



ORIGINAL ARTICLE

To What Extent the Hand Hygiene among Health Care Workers Become the Core of Best Practice in the COVID-19 Era?

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Abstract

In the Era of COVID-19 outbreak, hand hygiene become a particularly critical for frontline healthcare workers (HCWs) who are overstretched and for whom this key routine task must be easy to complete and effective to prevent Health-care-associated infections (HAIs). Therefore, this current study aims to assess the level of knowledge, attitude and practice of hand hygiene among the HCWs and the potential factors influencing hand hygiene (HH) compliance according to the hand hygiene protocols at primary health care (PHC) centers in Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia.

This cross-sectional study included clinical staff working at PHC centers. A pre-validate questionnaire was used with observational approach of the application of HH among the study sample. The data were analyzed using SPSS software, and descriptive statistics and logistic regression models were produced. A *P*-value less than 0.05 with 95% confidence interval was used to declare statistical significance.

Of 425 clinical study participants, 263 (61.9%) were females, 169 (39.8%) were at age group 31-39 years, and 215 (50.6%) were nurses/laboratory specialist, and 281 (33.9%) were from departments of high risk of contamination. Overall, the average knowledge score was 75%. However, there were significant higher scores in knowledge level among nurse and laboratory specialist had than the rest (*P* < 0.01) and three times likely more positive practice of hand hygiene in comparison to others [Adjusted Odds Ratio (AOR) = 3.285, 95% CI, 1.764-6.116].

Health care workers in this study showed a good score of hand hygiene knowledge but suboptimal practices which could be addressed the need for multimodal training program on strict implementation of the guidelines and compliance with hand hygiene best practices.

Keywords

Hand hygiene, Health care workers, Hand rub, Knowledge, COVID-19

Abbreviations

AOR: Adjusted Odds Ratio; HAIs: Healthcare-Associated Infections; HCWs: Health Care Workers; HH: Hand Hygiene; PHC: Primary Health Care; PSMMC: Prince Sultan Military Medical City

Introduction

It is well known that one of the International Patient Safety Goals (IPSGs) is reducing the risk of health-care-associated infections (HCAIs). However, HCAIs are still a common serious problem in hospitals worldwide, resulting in several health risks to both patients and healthcare providers [1,2]. In this context, in 2009, the World Health Organization reported that the prevalence of HCAIs in developed countries ranged between 5% and 15% of hospitalized patients. Another recent prevalence survey conducted in hospitals in several de-

veloping countries showed that the prevalence of HCAs ranged between 14.8% and 19.1% [1,2].

It has been reported in many studies that compliance with hand hygiene protocols plays an important role in preventing and controlling HCAs. In this context, the WHO stated in the "Hand Hygiene Technical Reference Manual" that hand hygiene is the primary infection control measure and the most efficient and cost-effective strategy to reduce HCAs [3]. However, many observational studies and reports have shown that compliance with hand hygiene among healthcare providers is still very low in both developed and developing countries [4]. This low compliance and adherence with hand hygiene can be explained by several factors, such as overcrowding and lack of time, shortage in hand hygiene tools, irritation caused by hand hygiene products, lack of effective leadership and administrative support, and most importantly, lack of adequate knowledge, awareness, and positive attitude toward the best practices of hand hygiene [5].

Nowadays, the use of hand hygiene protocols has played a substantial role in decreasing the likelihood of infection transmission between health workers [6]. A meta-analysis conducted by J Kantor, showed that practicing proper hand washing found to be associated with a 24% reduction in COVID-19 viral transmission, suggesting that hand-to face contact may play a substantial role in infection transmission [7]. Likewise, other study showed the importance of empowering patients to promote hand hygiene practice among health workers [8]. Several international studies have reported that the overall average compliance rate of hand hygiene among healthcare providers worldwide is still low and less than 40%, with rates being lower among physicians (32%) than among nurses (48%) [9]. Thus, it seems that lack of sufficient knowledge about hand hygiene guidelines and protocols have been reported to be a key reason for noncompliance [2,5].

Assessment of the knowledge, attitude and practice (KAP) of hand hygiene within the health institution should be the first essential step to improve hand hygiene compliance [10], followed by introducing the enforcement of infection control policies, continued management support, direct observation, continued performance monitoring, availability of hand hygiene tools, continued hand hygiene training workshops and educational campaigns, which are all important aspects to sustain a high level of compliance [11,12].

The Joint Commission (JC) states that the direct observation method is one of the most powerful methods to assess compliance with hand hygiene, and the Joint Commission expects hospitals to have a compliance of at least 90% with hand hygiene protocols [13]. Accordingly, in the year of 2017, the Infection Control Department in FCM performed daily direct observations of

hand hygiene practices among all HCWs in all wards by assigning an Infection Control Nurse in each ward [2]. These findings indicate that the level of compliance with hand hygiene needs improvement since the data collected for the year 2017 showed insufficient compliance rates ranging from 60.8% to 94.7%. In brief, since hand hygiene is considered to be the primary effective measure to prevent HCAs [14], the Family and Community Medicine Department at Prince Sultan Military Medical City should have a very high level of compliance with hand hygiene to prevent the spread of infectious diseases and to apply the essential level of safety required. This study will try to assess the level of knowledge, attitude and practice and identify the factors associated with the low compliance rate in order to provide local evidence to help in developing a process improvement project and sustaining a high level of hand hygiene practice.

To what extent were the HCWs knowledgeable enough with hand hygiene practices and what was their level of compliance with hand hygiene? Therefore, the aim of this study was to assess the knowledge, attitude and practice of hand hygiene among HCWs in primary health care centers at Prince Sultan Military Medical City, Riyadh, Saudi Arabia, as well as the motives and barriers associated with the low level of hand hygiene (HH) compliance with hand hygiene protocols in PHC centers.

Methods

Study design and setting

This is a hospital-based cross-sectional study, conducted in PHC centers at Prince Sultan Military Medical City (PSMMC), formerly known as Riyadh Military Hospital, which is one of the most advanced health care centers in the Middle East.

Study subjects

The study included clinical staff working at PHC centers, including physicians, nurses, emergency medical technicians and laboratory specialists. However, staff not in contact with patients, such as administrative staff, engineers and security were excluded.

Sample size and sampling technique

Findings from a previous study conducted at King Fahd Hospital of the University, Al-Khobar [15], Saudi Arabia, showed a mean hand hygiene compliance rate of 50.17% in a pre-intervention test among the hospital workers. Therefore, this prevalence was used to calculate the sample size of this study, at a 95% confidence interval and $\pm 5\%$ margin of error. Thus, the sample size in this study would be 377 participants. We assumed that not all the participants could respond appropriately; hence, we increased the sample size by 12.5%. Therefore, the final sample size was 425 participants.

A proportional sampling from each PHC centers was conducted as 210 from Al Wazarat Health Center, 116 from Al Morooj, 37 from Al Oreja, 29 from Al Janoob, 25 from Al Manar, and 13 from Al Nadeem Health Center. In the other side for the application of the observation checklist a total of 109 participants were enrolled with proportional distribution to the capacity of each center.

Data collection methods and instruments used

A structured, self-administered questionnaire was distributed to the participants after they consented and agreed to participate in the study. An explanation about the study was provided to the participants, and each participant signed a written consent.

The survey instrument was based on the revalidated World Health Organization (WHO) designed questionnaire for this purpose and was used as a standard tool [16], with very minor modifications to adapt to the local context in Saudi Arabia. It consisted of four parts, which included standard questions to gather participant information, questions pertaining to knowledge of standard precautions, questions on compliance with standard precautions, and a general self-efficacy scale.

The self-administered questionnaire was piloted to test the validity and reliability of the questions, using 20 HCWs from different local health settings and consequently changing the questions according to the needs.

In addition, a direct checklist was used to measure the adherence to the best practices in hand hygiene [17]. The checklist was based on that of the World Health Organization, which was used as a standard tool. For the hand hygiene observation protocol, 25% of the total sample was checked. Thus, it was considered as representative of the study cohort. Approximately 104 HCWs were included in this stage. However, the observation protocol randomly observed 30% of physicians, 10% of lab and paraclinics, 10% of emergency medical technicians and 50% of nurses, as they were the major group and had the most contact with patients. The researcher did the observation according to the WHO protocol. The compliance level was applied according to the WHO protocol score as compliant or non-compliant. Therefore, the term compliant is referred to a state of the performing all hand hygiene established movements, while the non-compliance is the missing of even one step in hand hygiene.

Statistical analysis

The data were cleaned, and the Statistical Package for Social Sciences (SPSS) version 20 (IBM, NY) was used for data analysis. A *P*-value lower than 0.05 was considered statistically significant. Descriptive statistics were carried out to illustrate means, standard deviations, and frequencies of the study variables. Both bivariate and multivariate logistic regression analyses were computed to identify variables having a significant association with

Table 1: Sociodemographic characteristics of the sample.

Variables	Category	No.	%
Age	≤ 30 years	67	15.8
	31-39 years	169	39.8
	40-49 years	112	26.4
	≥ 50 years	77	18.1
Sex	Male	162	38.1
	Female	263	61.9
Profession	Nurse/lab specialist	215	50.6
	Medical doctor/resident	98	23.1
	Emergency medical	31	7.3
	Technician/other	81	19.1
Health care center (HCC)	Al Wazarat	206	48.5
	Al Morooj	116	27.3
	Al Oreja	36	8.5
	Al Janoob	29	6.8
	Al Manar	25	5.9
	Al Nadeem	13	3.1
Department	Low contamination risk	281	66.1
	High contamination risk	144	33.9

hand hygiene knowledge and compliance. Odds ratios with 95% confidence intervals were used to determine the strength of association between the dependent and independent variables.

Results

Respondents' characteristics

Of the 425 participants in this study, the mean age was 40.0 years ± Standard Deviation (SD) 10.0 years, 263 (61.9%) were females, and 215 (50.6%) were nurses/laboratory specialist, 206 (48.5%) were from Alwazarat Health Care Center and 281 (66.1%) were from low contamination risk department. Age was categorized into 4 subgroups: ≤ 30 years (15.8%), 31-39 years (39.8%), 40-49 years (26.4%), and ≥ 50 years (18.4%), as seen in Table 1 and Figure 1.

Respondents' knowledge and attitude on hand hygiene

On the other hand regarding received training activities on hand hygiene, around 1,322 (75.8%) participants had received formal training in hand hygiene in the last 3 years, and 403 (94.8%) participants routinely used an alcohol-based hand rub. For the calculation of the overall hand hygiene knowledge of the participants, seven domains composed of twenty-five questions were used. The correct answers from the questionnaire were given one point, whereas incorrect answers were given a score of zero. The maximum score achievable for knowledge was 35 points. The level of hand hygiene knowledge was calculated by dividing the responses into three

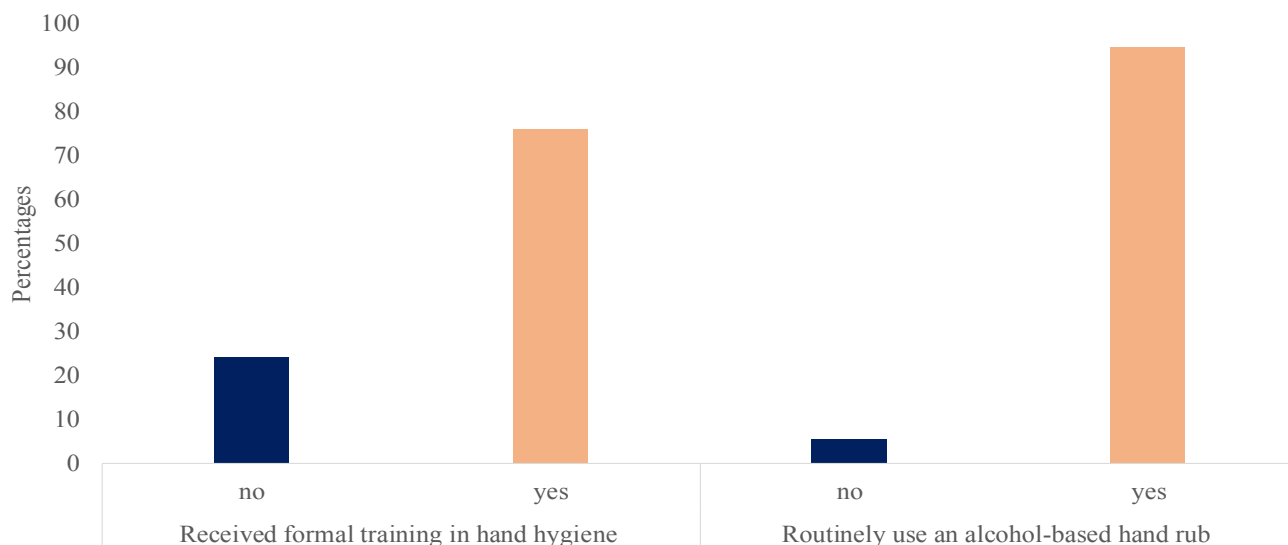


Figure 1: Hand hygiene training rates and used of alcohol-based hand rub (last 3 years).

Method: In the left side of the figure showed the percentage of the health care workers those received training (yes) in the past on hand hygiene and those had not received (no). In the other side (right) of the figure, showed those health care workers routinely using an alcohol-based hand rubs (Yes) and those not used (no).

Results: The majority of the health care workers (75.8%) had received formal training in hand hygiene in the last 3 years (yes). In the other side near almost all the (94.8%) health care workers routinely used an alcohol-based hand rub (Yes).

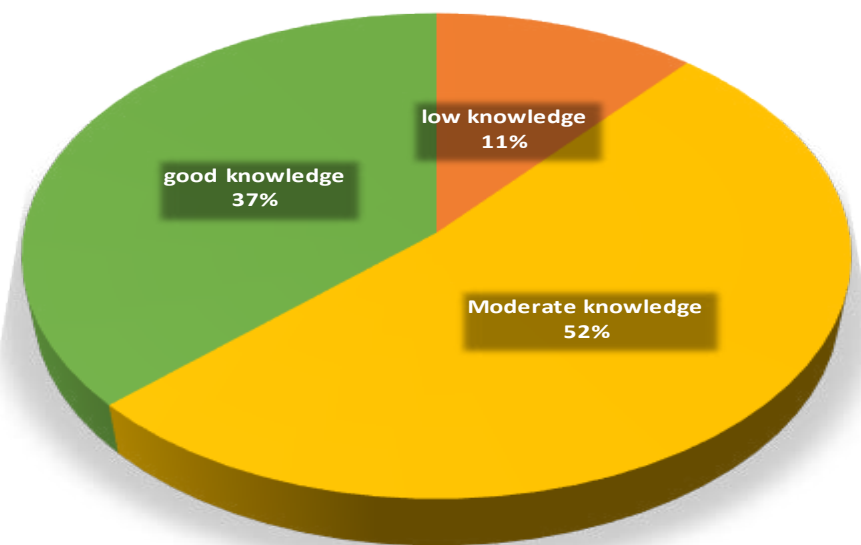


Figure 2: Level of hand hygiene knowledge among the participants.

Method: For the calculation of the overall hand hygiene knowledge of the participants, seven domains composed of twenty-five questions were used. The correct answers from the questionnaire were given one point, whereas incorrect answers were given a score of zero. The maximum score achievable for knowledge was 35 points. The level of hand hygiene knowledge was calculated by dividing the responses into three groups based on a score of more than 75% considered as adequate, 50-74% considered as moderate, and less than 50% considered as insufficient knowledge.

Results: Accordingly, 156 (36%) participants were found to have adequate knowledge, 221 (52%) participants had moderate knowledge (52%), and the rest of the participants (11%) had insufficient knowledge on hand hygiene.

groups based on a score of more than 75% considered as adequate, 50-74% considered as moderate, and less than 50% considered as insufficient knowledge. Accordingly, 156 (36%) participants were found to have adequate knowledge, 221 (52%) participants had moderate knowledge (52%), and the rest of the participants (11%) had insufficient knowledge on hand hygiene (Figure 2).

Regarding the main route of cross-transmission of

germs, the majority, 186 (43.8%) participants answered correctly that the “unclean hands of health care workers” was the main route, while, patients’ exposure to colonized surfaces, Air circulating in the hospital, and Sharing noninvasive objects were answered 28.2%, 17.9%, and 10.1%, respectively (Table 2).

Nevertheless, participants explained their opinions about the frequent source of germs responsible for

Table 2: Correct answers on hand hygiene knowledge.

Variables	No.	%
Main route of cross-transmission of germs		
Unclean hands of HCWs (True)	186	43.8
Air circulating in the hospital	76	17.9
Patients' exposure to colonized surfaces	120	28.2
Sharing noninvasive objects	43	10.1
Frequent source of germs responsible for infections		
The hospital's water system	49	11.5
The hospital's air	64	15.1
Germs present on the patient (True)	171	40.2
The hospital environment	141	33.2
Hand hygiene actions preventing transmission of germs to the patient		
Before touching a patient (True)	400	94.1
Immediately after a risk of body fluid exposure (No)	45	10.6
After exposure to the immediate surroundings of a patient (No)	42	9.9
Immediately before a clean/aseptic procedure (True)	394	92.7
Hygiene actions preventing transmission of germs to the health-care worker		
After touching a patient	383	90.1
Immediately after a risk of body fluid exposure [1]	382	89.9
Immediately before a clean/aseptic procedure (No)	51	12.0
After exposure to the immediate surroundings of a patient	385	90.6
Alcohol-based hand rub and handwashing with soap and water are true		
Hand rubbing is more rapid for hand cleansing than handwashing (True)	305	72.1
Hand rubbing causes skin dryness more than handwashing (False)	160	37.7
Hand rubbing is more effective against germs than handwashing (True)	190	44.7
Sequence performed in handwashing and hand rubbing (False)	229	54.0
Minimum time for alcohol-based hand hygiene to kill germs on hands (True)	241	56.7
Which type of hand hygiene method is required in the following situations?		
Before palpation of the abdomen (Rubbing)	230	54.1
Before giving an injection (Rubbing)	226	53.2
After emptying a bedpan (Rubbing)	175	41.2
After removing examination gloves	198	46.6
After making a patient's bed (Rubbing)	201	47.3
After visible exposure to blood	233	54.8
Which of the following should be avoided, as they are associated with an increased likelihood of colonization of hands with harmful germs?		

Wearing jewelry [1]	374	88.0
Damaged skin [1]	366	86.1
Artificial fingernails [1]	358	84.2
Regular use of a hand cream (No)	122	28.7

Table 3: Healthcare-associated infection.

Variables	Category	No.	%
Impact of a health care-associated infection on a patient's clinical outcome	Very low	13	3.1
	Low	51	12.0
	High	259	60.9
	Very high	102	24.0
What is the effectiveness of hand hygiene in preventing health care-associated infection?	Very low	9	2.1
	Low	55	12.9
	High	235	55.3
	Very high	126	29.6
Among all patient safety issues, how important is hand hygiene at your institution?	Very low	0	0.0
	Low	119	28.0
	High	191	44.9
	Very high	115	27.1

infections. A total of 171 (40.2%) participants indicated correctly that germs present on the patient were frequently responsible for infections, as seen in [Table 2](#). Similarly, most of the participants agreed that hand hygiene actions should be carried out before touching a patient and immediately before a clean/aseptic procedure, as the only methods to prevent transmission of germs (94.1% and 92.7%, respectively). It is likely, the participants' knowledge on the role of hand hygiene actions should be practiced after touching a patient (90.1%), immediately after a risk of body fluid exposure (89.9%), and after exposure to the immediate surroundings of a patient (90.6%).

The majority of the HCWs (72.1%) indicated that they prefer hand rubbing as more rapid for hand cleansing than handwashing, therefore they scored low level of response with regard to the effectiveness of hand rubbing versus handwashing against germs. The results of hand rubbing causing skin dryness, the sequence of handwashing and hand rubbing performances, and the indication of the accurate minimum time required for alcohol-based hand hygiene to kill most germs on hands were 44.7%, 37.7%, 54.0%, and 56.7%, respectively. When looking for the findings related to the type of hand hygiene method required according to the patient care situation, accurate responses ranged from washing is required after visible exposure to blood (54.8%) to rubbing is required after emptying a bedpan (41.2%).

With regards to the procedures and conditions that should be avoided by health care workers, as they are associated with an increased likelihood of colonization of the hands with harmful germs, 28.7% of participants indicated that the regular use of a hand cream was not

considered among the avoidable materials; however, the majority responded accurately with regard to the wearing of jewelry (88.0%) and avoiding rubbing with damaged skin or artificial fingernails (86.1% and 84.2%, respectively) (Table 2).

As shown in Table 3, the high impact of health-care-associated infections on a patient's clinical outcome (60.9%) and the effectiveness of hand hygiene in preventing healthcare-associated infections (55.3%)

were found dominant in this domain. On the other hand, the importance of hand hygiene at the study institution was found to range between a low of 28.0% and a high of 44.9%.

The study analyzed the data on the correlation between sociodemographic features and the level of hand hygiene knowledge, as shown in Table 4. It was found that the profession of nurse/lab specialist proved to significantly determine the level of knowledge of hand hy-

Table 4: Level of knowledge on hand hygiene according to sociodemographic characteristics.

Variables	Category	Low		Moderate		High		P value
		No.	%	No.	%	No.	%	
Age	≤ 30 years	4	8.3	42	19.0	21	13.5	0.119
	31-39 years	17	35.4	79	35.7	73	46.8	
	40-49 years	14	29.2	59	26.7	39	25.0	
	≥ 50 years	13	27.1	41	18.6	23	14.7	
Gender	Male	18	37.5	84	38.0	60	38.5	0.992
	Female	30	62.5	137	62.0	96	61.5	
Profession	Nurse/lab specialist	16	33.3	109	49.3	90	57.7	0.001
	Medical doctor/resident	8	16.7	52	23.5	38	24.4	
	Emergency Medical	1	2.1	16	7.2	14	9.0	
	Technician/others	23	47.9	44	19.9	14	9.0	
Health care center (HCC)	Al Wazarat	9	18.8	107	48.4	90	57.7	0.001
	Al Morooj	28	58.3	55	24.9	33	21.2	
	Al Oreja	2	4.2	24	10.9	10	6.4	
	Al Janoob	8	16.7	13	5.9	8	5.1	
	Al Manar	1	2.1	15	6.8	9	5.8	
	Al Nadeem	0	0.0	7	3.2	6	3.8	
Department	Low contamination risk	31	64.6	140	63.3	110	70.5	0.341
	High contamination risk	17	35.4	81	36.7	46	29.5	

Table 5: Logistic regression of the positive knowledge of hand hygiene and characteristics of the participants.

Variables	Category	OR	95% CI	p-value	AOR	95% CI	P value
Age	≤ 30 years	0.874	0.416-1.835	0.722	-	-	-
	31-39 years	1.481	0.812-2.704	0.201	-	-	-
	40-49 years	1.285	0.671-2.460	0.449	-	-	-
	≥ 50 years	R	-	-	-	-	-
Sex	Male	1.032	0.653-1.631	0.894	-	-	-
	Female	R	-	-	-	-	-
Profession	Nurse/lab specialist	3.178	1.640-6.159	0.001	3.467	1.829-6.571	0.001
	Medical doctor/resident	2.375	1.134-4.972	0.022	2.569	1.246-5.300	0.011
	Emergency medical	5.167	1.882-14.183	0.001	5.179	1.972-13.600	0.001
	Technician/others	R	-	-	R	-	-
Health care center	Al Wazarat	0.954	0.299-3.048	0.937	-	-	-
	Al Morooj	0.563	0.171-1.859	0.346	-	-	-
	Al Oreja	0.448	0.116-1.722	0.242	-	-	-
	Al Janoob	0.583	0.143-2.372	0.451	-	-	-
	Al Manar	0.716	0.178-2.886	0.639	-	-	-
	Al Nadeem	R	-	-	-	-	-
Department	Low contamination risk	1.548	0.879-2.728	0.131	-	-	-
	High contamination risk	R	-	-	-	-	-

giene, with a *P*-value of < 0.001. Also, Al Wazarat Health Center showed a statistically significant result of the knowledge level on hand hygiene, with a *P*-value of < 0.001. However, the study found a lack of association between hand hygiene knowledge level and some sociodemographic features, such as age, gender and department, with resulting *P*-values < 0.05. Level of knowledge of hand hygiene also proved to vary with gender, as females were more knowledgeable on hand hygiene (over 60%) compared with males. It was also associated with age between 31-39 years (46.8%) compared with other age ranges.

Associated factors with level of knowledge and attitude of hand hygiene

Both bivariate and multivariate logistic regression

analyses were applied for the assessment of the socio-demographic factors and the positive level of knowledge in the participants. Significant differences were found between the different categories of professionals (adjusted odds ratios) and clear likelihood of positive knowledge on hand hygiene practice was found among nurses, medical doctors, and emergency medical staff in comparison to the reference (technician/others), as shown in Table 5. The rest of the factors did not show any significant differences.

Logistic regression of the positive practice of hand hygiene and characteristics of the participants are shown in Table 6. The study found positive correlations between the positive practice of hand hygiene and the professions, while there was no positive logistic regression between the positive practice of hand hygiene and

Table 6: Logistic regression of the positive practice of hand hygiene and characteristics of the participants.

Variables	Category	OR	95% CI	P value	AOR	95% CI	P value
Age	≤ 30 years	0.674	0.331-1.373	0.277	-	-	-
	31-39 years	0.718	0.400-1.289	0.267	-	-	-
	40-49 years	0.983	0.528-1.830	0.956	-	-	-
	≥ 50 years	R	-	-	-	-	-
Sex	Male	0.823	0.522-1.298	0.402	-	-	-
	Female	R	-	-	-	-	-
Profession	Nurse/lab specialist	3.492	1.849-6.594	0.000	3.285	1.764-6.116	0.001
	Medical doctor/resident	2.313	1.125-4.753	0.023	2.306	1.149-4.625	0.019
	Emergency medical	3.138	1.149- 8.569	0.026	2.436	0.958-6.193	0.061
	Technician/others	R	-	-	R	-	-
Health care center	Al Wazarat	2.036	0.590-7.030	0.261	2.184	0.638-7.472	0.213
	Al Morooj	1.036	0.291-3.689	0.956	1.126	0.318-3.982	0.854
	Al Oreja	1.113	0.278-4.466	0.879	1.228	0.309-4.878	0.771
	Al Janoob	0.948	0.218-4.128	0.943	1.000	0.233-4.291	1.000
	Al Manar	0.876	0.197-3.903	0.863	0.908	0.205-4.014	0.899
	Al Nadeem	R	-	-	R	-	-
Department	Low contamination risk	1.239	0.744-2.064	0.410	-	-	-
	High contamination risk	R	-	-	-	-	-

Table 7: Hand hygiene attitude among the study participants.

Variables	Category	Attitude level				P value
		Poor		Good		
		No.	%	No.	%	
Age	≤ 30 years	53	15.5	14	16.9	0.927
	31-39 years	135	39.5	34	41.0	
	40-49 years	90	26.3	22	26.5	
	≥ 50 years	64	18.7	13	15.7	
Sex	Male	144	42.1	18	21.7	0.001
	Female	198	57.9	65	78.3	
Profession	Nurse/lab specialist	157	45.9	58	69.9	0.001

	Medical doctor/resident	83	24.3	15	18.1	
	Emergency medical	27	7.9	4	4.8	
	Technician/others	75	21.9	6	7.2	
Health care center (HCC)	Al Wazarat	141	41.2	65	78.3	0.001
	Al Morooj	108	31.6	8	9.6	
	Al Oreja	30	8.8	6	7.2	
	Al Janoob	28	8.2	1	1.2	
	Al Manar	23	6.7	2	2.4	
	Al Nadeem	12	3.5	1	1.2	
Department	Low contamination risk	221	64.6	60	72.3	0.185
	High contamination risk	121	35.4	23	27.7	

Table 8: Hand hygiene positive practice among the study participants.

Variables	Category	Practice Level				P value
		Low		High		
		No.	%	No.	%	
Age	≤ 30 years	42	16.3	25	14.9	0.959
	31-39 years	103	40.1	66	39.3	
	40-49 years	67	26.1	45	26.8	
	≥ 50 years	45	17.5	32	19.0	
Sex	Male	106	41.2	56	33.3	0.101
	Female	151	58.8	112	66.7	
Profession	Nurse/lab specialist	113	44.0	102	60.7	0.001
	Medical doctor/resident	59	23.0	39	23.2	
	Emergency medical	20	7.8	11	6.5	
	Technician/others	65	25.3	16	9.5	
Health care center (HCC)	Al Wazarat	105	40.9	101	60.1	0.008
	Al Morooj	81	31.5	35	20.8	
	Al Oreja	23	8.9	13	7.7	
	Al Janoob	21	8.2	8	4.8	
	Al Manar	18	7.0	7	4.2	
	Al Nadeem	9	3.5	4	2.4	
Department	Low contamination risk	164	63.8	117	69.6	0.214
	High contamination risk	93	36.2	51	30.4	

Table 9: Comparison of observed five moments of hand hygiene among HCWs in different PHC centers.

Centers	Number of HCWs	Opportunities	Action	Compliance (%)
Al Oreja Health Center	9	45	44	97.0
Al Janoob Health Center	7	35	33	94.0
Al Nadeem Health Center	3	15	14	93.0
Al Wazarat Health Center	52	155	144	92.0
Al Manar Health Center	6	30	24	80.0
Al Morooj Health Center	32	80	56	70.0
Total	109	360	315	87.5

age, gender, healthcare center, or department. Being a nurse/lab specialist (AOR = 3.285, 95% CI, 1.764-6.116, *P*-value = 0.001) tended to increase the odds of positive practice of hand hygiene by 3 times, while the odds of positive practice of hand hygiene tended to increase by 2 times in both medical doctor/resident and emergency

medical categories (AOR = 2.306, 95% CI, 1.149-4.625, *P*-value = 0.019 and AOR = 2.436, 95% CI, 0.958-6.193, *P*-value = 0.061, respectively).

The study analyzed the data on hand hygiene attitude among the study participants, as shown in [Table 7](#). It found that being male proved to significantly de-

termine the level of attitude of hand hygiene, with a *P*-value of 0.001. Also, the nurses showed a statistically significant result with regard to the attitude level of hand hygiene, with a *P*-value of 0.001. Additionally, Al Wazarat Health Center showed a statistically significant result with regard to the attitude level of hand hygiene, with a *P*-value of 0.0001.

Table 8 shows that the level of hand hygiene positive practice among the participants. The chi-square tests of the level of hand hygiene positive practice showed significant differences in professions and health care centers, where nurses and the Al Wazarat Health Center were found to have a high level of practice.

Table 9 shows the observed compliance of five moments of hand hygiene among HCWs in different PHC centers. The evaluation revealed the highest compliance rate (97%) at the Al Oreja Health Center; however, the Al Janoob, Al Nadeem and Al Wazarat Health Centers had compliance rates from 92% to 94%, with the Al Mannar and Al Morooj Health Centers having the lowest compliance rates (80% and 70%, respectively).

Discussion

Our 425 total participants were from a relatively young population, with a mean age of 40 ± 10 years, and most of them were between the ages of 31 and 39 years. However, age group could be varying from one study to other as shown in a study conducted among Saudi HCWs in Arar (20 and 39 years) [3], or in Al-Qassim (20 and 59 years) [18], as well as in Karad (19 and 25 years) [19]. Similarly, reported in African country (Nigeria) with a range of respondents between the ages of 20 and 29 years [20]. This variation in age group between different studies locally and internationally, could be explained by some authors as an indirect reflection of the level of adherence to hand hygiene. As age of the HCW (physicians or nurses) can be used as deceptive in regards to the number of years of practice, thus studied concluded that age and experience probably were positively correlated with adherence of HH [21].

In our findings, wearing jewelry was the main source of infection. It was similar to another study in Arar, Saudi Arabia, which found wearing jewelry and accessories were the main source of infection [3]. In our study, the role of hand hygiene actions in preventing the transmission of germs to the patient should be carried before touching the patient, which was the primary method to prevent infections. Another study from India found that 85% of participants knew that hand hygiene actions before touching a patient could prevent transmission of germs [22]. It was similar to another study in Jeddah, Saudi Arabia, carried out by Mohidin S, et al., which found hand hygiene practices should be carried out before touching the patient and his/her surrounding environment [5].

With the recent pandemic of COVID-19, the impor-

tance of hand hygiene is vital now more than ever in playing a significant role in preventing the spread of the infectious disease. In our study, 75.8% of participants had received formal training in hand hygiene and 94.8% routinely used an alcohol-based hand rub, which differed from another study in Ain Shams, Egypt, where 3.9% of participants used an antiseptic hand wash [23]. In our study, when analyzing the participants' level of attitude toward hand hygiene, our finding found that hand rubbing was more rapid than handwashing. A study in Jeddah, Saudi Arabia, found that most health care workers used alcohol and handwashing with water before touching the patient and handwashing with water more than alcohol after touching the patient [5]. Additionally, it differed from another study in Nepal carried out by Yadav SK, et al. that found that health care workers mostly used alcohol-based hand rubs [24]. It differed from another study in Al-Qassim, Saudi Arabia, that found soap and water were the most common agents for cleansing the hands of HCWs [18]. In our study, the main route of cross-contamination of germs was the unclean hands of HCWs (43.8%). It differed from another study in Arar, Saudi Arabia, carried out by Rawan D, et al. that found the main route of transmission of germs was bathrooms in hospitals [3]. Unlikely, our results were not agreed with findings from another study in Nepal carried out by Yadav SK, et al. that found that the hands of health care workers were the most common mode of transmission of pathogens to patients. Moreover, a study in India found 31% of participants reported that the main route of cross-transmission was the unclean hands of healthcare workers [22].

Center for Disease Control and Prevention has emphasized on the critical role of direct and indirect spread of coronaviruses (COVID-19) between Health care personnel while they are handling and supporting patients during the outbreak [25]. In our study, nurses, lab specialists, medical doctors, residents, emergency medical personnel and technicians had different rates of hand hygiene knowledge, with nurses having the highest knowledge (57.7%) compared to the other professions. The same results were found in another study carried by KM Abdalaziz, et al. in Ain Shams, Egypt, where they found the knowledge score was higher among nurses than other health care workers [23].

It differed from another study in Arar, Saudi Arabia, carried out by Rawan D, et al., where they found that both nurses and physicians had almost the same rated knowledge [3]. Additionally, it differed from another study in Karad, carried out by Mahado B, et al., where they found nursing students had better knowledge than nursing staff, and the health care workers there had moderate knowledge on handwashing [19]. A similar study was done in Al-Qassim, Saudi Arabia, carried by out by Badria A, et al., where they found HCWs had low knowledge of hand hygiene [18]. It differed from another study in Pakistan carried out by Sajida Pameen, et al.

who found 42.2% of all participants were well-qualified and knowledgeable about hand hygiene. This study showed that hospital staff needed to be educated on the practical and cost-effective benefits of hand hygiene [26]. It differed from a study in Kenya carried out by Hannah M, who found half of the respondents had poor knowledge of hand hygiene [27]. It differed from a study in India carried out by Krwathrth R, et al., who found that 76% of participants had moderate knowledge of hand hygiene [22].

Our findings were inconsistent with other study in Nepal carried out by Yadav SK, et al. that found only 9% of participants had good knowledge on hand hygiene, which proved that their health care workers had moderate knowledge on hand hygiene [24]. Another study in Vietnam carried out by Cam Dung, et al. found that health care workers had good knowledge of hand hygiene [28].

We are referring to the importance of hand hygiene to prevent and control infection in health among health care workers institution which applied to COVID-19. As we are in the Era of COVID-19, the strict implication of hand hygiene is of paramount consideration in the prevention of the infections, including COVID-19. Recently, global reports described that, hand hygiene campaign for the fight against COVID-19 is crucial to stop the spread of COVID-19 virus as it primarily spreads through droplet and contact transmission [29]. In addition, such research will be great helpful for the MOH in Saudi Arabia for example to develop guidance on COVID-19 surveillance in healthcare and community settings [30].

In our study, the WHO protocol score [2], was used to measured compliance level of the HCWs in the PHC centers during the observational sessions. Our findings revealed 87.5% of compliance level; however, variation between PHC centers was not statistically significant. Findings from a study assessing the compliance of HH in Qatar, has reported to our study (90%) [31], while other studies from Indonesia and Ethiopia showed very low compliance rate (27.1% and 14.9%, respectively) [32,33].

Eventually, low hand hygiene compliance levels are still a disquieting challenge worldwide despite the numerous interventions and campaigns performed in promoting this action. Nowadays, hand hygiene is particularly critical for frontline HCWs, who are overstretched for the response to the COVID-19 pandemic, where strict hand hygiene compliance by everyone is required and not exclusive to HCWs but include any person to avoid the infection. Recently, WHO launched the World-wide campaign called “#SafeHands Challenge” with the aim to reducing hand recontamination and therefore, infection prevention [34], as well as to ensuring patient and HCW safety at all times as an important key during this pandemic [30].

Although HH procedures are relatively simple, stud-

ies have shown that the compliance among healthcare workers is not favorable. Some authors revealed the main barriers in the compliance of HH include lack of education, lack of persuasion, high work load, working status, lack of techniques, poor quality of implemented method, and guidelines [35-37]. Moreover, some studies illustrated that educating the patients about the important of the hand hygiene, help in the compliance of the health care worker in applying hand hygiene [8]. Our findings revealed that more than 75.8% of the participants had a set for training on hand hygiene in the past three years. Though, exposure of the health care workers to training practice of hand hygiene can enhance significantly their contribution to their good practices [3,38].

Limitation

However, the study findings should be viewed in light of some limitations. This is a cross-sectional survey, which, by design, does not take into account the possible changes in knowledge and compliance of the same cohort of students across time. Other limitations are the use of self-reported responses on the practice of hand hygiene. Although self-reporting is the easiest way to collect data, bias can be introduced as respondents may report better practice than their actual practice. However, the investigator used an observational method in a representative sample to reflect the actual practice of hand hygiene among the health care workers.

Conclusion

In conclusion, health care workers in this study showed a good score of hand hygiene knowledge but suboptimal practices which could be addressed the need for multimodal training program on strict implementation of the guidelines and compliance with hand hygiene best practices. The study also showed that the participants had been trained on handwashing before, touching patients and after dealing with patients to prevent the transmission of diseases from one patient to another and to reduce infection.

Declarations

Conflict of interest

The authors declare they have no conflicts of interest.

Sources of funding

None.

Ethical approval

This work received an IRB approved from the Research Ethic Committee at the Prince Sultan Medical City (#HP-01-R079) and from King Abdulla International Medical Research Center at the Ministry of National Guard for Health Affair in Riyadh (#SP19/055/R).

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