European Review for Medical and Pharmacological Sciences 2022; 26: 4926-4946

Awareness, knowledge, attitudes, and practices before the second wave of the COVID-19 pandemic in Saudi Arabia

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Abstract. – OBJECTIVE: The COVID-19 outbreak was first reported in Wuhan City, China in early December 2019. It was declared a pandemic by WHO in March 2020. This study aimed at assessing the knowledge, awareness, and attitudes of the general population in Saudi Arabia towards COVID-19, as well as its adherence to preventive measures and its willingness to take the vaccine.

PATIENTS AND METHODS: This descriptive cross-sectional study involved an online sample of 7,188 participants (from five regions of Saudi Arabia) who completed a self-administered online-based questionnaire. They were recruited from 23 November 2020 to 29 November 2020 based on the nonprobability convenience sampling method. The self-administered questionnaire comprised four main sections: gathering information about participants' demographics, knowledge and awareness of COVID-19, participants' practices (hygiene and other) against infection, and vaccine acceptability.

RESULTS: More than half of the study participants were knowledgeable about COVID-19. The mean scores were 10.4 (SD=3.44, range: 0-18 – with high scores indicating better knowledge or awareness) for knowledge and 6.1 (SD=2.26, range: 0-11) for awareness, indicating a need for more educational campaigns to improve the level of knowledge and awareness among the Saudi Arabian population about COVID-19. The mean score for attitude was 5 (SD=1.67, range: 0-8 – from 0=very pessimistic to 8=very optimistic), indicating moderate optimism. As for practices, the mean score was 7.8 (SD=1.57, range: 0-10), indicating good practices to prevent or control infection. Concerning acceptability of the COVID-19 vaccine, 63.8% of the participants agreed to take the vaccine if it was proven to be 95% effective.

CONCLUSIONS: The findings of this study can help us designing effective measures against COVID-19 infections. Our results highlight the best practices adopted by the Saudi Arabian population, as well as those areas requiring improvement, including knowledge, attitudes, and practices against this disease.

Key Words:
COVID-19, Knowledge, Practices, Vaccine, Second wave, Healthcare worker, Saudi Arabia.

Introduction

In Wuhan City, Hubei Province, China, in December 2019, a pneumonia outbreak of unidentified etiology was reported among patients who had visited the Huanan Seafood Wholesale Market that contained some wild animal species[1]. Subsequently, other regions in China and many other countries reported large outbreaks, which were found to be caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). On 11 March 2020, the World Health Organization (WHO) declared the Coronavirus Disease-2019 (COVID-19) outbreak to be a pandemic[2,3].

The SARS-CoV-2 virus, belonging to a large family of RNA (ribonucleic acid) viruses, leads to different kinds of infections from the common cold to more severe illnesses such as severe acute respiratory syndrome (SARS-CoV) and Middle East Respiratory Syndrome (MERS-CoV)[4]. However, SARS-CoV-2 was found to have a lower mortality rate (4.4%) compared to MERS-CoV and SARS-CoV (11% and 34.4%, respectively)[5]. The incubation period ranges from 2 to 10 days; if it is longer than 14 days, this very long incubation period can indicate double exposure[6]. The clinical spectrum of the disease ranges from as-

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ymptomatic to clinical conditions characterized by severe respiratory failure to multiorgan failure and systemic manifestations. The main symptoms include fever, cough, dyspnea, headache, sore throat, and rhinorrhea[6,7]. The primary transmission routes for COVID-19 are aerosol transmissions, direct contact, and droplets. Evidence of transmission by asymptomatic individuals has been reported[8,9].

On 2 March 2020, the first confirmed COVID-19 case was reported in Saudi Arabia. The Saudi Arabian Government was among the first countries in the world to take serious and rapid actions. Strict measures have been implemented by the government's Ministry of Health (MOH) to control the transmission of COVID-19; these measures have included suspension of schools, limitation of outdoor activities, banning attendance in mosques, and minimization of social contacts[10,11].

Preventive measures have played an essential role in controlling the disease spread and decreasing infection rates. This highlights the importance of public adherence to control and preventative measures, which can be affected by the public's knowledge, awareness, attitudes, and practices (KAAP). Hence, several studies have aimed at assessing the Saudi population's KAAP towards the novel COVID-19 disease[11]. A cross-sectional study with a sample size of 3,388 was conducted in Saudi Arabia to investigate the Saudi community's knowledge, attitudes, and practices towards COVID-19. Participants gave similar responses concerning knowledge about transmission of COVID-19; for instance, nearly half of the participants were unaware that COVID-19 could spread from close contact between humans. However, 98% of the respondents were aware of the clinical symptoms. Regarding attitudes, respondents showed an optimistic and positive attitude towards COVID-19. Moreover, the generally high knowledge of COVID-19 that the respondents displayed translated into safe and sound practices during the COVID-19 pandemic: nearly 88% of the participants avoided handshaking, 95% refrained from attending social events, and 94% avoided crowded places. Indeed, awareness and knowledge of aspects the COVID-19 pandemic are essential to maintain positive attitudes and good practices, which is mandatory for overcoming the pandemic.

Vaccines are a vital strategy to stop the COVID-19 pandemic escalation. As of 8 April 2020, more than 100 COVID-19 vaccines were being developed. A study with a sample size of 992 people[12] was conducted in Saudi Arabia using a web-based self-administered questionnaire. Of the 992 respondents, 64.7% (642) agreed to take the COVID-19 vaccine. Another recent study by Al-Regaiey et al[13] reported that parents in Saudi Arabia showed confidence in the government's measures and were not hesitant for their children to get vaccinated.

There is a general lack of information about the COVID-19 pandemic. Although some research in Saudi Arabia has discussed the topic, information is lacking about society's awareness of the possibility of a second wave, as well as the factors that influence society's acceptance of the COVID-19 vaccine. It also did not discuss the issue of severe COVID-19 infection among healthcare workers (HCWs). Therefore, the present study aimed at assessing the level of KAAP in the Saudi public regarding the novel COVID-19 disease and which sociodemographic characteristics are associated with it. Secondary aims of the study were assessing public awareness regarding the possibility of a second wave, evaluating factors that influenced their decisions regarding the COVID-19 vaccine, and describing some of the issues regarding COVID-19 among HCWs.

Patients and Methods

Participants

This cross-sectional study was conducted from 23 November 2020 to 29 November 2020 before the start of winter in Saudi Arabia and before the approval of any COVID-19 vaccine candidate. The study was done using a self-administered online-based questionnaire in the central, northern, eastern, western, and southern regions of Saudi Arabia. The study's target population was the general population of Saudi Arabia, with a total number of 34,218,169 people, according to the latest Kingdom of Saudi Arabia (KSA) census[14]. The minimum sample size to conduct this research was 1,067, with a 3% margin of error and a 95% confidence level. However, we managed to collect responses from 7,188 subjects, which improved the generalizability and external validity of our results. Inclusion criteria included all the general population of Saudi Arabia who has consented to participate and who were aged over 18 years. Those who did not consent to participate in the study and/or who did not answer the questions of the study were excluded.

Questionnaire Development

The self-administered online-based questionnaire was developed by the study authors, following the guidelines of the Centre of Disease Control and Prevention (CDC) for clinical and community management of COVID-19[13]. The questionnaire was initially developed in the English language, then it was translated into Arabic to match the participants' first language.

On the first page of the online questionnaire, participants were clearly informed about the study's aims; they were reassured that all their information and opinions would be anonymous and confidential. Online informed consent was taken from participants before they proceeded with the questionnaire. The questionnaire included 29 questions distributed in four main sections. The first section gathered information on participants' demographic characteristics, including age, sex, nationality, place of residence, marital status, education level, family size, and income level. This section also included questions for participants to complete about whether they were infected with COVID-19 and their chronic disease status.

Respondents' awareness and knowledge of COVID-19 were assessed in the second section, which was subdivided into two parts. The first part included 20 items on the symptomatology of COVID-19, possible complications, and prevention measures. The second part included 11 statements about participants' awareness regarding the pandemic character of the COVID-19, main risk factors, mode of transmission, and antibiotic treatment.

Participants' attitudes towards COVID-19 were assessed *via* 12 statements and 1 question. Participants were asked to state whether they agreed, did not agree, or did not know about each of the 12 statements. The third section of the questionnaire evaluated the participants' practices (hygiene and other). This section consisted of six statements related to practices, including (a) avoidance of leaving the house, if not necessary, (b) properly wearing a mask in public places, (c) avoidance of handshakes, (d) regular hand sanitizing, (e) avoidance of touching the mouth or eyes before washing hands outside the house, and (f) following preventive measures when visiting a relative. It also included three questions about the course of action to take if COVID-19 infection was suspected, as well as gauging influenza vaccine intake in the last 8 months.

The last section was subdivided into three subsections: assessing participants' attitudes towards emerging COVID-19 vaccines; evaluating their expectations and concerns regarding a second wave of COVID-19; and evaluating the issue of HCWs as an essential part of the population during this pandemic. It included questions about infection of HCWs by COVID-19 along with the severity and source of infection.

The questionnaire was validated using both content validation by the research team and pilot testing. A pilot study was done on 15 participants from the population to test the reliability of the questionnaire, the time needed to fill the survey, and to identify limitations. These 15 participants were then excluded from the actual sample.

Scoring System

Respondents were asked to choose the correct items regarding symptomatology, prevention, and complications parts in the knowledge section. Each chosen item was given one point in the calculation of scores. This section contained 20 items, however, we excluded two items "bleeding" and "seizures" in the symptomatology section, as they are considered rare symptoms of COVID-19 infection. Therefore, the total score for knowledge ranged from 0 to 18, with high scores indicating better knowledge of COVID-19.

In the section on awareness, scores were calculated based on the respondents' answers to each statement. Each "I agree" answer to statements 3, 4, 5, and 6 and each "I do not agree" answer to statements 1, 2, 7, 8, 9, 10, 11 was assigned 1 point. The maximum score for high awareness was 11. Regarding the attitude section, scores were calculated based on the respondents' answers to each attitudinal statement. These statements were: "I trust the current health procedures in Saudi Arabia"; "before the coronavirus pandemic, I made sure to take vaccinations and advice the others to take them"; "we need a vaccine for coronavirus"; "if the vaccine against coronavirus was approved, I would take this vaccine"; "I would take the vaccine if it was 95% effective"; "I would take the vaccine if it was 50% effective"; "in case of a second wave, I think it is appropriate to reapply quarantine measures". 1 point was assigned for each "agree" answer and the first or second choices of the question "In the event of a second wave, will you increase your commitment to the general precautionary measures?" were also assigned 1 point. Therefore, the maximum score was 8 for the most positive attitude of participants. In the section on practices, respondents were asked to respond "yes" or "no" to the statements, and a

score of 1 was given to each "Yes" answer. As for the question asking about the course of action to take if COVID-19 was suspected, the answer "Perform test if only mild symptoms" was assigned 1 point. The total score ranged from 0 to 10, with high scores indicating better practices. Regarding second COVID-19 wave questions, respondents were asked to respond to 4 statements and 1 question. The statements were "I expect a second wave of coronavirus"; "I think that next winter an increase in the number of cases will be registered (another wave)"; "I think if there is a second wave it will be stronger than the first"; and "in case of a second wave, I think it is appropriate to reapply quarantine measures". Each "I agree" answer scored 1 point. As for the question, it asked about participant's practice in case of a second wave. A score of 1 was given to answers that reflected good practices in the case of a second wave. The total score for second wave questions ranged from 0 to 5, with high scores indicating better knowledge and better preparation for a possible second wave.

Study Variables

Sociodemographic characteristics (gender, age, education level, employment status, marital status, family size, and income level) were considered explanatory/independent variables whereas levels of awareness, knowledge, attitude, and practice were considered response/dependent variables. Each correct answer was given a score of 1, and both the "wrong" and "I do not know" responses were given a score of 0.

Ethical Considerations

Participation was voluntary, and data was collected only for research purposes. Self-identifying information such as name, ID number, and phone number were not collected. Hence, confidentiality and privacy were maintained during all the study phases. All participants were requested to give consent before filling in the questionnaire. Participants were given the freedom to terminate the survey at any time. Ethical approval was obtained on 22 November 2020 from Institutional Review Board at King Saud University College of Medicine (Ref. No. 20/0853/IRB).

Statistical Analysis

Data were analyzed using SPSS (version 24.0, IBM Corp., Armonk NY, USA). Descriptive statistics (mean, standard deviation, frequencies, and percentages) were used to describe the quantitative and categorical variables. Bivariate statistical analysis was carried out using the Chi-square test and Wilcoxon signed rank test. A p-value of <0.05 and a 95% confidence interval signified statistical significance and were used to measure the precision of results.

Results

A total of 7,188 participants were finally enlisted in the study; 4,973 (69.2%) were females and 2,215 (30.8%) were males. Most participants (50.8%) were within the 18-28 years age group. Regarding nationality, most respondents were Saudi Arabian (95.4%). Concerning the place of residence, most of the respondents were from the middle region (77.3%), followed by the eastern region (7.5%), and western region (6.7%). Regarding the highest level of educational attainment, most of the respondents (4,432; 61.7%) had bachelor's degrees, followed by 1,967 (27.4%) who finished after high school, and 603 (8.4%) with a postgraduate degree. In terms of marital status, more than half of the respondents (52.5%) were single, 3,298 (45.9%) were married, and 118 (1.6%) were widows. Regarding the size of the family, most of the respondents (3,613; 50.3%) had a family size of 5-7 individuals. As shown in Table I, respondents were grouped according to monthly income, with 2,553 (35.5%) in the 10,000-20,000 SR per month income group and 2,231 (31.0%) in the group who earned over 20,000 SR per month.

Regarding the history of chronic diseases, most respondents (81.1%) mentioned that they did not have any chronic illnesses. The most reported chronic diseases were diabetes (6.6% of respondents), followed by hypertension (6.3%), chronic respiratory disease (5.9%), and cardiovascular diseases (1.6%). Chronic renal disease, cancer, and other conditions were reported by less than 1% of respondents (Table II).

Regarding COVID-19 infection, most of the respondents (85.1%) had no history of confirmed infection while the remaining 1,072 (14.9%) had a previous infection (Figure 1). A total of 5,009 participants (69.7%) mentioned no infections among family members; 1,107 (15.9%) reported infection in at least one family member, and 753 (10.5%) reported infections in multiple family members, including the respondents themselves.

Table I. Socio-demographic characteristics of study participants (n=7,188).

Variable	Categories	N	%
Gender	Male	2,215	30.8%
	Female	4,973	69.2%
Age (years)	18-28	3,654	50.8%
	29-39	1,258	17.5%
	40-49	1,238	17.2%
	50-64	948	13.2%
	+65	90	1.3%
Nationality	Saudi	6,858	95.4%
	Non-Saudi	330	4.6%
Place of residence	Eastern Region	538	7.5%
	Middle Region	5,556	77.3%
	Northern Region	463	6.4%
	Southern Region	151	2.1%
	Western Region	480	6.7%
Level of Education	Primary School	45	0.6%
	Intermediate School	141	2.0%
	High school	1967	27.4%
	Bachelor's degree	4432	61.7%
	Postgraduate degree	603	8.4%
Marital status	Married	3,298	45.9%
	Not married	3,772	52.5%
	Widow/Widower	118	1.6%
Family size	2-4	1,712	23.8%
	5-7	3,613	50.3%
	More than 7	1,863	25.9%
Income level (SR)	Less than 5,000	574	8.0%
	5,000-10,000	1,830	25.5%
	10,000-20,000	2,553	35.5%
	More than 20,000	2,231	31.0%

The level of KAAP was assessed across the whole sample of participants. As shown in Table III, the mean score and standard deviation for general knowledge about COVID-19 was 10.4±3.44 (range: 2-18) while the mean scores and standard deviations for the knowledge sections were 4.7±1.75 (range: 1-6) for preventive measures, 3.5±1.52 (range: 0-7) for knowledge about symptoms and signs, and 2.2±1.07 (range: 1-5) for knowledge about complications. The mean score and standard deviation for awareness were 6.1±2.26 (range: 0-11). As for attitude and practice, the mean scores and standard deviations were 5.0±1.67 (range: 0-8) and 7.8±1.57 (range: 0-10), respectively.

Table II. History of chronic diseases.

39. Did you have any chronic diseases?	N (%)
Cancer	29 (0.40%)
Cardiovascular Disease	118 (1.6%)
Chronic Renal Disease	37 (0.52%)
Chronic Respiratory Disease	425 (5.9%)
Diabetes	476 (6.6%)
Hypertension	453 (6.3%)
Immunodeficiency Diseases	79 (1.1%)
Other	70 (0.97%)
No, I didn't have any chronic disease	5,832 (81.1%)

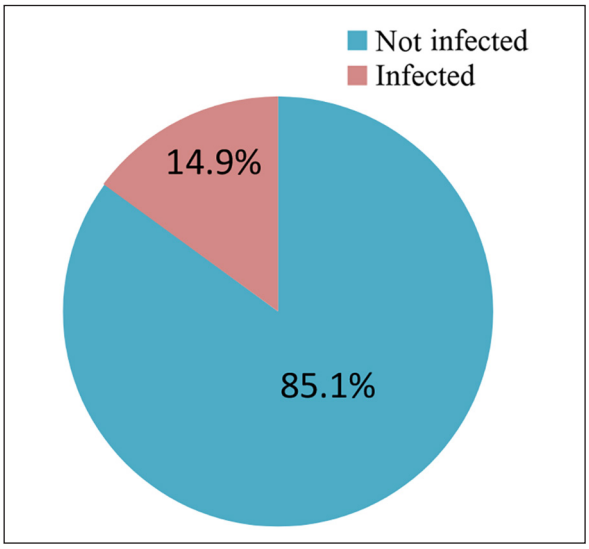

Figure 1. Rate of infection among participants.

Table III. Mean scores of knowledge, awareness, attitude, practice and second wave.

Domain	Mean	SD	Minimum	Maximum
Knowledge	10.4	3.44	2	18
Knowledge				
Preventive measures	4.7	1.75	1	6
Symptoms & signs	3.5	1.52	0	7
Complications	2.2	1.07	1	5
Awareness	6.1	2.26	0	11
Attitude	5.0	1.67	0	8
Practice	7.8	1.57	0	10
Second wave	2.8	1.38	0	5

Knowledge of Symptoms and Complications, as well as Preventive Measures Against COVID-19

Concerning the preventive measures that limit the spread of COVID-19, wearing masks (88.5%) was the most acknowledged measure listed by respondents, followed by avoiding crowded places by 6,006 (83.6%), and frequently disinfecting hands with alcohol or soap reported by 5,633 (78.4%) (Figure 2).

Regarding the symptoms of COVID-19, the most acknowledged symptom was influenza-like symptoms (fever, sore throat, cough, and myalgia) by 5,888 (81.9%) of respondents, loss of smell by 5,717 (77.5%), difficulty in breathing 5,238 (72.9%), and headache by 4,748 (66.1%) (Figure 3). The most reported complication of COVID-19 was death reported by 74.3% of respondents, acute respiratory failure by 65.8%, and pneumonia by 58.8% (Figure 4).

Practices During COVID-19

Concerning practices (hygiene and others) during the first wave, the vast majority (92.1%) of the respondents avoided leaving the house when it was not necessary. Properly wearing a mask in public places was reported by 6,800 (94.6%) while regular hand sanitization outside the house was reported by 6,488 (90.3%). A total of 6,530 (90.8%) respondents mentioned that they avoided touching their mouth or eyes outside before washing their hands, and 6,372 (88.6%) mentioned that they avoided shaking hands, while 660 (9.2%) stated that they did shake hands. A total of 6,287 (87.5%) of the respondents reported adherence to procedures for fighting a pandemic when visiting their relatives, and 5,562 (77.3%) stated that they would go to the hospital if symptoms of fever, cough, or difficulty in breathing appeared.

Regarding commitment to home quarantine in the event of getting infected, 6,853 (95.3%)

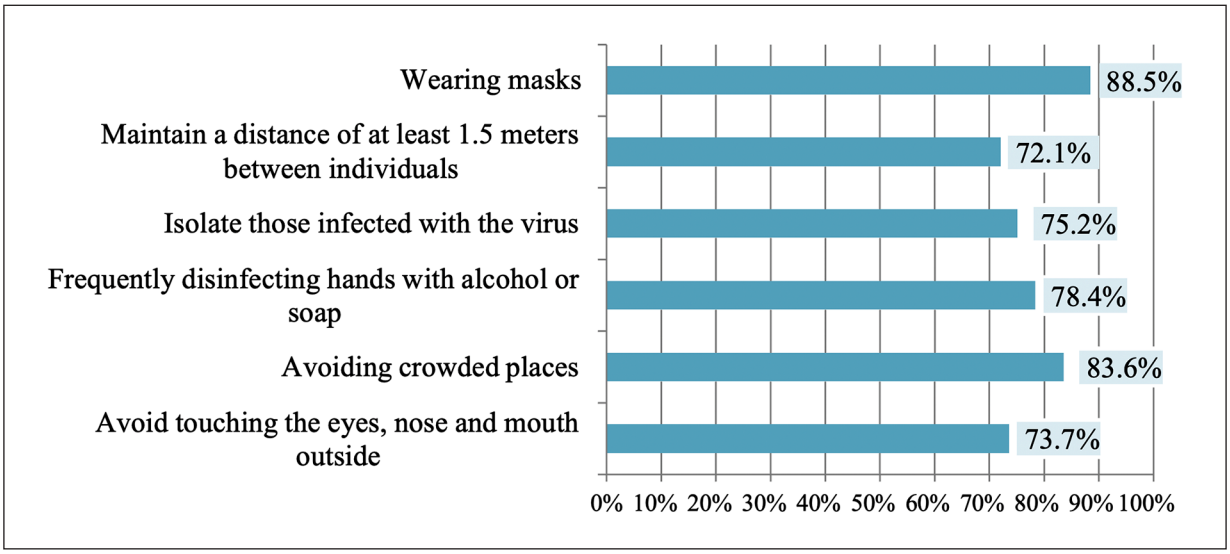

Figure 2. Knowledge about preventive measures of the Coronavirus.

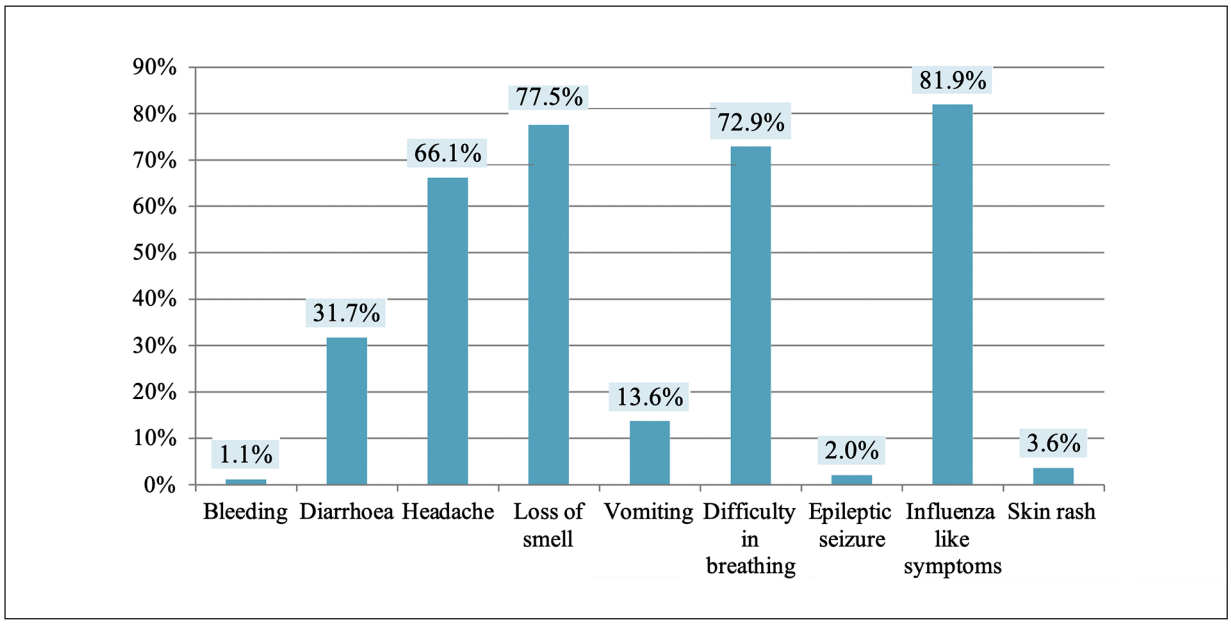

Figure 3. Knowledge about symptoms of the Coronavirus.

of respondents reported they would commit to home quarantine, but 215 (3.0%) mentioned that they would not. If they suspected getting coronavirus infection, 3,266 (45.4%) of respondents mentioned that they would get tested if mild symptoms, such as fever and cough, appeared, 3,018 (42.0%) declared that they would get a test before symptoms appear, 778 (10.8%) stated that they would get a test if only severe symptoms, such as shortness of breathing appeared, and 126 (1.8%) mentioned they would not get a test done at all (Table IV).

Comparison of Sociodemographic Characteristics and Mean Score of KAAP

We compared the sociodemographic characteristics of the sample with levels of KAAP as described in Tables V and VI. It was found that gender did not significantly affect knowledge score or awareness score (p=0.831 and 0.469, respectively). Still, males significantly had a higher attitude mean score compared to females (p<0.001) (Figure 5). Age was found to significantly affect the knowledge score (p=0.002); those older than 65 years of age were more knowledgeable compared to other age groups.

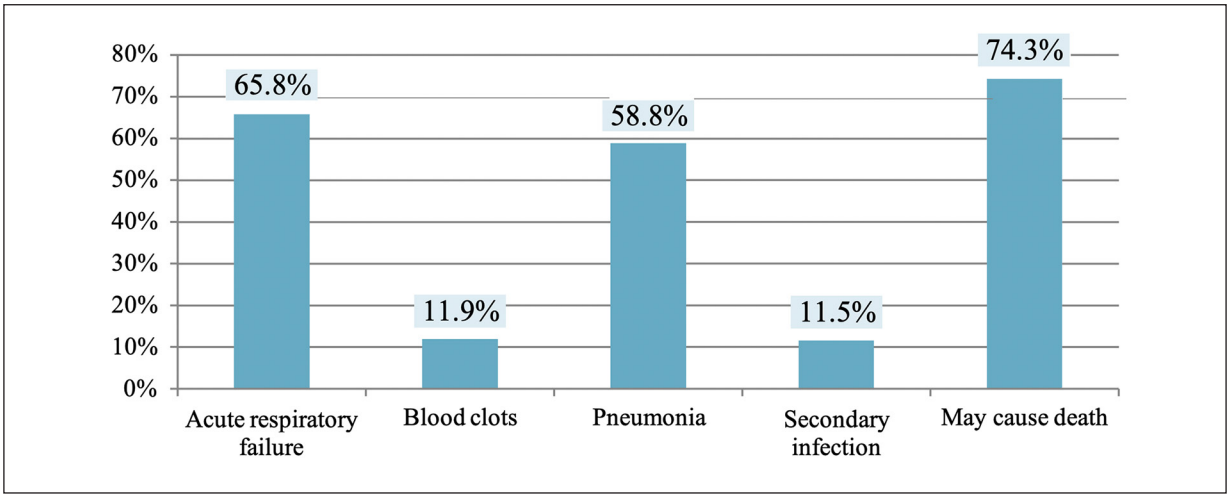

Figure 4. Knowledge about complications of the Coronavirus.

Table IV. Frequency of various responses to questions about Practice.

Did you do the following practices during the first wave:	Yes	No	I don't know
Avoid leaving the house when it is not necessary	6,621 (92.1%)	480 (6.7%)	87 (1.2%)
Properly wearing a mask in public places	6,800 (94.6%)	309 (4.3%)	79 (1.1%)
Regular hand sanitizing outside the house	6,488 (90.3%)	570 (7.9%)	130 (1.8%)
Aavoid touching my mouth or eyes before washing hands, out the house.	6,530 (90.8%)	477 (6.6%)	181 (2.6%)
Avoid shaking hands	6,372 (88.6%)	660 (9.2%)	156 (2.2%)
Following and adhere to procedures for fighting a pandemic when visitng my relative	6,287 (87.5%)	713 (9.9%)	188 (2.6%)
In the event that you contracted COVID-19, would you do the following practices:	Yes	No	I don't know
Going to the hospital if symptoms of fever, cough or difficulty in breathing appear	5,562 (77.3%)	1,205 (16.8%)	421 (5.9%)
Commitment to home quarantine in the event of getting infected	6,853 (95.3%)	215 (3.0%)	120 (1.7%)
If you are suspected of having a corona, when will you test for corona?			N (%)
I will not perform the test			126 (1.8%)
Perform the test before symptoms appear.			3,018 (42.0%)
Perform the test if only mild symptoms such as fever and cough appear.			3,266 (45.4%)
Perform the test if only severe symptoms such as shortness of breathing			778 (10.8%)
Have you ever had any vaccination against the influenza v irus in the last 8 months?		Yes	1,115 (15.5%)
		No	6,073 (84.5%)

Those aged between 29-39 years were significantly more aware compared to other age groups (p<0.001), and those aged 18-28 years had a good attitude more frequently in comparison with other age groups (p<0.001) (Figure 6). Non-Saudi participants were significantly more knowledgeable about COVID-19 than the Saudi population (p=0.011); otherwise, nationality did not significantly affect participant's awareness and attitude (p=0.584, p=0.451, respectively).

Place of residence significantly affected respondent's knowledge and awareness; hence, those from the middle region were more knowledgeable and more aware of COVID-19 than other regions (p<0.001). Postgraduate-qualified participants were significantly more knowledgeable, aware, and with a better attitude about COVID-19 than participants with other levels of educational attainment (p<0.001). Those who were single had a significantly higher mean of knowledge score compared to other groups (p=0.019), while married respondents were more aware than other marital status participants (p=0.036). In contrast, single participants had a good attitude compared to others (p<0.001). Family size significantly affected the respondents' knowledge and awareness about COVID-19 (p<0.001).

Participants with a family size of 5-7 members were more knowledgeable and more aware than the others. However, family size did not significantly affect the respondent's attitude (p=0.736). Respondents who had a monthly income level higher than 20,000 SR were significantly more knowledgeable, aware, and had a better attitude than those with other income levels (p<0.001).

Regarding practices during COVID-19, females had significantly higher practices' score compared to males (p<0.001) (Figure 5). A higher practice score was also found in respondents aged 65 years or more compared to other age groups (p<0.001) (Figure 6). Nationality did not significantly affect practice score (p=0.142). Those from the western region had a considerably higher practice score compared to those in other areas (p=0.001).

Both postgraduates and married people had significantly higher practice score compared to others (p<0.001). Families with 2-4 members had a significantly higher mean practice score

Table V. Comparison of socio-demographic characteristics and mean score of knowledge, Awareness and Attitude.

Variable	N	%	Knowledge score			Awareness score			Attitude scorel		
			Mean	SD	*p*	Mean	SD	*p*	Mean	SD	*p*
Gender					0.831			0.469			0.001
Male	2,215	30.8%	10.40	3.53		6.06	2.36		5.17	1.68	
Female	4,973	69.2%	10.42	3.41		6.10	2.21		4.89	1.65	
Age (years)					0.002			0.001			0.001
18-28	3,654	50.8%	10.42	3.31		6.01	2.20		5.18	1.65	
29-39	1,258	17.5%	10.39	3.60		6.39	2.33		4.88	1.67	
40-49	1,238	17.2%	10.18	3.56		6.22	2.29		4.76	1.65	
50-64	948	13.2%	10.58	3.54		5.82	2.27		4.63	1.62	
+65	90	1.3%	11.52	3.79		5.87	2.48		4.46	1.79	
Nationality					0.011			0.584			0.451
Saudi	6858	95.4%	10.39	3.44		6.08	2.24		4.98	1.66	
Non-Saudi	330	4.6%	10.88	3.58		6.16	2.54		4.91	1.72	
Place of residence					0.001			0.001			0.043
Middle Region	5,556	77.3%	10.54	3.39		6.17	2.25		4.95	1.66	
Northern Region	463	6.4%	9.47	3.73		5.51	2.16		5.04	1.75	
Southern Region	151	2.1%	9.93	3.45		5.65	2.40		5.17	1.87	
Eastern Region	538	7.5%	10.17	3.53		6.02	2.23		5.14	1.70	
Western Region	480	6.7%	10.25	3.54		5.83	2.29		5.00	1.58	
Education level					0.001			0.001			0.001
Primary	45	0.6%	8.76	4.84		5.11	2.33		5.02	2.16	
Intermediate	141	2.0%	9.68	3.64		5.30	2.06		5.04	1.80	
High school	1,967	27.4%	10.13	3.44		5.83	2.17		5.11	1.61	
Bachelor	4,432	61.7%	10.43	3.38		6.13	2.24		4.91	1.67	
Postgraduate	603	8.4%	11.51	3.53		6.88	2.43		4.98	1.70	
Marital status					0.019			0.036			0.001
Married	3,298	45.9%	10.29	3.56		6.10	2.33		4.79	1.67	
Not married	3,772	52.5%	10.52	3.31		6.09	2.19		5.15	1.64	
Widow/Widower	118	1.6%	10.28	4.18		5.56	2.21		4.76	1.85	
Family size					0.001						0.736
2 4	1,712	23.8%	10.00	3.61		6.15	2.34	0.001	4.97	1.70	
5-7	3,613	50.3%	10.61	3.38		6.16	2.23		4.97	1.64	
More than 7	1,863	25.9%	10.40	3.39		5.88	2.21		5.00	1.68	
Income level (SR)					0.001			0.001			0.001
Less than 5,000	574	8.0%	9.63	3.72		5.64	2.25		5.12	1.65	
5,000-10,000	1,830	25.5%	9.77	3.44		5.76	2.22		4.81	1.65	
10,000-20,000	2,553	35.5%	10.46	3.27		6.14	2.18		4.96	1.65	
More than 20,000	2,231	31.0%	11.07	3.44		6.40	2.33		5.10	1.70	

**Independent samples *t*-test and ANOVA test were used.

Table VI. Comparison of socio-demographic characteristics and mean score of Practice and Second wave.

Variable	N	%	Practice score			Second wave score		
			Mean	SD	*p*	Mean	SD	*p*
Gender					0.001			0.000
Male	2,215	30.8%	7.64	1.726		3.02	1.423	
Female	4,973	69.2%	7.84	1.495		2.75	1.352	
Age (years)					0.001			0.000
18-28	3,654	50.8%	7.44	1.703		3.02	1.388	
29-39	1,258	17.5%	7.96	1.466		2.77	1.398	
40-49	1,238	17.2%	8.15	1.291		2.66	1.352	
50-64	948	13.2%	8.29	1.182		2.45	1.246	
+65	90	1.3%	8.34	1.383		2.61	1.296	
Nationality					0.142			0.392
Saudi	6,858	95.4%	7.77	1.574		2.84	1.376	
Non-Saudi	330	4.6%	7.90	1.522		2.77	1.464	
Place of residence					0.001			0.001
Middle Region	5,556	77.3%	7.79	1.552		2.81	1.360	
Northern Region	463	6.4%	7.53	1.689		2.79	1.508	
Southern Region	151	2.1%	7.64	1.948		3.06	1.580	
Eastern Region	538	7.5%	7.77	1.660		3.06	1.366	
Western Region	480	6.7%	7.94	1.426		2.84	1.405	
Education level					0.001			0.144
Primary School	45	0.6%	7.40	2.535		2.60	1.338	
Intermediate School	141	2.0%	7.74	1.846		2.67	1.427	
High school	1,967	27.4%	7.67	1.607		2.85	1.363	
Bachelor	4,432	61.7%	7.80	1.534		2.82	1.378	
Postgraduate	603	8.4%	7.99	1.545		2.93	1.436	
Marital status					0.001			0.001
Married	3,298	45.9%	8.10	1.353		2.64	1.346	
Not married	3,772	52.5%	7.49	1.687		3.01	1.388	
Widow/Widower	118	1.6%	7.98	1.690		2.47	1.266	
Family size					0.001			0.173
2-4	1,712	23.8%	7.90	1.562		2.83	1.391	
5-7	3,613	50.3%	7.80	1.516		2.81	1.368	
More than 7	1,863	25.9%	7.61	1.672		2.88	1.391	
Income level (SR)					0.037			0.001
Less than 5,000	574	8.0%	7.71	1.772		2.85	1.433	
5,000-10,000	1,830	25.5%	7.84	1.550		2.70	1.360	
10,000-20,000	2,553	35.5%	7.81	1.521		2.83	1.368	
More than 20,000	2,231	31.0%	7.71	1.592		2.94	1.388	

**Independent samples *t*-test and ANOVA test were used.

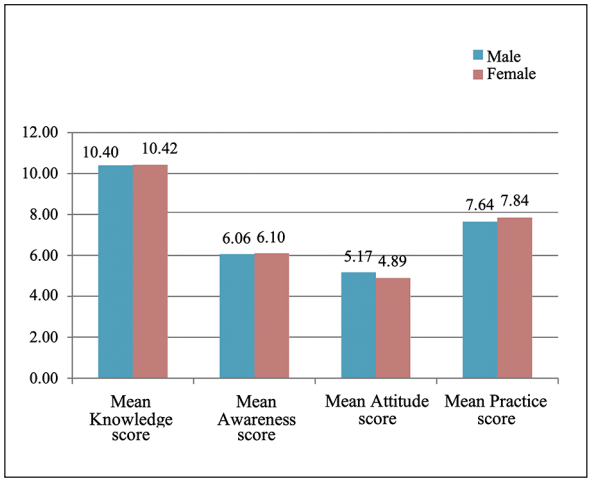

Figure 5. Mean of Knowledge, Awareness, Attitude and Practice scores among gender.

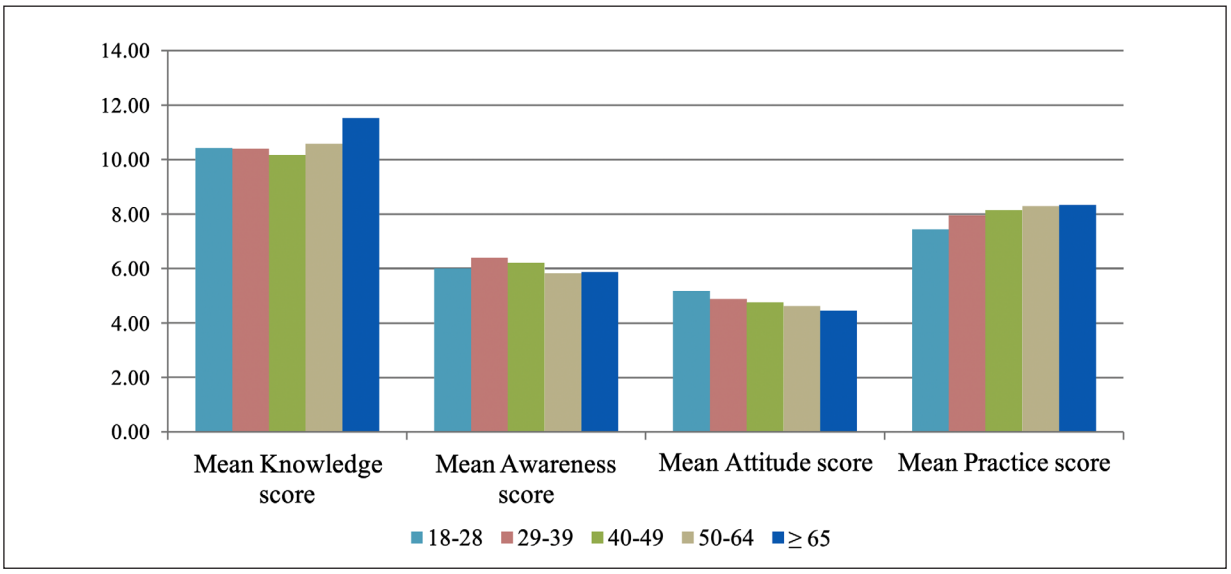

Figure 6. Mean of Knowledge, Awareness, Attitude and Practice scores among age groups.

(p<0.001), and those whose monthly income level was between 5,000-10,000 SR had a significantly higher mean score than others (p=0.037).

Attitudes and Willingness to Receive a COVID-19 Vaccination

The need to get vaccinated against COVID-19 was agreed upon by 5,599 (77.9%) of respondents; 3,413 (47.5%) decided that they will make sure to take the vaccines and to advise others to take them, while 1,891 (26.3%) of respondents agreed to participate in the trials of the COVID-19 vaccine if invited to one, even before its final approval. If the vaccine against COVID-19 was approved, 4,589 (63.8%) agreed to getting vaccinated if it is 95% effective, and 1,579 (22.0%) decided to get vaccinated if it was 50% effective.

The number of males agreeing that COVID-19 vaccination was needed was significantly higher than females (p<0.001). Individuals aged between 18-28 years agreed more frequently than other groups about the importance of the vaccine (p<0.001). Nationality did not affect people's willingness to take the vaccine (p=0.525). Residents of the southern and northern regions agreed more that they needed the vaccine compared to those in other regions (p=0.008). High school graduates agreed significantly more to the importance of the vaccine than those with other levels of educational attainment (p=0.001). Single people more frequently said they need the vaccine than those of other marital status (p<0.001). Families with more than seven family members agreed at a significantly higher rate than other family groups that they needed the vaccine (p=0.006). Similarly, respondents with monthly income level less than 5,000 SR agreed they need the vaccine more than those in other income levels (p=0.004) (Table VII).

Most females and those aged between 50-64 years would not take the vaccine if it was only 50% effective (p<0.001). Nationality did not affect one's willingness to take a 50%-effective vaccine (p=0.649). Middle region residents, postgraduates, widows, and those in 5-7 person families significantly disagree with taking a 50%-effective vaccine (p=0.015, p<0.001, p<0.001, and p=0.008, respectively). In addition, 10,000-20,000 SR monthly income participants significantly disagreed with taking a 50%-effective vaccine compared with those in other income levels (p<0.001) (Table VIII).

Most males and those aged between 18-28 years significantly agreed to take the vaccine if it was 95% effective (p<0.001). Nationality and place of residence did not affect respondents' willingness to take the vaccine if it was 95% effective (p=0.449 and p=0.736, respectively). High school graduates and married participants significantly agreed to take the vaccine compared with those with other levels of education and marital statuses (p<0.001). Large-family (i.e., more than 7 people) respondents and those with a monthly income higher than 20,000 SR were significantly more likely to take the vaccine than other groups (p=0.022 and p<0.001, respectively) (Table IX).

Table VII. Association between COVID-19 vaccine question 1 and socio-demographics.

Variable	Q1: We need a vaccine for Coronavirus			Total	Chi-Square	*p*-value
	Agree	Not agree	I don't know			
Gender					115.803	0.001
Male	1,897 (85.6%)	170 (7.7%)	148 (6.7%)	2,215 (100%)		
Female	3,702 (74.4%)	586 (11.8%)	685 (13.8%)	4,973 (100%)		
Age (years)					564.105	0.001
18-28	3,190 (87.3%)	212 (5.8%)	252 (6.9%)	3,654 (100.0%)		
29-39	985 (78.3%)	130 (10.3%)	143 (11.4%)	1,258 (100.0%)		
40-49	849 (68.6%)	191 (15.4%)	198 (16.0%)	1,238 (100.0%)		
50-64	527 (55.6%)	197 (20.8%)	224 (23.6%)	948 (100.0%)		
+65	48 (53.3%)	26 (28.9%)	16 (17.8%)	90 (100.0%)		
Nationality					1.290	0.525
Saudi	5,338 (77.8%)	719 (10.5%)	801 (11.7%)	6,858 (100.0%)		
Non-Saudi	261 (79.1%)	37 (11.2%)	32 (9.7%)	330 (100.0%)		
Place of residence					20.864	0.008
Eastern Region	418 (77.7%)	61 (11.3%)	59 (11.0%)	538 (100.0%)		
Middle Region	4,315 (77.7%)	569 (10.2%)	672 (12.1%)	5,556 (100.0%)		
Northern Region	380 (82.1%)	42 (9.1%)	41 (8.9%)	463 (100.0%)		
Southern Region	128 (84.8%)	14 (9.3%)	9 (6.0%)	151 (100.0%)		
Western Region	358 (74.6%)	70 (14.6)	52 (10.8%)	480 (100.0%)		
Education level					25.140	0.001
Primary	32 (71.1%)	10 (22.2%)	3 (6.7%)	45 (100.0%)		
Intermediate	106 (75.2%)	18 (12.8%)	17 (12.1%)	141 (100.0%)		
High school	1,594 (81.0%)	185 (9.4%)	188 (9.6%)	1,967 (100.0%)		
Bachelor	3,413 (77.0%)	470 (10.6%)	549 (12.4%)	4,432 (100.0%)		
Postgraduate	454 (75.3%)	73 (12.1%)	76 (12.6%)	603 (100.0%)		
Marital status					371.048	0.001
Married	2,252 (68.3%)	495 (15.0%)	551 (16.7%)	3,298 (100.0%)		
Not married	3,273 (86.8%)	234 (6.2%)	265 (7.0%)	3,772 (100.0%)		
Widow/Widower	74 (62.7%)	27 (22.9%)	17 (14.4%)	118 (100.0%)		
Family size					14.329	0.006
2-4	1,311 (76.6%)	186 (10.9%)	215 (12.6%)	1,712 (100.0%)		
5-7	2,785 (77.1%)	384 (10.6%)	444 (12.3%)	3,613 (100.0%)		
More than 7	1,503 (80.7%)	186 (10.0%)	174 (9.3%)	1,863 (100.0%)		
Income level (SR)					19.038	0.004
Less than 5,000	463 (80.7%)	54 (9.4%)	57 (9.9%)	574 (100.0%)		
5,000-10,000	1,376 (75.2%)	209 (11.4%)	245 (13.4%)	1,830 (100.0%)		
10,000-20,000	1,970 (77.2%)	277 (10.8%)	306 (12.0%)	2,553 (100.0%)		
More than 20,000	1,790 (80.2%)	216 (9.7%)	225 (10.1%)	2,231 (100.0%)		

Association Between Willingness to Take the Vaccine and Having Chronic Diseases

Willingness to take the vaccine while having chronic diseases were positively correlated (rho=0.098, $p<0.001$); 99 (83.9%) of those with cardiovascular disease agreed that they needed the COVID-19 vaccine while 30 (81.1%), 322 (75.8%), and 337 (70.8%) of those with chronic renal disease, chronic respiratory disease, and diabetes, respectively, also agreed that they needed the COVID-19 vaccine. Most participants who did not have any chronic diseases (78.9%) said they need to take the vaccine. Those with cardiovascular diseases (33.9%), chronic renal diseases (32.4%), and cancers (31%) agreed to participate if invited to a trial of the COVID-19 vaccine before its final approval, even if it had unknown effectiveness. They represented a higher percentage of participants even including those who did not have any chronic disease (26.9%) (Table X).

Regarding one's willingness to take COVID-19 vaccine, if it was 95% effective, most participants with chronic renal diseases (73%), cardiovascular diseases (70.3%), or chronic respiratory diseases (62.8%) would take the vaccine, while a lower percentage of cancer patients (44.8%) and immunodeficient patients (44.3%) would take it was with that efficacy. Lower percentages of participants would take the COVID-19 vaccine if it was 50% effective; those with cardiovascular diseases (28%), chronic respiratory diseases (25.4%), or

Table VIII. Association between Covid-19 vaccine question 5 and socio-demographics.

Variable	Q5: I will take the vaccine if it is 50% effective (50% effectiveness means that out of every 100 people who took the vaccine, 50 of them will not get the disease)			Total	Chi-Square	*p*-value
	Agree	Not agree	I don't know			
Gender					56.371	0.001
Male	590 (26.6%)	1,305 (58.9%)	320 (14.4%)	2,215 (100.0%)		
Female	989 (19.9%)	3,000 (60.3%)	984 (19.8%)	4,973 (100.0%)		
Age (years)					255.962	0.001
18-28	1,054 (28.8%)	1,931 (52.8%)	669 (18.3%)	3,654 (100.0%)		
29-39	230 (18.3%)	785 (62.4%)	243 (19.3%)	1,258 (100.0%)		
40-49	180 (14.5%)	829 (67.0%)	229 (18.5%)	1,238 (100.0%)		
50-64	106 (11.2%)	701 (73.9%)	141 (14.9%)	948 (100.0%)		
+65	9 (10.0%)	59 (65.6%)	22 (24.4%)	90 (100.0%)		
Nationality					0.862	0.649
Saudi	1,504 (21.9%)	4,115 (60.0%)	1,239 (18.1%)	6,858 (100.0%)		
Non-Saudi	75 (22.7%)	190 (57.6%)	65 (19.7%)	330 (100.0%)		
Place of residence					18.937	0.015
Eastern Region	114 (21.2%)	320 (59.5%)	104 (19.3%)	538 (100.0%)		
Middle Region	1,184 (21.3%)	3,380 (60.8%)	992 (17.9%)	5,556 (100.0%)		
Northern Region	129 (27.9%)	251 (54.2%)	83 (17.9%)	463 (100.0%)		
Southern Region	43 (28.5%)	82 (54.3%)	26 (17.2%)	151 (100.0%)		
Western Region	109 (22.7%)	272 (56.7%)	99 (20.6%)	480 (100.0%)		
Education level					48.954	0.001
Primary	14 (31.1%)	22 (48.9%)	9 (20.0%)	45 (100.0%)		
Intermediate	37 (26.2%)	79 (56.0%)	25 (17.7%)	141 (100.0%)		
High school	494 (25.1%)	1,067 (54.2%)	406 (20.6%)	1,967 (100.0%)		
Bachelor	914 (20.6%)	2,737 (61.8%)	781 (17.6%)	4,432 (100.0%)		
Postgraduate	120 (19.9%)	400 (66.3%)	83 (13.8%)	603 (100.0%)		
Marital status					179.032	0.001
Married	511 (15.5%)	2,202 (66.8%)	585 (17.7%)	3,298 (100.0%)		
Not married	1,052 (27.9%)	2,024 (53.7%)	696 (18.5%)	3,772 (100.0%)		
Widow/Widower	16 (13.6%)	79 (66.9%)	23 (19.5%)	118 (100.0%)		
Family size						
2-4	365 (21.3%)	1,012 (59.1%)	335 (19.6%)	1,712 (100.0%)	13.554	0.0088
5-7	772 (21.4%)	2,228 (61.7%)	613 (17.0%)	3,613 (100.0%)		
More than 7	442 (23.7%)	1,065 (57.2%)	356 (19.1%)	1,863 (100.0%)		
Income level (SR)					77.803	0.001
Less than 5,000	156 (27.2%)	277 (48.3%)	141 (24.6%)	574 (100.0%)		
5,000-10,000	343 (18.7%)	1,101 (60.2%)	386 (21.1%)	1,830 (100.0%)		
10,000-20,000	520 (20.4%)	1,606 (62.9%)	427 (16.7%)	2,553 (100.0%)		
More than 20,000	560 (25.1%)	1,321 (59.2%)	350 (15.7%)	2,231 (100.0%)		

those who did not have any chronic diseases (22.5%) were more willing to take the vaccine at that lower efficacy (Table X).

Influenza Vaccination Practice

Regarding influenza vaccination, only 1,115 (15.5%) of respondents said they had been vaccinated against the influenza virus during the previous 8 months. Conversely, 6,073 (84.5%) of respondents mentioned they had not received vaccination against the influenza virus in the last 8 months (Table IV). When asked about planning for seasonal flu vaccination in the next 4 months, 1905 (26.5%) responded positively, and 2,986 (41.5%) responded negatively. Influenza vaccine intake and exposure to COVID-19 infection were also positively correlated (rho=0.051, $p<0.001$, Table IV).

The Expectation of a Second Wave of COVID-19

A total of 3,061 (42.6%) respondents expected a second wave of COVID-19. "Next winter, there will be an increase in the number of cases": 3,002 (41.8%) of respondents agreed with this statement, 2,644 (36.8%) did not know, and 1,542 (21.4%) did not agree. A total of 2,164 (30.1%) respondents thought that if a second wave had

Table IX. Association between COVID-19 vaccine question 4 and socio-demographics.

Variable	Q4: I will take the vaccine if it is 95% effective (95% effectiveness means that out of every 100 people who take the vaccine, 95 of them will not get the disease)			Total	Chi-Square	*p*-value
	Agree	Not agree	I don't know			
Gender					96.917	0.001
Male	1,599 (72.2%)	357 (16.1%)	259 (11.7%)	2,215 (100.0%)		
Female	2,990 (60.1%)	1,123 (22.6%)	860 (17.3%)	4,973 (100.0%)		
Age (years)					216.974	0.001
18-28	2,599 (71.1%)	540 (14.8%)	515 (14.1%)	3654 (100.0%)		
29-39	764 (60.7%)	286 (22.7%)	208 (16.5%)	1,258 (100.0%)		
40-49	678 (54.8%)	353 (28.5%)	207 (16.7%)	1,238 (100.0%)		
50-64	503 (53.1%)	271 (28.6%)	174 (18.4%)	948 (100.0%)		
+65	45 (50.0%)	30 (33.3%)	15 (16.7%)	90 (100.0%)		
Nationality					1.599	0.449
Saudi	4369 (63.7%)	1,414 (20.6%)	1,075 (15.7%)	6,858 (100.0%)		
Non-Saudi	220 (66.7%)	66 (20.0%)	44 (13.3%)	330 (100.0%)		
Place of residence					5.192	0.736
Eastern Region	353 (65.6%)	107 (19.9%)	78 (14.5%)	538 (100.0%)		
Middle Region	3,549 (63.9%)	1,144 (20.6%)	863 (15.5%)	5,556 (100.0%)		
Northern Region	296 (63.9%)	89 (19.2%)	78 (16.8%)	463 (100.0%)		
Southern Region	98 (64.9%)	35 (23.2%)	18 (11.9%)	151 (100.0%)		
Western Region	293 (61.0%)	105 (21.9%)	82 (17.1%)	480 (100.0%)		
Education level					34.765	0.001
Primary School	27 (60.0%)	11 (24.4%)	7 (15.6%)	45 (100.0%)		
Intermediate School	90 (63.8%)	27 (19.1%)	24 (17.0%)	141 (100.0%)		
High school	1,302 (66.2%)	332 (16.9%)	333 (16.9%)	1,967 (100.0%)		
Bachelor's degree	2,810 (63.4%)	948 (21.4%)	674 (15.2%)	4,432 (100.0%)		
Postgraduate degree	360 (59.7%)	162 (26.9%)	81 (13.4%)	603 (100.0%)		
Marital status					147.626	0.001
Married	1890 (57.3%)	839 (25.4%)	569 (17.3%)	3298 (100.0%)		
Not married	2643 (70.1%)	604 (16.0%)	525 (13.9%)	3772 (100.0%)		
Widow/Widower	56 (47.5%)	37 (31.4%)	25 (21.2%)	118 (100.0%)		
Family size					11.407	0.022
2-4	1,038 (60.6%)	373 (21.8%)	301 (17.6%)	1,712 (100.0%)		
5-7	2,333 (64.6%)	735 (20.3%)	545 (15.1%)	3,613 (100.0%)		
More than 7	1,218 (65.4%)	372 (20.0%)	273 (14.7%)	1,863 (100.0%)		
Income level (SR)					34.524	0.001
Less than 5,000	349 (60.8%)	110 (19.2%)	115 (20.0%)	574 (100.0%)		
5,000-10,000	1,114 (60.9%)	392 (21.4%)	324 (17.7%)	1,830 (100.0%)		
10,000-20,000	1,634 (64.0%)	517 (20.3%)	402 (15.7%)	2,553 (100.0%)		
More than 20,000	1,492 (66.9%)	461 (20.7%)	278 (12.5%)	2,231 (100.0%)		

occurred, it would have been stronger than the first, and 5,300 (73.7%) believed that it was more appropriate to reapply quarantine measures if a second wave occurred (Figure 7a). In the case of second-wave, 3,876 (53.9%) of respondents mentioned that their commitment to the general precautionary measures would increase (Figure 7b).

To compare participants' responses against their sociodemographic characteristics, we calculated a score for second wave questions. The mean score and standard deviation were found to be 2.8±1.38 (range 0-5). Males had a higher second wave's score compared to females (p<0.001). Respondents aged 18-28 years old had a significantly higher mean score than other age groups (p<0.001). Nationality did not significantly affect the second wave score (p=0.392). Those from the southern and eastern areas had the highest mean second wave score (p<0.001). There was no significant difference among different educational levels regarding the second wave score (p=0.144). Respondents who were single had a significantly higher second wave score (p<0.001). Family size did not significantly affect the second wave's score (p=0.173), but income level did, significantly (p<0.001) (Table VI).

Table X. Association between willingness to take vaccine and having chronic diseases.

Chronic diseases	N	We need a vaccine for Coronavirus N (%)	I will participate if invited to participate in a trial of the Corona virus vaccine before its final approval and its effectiveness unknown N (%)	If the vaccine against Corona virus is approved, I will take this vaccine regardless its effective N (%)	I will take the vaccine if it is 95% effective N (%)	I will take the vaccine if it is 50% effective N (%)
Cancer	29	17 (58.6%)	9 (31%)	6 (20.7%)	13 (44.8%)	4 (13.8%)
Cardiovascular Disease	118	99 (83.9%)	40 (33.9%)	46 (39%)	83 (70.3%)	33 (28%)
Chronic Renal Disease	37	30 (81.1%)	12 (32.4%)	11 (29.7%)	27 (73%)	8 (21.6%)
Chronic Respiratory Disease	425	322 (75.8%)	126 (29.6%)	110 (25.9%)	267 (62.8%)	108 (25.4%)
Diabetes	476	337 (70.8%)	103 (21.6%)	113 (23.7%)	292 (61.3%)	73 (15.3%)
Hypertension	453	314 (69.3%)	77 (17%)	108 (23.8%)	277 (61.1%)	70 (15.5%)
Immunodeficiency Diseases	79	57 (72.2%)	12 (15.2%)	13 (16.5%)	35 (44.3%)	10 (12.7%)
Other	70	50 (71.4%)	15 (21.4%)	15 (21.4%)	37 (52.9%)	11 (15.7%)
No, I didn't have any chronic disease	5,832	4,603 (78.9%)	1,567 (26.9%)	1,503 (25.8%)	3,760 (64.5%)	1,312 (22.5%)

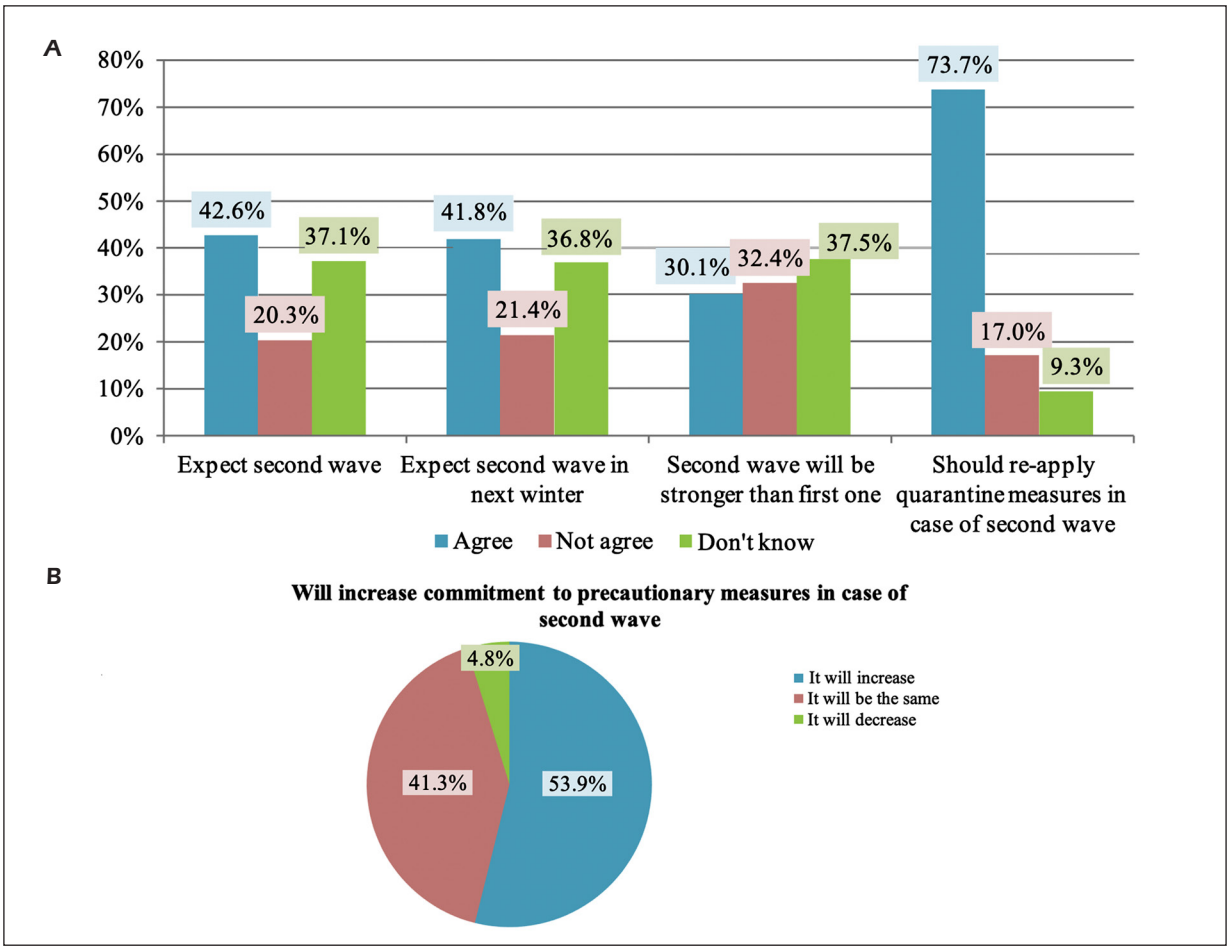

Figure 7. Expectation of second wave of coronavirus.

Healthcare Workers and COVID-19

There were 2,130 HCWs (29.6% of the sample). Concerning diagnosis with COVID-19, 317 HCWs stated that they had a history of COVID-19 infection; 192 of them mentioned that they got the virus from outside of their work environment. A total of 115 HCWs stated they got the virus from their work environment in the health sector (Figure 8). Regarding the severity of infection with COVID-19, 218 (68.8%) experienced mild symptoms, 68 (21.5%) reported moderate symptoms with the need to be hospitalized, and 31 (9.8%) reported severe disease and needed to be admitted to the intensive care unit (Figure 9).

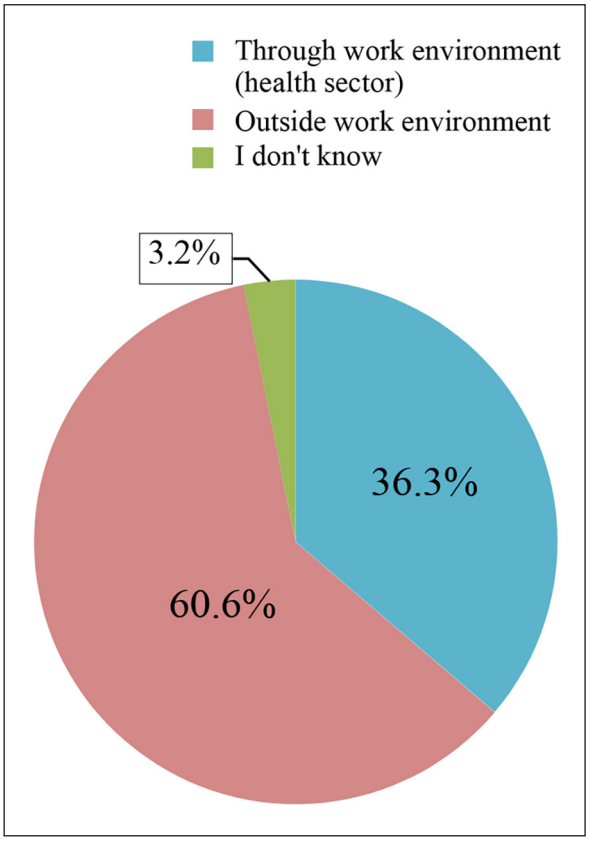

Figure 8. Source of infection of heath care workers.

Discussion

COVID-19 is an emerging infectious disease that creates a significant threat to public health. Therefore, the present study aimed at evaluating the degree of awareness and knowledge among the Saudi public about COVID-19 and to identify practices and attitudes taken towards the pandemic.

Our study found varying results for the KAAP levels. The mean level of knowledge about COVID-19 was 57.8%, which is not considered a very high level compared with the study conducted by Al-Hanawi et al[11], who stated that their participants achieved a high level of knowledge (mean of 81.64%). However, the knowledge section was subdivided into three categories in our study; the participants have shown a good level of knowledge regarding prevention measures with a mean of 78.3%. This can be explained by the massive efforts made by the Saudi government

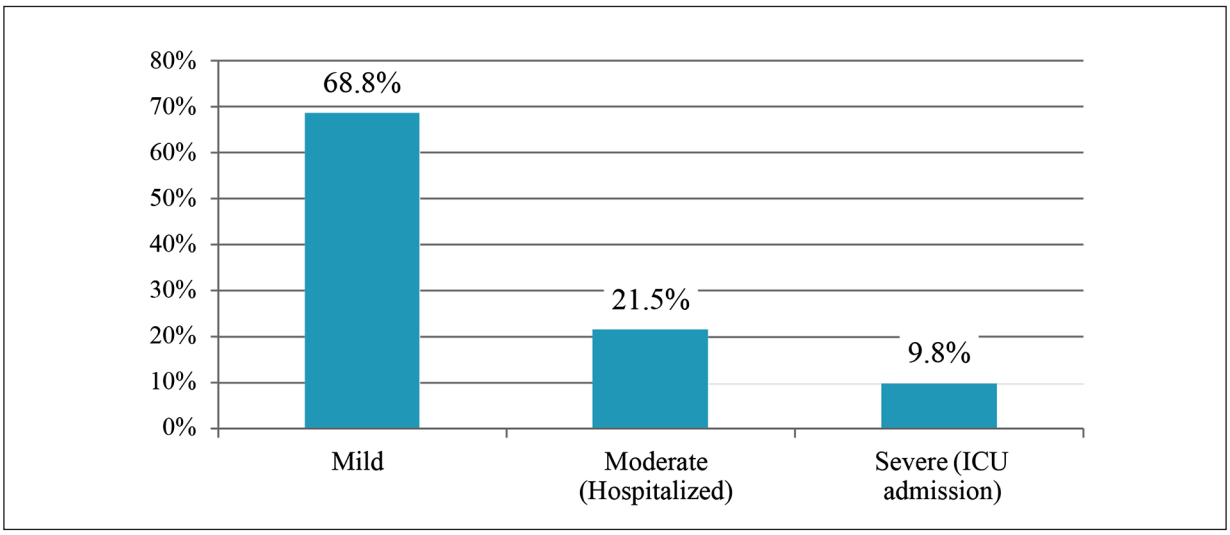

Figure 9. Severity of infection of heath care workers.

to increase the awareness of the public about precautionary measures. These efforts included disseminating information through many sources such as cellphone messages, social media advertisements, TV and radio coverage, teleconsultation through signs on the road, the Mawid App, and electronic screens in public places[15]. Meanwhile, there was an intermediate level of knowledge about symptoms and a low level of knowledge about complications, thus highlighting the need to continue and develop more campaigns to increase public knowledge about COVID-19 symptoms and complications.

Our study also tried to identify what the public had the greatest knowledge about along with aspects that they did not know well. This research may assist MOH campaigns to improve public knowledge of COVID-19. As we mentioned above, the participants were knowledgeable about prevention measures: wearing masks, and avoiding crowded places were known by 88.5%, and 83.6% of participants, respectively.

Regarding the knowledge of symptoms, the participants were very knowledgeable about influenza-like symptoms and loss of smell (81.9% and 77.5% of participants, respectively). However, most did not know that COVID-19 can cause vomiting, epileptic seizures, or skin rash (13.6%, 2%, and 3.6%, respectively). These results are consistent with the findings of a study done in Riyadh City by Alahdal et al[10], where only 4.6% of participants knew that skin rash could be a symptom of COVID-19 infection, and only 21.5% knew about the vomiting symptom. Regarding knowledge of complications, most participants did not know that COVID-19 can cause blood clots or secondary infections.

As for the rest of the KAAP levels, the participants had both good awareness and a positive attitude regarding the COVID-19 pandemic, with means 55.5% and 62.5%, respectively. Most of the respondents were aware of transmission *via* droplets, and that elderly and people with chronic diseases are more vulnerable to the virus. Less than half thought that the recovered patients had permanent immunity and would not be infected again. However, 33 recurrence cases were found at a single Brazilian healthcare center, which warns us against complacency among those who recover from the virus and prompts us to remain vigilant in the pursuit of protection *via* natural herd immunity[16]. Regarding practice, participants scored well (78%) in this category, which reflects the efforts of Saudi health authorities in providing education and outreach materials to boost the public's understanding of the disease and to influence behavioral changes[11]. Most of the respondents showed a good level of practice with 92.1% avoiding leaving the house when it is not necessary, 94.6% properly wore a mask in public places, and 90.3% regularly hand sanitized when outside the home. Adherence to these measures is possibly the most cost-effective method to control the spread of COVID-19 in communities[11,15].

Several of the population's socioeconomic characteristics were studied to gather information that could be used to map the awareness and impact of public health campaigns and to determine whether people's knowledge varied based on specific attributes of the target population. According to our study, age, education, income level, and place of residence were the most significant predictors of respondents' knowledge. As for the gender, there was no significant difference between the knowledge levels of males and females regarding COVID-19, which is contrary to studies[11,17] done in earlier phases of the outbreak in which women were more knowledgeable than men. This result reflects the fact that health education campaigns may have succeeded in targeting men, particularly to increasing their level of knowledge after poorer results in earlier studies. The highest knowledge levels were observed among elderly people which can be explained by the fact that they are more vulnerable to COVID-19 and other infections and health education interventions may have focused on them. Well-educated and persons with high income also showed higher levels of knowledge, consistent with other studies that explored this correlation[11,17]. Indeed, the direct link between a participant's educational level and their COVID-19 knowledge score is not unexpected; the more educated an individual is, the more knowledge they will pursue news about major diseases or events, and the better awareness they will have of the preventive measures proposed[18]. However, despite MOH's efforts in delivering educational information about COVID-19 in seven different languages across several platforms, individuals with lesser socioeconomic status might need alternative channels to obtain information about the risk and prevention of the virus[1].

Concerning practices towards COVID-19, females were a little more adherent to the precautionary measures than males in our study, which is consistent with results of earlier studies[10,17,19]

conducted in Saudi Arabia. A possible reason is distinct activities related to gender in family roles and professions. Other predictors of practice were age and educational level. Postgraduates showed the highest mean score of practice (79.9%) which agrees with what was mentioned above: the more educated a person is, the more they will seek knowledge and the more they will pursue good practices. In addition, elderly people tended to maintain better practices resulting from their worry about their susceptibility to developing a serious life-threatening disease.

Globally, countries are putting massive effort and resources into developing vaccines to combat COVID-19. High vaccine uptake rates amongst the population and sufficient vaccine coverage are the main factors that will guide the success of immunization against COVID-19. Skepticism and uncertainties have been documented in recent studies[20] regarding the vaccine of COVID-19, due to the mistrust of authorities and the spreading of wrong information or fake news *via* social media. Our study evaluated participants' attitudes towards the COVID-19 vaccine and tried to understand the factors that influence one's intention to take the vaccine; 77.9% of respondents agreed on the need for a vaccine for COVID-19. However, the perceived or actual efficacy dramatically affected the uptake and acceptance of the vaccine. For example, 4,589 (63.8%) agreed on taking the vaccine if it was approved to be 95% effective, while only 1579 (22.0%) agreed on taking the vaccine if it was approved to be 50% effective. Fortunately, emerging data on vaccines of COVID-19 show that the vaccines are highly effective and very safe, at least against some of the variants[20]. One significant predictor of willingness to take the vaccine was having chronic diseases (rho=0.098, $p<0.001$). Those with chronic renal failure and cardiovascular diseases had the highest rates of acceptability to take the vaccine if it had a 95% efficacy (73% and 70.3%, respectively). Other predictors of acceptability rates were gender, age, residence, and income level. Males agreed more than females on the need for a vaccine and expressed their intention to take the vaccine if it was 95% effective. This finding was consistent with a recent study[20], where males had more intention to get vaccinated.

Emerging evidence suggests that men are dying in greater numbers from COVID-19 than females because of high smoking rates, high reluctance to pursue health care, and sex-based biological differences[20]. Respondents with a monthly income level lower than 5,000 SR agreed that they need the vaccine more than other income levels. Participants aged 18-28 years agreed more frequently than other age groups on the importance of the vaccine. One reason for this may be that younger people always have the potential to take more risks than older people. Southern and northern regions' respondents agreed that they need the vaccine more than other regions (84.8% and 82.1%, respectively), which agrees with the findings of Alfageeh et al[20], where participants from the southern region had the strongest intention to be vaccinated.

A second wave of the COVID-19 poses an imminent threat to society, with a destructive impact on economics and an enormous loss of human lives. A century ago, the Spanish flu devastated populations worldwide, and its second wave in 1918 killed substantially more people than the first wave. As a result, the main objective of all countries should be preparing well to tackle the second wave.

Concerning Saudi Arabia, since the first confirmed case of COVID-19 reported on 2 March 2020, strict policies have been enforced to tackle the spread of the virus. Moreover, a second COVID-19 wave is a concern in Saudi Arabia, particularly because most countries that reopened their international flights are suffering from the second wave[21]. Therefore, our study aimed at assessing the attitude of participants regarding a potential second wave; 42.6% of respondents expected a second wave of coronavirus, and only 30.1% thought that if there was a second wave it would be stronger than the first. These rates reflect a low awareness about pandemics among participants. Previous pandemics tended to have more than one wave; for example, the Spanish flu had three waves and the second and third waves had higher mortality rates than the first[22].

Regardless, in the case of a second wave, 73.7% of respondents thought it would be more appropriate to re-apply quarantine measures (Figure 7a). Moreover, only 4.8% mentioned that their commitment to the general precautionary measures would decrease (Figure 7b). Although most people intended to increase their adherence to preventive measures in case of a second wave, our finding is not surprising because of the long period of this pandemic and the difficulty in maintaining the same high level of adherence. We identified several factors that were associated with attitudes towards a second wave of the pan-

demic. Males and 18-28 years-old were more expectant of a second wave than females and those in other age groups.

HCWs stand at the frontier for fighting the COVID-19 pandemic. This puts them at higher risk of catching the virus than other people in the community. The evidence on COVID-19 infection amongst HCWs is increasing, and numerous studies have estimated the SARS-CoV-2 seroprevalence amongst their HCWs. Those studies' results show that 1.7-11% of HCWs were seropositive[23]. In our survey, 29.6% of the total sample were HCWs. 14.9% of them stated that they had COVID-19 infection, in agreement with the rates found in previous studies[23]. However, to our knowledge, no studies in Saudi Arabia have discussed the severity of infection among HCWs. Therefore, we collected information about this matter, and the results showed that most of the infected respondents had mild-to-moderate disease, with only 9.8% having severe disease. This is consistent with a recent study done in Oman where most HCWs suffered from a mild COVID-19 infection, and only one HCW needed hospitalization for moderate pneumonia[24].

HCWs are one of the groups at highest risk of catching the virus during the pandemic of COVID-19. Thus, infection status analysis of HCWs is essential to uphold enough attention from the public, provide suggestions that are effective for government agencies, and expand protective measures to reduce infection rates[23].

A strength of our study is that it has addressed multiple outcomes, including KAAP towards COVID-19, attitudes towards vaccination and the second wave of the pandemic, and COVID-19 infection among HCWs. The government and other health associations can use the data collected in our study to enhance precautionary measurements in preparation for future waves of the COVID-19 pandemic.

Limitations

However, the study was limited by several factors. Data used in the analysis of this study were self-reported, therefore reporting bias might have occurred. Furthermore, there were fewer males than females among the participants, and those from the central regions were much more than from other regions. Even though the authors tried to equally distribute the survey through their professional and personal channels of social networks, another limitation is no implication of causality, given that it is a cross-sectional study.

Conclusions

COVID-19 is a massive health challenge worldwide. Public knowledge about the infection and adherence to preventive measures is the most vital strategy to confront this pandemic. Our study evaluated the knowledge, awareness, and practices of the general population in Saudi Arabia, and it demonstrated a satisfactory knowledge level and a good application of practices among the participants. Moreover, demographic characteristics such as educational level, gender, and age were significantly associated with improved knowledge and practices. Our study also showed a positive attitude towards the COVID-19 vaccine with a moderate level of expectation regarding a second wave. Continuous monitoring of KAAP levels is mandatory for countries like Saudi Arabia in order to be fully prepared against any future waves of COVID-19, and more information about the acceptability of vaccines among the Saudi Arabia population is needed in order to design more effective public health awareness campaigns.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Acknowledgements

We thank the following people for helping us with data collection: Abdulwahab Abdullah Alshahrani, Fahad Khaleel Alzahrani, Meshal Fahad Alaqidi, Mohammed Abdullah Alqarni, Naif Abdulrahman Alotaibi, Nwaf Abdullatif Al watban, Lama Fahad Bin Salamh, Abdulaziz Assaf Alassaf, Khalid Mohammed Alkwai, Ibrahim Mohammed Alotaibi, Reema Abdullah Almasad, Abdulaziz Mohammed Alsubaie, Abdulrhman Mamdooh Mokhtar, Renad Musaed Al-Hussein, Ghadah Fahad Alshalan, Mais Abdullah Alajami, Reema Wajeeh Aldekhail, Abdulaziz Mohammed Alothman, Rahaf Abdullah Alamri, Reema Adel Alrashedi, Yahya Ali Al Ghamdi, Bader Hammad Alharbi, Nuha Abdulrahman Alkudsi, Ahmed Tawfik Khoja, Ibrahim Mohammed Al-Hazza, Hamad Othman Aljubayr, Nawaf Hamad Alzaben, Tarfah Wafi Hamad Alkaltham, Ziyad Musa Alzammam, Laith Ahmed AlReshaid, and Samu Abdulrahman Alzeer.

Ethical Approval

Ethical approval was obtained on 22 November 2020 from Institutional Review Board at King Saud University College of Medicine (Ref. No. 20/0853/IRB).

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