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ORIGINAL RESEARCH

Knowledge, Attitude, and Perceived Risks Towards COVID-19 Pandemic and the Impact of Risk Communication Messages on Healthcare Workers in Saudi Arabia

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Purpose: To investigate knowledge, attitude, and perceived risks towards COVID-19 pandemic among healthcare workers (HCWs) in Saudi Arabia. Besides, the impact of risk communication strategy on the attitude and practice of HCWs was investigated.

Patients and Methods: We conducted a cross-sectional study that targeted HCWs from various Saudi health facilities. We utilized a self-administrated, online-based questionnaire designed to assess basic knowledge of COVID-19, attitude and disease perception, and the impact of risk communication messages among HCWs.

Results: A total of 1691 responses were received in the study. The HCWs exhibited good levels of knowledge (total maximum score is 1) of COVID-19 concerning the modes of transportation of COVID-19 (0.82±0.16), sample collection method for COVID-19 diagnosis (0.98±0.08), transmission of infection from asymptomatic individuals (0.99±0.11), and that antibiotics are not effective against the new COVID-19 (0.83±0.38). Nearly one-third of the participants considered a high/very high possibility of acquiring COVID-19 infection. HCWs had good attitude scores concerning their willingness to deal with new COVID-19 patients (0.87±0.33) and their beliefs in being educated on COVID-19 (0.99 ±0.11). Almost all participants strongly agree/agree that it is important to take action to prevent the spread of COVID-19 within healthcare facilities and received health information messages. Notably, 93.4% of the participants stated that the received messages changed their attitude towards COVID-19 and its preventive measures. Good knowledge scores were significantly associated with age > 49 years old, higher educational level, and physician occupation. Similarly, good attitude scores were higher among males, HCWs aged 40–49 years old, non-Saudi nationals, and physician and nurse occupations.

Conclusion: HCWs have fair knowledge and attitude towards the COVID-19 pandemic. The risk communication is an effective strategy to improve the attitude and practice of HCWs towards COVID-19 in Saudi Arabia.

Keywords: COVID-19 pandemic, knowledge, attitude, risk communication, perceived benefits, Saudi Arabia

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Introduction

The novel coronavirus disease 2019 (Covid-19) has spread rapidly in different countries till becoming a global pandemic as declared by the World Health Organization (WHO) on March 11, 2020,[1] causing a massive impact on healthcare

services and economics.[2] Given that no effective treatment is currently available, preventive measures represent the cornerstone in managing the pandemic, including quarantine and lockdown measures, facial masks, hand hygiene,[3–5] and self-isolation in suspected cases.[6] Nonetheless, community compliance is crucial for the successful implementation of these measures; the public's perception about the risk of the disease and their knowledge about proper preventive strategies play a critical role in limiting pandemic spread.[7] Recently, a growing body of evidence has tried to identify the level of knowledge and attitude towards the COVID-19 pandemic across different populations. However, these studies showed variable results as the population awareness and attitude regarding the COVID-19 can differ significantly by geographical distribution, age, gender, education level, and occupation.[8,9]

Healthcare workers (HCWs) represent the cornerstone in the fight against the COVID-19 pandemic. Previous reports showed that HCWs are at high risk of acquiring the infection and psychological distress during pandemics;[10] besides, they play a crucial role in disseminating proper knowledge during an emergency.[11] Therefore, it is imperative that HCWs have knowledge and attitude towards the COVID-19 pandemic to ensure their strict compliance to control measures and effectively disseminate accurate information about the pandemic.[12] Nonetheless, the current body of published literature shows conflicting results regarding the level of HCWs' knowledge and attitudes regarding COVID-19.[12–14] Likewise, studies from the Middle East showed variable levels of HCWs' knowledge and attitudes regarding COVID-19.[15–17] Thus, big data and real-life evidence are needed to orient the already challenged healthcare systems during the pandemic and reflect the single community dynamics.[18–20]

As stated by WHO, risk communication is "the exchange of real-time information, advice, and opinions between experts and people facing threats to their health, economic or social well-being".[21] It is widely acknowledged that effective risk communication during a pandemic, which encompasses risk perception and measures to minimize it, can improve public perception of the benefits of preventive measures, compliance. Besides, it can mitigate exaggerated displays of panic in the form of uncontrolled buying of medications, goods, and personal protective equipment (PPE).[11,22] Thus, a successful risk communication strategy should positively impact HCWs' perceived risk of infection, knowledge, and attitude towards the COVID-19 pandemic.

Saudi Arabia is the largest county in the Arabian Peninsula. It has a well-established healthcare system that is offered for free to all residents. The health system in Saudi Arabia consists mainly of MOH-affiliated public hospitals, other governmental institutions, and the private sector.[23] The healthcare system is equipped with 494 hospitals and 22.5 beds per 10,000 inhabitants.[24] In 2019, there were a total of 113,000 physicians in Saudi Arabia.[25] In Saudi Arabia, the authority has taken several risk communication measures to minimize the risk of COVID-19 transmission.[26,27] These measures include a daily press conference by the Ministry of Health (MoH),[28,29] public Health Hotline Center to provide reliable information and mitigate public concerns, professional media materials, using media platforms and social media to deliver scientific information in a public language,[24] and mobile applications to provide educational information.[30,31]

Although recent reports have tried to evaluate public knowledge and attitude towards the COVID-19 pandemic in Saudi Arabia,[32,33] little information is available concerning the impact of risk communication on HCWs' knowledge and attitudes during this pandemic. This cross-sectional, survey-based study aimed to investigate knowledge, attitude, and perceived risks towards the COVID-19 pandemic among HCWs in Saudi Arabia. Besides, we assessed the impact of risk communication strategy on the attitude and practice of HCWs towards the COVID-19 pandemic. We hypothesized that the risk communications strategies provided by Saudi authorities led to good levels of HCWs' knowledge and attitude towards the COVID-19 pandemic.

Methodology

Study Design and Population

We conducted a survey-based, cross-sectional study that targeted HCWs in Saudi Arabia aged over 18 years; HCWs from various health facilities were recruited regardless of their history of contact with suspected/confirmed COVID-19 cases. The participants were recruited through the period from May 20 to June 4, 2020, at the various healthcare institutions. All HCWs on duties were invited via online-based surveys; a healthcare worker who does not deliver services was excluded. All procedures were done after ethical approval from participating centers and

the MOH in Saudi Arabia (IRB log. No.: 20–76M). The cover page of the online survey stated the main objectives of the study and informed the participants that their answers to the survey's questions will be used to assess the study's objectives. Thus, participants, who filled the survey, implied their consent to participate in the study. All personal data of the participants were anonymized or maintained with confidentiality. The was conducted in accordance with the Declaration of Helsinki.

Data Collection and Questionnaire Validation

We utilized a self-administrated, online-based questionnaire designed to assess the impact of risk communication among HCWs during the new COVID-19 pandemic in Saudi Arabia and collect information concerning HCWs' knowledge and attitude towards the disease. The questionnaire was distributed online to eligible participants using a standardized platform. This platform was customized to permit only one response from every participant. Each participant received an email that enclosed the study's objectives and the questionnaire link. The questionnaire was developed in English and Arabic by reviewing available surveys in the literature and WHO recommendations.[8,13,34,35] Two public health experts then reviewed the questionnaire content.

The questionnaire consisted of four parts. The first part collected the demographics and professional characteristics of the included HCWs. The second part consists of seven questions that collect some basic information about the participant's knowledge of COVID-19. The third part collected data regarding the attitude towards COVID-19, including HCWs' willingness to deal with COVID-19 cases, COVID-19 education, level of knowledge in dealing with COVID-19, and level of adherence towards the standard precautionary measures stated by the MOH. The last part of the questionnaire consisted of eight items concerned with HCWs' perception of risk communication principles. Besides, HCWs were asked about their level of trust towards the most commonly utilized sources of information about the COVID-19 pandemic. A scoring system was developed to score the knowledge and attitude of study participants, as described previously.[36,37] Briefly, incorrect/inappropriate were given a 0 score, while one point was given for choosing the correct/appropriate answer; a correct/appropriate response was based on current literature and the good attitude. For multiple-choice questions with more than one correct answer, one score was given for the correct/appropriate response and for not choosing the incorrect/inappropriate responses. The question's score was then divided by the total number of multiple-choices in the question to standardize the scores to be between 0 and 1. Additionally, overall mean scores, ranging from 0 to 1, were calculated for each section of the questionnaire (knowledge and attitude). They were then further divided into four categories to reflect the level of knowledge and attitude among HCWs: poor (score <0.25), below average ($0.25 \leq$ score < 0.50), above average ($0.5 \leq$ score < 0.75), and good (score ≥ 0.75).

Sample Size Calculation and Statistical Analysis

We used the Raosoft ® sample size calculator to calculate the appropriate sample size for this survey using the following parameters: a 95% confidence interval, a response distribution of 50%, and a 3% margin of error. The targeted sample size was calculated to be 1067 participants. After adjusting for a projected 10% attrition, the target sample size for the study was 1200 participants. By the end of the study, we enrolled a larger sample size of 1746 HCWs after excluding participants who did not provide direct healthcare services.

Frequencies and percentages were used for categorical variables. Continuous variables were represented as means ±standard deviations (SD), minimum, and maximum. The association between categorical variables was evaluated by the Chi-square test or Fisher's exact test, as appropriate. Continuous variables were assessed using the Independent *t*-test or One-way ANOVA. Bivariate and multivariate logistic regression models were also conducted between the variables and good knowledge/ attitude scores, respectively. All significance tests were two-sided, and a p-value of <0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA).

Results

Study Population and Demographics

A total of 1691 responses were received in the study, with a mean age of 36.94 ±9.21 years and female predominance (53.6%). Nearly 55.4% of the HCWs worked within the MOH-affiliated sector. The majority of the sample were physicians (35%) and nurses (26.4%). Nearly half of the

HCWs sample had already dealt with one or more suspected/confirmed COVID-19 cases (Table 1).

Knowledge and Attitude Towards COVID-19

Table 2 presented the knowledge and attitude scores of HCWs regarding COVID-19.

The HCWs exhibited good levels of knowledge of COVID-19 concerning the modes of transportation of COVID-19 (0.8±0.2), which sample collection method is the most useful for the diagnosis of COVID-19 (0.9±0.1), the knowledge of asymptomatic individuals infecting other healthy individuals (0.9±0.1), the knowledge that the seasonal flu vaccine does not protect recipients from the new COVID-19 (0.9±0.2), and antibiotics are not effective against the new COVID-19 (0.8±0.4). The level of the remaining two items was above average. The overall mean knowledge score was 0.9 ±0.1; 1343 participants (84.8%) had good level of knowledge (score >0.75) regarding COVID-19 pandemic (Figure 1).

On the other hand, HCWs had good attitude scores concerning their willingness to deal with new COVID-19 patients (0.9±0.3), their beliefs in being educated on COVID-19 (0.9±0.1), their feeling of having the appropriate knowledge when dealing with new COVID-19 patients (0.8±0.4), and their feeling that following the standard precautionary measures advised by MOH would minimize HCWs risk of contracting new COVID-19 (0.9±0.2). The remaining two items were scored above average. The overall mean knowledge score was 0.8 ±0.2; 1091 participants (64.5%) had good level of attitude (score >0.75) regarding COVID-19 pandemic (Figure 1).

Risk Communication Practice

Nearly all participants (97.9%) received health information messages concerning COVID-19 and strongly agreed/agreed that it is important to take actions to prevent the spread of COVID-19 within healthcare facilities. Most (94.1%) HCWs felt a chance to develop COVID-19 while conducting their duties (Table 3).

Regarding the impact of the health messages on HCWs' attitude, 93.4% of the participants stated that the received messages changed their attitude towards COVID-19, mainly in the form of applying stricter infection control practices (78.8%) and self-education about COVID-19 (76.5%). Besides, participants reported attitude changes regarding the willingness to deal with COVID-19 patients (61.4%) and receiving work instructions/endorsement remotely (56.8%). Preventive measures were also impacted after receiving health messages regarding COVID-19 (Table 3).

Finally, HCWs were asked about what type of information they would like to know more about regarding COVID 19; the majority reported that they would like to know more about therapeutic options (77.3%). Overall, the majority of the sample (89.4%) felt that there is a gap of information that they believe they need to have fulfilled (Table 3). The most trusted source regarding received information related to COVID 19, as reported by the HCWs, was the Saudi MOH (96.2%), followed by the WHO (56.4%).

Predictors of Good Knowledge and Attitude Levels

HCWs with higher education levels had higher knowledge mean scores (p <0.001). Besides, physicians and pharmacists had the highest knowledge mean scores than remaining occupations (p <0.001; Table 4). At the multivariate level, nurse occupation (OR 0.4, 95% CI 0.3–0.7, p =0.001), being a radiotherapist (OR 0.3, 95% CI 0.1–0.6, p =0.001), and public health occupation (OR 0.2, 95% 0.1–0.8, p =0.021) were independent negative predictors of good knowledge levels (Table 5).

The results demonstrated that the attitude mean scores were significantly higher among males (p <0.001), older age groups (p =0.008), non-Saudis (p <0.001), HCWs work within a governmental sector other than the MOH (P=0.014), nurses (P<0.0001), HCWs stationed in ICU (P<0.0001), and HCWs with a history of dealing with COVID19 patient (P<0.0001; Table 4). At the multivariate level, male gender (OR 2, 95% CI 1.6–2.6; p <0.001), nurse occupation (OR, 1.6, 95% CI 1.1–2.2, p =0.006), being a laboratory staff (OR 2.7, 95% CI 1.1–6.9, p =0.039), being stationed in ICU (OR 2.9, 95% CI 1.5–5.8, p =0.001), being stationed in the ER (OR 1.8, 95% CI (1.1–2.9), p =0.017), and dealing with COVID-19 suspected/confirmed cases (OR 2.6, 95% CI 2–3.3, p <0.001) were independent positive predictors of good attitude score. On the other hand, working in governmental sectors other than the MOH (OR 0.6, 95% CI 0.5–0.9, p =0.003) was an independent negative predictor of good attitude score (Table 5).

There was a statistically significant positive correlation between knowledge and attitude (p < 0.0001).

Table 1 Demographic and Professional Characteristics of the Study Population

Variable	Number	Percentage (%)
Study enrolled	1691	
Gender	1114	
Female	906	53.6
Age Group	1690	
<30 years	384	22.7
30–39 years	750	44.4
40–49 years	351	20.8
>49 years	205	12.1
Nationality	1669	
Non-Saudi	642	38.5
Saudi	1027	61.5
Highest level of education:	1690	
Diploma	339	20.0
Bachelor	892	52.7
Masters\Ph.D	400	23.7
Other	59	3.5
Employer	1691	
Governmental - Ministry of Health	937	55.4
Governmental - Other than the Ministry of Health	346	20.5
Private sector	398	23.5
Work location	1646	
Hospital	1366	83
PHC	280	17
Occupation	1687	
Laboratory staff	137	8.1
Nurse	445	26.4
Other	328	19.4
Pharmacist	99	5.9
Physician	590	35
Public Health	16	0.9
Radiotherapist	72	4.3
Ward stationed in:	1498	14.7
Medical ward	220	18.8
O&G ward	62	25.3
Pediatric ward	97	31.2
ICU	88	44.7
ER	202	52.0
Laboratory	110	56.3
Pharmacy	64	58.5
Isolation ward	34	58.7
Optometrists	3	85.7
Other, specify	404	86.7
OPD	15	89.1
Radiology	36	97.7
Dentist	128	98.5
Nutrition	12	14.7
Physiotherapy	23	18.8
Dealt with a COVID-19 suspected/ confirmed case	1689	
Yes	846	50.1

Abbreviations: PHC, Primary healthcare center; O&G ward, Obstetrics and gynecology ward; ICU, intensive care unit; ER, emergency room; OPD, outpatient department; COVID-19, coronavirus disease-2019.

Discussion

The landscape of the COVID-19 pandemic has changed dramatically in the EMR, including Saudi Arabia, with a sharp rise in the number of documented cases and related mortality.[38] During this unprecedented time, community compliance with preventive measures and limited panic-related behaviors play a crucial role in the pandemic's successful control.[11] It is well-established that an improper risk management strategy can negatively impact public compliance to self-protective measures, especially when these measures interfere with normal activities or have socioeconomic impacts.[39] Effective risk communication represents the cornerstone for a risk management strategy aiming to improve not only how people perceive health risks during the pandemic but also how they react to healthcare emergencies and adhere to self-protective measures.[11,40–42] In the case of the COVID-19 pandemic, with its associated high transmission rates, morbidities, and mortality, lack of proper risk communication can exaggerate panic displays, increase public confusion, or lead to unfavorable perception towards the benefits of preventive measures.[43] In this regard, HCWs are the front-line soldiers in the fight against COVID-19; previous reports demonstrated that HCWs account for up to 24% of the global number of documented COVID-19 cases.[44] It is postulated that insufficient information about COVID-19 transmission, incubation period, and clinical symptoms are the main reasons for the high risk of infection among HCWs;[45] thus, it is of paramount importance to ensure proper risk communication among this vulnerable group during the COVID-19 pandemic. Besides, HCWs are key players in the expert–public communication component of the risk communication strategy,[46,47] and ensuring reliable

Table 2 The Knowledge and Attitude Scores of HCWs Regarding COVID-19

Variable	N	Minimum	Maximum	Mean	Std. Deviation
1. Knowledge Score					
1.1 What are the known modes of transmission so far for new COVID-19?	1687	0.17	1	0.82	0.16
1.2 Which of the following are the most common symptoms of new COVID-19 according to the WHO?	1689	0.17	1	0.74	0.17
1.3 What method of sample collection is the most useful for new COVID-19 diagnosis from the upper respiratory tract?	1686	0.33	1	0.98	0.08
1.4 Infected people without symptoms can spread new COVID-19?	1688	0	1	0.99	0.11
1.5 Seasonal flu vaccination protects the recipient from a new COVID-19?	1688	0	1	0.95	0.21
1.6 Only elderly people or people with underlying health conditions (eg: Diabetes, Cardiovascular diseases) are at the risk of developing severe illness due to new COVID-19?	1688	0	1	0.64	0.48
1.7 Antibiotics are effective against new COVID 19?	1688	0	1	0.83	0.38
Attitude Score					
2.1 I would be willing to deal with new COVID-19 patients?	1691	0	1	0.87	0.33
2.2 I find it important for all HCWs to educate themselves regarding new coronavirus COVID-19 whether they come into direct contact with new COVID-19 patients or not.	1691	0	1	0.99	0.11
2.3 I feel have the appropriate knowledge to deal with new COVID-19 patients?	1691	0	1	0.76	0.43
2.4 I feel I have the appropriate skills to deal with new COVID-19 patients?	1691	0	1	0.66	0.47
2.5 I feel I was provided with the appropriate equipment to deal with new COVID-19 patients?	1691	0	1	0.53	0.50
2.6 I feel that following the standard precautionary measures advised by MoH minimizes my risk of contracting new COVID-19?	1691	0	1	0.97	0.17

Abbreviations: HCWs, healthcare workers; MoH, Ministry of Health; COVID-19, coronavirus disease-2019.

risk perception in this group would potentially reflect on public perception and compliance during the pandemic.

Thus, we aimed to understand the impact of risk communication on the perceived risk and attitude towards COVID-19 among HCWs in Saudi Arabia. Our results demonstrated that only one-third of the HCWs perceived themselves at a high possibility of acquiring COVID-19 infection. Nonetheless, HCWs within the Kingdom positively perceived the benefits of preventive measures and health messages; these messages positively changed HCW's attitude and practice towards COVID-19-related preventive measures. Besides, the majority of the HCWs stated that there is a gap of information that needs to be fulfilled. To our knowledge, there no published reports about the impact of risk communication among HCWs in Saudi Arabia. In a recent report by Abolfotouh et al,[48] HCWs from Saudi Arabia exhibited a high level of concerns about acquiring COVID-19 infection and a high level of support of actions taken by healthcare authorities to minimize infection risk. Besides, HCWs in this report stated an unmet gap regarding the information about COVID-19 in the media.[48] In another report that covered ten countries from America, Europe, and Asia, the information received from government and healthcare professionals was a significant predictor of proper COVID-19 risk perception,[49] highlighting the beneficial role of risk communication on the perceived risk and attitude towards COVID-19 pandemic. Thus, healthcare authorities in the Kingdom should implement continuous education programs and training that support HCWs with updated

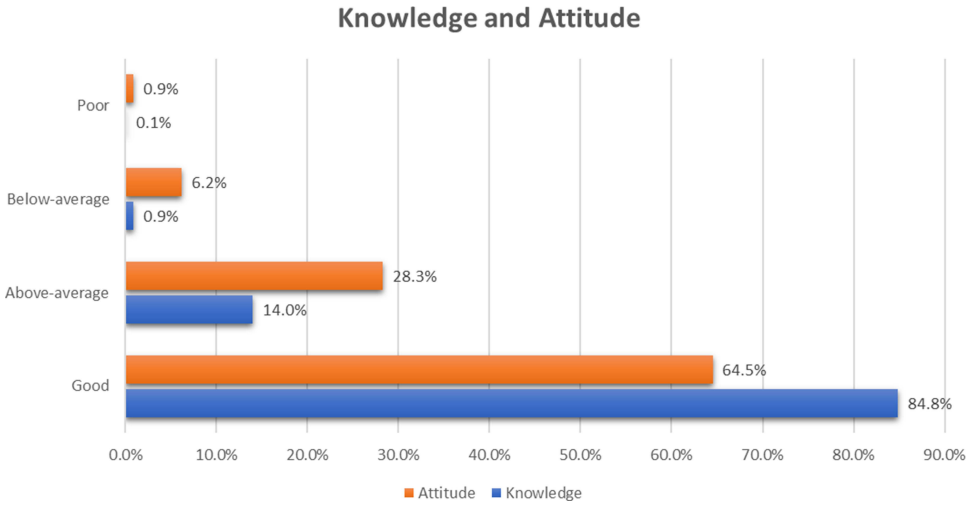

Figure 1 Level of knowledge and attitude towards COVID-19 pandemic among HCWs in Saudi Arabia.

information and protocols on minimizing the risk of COVID-19 infection in the hospital setting. Besides, clear and pertinent guidance about applying preventive measures during COVID-19 should be developed to aid HCWs in minimizing the risk of infection. Future research should also focus on the impact of different risk communication strategies on the HCWs' knowledge and attitude.

Proper knowledge is a major determinant of any successful control strategy during health emergencies. Previous reports highlighted that the high level of knowledge was a driven factor for proper implementation of preventive measures and authority's directives during previous outbreaks such as severe acute respiratory syndrome (SARS) and H1N1 influenza.[50,51] Particularly, the importance of proper knowledge among HCWs cannot be overstated, owing to their high risk of infection and the public view of HCWs as a trusted source of information during a health crisis. This survey found that HCWs from Saudi Arabia had good knowledge about basic COVID-19 information such as mode of transmission, clinical presentation, and standard of care. Such good knowledge can be viewed in the context of effective risk communication, as stated earlier. Such findings are in line with reports from China,[12] Egypt,[15] and Pakistan.[13] On the contrary, a recent report from the United Arab Emirates demonstrated a poor level of knowledge among HCWs.[16] Notably, our findings demonstrated that good knowledge was significantly associated with older age, and the educational level above diploma degree and physician occupation. We postulated that these findings stem from the fact that the elderly are more vulnerable to severe presentations of COVID-19 and, hence, they are more eager for self-education about basic information of the COVID-19 pandemic. Likely, physicians are more likely to get in direct contact with COVID-19 cases than other specialties –such as pharmacists and laboratory staffs-. Our findings come in agreement with Abdel Wahed et al,[15] in which physicians and HCWs with an educational level above diploma had significantly higher knowledge scores. Previous studies further support the impact of age and education on the knowledge level during previous outbreaks.[52] Therefore, it is essential to launch targeted educational campaigns covering HCWs with low educational level, non-physician occupations, and non-MOH workers.

Behavioral changes are critical for the successful implementation of any precautionary measures and risk communication strategy. Previous reports demonstrated that attitude and perception are major driving factors for behavioral changes during outbreaks.[53] In this regard, HCWs are at increased risk of psychological stress, burnout, and occupational stigma, especially during the time of pandemic.[15,48] Such factors may be associated with negative personal feelings towards the work environment during the pandemic, dealing with new cases, and the response of the government to the epidemic management.[54,55] In return, the unfavorable attitude by HCWs can lead to improper self-protection practice and delayed diagnosis.[15] In this report, we found that HCWs from Saudi Arabia had good attitude levels towards dealing with COVID-19, governmental actions to minimize the risk of infection, and their level of knowledge and preparation to face the pandemic. Such findings are in line

Table 3 Risk Communication Messages Practice

Variable	Number	Yes	Percentage (%)
Did you receive health information messages concerning new coronavirus COVID-19?			
Yes	1688	1652	97.9
Do you think you are likely to become sick with the new coronavirus COVID-19?			
The possibility of infection is high/very high	1689	583	34.5
The possibility of infection is moderate	1689	548	32.4
The possibility of infection is low/very low	1689	459	27.1
Unlikely to get infected at all	1689	99	5.9
Do you consider important to take actions to prevent the spread of new coronavirus COVID-19 in healthcare facilities?			
Strongly agree/ Agree	1687	1653	98
Neutral	1687	31	1.8
Strongly disagree/ disagree	1687	2	0.2
What kind of information have you received about the new coronavirus COVID-19?			
How to protect your self	1602	1544	96.4
Symptoms of COVID-19	1602	1508	94.1
How the disease is transmitted	1602	1384	86.4
What to do if you have symptoms	1602	1456	90.9
Risk groups	1602	1399	87.3
How is the COVID-19 treated	1602	1002	62.5
Other	1602	227	14.2
Attitude changed after receiving health messages about new coronavirus COVID-19?			
Willing to deal with COVID-19 patients	1675	1029	61.4
Willing to receive work Instruction\endorsement remotely	1675	951	56.8
Willing to educate yourself about COVID-19	1675	1281	76.5
Willing to follow infection control practices more strictly	1675	1320	78.8
No, it did not change any attitude	1675	111	6.6
Other attitude were changed	1675	28	1.7
Preventive practices changed after receiving health messages about new coronavirus COVID-19?			
Keeping update with scientific publications regarding new coronavirus COVID-19	1677	1056	63
Commitment to the home isolation except for my professional obligations	1677	1358	81
More adhere to the hand hygiene	1677	1449	86.4
More adhere to correct misconceptions regarding new coronavirus COVID-19	1677	1184	70.6
No, it did not change any Practice	1677	61	3.6
Other preventive practices were changed	1677	31	1.8
What more would you like to know about the new coronavirus COVID-19?			
About infection prevention and control	1677	825	49.2
About therapeutic options	1677	1297	77.3
About patients management	1677	958	57.1
No, I have sufficient information	1677	139	8.3
Other	1677	39	2.3
Describe your feelings in term of stress and panic toward the COVID-19?			
Very high/ high level of stress	1687	625	37.1
Neutral	1687	652	38.6
Very low/ low level of stress	1687	280	16.6
Unconcerned	1687	130	7.7

Abbreviation: COVID-19, coronavirus disease-2019.

with reports from China,[12] Egypt,[15] and Pakistan.[13] HCWs from these countries exhibited fair levels of attitude towards the COVID-19 pandemic in dealing with confirmed cases and measures to minimize the spread of infection. Concerning the predictors of good attitude levels, we found that the male gender was an independent positive predictor of good attitude score. Such findings may be attributed to the higher level of education among males in Saudi Arabia, gender difference in employment status, higher exposure to pandemic-related information among males, and the fact that males are more likely to suffer from more severe forms of COVID-19 than

Table 4 The Association Between Knowledge/Attitude Scores and HCW's Characteristics

Variable	Category	Knowledge Score				Attitude Score			
		N	Mean	S.D	p-value	N	Mean	S.D	p-value
Gender[a]	Female	904	0.5	0.5	0.754	906	0.37	0.48	0.000
	Male	784	0.49	0.5		785	0.49	0.5	
Age Groups[b]	<30 years	383	0.51	0.5	0.606	383	0.35	0.48	0.008
	30–39 years	749	0.5	0.5		750	0.42	0.49	
	40–49 years	350	0.46	0.49		351	0.48	0.5	
	>49 years	205	0.48	0.5		206	0.48	0.5	
Nationality[a]	Non Saudi	640	0.5	0.5	0.537	642	0.47	0.5	0.000
	Saudi	1027	0.49	0.5		1027	0.39	0.49	
Highest level of education[b]	Diploma	339	0.37	0.48	0.000	339	0.43	0.5	0.292
	Bachelor	891	0.49	0.5		891	0.4	0.49	
	Masters\Ph.D	399	0.58	0.49		399	0.46	0.5	
	Other	59	0.63	0.49		59	0.47	0.5	
Employer[b]	Governmental - Ministry of Health	935	0.48	0.5	0.65	937	0.43	0.5	0.014
	Governmental - Other than the Ministry of Health	346	0.53	0.5		346	0.4	0.49	
	Private sector	398	0.5	0.5		398	0.43	0.50	
Occupation[b]	Physician	589	0.62	0.49	0.000	590	0.42	0.49	0.000
	Pharmacist	99	0.51	0.5		99	0.29	0.46	
	Nurse	444	0.39	0.49		445	0.5	0.5	
	Laboratory staff	137	0.37	0.49		137	0.42	0.5	
	Radiotherapist	72	0.38	0.49		72	0.44	0.5	
	Public Health	16	0.38	0.5		16	0.38	0.5	
	Other	328	0.49	0.5		328	0.36	0.48	
Ward stationed in[b]	Medical ward	220	0.52	0.5	0.073	220	0.48	0.5	0.000
	O&G ward	62	0.48	0.5		62	0.23	0.42	
	Paediatric ward	97	0.58	0.5		97	0.38	0.49	
	ICU	88	0.55	0.5		88	0.67	0.47	
	ER	202	0.41	0.49		202	0.49	0.5	
	Laboratory	110	0.44	0.5		110	0.44	0.5	
	Pharmacy	64	0.44	0.5		64	0.3	0.46	
	Isolation ward	33	0.42	0.5		34	0.44	0.5	
	Optometrists	3	0.33	0.58		3	0	0	
	Other	403	0.48	0.5		404	0.44	0.5	
	OPD	15	0.53	0.52		15	0.4	0.51	
	Radiology	36	0.47	0.51		36	0.39	0.49	
	Dentist	128	0.58	0.5		128	0.27	0.44	
	Nutrition	12	0.67	0.49		12	0.25	0.45	
	Physiotherapy	23	0.61	0.5		23	0.35	0.49	
Dealt with a COVID-19 suspected/confirmed case[a]	Yes	845	0.48	0.5	0.404	846	0.53	0.5	0.000
	No	843	0.5	0.5		843	0.32	0.47	

Notes: [a]Independent *t*-test; [b]ANOVA test.

Abbreviations: PHC, Primary healthcare center; O&G ward, Obstetrics and gynecology ward; ICU, intensive care unit; ER, emergency room; OPD, outpatient department; COVID-19, coronavirus disease-2019.

Table 5 The Univariate and Multivariate Regression Analysis for Predictors of Good Knowledge/Attitude Scores

Variable	Category	N	Good Knowledge				Good Attitude			
			OR[95%]	P-value	aOR[95%]	P-value	OR[95%]	P-value	aOR[95%]	P-value
Gender	Female	725	1.00	–						
	Male	744	0.846 (0.647–1.104)	0.218			1.777 (1.449–2.178)	<0.0001	2.03 (1.571–2.622)	<0.0001
Age Groups	<30 years	333	1.00	–						
	30–39 years	654	1.181 (0.849–1.644)	0.324	0.947 (0.643–1.395)	0.784	1.144 (0.888–1.475)	0.297	1.077 (0.788–1.471)	0.643
	40–49 years	304	1.188 (0.802–1.761)	0.391	0.920 (0.571–1.482)	0.732	1.572 (1.154–2.140)	0.004	1.263 (0.85–1.876)	0.247
	>49 years	178	1.961 (1.153–3.336)	0.013	0.873 (0.459–1.659)	0.678	1.079 (0.761–1.529)	0.671	0.924 (0.579–1.476)	0.742
Nationality	Non Saudi	560	1.00	–						
	Saudi	909	1.017 (0.773–1.339)	0.903			0.812 (0.659–0.999)	0.049	0.976 (0.727–1.311)	0.872
Highest level of education	Diploma	300	1.00	–	1.00	–	1.00	–		
	Bachelor	771	1.603 (1.176–2.183)	0.003	1.162 (0.809–1.671)	0.416	0.877 (0.673–1.141)	0.328		
	Masters/ Ph.D.	345	3.607 (2.312–5.627)	<0.0001	1.769 (0.991–3.159)	0.054	0.918 (0.677–1.246)	0.585		
	Other	53	8.660 (2.068–36.27)	0.003	3.210 (0.722–14.26)	0.125	0.905 (0.507–1.614)	0.735		
Employer	Governmental - Ministry of Health	839	1.00	–						
	Governmental - Other than the Ministry of Health	305	1.048 (0.734–1.494)	0.797			0.638 (0.495–0.822)	<0.0001	0.644 (0.48–0.864)	0.003
	Private sector	325	0.819 (0.596–1.126)	0.219			0.861 (0.673–1.101)	0.232	1.096 (0.799–1.503)	0.568

Occupation	Physician	518	1.00	–						
	Pharmacist	88	0.508 (0.262–0.985)	0.045	0.552 (0.169–1.803)	0.325	0.498 (0.324–0.764)	0.001	0.668 (0.265–1.682)	0.392
	Nurse	408	0.315 (0.213–0.466)	<0.0001	0.418 (0.253–0.690)	0.001	1.553 (1.187–2.030)	0.001	1.592 (1.141–2.221)	0.006
	Laboratory staff	107	0.624 (0.335–1.162)	0.138	0.916 (0.242–3.458)	0.897	1.212 (0.816–1.800)	0.342	2.695 (1.05–6.918)	0.039
	Radiotherapist	54	0.2 00 (0.109–0.365)	<0.0001	0.281 (0.133–0.595)	0.001	1.303 (0.768–2.211)	0.326	1.261 (0.643–2.474)	0.500
	Public Health	13	0.169 (0.056–0.509)	0.002	0.233 (0.068–0.806)	0.021	0.344 (0.123–0.960)	0.041	0.621 (0.190–2.030)	0.431
	Other	281	0.283 (0.188–0.427)	<0.0001	0.358 (0.213–0.602)	<0.0001	0.82 (0.622–1.081)	0.159	1.037 (0.729–1.475)	0.841
Ward stationed in	Medical ward	216	1.00	–						
	O&G ward	62	0.541 (0.248–1.183)	0.124	0.671 (0.298–1.512)	0.335	0.618 (0.35–1.089)	0.096	0.757 (0.412–1.388)	0.368
	Paediatric ward	93	1.016 (0.464–2.225)	0.969	0.815 (0.362–1.832)	0.620	0.88 (0.541–1.433)	0.608	1.041 (0.611–1.774)	0.882
	ICU	86	1.025 (0.454–2.312)	0.953	1.340 (0.581–3.088)	0.492	3.006 (1.619–5.580)	<0.0001	2.951 (1.513–5.755)	0.001
	ER	199	0.396 (0.23–0.681)	0.001	0.586 (0.333–1.031)	0.064	2.848 (1.813–4.473)	<0.0001	1.806 (1.111–2.936)	0.017
	Laboratory	109	0.953 (0.455–1.996)	0.899	0.697 (0.180–2.698)	0.601	1.17 (0.726–1.887)	0.519	0.686 (0.268–1.755)	0.431
	Pharmacy	63	0.817 (0.347–1.926)	0.645	1.076 (0.271–4.269)	0.917	0.48 (0.273–0.844)	0.011	0.871 (0.301–2.522)	0.800
	Isolation ward	33	0.434 (0.169–1.110)	0.081	0.543 (0.207–1.426)	0.215	2.882 (1.146–7.252)	0.025	1.852 (0.703–4.880)	0.213
	Other	608	0.677 (0.417–1.101)	0.116	0.963 (0.576–1.610)	0.887	0.952 (0.694–1.306)	0.759	1.118 (0.784–1.596)	0.537
dealt with a COVID-19 suspected/ confirmed case	No	725	1.00	–						
	Yes	744	0.897 (0.687–1.172)	0.426			2.889 (2.345–3.558)	<0.0001	2.576 (2.004–3.310)	<0.0001

Abbreviations: PHC, Primary healthcare center; O&G ward, Obstetrics and gynecology ward; ICU, intensive care unit; ER, emergency room; OPD, outpatient department; COVID-19, coronavirus disease-2019

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females.[56] Besides, the results showed that nurse occupation, being stationed in ICU or ER, and dealing with COVID-19 suspected/confirmed cases were independent positive predictors of good attitude score. Such findings are expected since these occupations deal closely with hospitalized COVID-19 cases and accumulate more experience, knowledge, and favorable attitude.[57]

Study Limitations

While the present study has the strength of a large sample size and comprehensive coverage of HCWs from different institutions and levels of care, we acknowledge the existence of some limitations in this survey. Our survey was based on a self-reported, online-based survey that might suffer from selective participation, difficulties in measuring attrition rates, and liability to participants' feelings during survey filling. Besides, the questionnaire was not validated quantitatively, which might have affected the precision of our conclusion.

Conclusion

Our results demonstrated that HCWs felt a notable change in their attitude after receiving proper information about COVID-19 from health authorities. Thus, healthcare authorities in the Kingdom should implement continuous education programs and training that support HCWs with updated information and protocols on minimizing the risk of COVID-19 infection in the hospital setting. Besides, clear and pertinent guidance about applying preventive measures during COVID-19 should be developed to aid HCWs in minimizing the risk of infection. On the other hand, HCWs from Saudi Arabia exhibited fair levels of knowledge and attitude towards COVID-19; however, the knowledge of HCWs towards the impact of old age on the outcomes of COVID-19 and the presentation of the disease was unsatisfactory. Higher levels of knowledge and attitude were significantly associated with higher educational levels, physician occupation, and working in MOH affiliated hospitals. Therefore, it is essential to launch targeted educational campaigns covering HCWs with low educational level, non-physician occupations, and non-MOH workers.

Disclosure

The authors report no conflicts of interest in this work.

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