 and hand hygiene among adults in South Korea: a cross-sectional study. *BMC Public Health* [Internet]. 2022;22(1):1–10. <https://doi.org/10.1186/s12889-022-13951-x>.
31. International Labour Organization. United Arab Emirates [Internet]. 2023 [cited 2024 May 19]. Available from: https://www.ilo.org/beirut/countries/united-arab-emirates/WCMS_533531/lang-en/index.htm.
32. Altare C, Kostandova N, O'Keefe J, Hayek H, Fawad M, Musa Khalifa A, et al. COVID-19 epidemiology and changes in health service utilization in Azraq and Za'atari refugee camps in Jordan: a retrospective cohort study. *PLoS Med*. 2022;19(5):e1003993.
33. Mahdi H, Alqahtani A, Barasheed O, Alemam A, Alhakami M, Gadah I, et al. Hand hygiene knowledge and practices among domestic Hajji pilgrims: implications for future mass gatherings amidst COVID-19. *Trop Med Infect Dis*. 2020;5(4):160.
34. World Health Organization. Hand Hygiene [Internet]. 2021. Available from: https://www.who.int/health-topics/hand-hygiene#tab=tab_1.
35. Centers for Disease Control and Prevention. About Handwashing as a Healthy Habit in the Kitchen [Internet]. 2022. Available from: https://www.cdc.gov/clean-hands/prevention/about-handwashing-a-healthy-habit-in-the-kitchen.html?CDC_AAref_Val=https://www.cdc.gov/handwashing/handwashing-kitchen.html.
36. Centers for Disease Control and Prevention. Show Me the Science – When & How to Use Hand Sanitizer in Community Settings [Internet]. Handwashing in Communities: Clean Hands Save Lives. 2020 [cited 2024 May 19]. Available from: <https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html>.
37. World Health Organization (WHO). Coronavirus Disease (COVID-19) Advice for the Public: When and How to Use Masks [Internet]. [cited 2022 Jun 13]. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-use-masks#:~:text=If-COVID-19-is-spreading,Do-it-all!>.
38. Cuan-Baltazar JY, Muñoz-Perez MJ, Robledo-Vega C, Pérez-Zepeda MF, Soto-Vega E. Misinformation of COVID-19 on the internet: infodemiology study. *JMIR Public Health Surveill*. 2020;6(2):e18444.
39. Sahni H, Sharma H. Role of social media during the COVID-19 pandemic: beneficial, destructive, or reconstructive? *Int J Acad Med*. 2020;6(2):70.
40. Al-Wutayd O, Mansour AE, Aldosary AH, Hamdan HZ, Al-Batanony MA. Handwashing knowledge, attitudes, and practices during the COVID-19 pandemic in Saudi Arabia: a non-representative cross-sectional study. *Sci Rep*. 2021;11(1):16769.
41. Al-Hanawi MK, Angawi K, Alshareef N, Qattan AMN, Helmy HZ, Abudawood Y, et al. Knowledge, attitude and practice toward COVID-19 among the public in the Kingdom of Saudi Arabia: a cross-sectional study. *Front Public Health*. 2020;8:217.
42. Al Dossary R, Alnimr A, Aljindan R, Alkharsah KR, Al-Qurayn AK, Eltreifi O, et al. Predictors of illness severity in COVID-19 cases in Saudi Arabia. *Infect Drug Resist*. 2021;14:4097–105.
43. Ghach W, Takshe AA, Rababa M, Al-Rawashdeh S, Alwan N. Evaluation of awareness and performance towards COVID-related disinfectant use: a comparative study between Jordan and United Arab Emirates. *BMC Infect Dis*. 2024;24(1):1–11.
44. Al-Mohrej OA, Al-Shirian SD, Al-Otaibi SK, Tamim HM, Masuadi EM, Fakhoury HM. Is the Saudi public aware of middle East respiratory syndrome? *J Infect Public Health*. 2016;9(3):259–66.
45. Abdelhafiz AS, Mohammed Z, Ibrahim ME, Ziady HH, Alorabi M, Ayyad M, et al. Knowledge, perceptions, and attitude of Egyptians towards the novel coronavirus disease (COVID-19). *J Community Health*. 2020;45:881–90.
46. Curtis V, Aunger R, Rabie T. Evidence that disgust evolved to protect from risk of disease. *Proc R Soc Lond B Biol Sci*. 2004;271(suppl4):S131–3.
47. Mahdi HA, Assaggaf HM, Alfalali M, Ahmed OB, Alsafi R, Shaban RZ, et al. Hand hygiene knowledge, perception, and practices among domestic visitors to the prophet's mosque in al Madinah City amid the

- covid-19 pandemic: a cross-sectional study. *Int J Environ Res Public Health*. 2021;18(2):673.
48. Alwan N, Almazrouei S, Almazrouei M, Aldhaheeri J, Alismaili F, Ghach W. Evaluation of public awareness and performance toward the safe use of household disinfectants-cleaners to prevent COVID- in the emirate of Abu Dhabi. *Front Public Heal*. 2023;11:1214240.
49. Ghach W, Ibrahim SA, Merhi A, Buhamdan V, Ghannam NB, Salhab R. Community awareness and performance regarding the safe use of disinfectants and household cleaners during the spread of COVID-19 in Lebanon. *Univ J Public Heal*. 2023;11(6):877–87.
50. Ergin A, Bostancı M, Önal Ö, Bozkurt Ail, Ergin N. Evaluation of students' social hand washing knowledge, practices, and skills in a university setting. *Cent Eur J Public Health*. 2011;19(4):222–7.
51. Ghanim M, Dash N, Abdullah B, Issa H, Albarazi R, Al Saheli Z. Personal hygiene, hand hygiene, hand washing, primary school children; personal hygiene, hand hygiene, hand washing, primary school children. *J Health Sci*. 2016;6(5):67–73.
52. Oluwafemi O, Akinkunmi C, Temitope A, Lawal IK. Hand hygiene knowledge and practice among students in selected departments at Adeleke university, Ede, Osun state. *J Biol Pharm Chem Res*. 2022;9(4):1–16.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.