Knowledge and awareness of COVID-19 epidemic preparedness and response among health care workers in Makkah city

Asrar Mansoor Alrajhi, Waleed Abdul-Halim Hussain, Basmah Amin Rafie, Mehar Taj and Abdelaziz Moustafa Elgarf

Abstract
Objective: This study determined and examined the knowledge and awareness of COVID-19 pandemic preparedness and response measures by health care workers (HCWs) in Makkah city.

Methods: This descriptive study used a quantitative method with a cross-sectional design. A survey (questionnaire) collected data from 251 HCWs working in 10 hospitals and 80 health care centers.

Results: The total score for the knowledge level was high (range: 50–76, mean ± SD = 65.370 ± 4.805). There was a relationship between the participants’ workplace and education levels to the nature of the disease (p = 0.009*, 0.037*, respectively). Job descriptions were related to the transmission of the disease (p = 0.003*). The participants’ age groups and years of experience were also associated with their actions in suspected, probable, and confirmed cases (p = 0.015*, 0.03*, respectively). The HCWs’ knowledge of precautionary measures was not related to their demographic data, except for the education level shown (p = 0.037*).

Discussion: A similar level of knowledge and awareness was detected in Saudi Arabia in Riyadh and Al-Jouf, the UAE, Vietnam, and Uganda. Further study is recommended to measure the factors affecting HCWs’ knowledge and awareness during an epidemic situation.

Keywords: knowledge, health care workers, COVID-19, response, Makkah city

Introduction
The coronavirus disease 2019 (COVID-19) is a unique virus that infects animals and humans. Although bats are acknowledged as its natural hosts, other animals, such as camels and civet cats, are counted among its sources.

COVID-19 was first discovered in China and is genetically similar to the severe acute respiratory syndrome coronavirus 1 (SARS-CoV-1) virus, which killed thousands of people in 2002. The current COVID-19 outbreak has resulted in many reported cases worldwide. There is no cure yet for this virus. Also, since it is a new virus, no one has preexisting immunity, which implies that the entire human population is potentially susceptible to COVID-19 infection.

The COVID-19 virus is transmitted from person to person. The virus is mainly transferred through respiratory droplets produced when people sneeze, cough, or exhale. The virus may also survive for many hours on surfaces like tables and doorknobs.

The COVID-19 incubation period is expected to be between 2 and 14 days. Infected people exhibit flu-like symptoms that range in clinical presentation from a mild upper respiratory infection to rapidly progressive pneumonia and multi-organ...
failure. The symptoms are fever, cough, difficulty breathing, muscle discomfort, and fatigue. In more extreme cases, severe pneumonia, acute respiratory distress syndrome, sepsis, and septic shock may result in mortality.¹

Severe symptoms are more prevalent among the elderly and individuals with chronic health disorders such as hypertension, diabetes, cardiovascular disease, chronic respiratory illness, and cancer. Infections in children seem to be rare and minor. The illness severity of pregnant women after childbirth has yet to be explored. However, pregnant women follow the same COVID-19 preventive methods as any person.

The European Center for Disease Prevention and Control is monitoring the pandemic situation.³ The current testing advice is based on the pandemic stage in the nation or region. Testing methods may also change depending on national legislation. All these are tailored to the circumstances at the local and national scales.⁴

Preventive measures include hand washing with soap and water, keeping away from other individuals who are unwell and from others in general as some people may be asymptomatic and self-isolating if symptoms are experienced while seeking medical attention.⁵ As there is no particular therapy for this condition, health care practitioners address patients' clinical symptoms (e.g. fever and trouble breathing) using supportive treatment (e.g. hydration management and oxygen therapy), which may benefit individuals suffering from COVID-19 symptoms.

There is a growing corpus of academic studies on this subject. It is critical to examine the public’s knowledge, attitude, and behavior regarding significant and widespread infectious illnesses. This information offers a baseline for preventing and controlling these illnesses by estimating the effect of previous government preventive initiatives and determining the need for further actions.¹

The best way to prevent and slow down the transmission of COVID-19 is to make people well informed about it and how it spreads. The COVID-19 has already taken hold in Europe, the United States, and Southeast Asia and has begun to wreak havoc in Saudi Arabia.² There have been more than 141,984,507 cases, 120,515,040 recoveries, and 3,032,182 deaths worldwide.⁵ In Saudi Arabia, where the first COVID-19 infection was declared by the Ministry of Health (MOH) on 2 March 2020, increased diagnostic examinations, preventive measures, vaccination, and preparedness measures to contain the spread of the disease led to 388,702 recoveries.⁶

Health care workers (HCWs) are the first line of defense against any disease outbreak, but their knowledge levels vary. HCWs in Lebanon have shown a satisfactory level of knowledge about COVID-19.⁷ In Northern Ethiopia, the HCWs displayed good knowledge, good infection prevention practices, but disturbing psychological responses toward COVID-19.⁸

In a study of 500 HCWs in five regions of Saudi Arabia, most of the HCWs had excellent knowledge of COVID-19. Some HCWs reported significant prevention knowledge and treatment skills, while the rest had little expertise on COVID-19. More than half of the HCWs had strong positive attitudes toward caring for COVID-19 patients. However, non-Saudi nurses self-reported higher levels of knowledge and awareness, positive attitudes and perceptions, and optimal prevention skills compared to Saudi nurses.⁹

In Jeddah city, which has been seriously affected by the global pandemic, HCWs showed sufficient knowledge and positive attitudes toward COVID-19.¹⁰ Jeddah is near Makkah city, which receives millions of Muslims around the world who do Umrah and Hajj yearly, considered among the largest mass gatherings in the world.¹¹,¹² The importance of Makkah city motivated the researchers to conduct this study so as to examine the city HCWs’ knowledge and awareness of the COVID-19 pandemic as well as their preparedness and response. This study examined the knowledge and awareness of COVID-19 pandemic preparedness and response measures by HCWs in Makkah city.

Methods
This descriptive study used a quantitative method with a cross-sectional design. A survey (questionnaire) collected data from 9,317 HCWs working in 10 hospitals and 80 health care centers. The HCWs included technicians, physicians, nurses,
pharmacists, social workers, dieticians, and paramedics in Makkah city to assess their preparedness and response to COVID-19. Ethical approval was granted by Makkah’s Ethical Committee at the Ethical Approval Department of Makkah Health Affairs (no. H-02-K-076-0520-295). The survey started on 23 June 2020 and ended on 20 December 2020. The data were analyzed over 4 months.

**Inclusion criteria**
The following criteria for HCWs who were included in the survey:

- HCWs in Makkah city.
- Working in hospitals and health care centers in Makkah.
- Male or female.
- Saudi and non-Saudi.

**Exclusion criteria**
The following criteria for HCWs who were excluded from the survey:

- HCWs outside Makkah city.
- HCWs outside health care centers and hospitals.
- Employees other than HCWs.

**Sample size calculation**
The size of the study sample was calculated based on the number of HCWs in Makkah city in 2019: 9,317 workers. The researchers desired a degree of confidence of 95% with a type-I error (5%) and a power of the test of 90%, which required a minimum sample of 369 respondents.

**Research rigor**
A team of experts from the Medical Research Center at Hera General Hospital in Makkah city assessed the final questionnaire in this study for face validity and pilot-tested it on 20 people from the target group who were not involved in this study.

**Survey composition**
The research data were gathered using one tool: a structured questionnaire that examined the HCWs’ knowledge and awareness of pandemics and their preparedness to face the COVID-19 pandemic. The survey was based on the knowledge scale factor load. The base knowledge of the survey was gathered from the Centers for Disease Control and Prevention. The questionnaire had two main sections. The first section contains nine questions asked about the participants’ demographic and socioeconomic data (age, gender, income, working experience, working place, and education). The second section covered the participants’ COVID-19 epidemiological data.

The second section included 43 questions divided into four domains or fields of COVID-19 knowledge and awareness. The first domain was the nature of the disease, under which there were nine questions. The second domain was the transmission of the disease, with eight items. The third domain was the correct actions to deal with suspected, probable, and confirmed cases, with 22 items. The fourth and final domain was the precautionary measures, with four items. Thanks to expert translators familiar with the medical language, the survey was available in Arabic and English (see Table 1).

**Data collection and analysis**
The survey was distributed electronically through a link to a Google Form sent officially to the participants’ official MOH emails and distributed on social media. A brief introductory message explained the aim of the study and the researchers’ qualifications. The participants were informed of their right to withdraw from the survey before answering any questions. They were also made aware that their completion of the surveys would mean they were consenting to the researchers’ inclusion of their answers in this study.

The questionnaire was open for 6 months. The participants’ responses were collected directly from the Google Form and posted on an Excel sheet. Then the expert researchers analyzed them using SPSS v23 and determined significant values using the chi-square, mean, and standard deviation, as well as the results of a T-test and ANOVA, which they then organized into categories in tables.

The proportion of correct responses to the questionnaire’s 43 questions was used to get the
Table 1. Knowledge scale factor load.

| First domain: nature of the disease | Yes | No | I do not know |
|-------------------------------------|-----|----|--------------|
| 1. Do you know the symptoms of COVID-19? |     |    |              |
| 2. The diagnostic sample for COVID-19 is throat swab? |     |    |              |
| 3. The diagnostic sample for COVID-19 is blood test? |     |    |              |
| 4. Some types of fruit-eating bats are the main source of the disease in wildlife |     |    |              |
| 5. The causative agent of COVID-19 is COVID-19 |     |    |              |
| 6. COVID-19 can be eliminated with 70% alcohol |     |    |              |
| 7. COVID-19 can be prevented with the injection of a vaccine |     |    |              |
| 8. The incubation period of COVID-19 is 2–14 days |     |    |              |
| 9. The COVID-19 can survive for 48 hours in the environment |     |    |              |

| Second domain: transmission of disease | Yes | No | I do not know |
|---------------------------------------|-----|----|--------------|
| 1. COVID-19 is transmitted through direct contact |     |    |              |
| 2. The disease can be transmitted through contact with contaminated Person-to-person |     |    |              |
| 3. The disease can be transmitted through someone without being sick? |     |    |              |
| 4. COVID-19 is spread from contact with contaminated surfaces or objects |     |    |              |
| 5. The virus that causes COVID-19 to be spreading easily and sustainably in the community ("community spread") are one of the sources of transmission of COVID-19 to human |     |    |              |
| 6. COVID-19 is probably transmissible community spread means people have been infected with the virus in an area, including some who are not sure how or where they became infected |     |    |              |
| 7. The disease can be transmitted from asymptomatic patients or those who are in the latent period of the disease |     |    |              |

| Third domain: actions in dealing with suspected, probable, and confirmed cases | Yes | No | I do not know |
|------------------------------------------------------------------------------|-----|----|--------------|
| 1. The use of personal protective equipment is necessary during aerosol production procedures, such as preparing for community N95 respirators are the PPE most often used to control exposures to infections transmitted via the airborne route, though their effectiveness is highly dependent upon proper fit and use |     |    |              |
| 2. The complete collection of data, including disease history, clinical presentation, complications, and completion of the relevant form are required after confirmed diagnosis of COVID-19 infection |     |    |              |
| 3. Suspected cases of COVID-19 infection after triage should be taken into care in a respiratory isolation room |     |    |              |
| 4. Training and observation of standard precautionary measures are required by care-giving staff in suspected and probable cases of COVID-19 infection |     |    |              |
| 5. It is advisable to sample all respiratory secretions from all patients admitted to the hospital with a primary diagnosis of pneumonia and suspicion of COVID-19 infection |     |    |              |
| 6. Suspected and probable cases of COVID-19 infection must be reported immediately to the infectious disease control center |     |    |              |

(Continued)
Table 1. (Continued)

| Third domain: actions in dealing with suspected, probable, and confirmed cases | Yes | No | I do not know |
|---|---|---|---|
| 7. A complete list should be provided of all people who have been in contact with the confirmed patient with COVID-19 infection | | | |
| 8. The use of N95 masks is necessary when sampling of induced sputum from patients suspected of COVID-19 infection | | | |
| 9. Avoid the visitors to patients with suspected, probable and confirmed cases of COVID-19 infection | | | |
| 10. The number of caregiving personnel for suspected, probable, and confirmed cases of COVID-19 infection, including physicians and nurses, should be limited and certain | | | |
| 11. Exposed people with symptoms of fever, cough, and diarrhea should have sputum samples taken and PCR testing | | | |
| 12. Admitted patients should be hospitalized in the respiratory isolation room, preferably with negative pressure | | | |
| 13. All members of the family of a patient with COVID-19 infection are considered to have a history of contact with the disease | | | |
| 14. If no isolation room is available, patients with a diagnosis of COVID-19 infection can be put in the same room with beds 1 m apart | | | |
| 15. After confirming the diagnosis of COVID-19 infection, patient’s contacts in the past 14 days must be checked and controlled | | | |
| 16. After diagnosis of COVID-19 infection, it is necessary to find possible patients among those who have been in contact with the patient | | | |
| 17. The N95 mask is required to be put on when entering the room of a patient with COVID-19 infection and caring at a distance of 2 m from the patient | | | |
| 18. A person with mild symptoms of COVID-19 infection must remain at home until resolution of clinical symptoms and negative results of the PCR test | | | |
| 19. Patients with COVID-19 infection admitted to an isolation room should use a surgical mask when moving and leaving the room for diagnostic and therapeutic procedures | | | |
| 20. All surfaces contaminated by the patients with COVID-19 infection should be cleaned with diluted bleaching solution | | | |

| Fourth domain: HCWs’ precautionary measures | Yes | No | I do not know |
|---|---|---|---|
| 1. Droplet precautions should be followed by health care providers in dealing with suspected, probable, and confirmed cases of COVID-19 infection | | | |
| 2. Contact precautions should be followed by health care providers in dealing with suspected, probable, and confirmed cases of COVID-19 infection | | | |
| 3. People in the high-risk group with heart, lung and kidney disease can be selected as care providers at home and in hospital | | | |
| 4. Standard precautions should be followed by health care providers in dealing with suspected, probable, and confirmed cases of COVID-19 infection | | | |
| 5. Airborne precautions should be followed by health care providers in dealing with suspected, probable, and confirmed cases of COVID-19 infection | | | |

COVID-19, coronavirus disease; HCW, health care workers; PCR: polymerase chain reaction; PPE, personal protective equipment.
Categorical variables were expressed in percentages, while continuous variables were presented as means and standard deviations. The Kolmogorov–Smirnov test was performed to determine whether the data had a normal distribution or not and the type of test used.

**Results**

A total of 260 participants responded to the survey. Nine participants were working outside the Makkah region and were excluded from the data, so 251 participants were ultimately included.

**Demographic data**

Both genders responded to the survey. There were 161 female participants (64.1%) and 90 male participants (35.9%). Sixty-two were 20–30 years of age (24.7%), 116 were 31–40 (46.2%), and 73 were 40 or above (29.1%). The hospital setting was the most common workplace, as it was the workplace of 187 participants (74.5%), while 59 worked in health care centers (23.5%) and five worked in other locations (2%). There were 157 nurses (62.5%), 63 physicians (25.1%), 3 technicians (1.2%), and 28 in other roles (11.2%). A total of 148 respondents (59.0%) had 9–15 years of experience, 55 (21.9%) had 3–9 years, 28 (11.2%) had 1–3 years, 16 (6.4%) had less than 1 year, and 4 (1.6%) had more than 15 years. Half of the respondents (128) had a bachelor’s degree, 75 had a diploma (29.9%), 35 (13.9%) had a master’s degree, 10 (4%) had a higher education degree, and 3 (1.2%) did not specify their educational achievement.

**Knowledge and awareness level**

Of the four domains (nature of the disease; transmission of the disease; actions dealing with suspected, probable, and confirmed cases; and HCWs’ precautionary measures).

A total of 183 (72.91%) participants showed a moderate level of knowledge of the nature of the disease. The range of their knowledge level to the nature of the disease was 6–18, and the mean ± SD = 12.087 ± 1.969 (see Table 2). A total of 206 (82.07%) participants showed a high

| Items | Nature of the disease domain. | Nature of the disease | Chi-square |
|-------|------------------------------|-----------------------|------------|
|       | No. | I do not know | Yes | $\chi^2$ | $p$ value |
| 1. Are you aware of the updated definition of COVID-19? | 13 | 5.2 | 11 | 4.4 | 227 | 90.4 | 368.351 | 0.000 |
| 2. Do you know the symptoms of COVID-19? | 0 | 0.0 | 0 | 0.0 | 251 | 100.0 | – | – |
| 3. Is the diagnostic sample for COVID-19 a throat swab? | 65 | 25.9 | 2 | 0.8 | 184 | 73.3 | 204.199 | 0.000 |
| 4. Is the diagnostic sample for COVID-19 a blood test? | 218 | 86.9 | 6 | 2.4 | 27 | 10.8 | 326.159 | 0.000 |
| 5. The causative agent of COVID-19 is COVID-19 | 36 | 14.3 | 23 | 9.2 | 192 | 76.5 | 211.418 | 0.000 |
| 6. We can eliminate the COVID-19 virus by 70% using alcohol | 59 | 23.5 | 37 | 14.7 | 155 | 61.8 | 94.120 | 0.000 |
| 7. COVID-19 can be prevented with the injection of a vaccine | 118 | 47.0 | 67 | 26.7 | 66 | 26.3 | 21.139 | 0.000 |
| 8. The incubation period of COVID-19 is 2–14 days | 4 | 1.6 | 7 | 2.8 | 240 | 95.6 | 438.223 | 0.000 |
| 9. The COVID-19 virus can survive for 48 hours in the environment | 40 | 15.9 | 47 | 18.7 | 164 | 65.3 | 115.992 | 0.000 |

COVID-19, coronavirus disease.
The level of knowledge of the transmission of disease. The range of their knowledge level to the transmission of disease was 8–16 and the mean $\pm$ SD = 13.051 $\pm$ 2.014 (see Table 3). A total of 191 (76.10%) participants were highly knowledgeable about dealing with suspected, probable, and confirmed cases. The range was 24–42 and the mean $\pm$ SD = 34.577 $\pm$ 3.420 (see Table 4). A total of 207 (82.47%) participants were highly knowledgeable about precautionary measures. The content was 0, and the mean $\pm$ SD = 5.653 $\pm$ 0.9052 (see Table 5). The total score for the knowledge level was high, as the range was 50–76 and the mean $\pm$ SD = 65.370 $\pm$ 4.805 (see Table 6).

**Table 3.** Transmission of disease domain.

| Items | Transmission of disease | No. | I don’t know | Yes | Chi-square |
|-------|-------------------------|-----|-------------|-----|------------|
| 1. COVID-19 is transmitted through direct contact | 30 | 12.0 | 2 | 87.3 | 333.044 | 0.000 |
| 2. COVID-19 is transmitted through indirect contact | 99 | 39.4 | 10 | 4.0 | 142 | 56.6 | 108.343 | 0.000 |
| 3. COVID-19 is transmitted through the airborne route | 122 | 48.6 | 10 | 4.0 | 119 | 47.4 | 97.347 | 0.000 |
| 4. COVID-19 is transmitted through the droplet route | 6 | 2.4 | 2 | 0.8 | 243 | 96.8 | 455.243 | 0.000 |
| 5. The disease can be transmitted through contact with a contaminated person | 7 | 2.8 | 4 | 1.6 | 240 | 95.6 | 438.223 | 0.000 |
| 6. The disease can be transmitted from asymptomatic patients | 41 | 16.3 | 5 | 2.0 | 205 | 81.7 | 271.681 | 0.000 |
| 7. COVID-19 spreads from contact with contaminated surfaces or objects | 4 | 1.6 | 5 | 2.0 | 242 | 96.4 | 449.458 | 0.000 |
| 8. The disease can be transmitted from those who are in the latent period of the disease | 34 | 13.5 | 22 | 8.8 | 195 | 77.7 | 223.084 | 0.000 |

COVID-19, coronavirus disease.

Relationships between demographic data and domains

The HCWs’ age group, gender, job description, and years of experience were statistically unrelated to the nature of the disease domain. On the contrary, the HCWs’ workplace and education level were significantly related to the nature of the disease domain ($p$ values = 0.009* and 0.037*, respectively; see Table 7). The age group, gender, workplace, education level, and years of experience were not related to the transmission of the disease domain. However, the job descriptions were related to the transmission of the disease domain ($p$ value = 0.003*; see Table 8).

The actions to deal with suspected, probable, and confirmed COVID-19 cases were unrelated to the participants’ gender, workplace, job description, and education level. However, the participants’ age group and years of experience were related to their actions to deal with suspected, probable, and confirmed cases ($p$ values = 0.015* and 0.03*, respectively; see Table 9).

The precautionary measures taken by health care providers were unrelated to their demographic data but were related to their education level,
Table 4. Actions dealing with suspected, probable, and confirmed cases domain.

| Items                                                                 | Actions in dealing with suspected, probable, and confirmed cases | Chi-square |
|----------------------------------------------------------------------|------------------------------------------------------------------|------------|
|                                                                      | No. | % | I do not know | Yes | % | % | χ² | p value |
| 1. The use of personal protective equipment (PPE) is necessary to deal with COVID-19 cases | 1   | 0.4 | 0 | 0.0 | 250 | 99.6 | 247.016b | 0.000 |
| 2. Caregivers must have training and observe standard precautionary measures for suspected and probable cases of COVID-19 infection | 0   | 0.0 | 0 | 0.0 | 251 | 100.0 | – | – |
| 3. N95 respirators are the PPE most often used to control the spread of COVID-19 | 102 | 40.6 | 12 | 4.8 | 137 | 54.6 | 99.402 | 0.000 |
| 4. Surgical masks are the PPE most often used to control the spread of COVID-19 virus | 37  | 14.7 | 1 | 0.4 | 213 | 84.9 | 307.633 | 0.000 |
| 5. Suspected cases of COVID-19 infection after triage should be taken into care in a respiratory isolation room | 25  | 10.0 | 5 | 2.0 | 221 | 88.0 | 340.526 | 0.000 |
| 6. It is advisable to sample all respiratory secretions from all patients admitted to the hospital with a primary diagnosis of pneumonia and suspicion of COVID-19 infection | 36  | 14.3 | 24 | 9.6 | 191 | 76.1 | 207.402 | 0.000 |
| 7. Suspected and probable cases of COVID-19 infection must be reported immediately to the infectious disease control center | 5   | 2.0 | 10 | 4.0 | 236 | 94.0 | 416.183 | 0.000 |
| 8. A complete list should be provided of all people who have been in contact with the patient with a confirmed COVID-19 infection | 5   | 2.0 | 3 | 1.2 | 243 | 96.8 | 455.171 | 0.000 |
| 9. Avoid allowing visitors to patients with suspected, probable, and confirmed cases of COVID-19 infection | 0   | 0.0 | 4 | 1.6 | 247 | 98.4 | 235.255b | 0.000 |
| 10. All family members of a patient infected by COVID-19 may be considered infected by a COVID-19 | 89  | 35.5 | 8 | 3.2 | 154 | 61.4 | 127.896 | 0.000 |
| 11. The number of caregiving personnel with suspected, probable, and confirmed cases of COVID-19, including physicians and nurses, should be limited and certain | 21  | 8.4 | 18 | 7.2 | 212 | 84.5 | 295.323 | 0.000 |
| 12. After the diagnosis of the COVID-19 infection, it is necessary to find possible patients among people who have been in contact with the patient | 7   | 2.8 | 6 | 2.4 | 238 | 94.8 | 427.036 | 0.000 |
| 13. The use of full PPE is necessary when sampling induced sputum from patients suspected of COVID-19 infection | 0   | 0.0 | 1 | 0.4 | 250 | 99.6 | 247.016b | 0.000 |

(Continued)
| Items                                                                 | Actions in dealing with suspected, probable, and confirmed cases | Chi-square |
|----------------------------------------------------------------------|-----------------------------------------------------------------|------------|
| 14. The use of N95 masks is enough protection when sampling induced sputum from patients suspected of COVID-19 infection | N                  | %     | N                  | %     | N                  | %     | χ²     | p value |
|                                                                      | 132                | 52.6  | 8                  | 3.2   | 111                | 44.2  | 105.283 | 0.000   |
| 15. The use of surgical masks is enough protection when sampling induced sputum from patients suspected of COVID-19 infection | 196                | 78.1  | 10                 | 4.0   | 45                 | 17.9  | 233.554 | 0.000   |
| 16.Exposed people with symptoms of fever, cough, and diarrhea should have sputum samples taken | 23                 | 9.2    | 7                  | 2.8   | 221                | 88.0  | 339.665 | 0.000   |
| 17. When the doctor makes the decision to admit a patient, he/she should be admitted to be hospitalized in a negative pressure room | 46                 | 18.3   | 24                 | 9.6   | 181                | 72.1  | 172.741 | 0.000   |
| 18. If no isolation room is available, patients with a COVID-19 diagnosis can be admitted in a room distanced from other beds | 38                 | 15.1   | 16                 | 6.4   | 197                | 78.5  | 233.171 | 0.000   |
| 19. A person with mild symptoms of a COVID-19 infection must be isolated at home until the resolution of clinical symptoms and negative results of the sample test | 9                  | 3.6    | 5                  | 2.0   | 237                | 94.4  | 421.610 | 0.000   |
| 20. Patients with COVID-19 infection admitted to an isolation room should use a surgical mask when moving around and leaving the room for diagnostic and therapeutic procedures | 18                 | 7.2    | 6                  | 2.4   | 227                | 90.4  | 369.187 | 0.000   |
| 21. All surfaces contaminated by patients with COVID-19 should be cleaned with a sterile solution | 33                 | 13.1   | 15                 | 6.0   | 203                | 80.9  | 257.243 | 0.000   |
| 22. A patient with COVID-19 can usually receive a second throat swab after 10 days | 69                 | 27.5   | 10                 | 4.0   | 172                | 68.5  | 160.693 | 0.000   |

COVID-19, coronavirus disease; PPE, personal protective equipment.
which significantly differed \((p\text{ value } = 0.037^*;\text{ see Table 10})\). The connection between the participants’ demographic data and their total scores for the domains were unrelated to all their demographic data, except to their workplace, which significantly differed \((p\text{ value } = 0.008^*;\text{ see Table 11})\).

**Discussion**

An online survey measured Makkah HCWs’ knowledge and awareness of COVID-19 and their preparedness for and response to the pandemic. More than half of the participants were women \((161, 64.1\%);\text{ most likely because nursing is regarded as a female-dominant profession, as it was established by the efforts of Florence Nightingale in the 19th century.}^{15}\text{ According to the findings of this study in terms of age and education level, the majority of the HCWs in this study (46.2\%) were between the ages of 31 and 40, and half of the respondents (128, 51\%) had a bachelor’s degree. These results are similar to those of Al-Rasheedi et al.,}\text{ in which the majority of the participants (66\%) had a bachelor’s degree and around 75\% were 20–40 years old. The focus of this study was whether health care providers are aware of the condition they are fighting and if they are helping to eliminate it. COVID-19 is well-known for sneaking up on the Saudi nation just as it was preparing to deal with the outbreak. In Saudi Arabia, no prior study had been conducted to establish how aware health care...}^{16}\text{ In Table 5, the HCWs’ precautionary measures are listed with their respective Chi-square values and p values.**

**Table 5. HCWs’ precautionary measures.**

| Items                                                                 | HCWs’ precautionary measures | Chi-square | 
|----------------------------------------------------------------------|----------------------------|------------|
|                                                                     | No. | I do not know | Yes | \(\chi^2\) | \(p\text{ value}\) |
| 1. Health care providers should follow standard precautions when dealing with suspected, probable, and confirmed cases of COVID-19 | 4   | 1.6 | 1 | 0.4 | 246 | 98.0 | 472.502 | 0.000 |
| 2. Health care providers should follow droplet precautions when dealing with suspected, probable, and confirmed cases of COVID-19 | 4   | 1.6 | 1 | 0.4 | 246 | 98.0 | 472.502 | 0.000 |
| 3. Health care providers should follow contact precautions when dealing with suspected, probable, and confirmed cases of COVID-19 | 6   | 2.4 | 2 | 0.8 | 243 | 96.8 | 455.243 | 0.000 |
| 4. Health care providers should follow airborne precautions when dealing with suspected, probable, and confirmed cases of COVID-19 | 34  | 13.5 | 5 | 2.0 | 212 | 84.5 | 300.295 | 0.000 |

HCW, health care workers; COVID-19, coronavirus disease.
personnel and other Saudi people were of COVID-19 and how prepared they were for it.

The participants in this study showed a moderate level of knowledge and awareness of the nature of the disease, which was inconsistent with the results of the study conducted in the Qassim region. The researchers found that 129 of the 130 participants were aware of COVID-19.16 However, in this study, 95.6% of the participants recognized the correct incubation period of the virus, similar to the findings of Al-Rasheedi et al.16 A similar level of knowledge and awareness was detected in Riyadh17,18 and Al-Jouf 19 in Saudi Arabia and in the UAE,20 Vietnam,21 and Uganda.22 Nour et al. 23 assessed the knowledge, attitudes, and practices (KAP) of health care providers in public hospitals in Makkah with regard to the MERS-CoV infection and evaluated the effectiveness of a health education intervention to improve KAP. Significant post-intervention improvements were found in the median scores for knowledge ($p<0.001$) and attitudes ($p=0.022$), and in the cumulative KAP $p<0.001$). The scores improved irrespective of the age group and the gender.23 These results support this study’s finding that the HCWs were moderately knowledgeable of the nature of the disease.

In this study, 207 participants (82.47%) were highly knowledgeable about the precautionary measures. The range was 0–8 and the mean ± SD = 5.6534 ± 0.9052. These results are in line with those of Tripathi et al.24 that most of the respondents knew that COVID-19 is transmitted through human-to-human contact (97.7%). Hand hygiene (92.7%), and social distancing (92.3%) were the most common preventive measures that the respondents took, followed by avoiding travel (86.9%) to an infected area or country, and wearing face masks (86.5%). An overwhelming 88% of the participants were familiar with the associated symptoms and common causes of COVID-19, similar to Tripathi et al.24

The participants’ age, gender, and area were insignificant predictors of COVID-19 knowledge and awareness by Tripathi et al.,24 as they were in this study, except for the relationship between the job description and the transmission of the disease domain ($p$ value = 0.003*). A total of 157 nurses participated in this study (62.5%), which reflects a high total knowledge level, as the range was 50–76 and the mean ± SD = 65.370 ± 4.805. Similarly, in a study done in radiology departments in Saudi Arabia again through a survey, 234 HCWs (91%) replied that they had good knowledge of the precautions needed to examine positive COVID-19 cases in radiology departments, and 216 (84%) answered that they knew the necessary precautions when using a portable X-ray machine.25 These results reflect that among HCWs in Saudi Arabia, nurses, and radiologists generally have the same level of knowledge.

COVID-19 awareness and knowledge increased by combining characteristics such as specialization, degree of education, and wealth. HCWs between the ages of 20 and 30 were particularly

Table 6. Knowledge and awareness scores.

| Domains                                        | Weak | Average | High | Score             |
|------------------------------------------------|------|---------|------|-------------------|
|                                                 | N    | N       | N    | Range            |
| Nature of the disease                          | 11   | 183     | 57   | 6–18             |
| transmission of disease                       | 0    | 45      | 206  | 8–16             |
| Actions dealing with suspected, probable, and confirmed cases | 0    | 60      | 191  | 24–42            |
| HCWs' precautionary measures                  | 3    | 41      | 207  | 0–8              |
| Total                                          | 0    | 95      | 156  | 50–76            |

HCW, health care workers; SD, standard deviation.
knowledgeable about COVID-19, which may be attributed to their involvement in COVID-19 initiatives on either prevention or treatment of the infected.

Infectious illness outbreaks, such as SARS, avian influenza, and the influenza strain H1N1, have been the subject of several investigations. However, a literature search has yielded no public awareness of coronavirus in Saudi Arabia. As a result, the government might find the information gathered from this poll of the general public useful for its development of preventive measures in the event of another pandemic.

Table 7. Relationships between demographic data and the nature of the disease.

| Nature of the disease | N  | T or F | T-test or ANOVA |
|-----------------------|----|-------|----------------|
|                       | Mean ± SD | Test value | p value |
| Gender                |    |       |               |
| Female                | 161| 12.050 ± 1.836 | T | -0.408 | 0.684 |
| Male                  | 90 | 12.156 ± 2.198 |   |          |       |
| Age                   |    |       |               |
| 20–30                 | 62 | 12.048 ± 2.092 | F | 0.070   | 0.932 |
| 31–40                 | 116| 12.138 ± 2.085 |   |          |       |
| 40 or above           | 73 | 12.041 ± 1.679 |   |          |       |
| Working place         |    |       |               |
| Hospital              | 187| 11.914 ± 1.882 | F | 4.779   | 0.009*|
| Health care center    | 59 | 12.458 ± 1.959 |   |          |       |
| Other                 | 5  | 14.200 ± 3.633 |   |          |       |
| Job description       |    |       |               |
| Physician             | 63 | 11.889 ± 1.567 | F | 0.296   | 0.828 |
| Nurse                 | 157| 12.166 ± 2.115 |   |          |       |
| Technician            | 3  | 12.000 ± 0.000 |   |          |       |
| Other                 | 28 | 12.107 ± 2.079 |   |          |       |
| Years of experience   |    |       |               |
| <1                    | 16 | 12.375 ± 2.156 | F | 1.782   | 0.133 |
| 1–3                   | 28 | 12.000 ± 2.373 |   |          |       |
| 3–9                   | 55 | 11.491 ± 1.643 |   |          |       |
| 9–15                  | 148| 12.291 ± 1.970 |   |          |       |
| >15                   | 4  | 12.250 ± 1.258 |   |          |       |
| Education level       |    |       |               |
| Higher education      | 10 | 11.600 ± 1.838 | F | 2.594   | 0.037*|
| Diploma               | 75 | 12.653 ± 2.121 |   |          |       |
| Bachelor              | 128| 11.867 ± 1.884 |   |          |       |
| Masters               | 35 | 11.743 ± 1.837 |   |          |       |
| Other                 | 3  | 13.000 ± 1.000 |   |          |       |

ANOVA, analysis of variance; SD, standard deviation.
Limitations

The researchers used a survey due to strict curfew and health regulations during the pandemic. The researchers avoided writing the respondents’ names on the survey questionnaire to prevent bias, as the participants and the researchers might have known each other. The researchers only sent the respondents an official email to offer them further information if needed. Since this study was conducted during the early stages of the Makkah COVID-19 pandemic, it had a small sample size. The researchers’ ability to reach out to the targeted population was restricted due to the pandemic lockdown, so the researchers performed a self-reported poll online. Access by the respondents

Table 8. Relationships between demographic data and the transmission of disease.

|                  | N   | Transmission of disease | T or F | T-test or ANOVA |
|------------------|-----|-------------------------|--------|-----------------|
|                  |     | Mean                  | ±      | SD             | Test value | p value |
| **Gender**       |     |                        |        |                |            |        |
| Female           | 161 | 12.907                 | ±      | 2.024          | T          | -1.529  | 0.128  |
| Male             | 90  | 13.311                 | ±      | 1.981          |            |         |        |
| **Age**          |     |                        |        |                |            |        |
| 20–30            | 62  | 13.339                 | ±      | 1.679          | F          | 1.015   | 0.364  |
| 31–40            | 116 | 12.888                 | ±      | 2.113          |            |         |        |
| 40 or above      | 73  | 13.068                 | ±      | 2.110          |            |         |        |
| **Working place**|     |                        |        |                |            |        |
| Hospital         | 187 | 13.075                 | ±      | 1.885          | F          | 0.048   | 0.953  |
| Health care center | 59  | 12.983                 | ±      | 2.453          |            |         |        |
| Other            | 5   | 13.000                 | ±      | 1.000          |            |         |        |
| **Job description** |   |                         |        |                |            |        |
| Physician        | 63  | 13.857                 | ±      | 1.615          | F          | 4.740   | 0.003* |
| Nurse            | 157 | 12.796                 | ±      | 2.044          |            |         |        |
| Technician       | 3   | 12.333                 | ±      | 2.887          |            |         |        |
| Other            | 28  | 12.750                 | ±      | 2.188          |            |         |        |
| **Years of experience** | |                      |        |                |            |        |
| <1               | 16  | 13.938                 | ±      | 1.611          | F          | 1.790   | 0.131  |
| 1–3              | 28  | 13.500                 | ±      | 1.915          |            |         |        |
| 3–9              | 55  | 12.636                 | ±      | 1.975          |            |         |        |
| 9–15             | 148 | 13.014                 | ±      | 2.050          |            |         |        |
| >15              | 4   | 13.500                 | ±      | 2.517          |            |         |        |
| **Education level** |   |                        |        |                |            |        |
| Higher education | 10  | 14.300                 | ±      | 1.947          | F          | 1.881   | 0.114  |
| Diploma          | 75  | 12.680                 | ±      | 1.925          |            |         |        |
| Bachelor         | 128 | 13.125                 | ±      | 2.031          |            |         |        |
| Masters          | 35  | 13.286                 | ±      | 2.052          |            |         |        |
| Other            | 3   | 12.333                 | ±      | 2.082          |            |         |        |

ANOVA, analysis of variance; SD, standard deviation.
to a computer and the Internet to answer the survey was considered a challenge due to their inability to use the Internet, which affected the sample size. However, the researchers thought the main reason for the small sample size was the work overload of the HCWs during the pandemic.

Summary and recommendations
This study examined the knowledge and awareness of COVID-19 pandemic preparedness and response among HCWs in Makkah city. The total score for their knowledge level was high (50–76 and mean ± SD = 65.370 ± 4.805). In terms of the demographic data, there was a relationship...
between the participants’ workplace and education levels and the Nature of the disease domain (p-values = 0.009* and 0.037*, respectively). Job descriptions were related to the Transmission of the disease domain (p-value = 0.003*). The participants’ age groups and years of experience were also associated with their actions in suspected, probable, and confirmed cases (p-value = 0.015* and 0.03*, respectively). The HCWs’ knowledge of precautionary measures was not related to their demographic data, except for the education level, with significant differences (p-value = 0.037*).

### Table 10. Relationships between demographic data and the precautionary measures by health care providers.

|                         | N  | Precautionary measures by health care providers | T or F | T-test or ANOVA |
|-------------------------|----|-----------------------------------------------|-------|-----------------|
|                         |    | Mean ± SD                                     |       |                 |
| Gender                  |    |                                              |       |                 |
| Female                  | 161| 5.696 ± 0.895                                | T     | 0.989           | 0.323           |
| Male                    | 90 | 5.578 ± 0.924                                | F     | 0.031           | 0.970           |
| Age                     |    |                                              |       |                 |
| 20–30                   | 62 | 5.629 ± 0.996                                | F     | 1.996           | 0.138           |
| 31–40                   | 116| 5.664 ± 0.874                                | F     | 1.556           | 0.201           |
| 40 or above             | 73 | 5.658 ± 0.885                                | F     | 0.979           | 0.420           |
| Working place           |    |                                              |       |                 |
| Hospital                | 187| 5.588 ± 0.993                                | F     | 1.996           | 0.138           |
| Health care center      | 59 | 5.831 ± 0.562                                | F     | 0.031           | 0.970           |
| Other                   | 5  | 6.000 ± 0.000                                | F     | 0.031           | 0.970           |
| Job description         |    |                                              |       |                 |
| Physician               | 63 | 5.571 ± 1.027                                | F     | 0.979           | 0.420           |
| Nurse                   | 157| 5.707 ± 0.834                                | F     | 0.979           | 0.420           |
| Technician              | 3  | 4.667 ± 2.309                                | F     | 0.979           | 0.420           |
| Other                   | 28 | 5.643 ± 0.780                                | F     | 0.979           | 0.420           |
| Years of experience     |    |                                              |       |                 |
| <1                      | 16 | 5.875 ± 0.500                                | F     | 0.979           | 0.420           |
| 1–3                     | 28 | 5.786 ± 0.568                                | F     | 0.979           | 0.420           |
| 3–9                     | 55 | 5.491 ± 1.230                                | F     | 0.979           | 0.420           |
| 9–15                    | 148| 5.655 ± 0.855                                | F     | 0.979           | 0.420           |
| >15                     | 4  | 6.000 ± 0.000                                | F     | 0.979           | 0.420           |
| Education level         |    |                                              |       |                 |
| Higher education        | 10 | 4.800 ± 1.033                                | F     | 2.593           | 0.037*          |
| Diploma                 | 75 | 5.760 ± 0.654                                | F     | 2.593           | 0.037*          |
| Bachelor                | 128| 5.641 ± 0.876                                | F     | 2.593           | 0.037*          |
| Masters                 | 35 | 5.714 ± 1.296                                | F     | 2.593           | 0.037*          |
| Other                   | 3  | 5.667 ± 0.577                                | F     | 2.593           | 0.037*          |

ANOVA, analysis of variance; SD, standard deviation.
Finally, the HCWs’ total scores for the four domains showed no relation to all their demographic data, except for their workplace, which had significant differences (p-value = 0.008*). Further study is recommended to measure the factors that affect HCWs’ knowledge and awareness during a pandemic situation. Moreover, we hope this study might motivate the government and the health sector to raise HCWs’ knowledge and awareness of COVID-19.

**Acknowledgements**

The authors would appreciate the participants for being a valuable part of this research.

---

**Table 11. Participants’ demographic data and total score for the domains.**

|                  | N  | Total            | T or F | T-test or ANOVA |
|------------------|----|------------------|--------|-----------------|
|                  |    | Mean ± SD        |        | Test value      | p value |
| Gender           |    |                  |        |                 |         |
| Female           | 161| 65.280 ± 4.925   | T      | -0.401          | 0.689   |
| Male             | 90 | 65.533 ± 4.606   |        |                 |         |
| Age              |    |                  |        |                 |         |
| 20–30            | 62 | 64.532 ± 5.533   | F      | 1.430           | 0.241   |
| 31–40            | 116| 65.483 ± 4.418   |        |                 |         |
| 40 or above      | 73 | 65.904 ± 4.706   |        |                 |         |
| Working place    |    |                  |        |                 |         |
| Hospital         | 187| 64.877 ± 4.806   | F      | 4.931           | 0.008*  |
| Health care center | 59 | 66.576 ± 4.496   |        |                 |         |
| Other            | 5  | 69.600 ± 4.561   |        |                 |         |
| Job description  |    |                  |        |                 |         |
| Physician        | 63 | 66.175 ± 4.305   | F      | 1.418           | 0.238   |
| Nurse            | 157| 65.153 ± 4.907   |        |                 |         |
| Technician       | 3  | 61.333 ± 9.866   |        |                 |         |
| Other            | 28 | 65.214 ± 4.614   |        |                 |         |
| Years of experience |  <1 | 16 | 64.554 ± 4.281 | F | 2.091 | 0.083 |
|                  |  1–3 | 28 | 65.286 ± 5.623 | |                 |         |
|                  |  3–9 | 55 | 64.036 ± 4.367 | |                 |         |
|                  |  9–15 | 148 | 65.872 ± 4.607 | |                 |         |
|                  |  >15 | 4  | 68.750 ± 5.123 | |                 |         |
| Education level  |    |                  |        |                 |         |
| Higher education | 10 | 65.000 ± 5.598   | F      | 1.573           | 0.182   |
| Diploma          | 75 | 66.280 ± 4.373   |        |                 |         |
| Bachelor         | 128| 64.711 ± 4.856   |        |                 |         |
| Masters          | 35 | 65.714 ± 5.228   |        |                 |         |
| Other            | 3  | 68.000 ± 2.000   |        |                 |         |

ANOVA, analysis of variance; SD, standard deviation.
Author contributions
Asrar Mansoor Alrajhi: Project administration; Writing – original draft; Writing – review & editing.
Waleed Abdul-Halim Hussain: Resources; Supervision.
Basmah Amin Rafie: Supervision; Writing – review & editing.
Mehar Taj: Formal analysis; Methodology; Writing – original draft.
Abdelaziz Moustafa Elgarf: Data curation; Formal analysis; Investigation; Validation.

Conflict of interest statement
The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iD
Asrar Mansoor Alrajhi https://orcid.org/0000-0001-9084-6867

References
1. World Health Organization (WHO). Coronavirus, 2020, https://www.who.int/health-topics/coronavirus#tab=tab_1
2. Khan N and Faisal S. Epidemiology of coronavirus in the world and its effects on the China economy. SSRN Electronic Journal, 2020, https://doi.org/10.2139/ssrn.3548292
3. European Centre for Disease Prevention and Control. COVID-19, 2020, https://www.ecdc.europa.eu/en/novel-coronavirus-china
4. Organisation for Economic Co-operation and Development (OECD). The territorial impact of COVID-19: managing the crisis and recovery across levels of government. OECD, 2021, https://www.oecd.org/coronavirus/policy-responses/the-territorial-impact-of-covid-19-managing-the-crisis-and-recovery-across-levels-of-government-a2c6abaf/
5. Worldometers. COVID live update: 141,984,507 cases and 3,032,182 deaths from the coronavirus, 2021, https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas1%
6. Ministry of Health (MOH). MOH news – MOH issues COVID-19 awareness guidelines in many languages, 2020, https://www.moh.gov.sa/en/Ministry/MediaCenter/NewsPages/News-2020-03-17-001.aspx
7. Saadeh D, Sacre H, Hallit S, et al. Knowledge, attitudes, and practices toward the coronavirus disease 2019 (COVID-19) among nurses in Lebanon. Perspect Psychiatr Care 2021; 57: 1212–1221.
8. Tadesse D, Gebrewahd G and Demoz G. Knowledge, attitude, practice and psychological response toward COVID-19 among nurses during the COVID-19 outbreak in northern Ethiopia, 2020. New Microbes New Infect 2020; 38: 100787.
9. Al-Dossary R, Alamri M, Albaqawi H, et al. Awareness, attitudes, prevention, and perceptions of COVID-19 outbreak among nurses in Saudi Arabia. Int J Environ Res Public Health 2020; 17: 8269.
10. Qadah T. Knowledge and attitude among healthcare workers towards COVID-19: a cross sectional study from Jeddah city, Saudi Arabia. J Infect Dev Ctries 2020; 14: 1090–1097.
11. The-Saudi.Net. Makkah city profile, Saudi Arabia, 2021, http://www.the-saudi.net/saudi-arabia/makkah/makkah_city_profile.htm#Geography
12. Algaissi A, Alharbi N, Hassanain M, et al. Preparedness and response to COVID-19 in Saudi Arabia: building on MERS experience. J Infect Public Health 2020; 13: 834–838.
13. Nsubuga P, White M, Thacker S, et al. Public health surveillance: a tool for targeting and monitoring interventions. 2nd ed. Washington, DC; New York: International Bank for Reconstruction and Development, World Bank Group, 2006.
14. Centers for Disease Control and Prevention. Coronavirus disease 2019 (COVID-19) – interim guidance for businesses and employers, 2020, https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html
15. Kaplow R. AACN synergy model for patient care: a framework to optimize outcomes. Crit Care Nurse 2003; Suppl: 27–30.
16. Al-Rashedi M, Alhazmi Y, Mateq Ali A, et al. Public and healthcare providers awareness of Coronavirus (COVID-19) in Qassim Region, Saudi Arabia. Saudi J Biol Sci 2021; 28: 90–98.
17. Alahdal H, Basingab F and Alotaibi R. An analytical study on the awareness, attitude and practice during the COVID-19 pandemic in Riyadh, Saudi Arabia. J Infect Public Health 2020; 13: 1446–1452.

18. Almutairi K, Al Helih E, Moussa M, et al. Awareness, attitudes, and practices related to coronavirus pandemic among public in Saudi Arabia. Fam Community Health 2015; 38: 332–340.

19. Nooh H, Alshammary R, Alenezy J, et al. Public awareness of coronavirus in Al-Jouf region, Saudi Arabia. J Public Health. Epub ahead of print 13 February 2020. DOI: 10.1007/s10389-020-01209-y.

20. Rabbani S, Mustafa F and Mahtab A. Middle East respiratory syndrome (MERS): awareness among future health care providers of United Arab Emirates. Int J Med Public Health 2020; 10: 8–13.

21. Huynh G, Nguyen T, Tran V, et al. Knowledge and attitude toward COVID-19 among healthcare workers at District 2 Hospital, Ho Chi Minh City. Asian Pac J Trop Med 2020; 13: 260.

22. Olum R, Chekwech G, Wekha G, et al. Coronavirus disease-2019: knowledge, attitude, and practices of health care workers at Makerere University Teaching Hospitals, Uganda. Front Public Health 2020; 8: 181.

23. Nour M, Babalghith A, Natto H, et al. Raising awareness of health care providers about MERSCoV infection in public hospitals in Mecca, Saudi Arabia. East Mediterr Health J 2017; 23: 534–542.

24. Tripathi R, Alqahtani S, Albarraq A, et al. Awareness and preparedness of COVID-19 outbreak among healthcare workers and other residents of South-West Saudi Arabia: a cross-sectional survey. Front Public Health 2020; 8: 482.

25. Aljondi R, Alghamdi S, Abdelaziz I, et al. Knowledge of COVID-19 infection control among healthcare workers in radiology departments in Saudi Arabia. J Radiat Res Appl Sci 2020; 14: 51–60.