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Awareness and knowledge of COVID-19 infection control precautions and waste management among healthcare workers

Saudi cross-sectional study

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Abstract

Healthcare workers (HWs) perform a critical role not only in the clinical management of patients but also in providing adequate infection control and prevention measures and waste management procedures to be implemented in healthcare facilities. The aim of this study was to evaluate the awareness and knowledge of COVID-19 infection control precautions and waste management procedures among HWs in Saudi Arabian hospitals.

This was a descriptive, cross-sectional study. Information on knowledge, awareness, and practice of infection control and waste management procedures were obtained from the HWs using a structured questionnaire. A thematic analysis was used to analyze the data.

Our findings indicated that most of the study participants were knowledgeable, with a mean score of 78.3%. In total, 92.5%, 90.3%, and 91.7% of the participants were aware of the infection control precautions, COVID-19 waste management procedures, the availability of infection control supplies, respectively. HWs' Knowledge regarding waste management and infection control procedures correlated significantly with sex ($P \leq .001$ and $<.001$), education ($P = .024$ and .043), and working experience ($P = .029$ and .009), respectively.

Most participants appreciated the importance of their role in infection control, surveillance, and monitoring of the ongoing safety practices in their patients as well as their facilities and communities.

Abbreviations: HWs = healthcare workers, MERS = Middle East respiratory syndrome, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2, WHO = World health organization.

Keywords: COVID-19 infection, healthcare workers, infection control, infection supplies, waste management

1. Introduction

In December 2019, pneumonia cases of unknown origin were officially reported in China, named COVID-19.[1] This disease has rapidly spread around many other regions within China, and then worldwide. Globally, as of 1:41 pm CEST, September 13, 2020, 28,637,952 confirmed cases of COVID-19, including 917,417 deaths, were reported to World Health Organization (WHO) from 216 countries, areas, or territories.[2] In Saudi Arabia, from March 2 to September 13, 2020 (1:41 pm CEST), there have been 325,050 confirmed cases of COVID-19 with 4240 deaths.[3]

The disease is mainly transmitted through respiratory droplets,[4] as Middle East respiratory syndrome coronavirus (MERS-CoV), severe acute respiratory syndrome (SARS), and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[5–7] Patients with COVID-19 present with clinical symptoms of dyspnea and radiological abnormalities on chest computed tomography showing multiple lesions located in the posterior or peripheral lung.[8–10] Symptoms such as headaches and diarrhea are rarely reported by these patients.[8] COVID-19 progresses rapidly, and early intervention and treatment are crucial to determine patient prognosis.[10] Patients with COVID-19 usually die of acute respiratory distress syndrome and multiple organ failure caused by a cytokine storm.[9,10]

The unusual and profligate increase in the number of global reported cases is of worldwide concern.[2,3] Therefore, healthcare

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

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workers (HWs) globally should be aware of the disease and be vigilant and prepared to prevent its spread. They must put in place enhanced public health surveillance to identify suspected cases using the WHO-recommended case definition and investigation protocols, in order to protect both global health and local community wellbeing.[11]

In Saudi Arabia, COVID-19 is of great concern at governmental and public levels because of the cumulative number of infected individuals and deaths despite extensive persistent effort considered in order to curb the disease spread.[12,13] This includes a wide range of interventions related to prevention and control procedures; distinct measures for HWs; risk communications and community engagement; and national, ministerial, and international coordination for the investigation and management of cases in the country as well as the conduction of research studies.[12–16]

During previous MERS-CoV infections, Saudi Arabian Ministry of Health reported 1297 confirmed cases of from June 2012 to February 2016, accounting for about 79% of the global cases; of these, 554 (43%) died, accounting for 94% of total global deaths.[17,18] As reported possible source of infection, in January 2015, 32% of the patients contracted the infection in a health care setting, while 12% of the infected patients were HWs.[17,18] Based on the available data and WHO's risk assessment as well as reports from Saudi Arabian Ministry of Health Command and Control Centre for COVID-19, human-to-human transmission within communities has been documented, and careful monitoring of the current situation is crucial, particularly in the absence of any prophylactic vaccines or curative treatment globally.[17,18] Until now, global protective measures include curfew and quarantines either at homes or healthcare facilities.[19,20] HWs perform a critical role not only in the clinical management of patients but also in confirming acceptable infection control and prevention measures implemented in health care facilities. Healthcare providers in hospitals are at risk of infection through occupational exposure to patients with suspected COVID-19 infection. Therefore, it is important that they have adequate and correct knowledge, attitudes, and practices towards pandemics in general. The aim of this study was to evaluate the awareness and knowledge of COVID-19 infection control precautions and waste management among HWs in Saudi Arabian hospitals.

2. Methods

2.1. Study design

The questionnaire was sent by e-mail through the Saudi Commission for Health Specialties and distributed to all HWs in all Saudi healthcare facilities. The sample included all healthcare providers (physicians, specialists, pharmacists, technicians, and nurses) in all departments of Saudi hospitals. Inclusion criteria were as follows: working at hospitals, having direct contact with patients, and willingness to participate in the study and complete the questionnaire. We evaluated their knowledge and awareness of infection control precautions and waste management procedures during the COVID-19 pandemic. A written informed consent was obtained from the Standing Committee for Research Ethics at King Saud University (Ref No: KSU-HE-20-192).

2.2. Sample size and participants

Based on a previous study,[21] the total number of HWs in Saudi Arabia is approximately 350,000; thus, the sample is sufficiently representative, with a 5% margin of error and a confidence level of 95%. In total, 384 participants should be derived using the following sample size calculation websites (https://select-statistics.co.uk/calculators/sample-size-calculator-population-proportion/).

2.3. Dependent variables

Respondents were asked to provide answers to knowledge questions as either yes or no, with an additional "don't know" option. Uncertain (do not know) responses were scored 0, and correct answers were assigned a score of 1. The total knowledge score ranged from 0 to 22, with high scores indicating better knowledge of COVID-19. Items were evaluated for internal reliability using the chi-square test, non-parametric binomial test, Kruskal–Wallis test, and multi-linear regression analysis. In the knowledge and awareness sections, scores were calculated based on the respondents' answers to each attitudinal statement: 1 = I do not know, 2 = yes, and 0 = no. In the availability of supplies section, 1 = available and 0 = not available.

2.4. Statistical methods

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 24.0 software (SPSS Inc., Chicago, IL). Calculated frequencies and percentages of all nominal variables as well as calculated mean, standard deviation (SD), median, and range (minimum to maximum) for the total score of all variables are presented. Pearson correlation coefficient (r) was calculated to determine the relationship between the different variables and total knowledge score. The chi-square and non-parametric binomial tests were used to compare the frequencies (percentages) for different items of different variables. Non-parametric Mann–Whitney and Kruskal–Wallis tests were used to compare the total score of different variables with respect to demographic characteristics (sex, age group, year of experience, and educational level). Multiple linear regression analysis was used for different variables, to obtain a prediction equation between the total score of different variables and demographic characteristics. $P < .05$ was considered statistically significant.

3. Results

The survey was divided into 4 main sections, each for explicit categorical information. Section 1: demographic information, Section 2: knowledge and awareness of infection control and prevention guidelines, Section 3: knowledge of waste management procedures, Section 4: knowledge of infection control resources/supplies usage and availability. In total, 710 HWs participated in this study. As shown in Table 1, of the total sample, there were 373 (52.5%) women and 337 (47.5%) men. The majority of the studied cases (46.6%) were between the ages of 31 and 40 years, with a significant difference ($P < .001$). All the participants had a college or university degree ranging from diploma degree (10%), bachelor's degree (52%), and master's degree and above (38%). Regarding working experience, the majority significantly had between 5 to 10 years (32.8%) and 11 to 20 years (30.3%) of working experience, while 25.8% have been working for <5 years, and 11.1% for >20 years.

Regarding the knowledge and awareness of infection control and prevention guidelines (Table 2) among the HWs, the mean

Table 1

Demographic characteristics of the participants.

	Frequency (%)	*P*-value
Sex		
Male	337 (47.5%)	.189**
Female	373 (52.5%)	
Age		
20–30 y	204 (28.7%)	<.001*
31–40 y	331 (46.6%)	
41–50 y	129 (18.2%)	
>50 y	46 (6.5%)	
Years of experience		
<5 y	183 (25.8%)	<.001*
5–10 y	233 (32.8%)	
11–20 y	215 (30.3%)	
>20 y	79 (11.1%)	

* By Chi-square test.
** By non-parametric binomial test.

knowledge and awareness of infection control and prevention guidelines score was 23.46 (SD = 5.911, range: 1–30). Analysis of awareness and knowledge of waste management procedure (Table 3) revealed a mean score of 26.92 (SD = 7.961, range: 0–36). Analysis of awareness of the availability of infection control resources/supplies showed a mean score of 11.92 (SD = 1.731, range: 1–13), indicating a good level of knowledge (Table 4).

The results of a multiple regression analysis are shown in Table 5, in which knowledge of infection control and prevention guidelines, knowledge of waste management procedures, and knowledge of the availability of infection control resources/supplies at their facilities were the dependent variables against possible demographic and basic characteristics of the surveyed respondents. Knowledge of infection control and prevention guidelines significantly correlated with sex ($P = .005$) and working experience ($P = .009$), but it was not affected by age, educational level, and occupation. Knowledge of waste management procedures in their facility correlated significantly with sex ($P \leq .001$), education ($P = .024$), and working experience ($P = .029$), but not with age and education. Knowledge of availability of infection control resources/supplies at their facilities correlated with sex ($P \leq .001$) and education ($P = .043$), but not with age, occupation, and working experience.

As shown in Table 6, there were more women than men in all sections. Age had a significant contribution in "respondent comeback" to all sections, as revealed by the Kruskal–Wallis test. Further analysis using the Mann–Whitney *U* test indicated that participants in the age group 20 to 30 years responded significantly more in Sections II, III, and IV than those aged 41 to 50 years ($P < .05$). People aged 20 to 30 years and 31 to 40 years responded significantly more in Section III when compared with people aged ≥50 years. Those in the age group 31 to 40 years responded significantly more than those in age group 41 to 50 years did in Sections III and IV ($P = .004$ and $P = .023$,

Table 2

Analysis of healthcare workers' awareness of the infection control and prevention guidelines at their facilities.

Survey element	Yes	I don't know	No	*P*-value*
Infection control management				
Do you have infection control program at your institution?	624 (87.9%)	43 (6.1%)	43 (6.1%)	<.001
Do you have infection control policies and guidelines in your unit?	655 (92.3%)	21 (3.0%)	31 (4.4%)	<.001
As a health provider, do you know the guidelines on standard precautions for infection prevention?	657 (92.5%)	21 (3.0%)	29 (4.1%)	<.001
Do you have an emerging infectious diseases taskforce (dealing with outbreaks)?	467 (65.8%)	83 (11.7%)	157 (22.1%)	<.001
Have you encountered any outbreak?	406 (57.2%)	58 (8.2%)	243 (34.2%)	<.001
Do you think that all staff in your unit is following infection control policies, rules, and guidelines promptly?	434 (61.1%)	91 (12.8%)	182 (25.6%)	<.001
Do you think that all staff can differentiate between different isolation protocols such as droplet or contact	469 (66.1%)	95 (13.4%)	143 (20.1%)	<.001
Do you know if checks of standards are being met for personal protection, infection prevention and control, for cleaning, disinfection, and laboratory waste management at your hospital?	473 (66.8%)	168 (23.7%)	66 (9.3%)	<.001
Training				
Have you received any training about infection prevention and control management and guidelines and protocol?	583 (82.1%)	15 (2.1%)	109 (15.4%)	<.001
Surveillance				
Is your hospital enrolled in national surveillance system?	440 (62.0%)	210 (29.6%)	57 (8.0%)	<.001
Do you have a list of reportable infectious disease available at your unit and accessible to all staff?	451 (63.5%)	127 (17.9%)	129 (18.2%)	<.001
Do infectious agents reported to Ministry of Health?	533 (75.1%)	128 (18.0%)	46 (6.5%)	<.001
Is there a known turnaround time of laboratory results of the reportable infectious agents at your institution?	375 (52.8%)	238 (33.5%)	94 (13.2%)	<.001
Do you think your hospital is prepared for any infection outbreak?	483 (68.0%)	114 (16.1%)	110 (15.5%)	<.001
Do you agree that surveillance tool used in your institution is effective to prevent or control infection?	487 (68.6%)	108 (15.2%)	112 (15.8%)	<.001

* By Chi-square test.

Table 3

Analysis of healthcare workers' awareness and knowledge of waste management procedures in their facilities.

Survey element	Yes	I don't know	No	*P*-value*
Procedure and guidelines				
Do you know the management practices and protocol for sharps waste, such as needles or blades?	641 (90.3%)	36 (5.1%)	33 (4.6%)	<.001
Do you know the procedure and protocol for processing of equipment's for reuse?	351 (49.4%)	238 (33.5%)	118 (16.6%)	<.001
Do you know if policies and procedures that are used for managing routine (i.e., non-emergency) laboratory services are adaptable to an emergency situation?	368 (51.8%)	245 (34.5%)	94 (13.2%)	<.001
Do you know that all laboratory staff members must prepare job action sheets describing their roles and tasks in an emergency situation?	309 (43.5%)	281 (39.6%)	117 (16.5%)	<.001
Do you know laboratory biosafety measures of your institution and if they comply with national guidelines or the guidelines provided in the WHO Laboratory Biosafety Manual (Third Edition, WHO 20041)	340 (47.9%)	261 (36.8%)	106 (14.9%)	<.001
Do you know that the laboratory waste management and cleaning should be given high priority among the hospital's activities?	482 (67.9%)	155 (21.8%)	70 (9.9%)	<.001
Do you know WHO guidelines for collecting, preserving, and shipping specimens?	321 (45.2%)	182 (25.6%)	204 (28.7%)	<.001
Do you know standardized laboratory procedures, checklists, forms, and log sheets used in your hospital?	370 (52.1%)	179 (25.2%)	158 (22.3%)	<.001
Do you know that laundry and cleaning procedures should comply with national Ministry of Health guidelines, especially those on preventing spread of infection to maintain sterility requirements?	484 (68.2%)	161 (22.7%)	62 (8.7%)	<.001
Do you know that during an epidemic, handling and transportation of dead bodies and autopsy procedures should comply with national Ministry of Health guidelines, especially those on preventing spread of infection	454 (63.9%)	200 (28.2%)	53 (7.5%)	<.001
Compliance training				
Do laboratory staffs receive training?	332 (46.8%)	325 (45.8%)	50 (7.0%)	<.001
Do you know if staff providing waste management, cleaning and laundry services should have been trained in infection prevention and control?	465 (65.5%)	196 (27.6%)	46 (6.5%)	<.001
Practice				
Do you know the effective and correct way to dispose sharps waste?	644 (90.7%)	31 (4.4%)	32 (4.5%)	<.001
Do you know how to dispose medical waste other than sharps boxes?	606 (85.4%)	44 (6.2%)	57 (8.0%)	<.001
Do you know how to dispose medical waste as blood containers?	544 (76.6%)	67 (9.4%)	96 (13.5%)	<.001
Coordination				
Do you know if your hospital established and maintained agreements with other laboratories, to cope with increased demand for laboratory services?	336 (47.3%)	317 (44.6%)	54 (7.6%)	<.001
Do you know if there is coordination between clinical staff and waste management and cleaning staff?	427 (60.1%)	211 (29.7%)	69 (9.7%)	<.001
Do you know if laboratory management in your hospital cooperates with other hospitals and throughout national, regional, and international laboratory networks?	356 (50.1%)	248 (34.9%)	103 (14.5%)	<.001

WHO = world health organization.

* By Chi-square test.

Table 4

Analysis of healthcare workers' awareness of the availability of infection control resources/supplies at their facilities.

Survey element	Available	Not available	*P*-value*
Clean running water	671 (94.5%)	39 (5.5%)	<.001
Hand-washing soap/liquid soap	694 (97.7%)	16 (2.3%)	<.001
Alcohol based hand rub	689 (97.0%)	21 (3.0%)	<.001
Disposable latex gloves	680 (95.8%)	30 (4.2%)	<.001
Waste receptacle (pedal bin) with lid and plastic bin liner	614 (86.5%)	96 (13.5%)	<.001
Sharps container ("safety box")	692 (97.5%)	18 (2.5%)	<.001
Service availability and readiness assessment tool	599 (84.4%)	111 (15.6%)	<.001
Environmental disinfectant (e.g., chlorine, alcohol)	667 (93.9%)	43 (6.1%)	<.001
Gowns	680 (95.8%)	30 (4.2%)	<.001
Eye protection (goggles, face shields)	590 (83.1%)	120 (16.9%)	<.001
Medical (surgical or procedural) masks	680 (95.8%)	30 (4.2%)	<.001
Disposable syringes with disposable needles	684 (96.3%)	26 (3.7%)	<.001
Auto-disable syringes	524 (73.6%)	186 (28.2%)	<.001

* Using non-parametric binomial test.

Table 5

Results from multi-linear regression analysis obtained to verify associations with age, sex, education, occupation, location of facility, and type of facility.

Variables	Sex	Age	Education	Occupation	Year of experience
Section II: knowledge and awareness of infection control and prevention guidelines					
Coefficient β	1.253	0.050	0.648	0.191	0.928
P value	.005*	.903	.089	.152	.009*
Section III: Knowledge of waste management and procedure					
Coefficient β	3.173	0 .855	-0.323	0.397	1.028
P value	<.001*	.115	.521	.024*	.029*
Section IV: Knowledge of infection control resources/supplies availability					
Coefficient β	0.396	0.102	0.227	– 0.001	0.110
P value	.003*	.399	.043*	.979	.294

respectively). All-round knowledge was higher in respondents with >5 years of working experience ($P<.05$). Educational level did not have a significant influence on participant response except for Section IV, in which those with a bachelor's degree responded more than those with a master's degree did ($P=.002$). Furthermore, occupation had a significant effect on all-round knowledge of the surveyed HWs ($P<.05$). Using the Mann–Whitney *U* test, the results showed that medical doctors were significantly more knowledgeable than pharmacists regarding infection control and prevention guidelines and concerning the availability of infection control resources/supplies, but not in the case of waste management procedures in their facility. Nurses were significantly more knowledgeable than pharmacists in all the aspects of knowledge assessed.

A moderate positive relationship was knowledge found between the total score of Section II: of infection control and prevention guidelines and total score of Section III: knowledge of waste management procedures since $r=.635$, $P<.001$. In addition, a weak positive relationship was found between the total score of Section IV: knowledge of the availability of infection control resources/supplies usage and each of the total scores of Section II: knowledge of infection control and prevention guidelines and Section III: knowledge of waste management procedures, since $r=0.468$, $P<.001$ and $r=0.40$,

Table 6

Comparison of knowledge and awareness of infection control guidelines, availability of resources, and waste management with age, sex, years of working experience, education, and occupation (n=710).

	Section II: Awareness of infection control and prevention guidelines				Section III: Knowledge of waste management and procedure				Section IV: Knowledge of infection control resources/supplies availability			
	N	Mean	SD	*P*-value*	N	Mean	SD	*P*-value*	N	Mean	SD	*P*-value*
Sex												
Male	337	22.8750	6.20466	.017	337	25.3155	8.52014	<.001	337	11.7507	1.88593	.017
Female	373	23.9946	5.58763		373	28.3747	7.12341		373	12.0751	1.56568	
Age												
20–30 y	204	22.7941	6.18569	.049	204	26.2010	8.14667	.001	204	11.7304	1.84921	.023
31–40 y	331	23.2409	6.16788		331	26.1829	8.45369		331	11.8792	1.74179	
41–50 y	129	24.5581	5.18397		129	28.9302	6.33343		129	12.1783	1.66981	
>50 y	46	24.9348	3.83204		46	29.7391	5.95701		46	12.3478	1.03746	
Years of experience												
<5 y	182	21.7253	6.06241	<.001	182	25.2033	8.25541	<.001	183	11.5683	1.97914	.013
5–10 y	235	23.9310	5.91604		235	26.9698	7.71314		235	12.0601	1.45797	
>10 y	293	24.171	5.609		293	27.949	8.12773		294	12.031	1.87475	
Education												
Diploma degree	70	22.328	6.858	.421	70	28.171	9.160	.139	70	11.657	2.484	.010
Bachelor's degree	370	23.351	6.199		370	26.695	8.341		370	11.827	1.614	
Master's degree and above	270	23.914	5.164		270	26.906	7.031		270	12.119	1.636	
Occupation												
Dentist	12	19.667	6.0503	<.001	12	25.417	5.7755	<.001	12	12.167	1.1146	<.001
Lab technician	14	23.231	5.7323		14	31.00	6.00		14	12.929	0.2673	
MD doctor	243	23.798	5.3068		243	25.605	7.3429		243	12.091	1.2985	
Medical technician	53	20.774	7.6325		53	23.491	10.3341		53	10.755	2.4251	
Nurse	230	24.947	5.4673		230	30.123	6.6434		230	12.106	1.5874	
Pharmacists	92	21.217	5.7368		92	24.233	7.8812		92	11.457	2.4292	
Paramedic	38	23.474	5.9217		38	26.447	9.3164		38	12.105	1.3909	
Physiotherapist	10	20.50	3.6286		10	22.70	5.2504		10	12.40	0.9661	
Administrative employee	18	24.944	4.5306		18	28.722	7.3629		18	12.611	0.6077	

* Kruskal–Wallis test.

$P < .001$, respectively, where r is the Pearson correlation coefficient.

4. Discussion

Recently, there has been a significant threat to public health due to the emergence of the COVID-19 pandemic. Protective measures are important to overcome and control the spread of the COVID-19 pandemic, and such measures not only include household and community contact management.[12,13] Different wastes are generated in all health establishments, which can be categorized into hazardous and non-hazardous wastes. Hazardous wastes include laboratory and isolation materials, sharps, pathological specimens, expired drugs, chemotherapeutic drugs and items used to prepare and administer them, and radioactive and chemical elements. Non-hazardous wastes include food, packaging, and empty boxes of drugs and medical supplies. Hospitals also generate ordinary household waste from kitchens, housekeeping, and administrative jobs. Hazardous wastes are harmful to people and the environment, and unlike non-hazardous wastes, it must be treated in a special way following guidelines related to handling wastes from healthcare activities.[22,23] Adherence to preventive and control measures are affected by the HWs' knowledge, awareness, and practices regarding these wastes. The results of our survey show that most study participants were competent, with a mean score of 78.3%. Approximately 92.5% were aware of infection control protocols, 90.3% were aware of COVID-19 waste management procedure, and 91.7% were aware of the availability of all infection control supplies. In our study, sex, education, and working experience had significant impacts on HWs' awareness of waste management procedures in their facility and knowledge of the availability of infection control resources. These findings are consistent with other studies that have shown satisfactory levels of knowledge across the Saudi population for epidemics such as MERS-CoV.[24–26] In our study, the high rate of correct answers to knowledge-related questions among participants was not surprising, which may be due to the characteristics of the sample, as 90% had a college or university degree or above, and 74.23% had >5 years of work experience. This may also be due to the distribution of questionnaires during the COVID-19 outbreak. At that time, with extensive local and international education, people had gained awareness and knowledge about the disease and its transmission via television, news, and media platforms to protect themselves and their families. The positive association found between knowledge, educational background, and age supports this study's argument. Qualitative assessment reveals differences in experience and awareness among HWs across all professional groups, where nurses, medical doctors, lab technicians, pharmacists, and paramedics showed the highest means of knowledge score.

Several previous studies have shown inadequate knowledge and poor practice among HWs regarding biomedical waste management. These studies have been reported in different countries such as Brazil,[27] Dhaka,[28] India,[29,30] and Turkey.[31] These studies were mainly focused on biomedical waste management in general, while the present study focused on infectious waste to minimize the spread of the infection and maintain adequate and proper waste disposal practice. Risks of improper management and improper disposal of biomedical waste are global concerns, in particular infectious waste.[32] In our study, the knowledge of waste management procedure correlated significantly with sex ($P \leq .001$), education ($P = .024$), and working experience ($P = .029$) but not with age and education. Knowledge of the availability of infection control resources correlated with sex ($P = .003$) and education ($P = .043$), but not with age, occupation, and working experience. The knowledge of infection control and prevention guidelines showed a significant correlation with sex ($P = .005$) and working experience ($P = .009$), but it was not affected by age, educational level, and occupation. Sex differences in association with knowledge might be due to higher number of women than men; however, working experience has influenced the participants' knowledge, which is in agreement with a previous study.[33] HWs should always remember the risk of treating patients with infectious diseases. HWs and patients may be exposed to COVID-19 infection, and cross-infection could occur and might lead to further transmission to their families. Knowing this might add further pressure on HWs to gain more knowledge of all aspects of COVID-19 infection and related hazards. In the present study, it was found that most of the HWs were knowledgeable about biomedical waste disposal, particularly from COVID-19 infected persons. The Saudi Ministry of Health not only educated HWs about COVID-19 but also emphasized instructions to follow regarding the hazards of infectious waste.[12,13,17]

4.1. Study limitation

This study had some limitations. The first limitation was related to the sample size. Another limitation is that, because the study was performed during the COVID-19 outbreak, we used a web-based survey method, to avoid possible transmission; thus, the sample in our study consisted of voluntary participants who were comfortable using an online system. Therefore, a selection bias must be considered.

5. Conclusions

This study provides an overview of the experience and beliefs of healthcare professionals in relation to knowledge and awareness of infection precautions and waste management procedures. The qualitative assessment revealed differences in the experience and awareness of HWs across all professions. Most participants appreciated the importance of their role in infection control, surveillance, and monitoring of the ongoing safety of their patients, their facilities, and communities. The Saudi Ministry of Health created initiatives to improve education, such as increasing training to HWs, particularly medical professionals, during the COVID-19 pandemic.

Author contributions

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