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Knowledge, attitudes and practices among people in Saudi Arabia regarding COVID-19: A cross-sectional study

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Abstract

Background: The general population's compliance with preventive measures and legislation is mainly influenced by their knowledge level, attitude, and practices. This study assessed the knowledge, attitude, and practices of public residents towards corona virus disease-2019 preventive measures in Saudi Arabia.

Design and Methods: This is a cross-sectional study; it used a validated cross-sectional online survey that received responses from 13 Saudi administrative regions.

Results: There were 1513 participants who completed the study (55% females; 77.7%, university education). Knowledge level, attitude, and practices towards corona virus disease-2019 were 81.3%, 86.6%, and 81.9%, respectively. The knowledge subscales showed that 1496 (98.9%) participants knew the system targeted by the virus, 96.2% and 97.3% knew the causative agent and symptoms, 783 (52.2%) participants knew the transmission modes, and 696 (46.0%) participants knew about the complications. The attitude subscales included 1465 (96.5%) participants who had dealt with an infected person, 1451 (95.9%) participants who isolated in a health facility, 1195 (97.0%) participants who knew about hand washing, and 1387 (91.7%) participants who thought the virus spread through home delivery. The practice subscales included 1505 (99.5%) participants who properly disposed of gloves and tissues and 1347 (89.0%) participants who reported safe practices when coughing or sneezing.

Conclusions: This study showed satisfactory knowledge, attitude, and practice towards corona virus disease-2019 in Saudi Arabia. The educational level is a dominant influencing factor for knowledge, attitude, and practice.

Introduction

In 2020, the World Health Organisation (WHO) stated that a new coronavirus strain had been identified in Wuhan City, China, and it was recognised as a novel coronavirus that caused new types of respiratory infections.[1,2] The disease was later called the Coronavirus Disease 2019 (COVID-19).[3,4] Coronavirus family strains can cause diseases that are known as respiratory infections including the common cold and up to serious infections such as Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome (SAR-COV). The most recently discovered viruses that causes coronavirus are RAR-COV2 and COVID-19. This virus may remain on surfaces for a few hours or up to many days; this varies according to different conditions based on types of surfaces, temperatures, and humidity levels.[3,5] COVID-19 viruses lead to severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which is highly contagious.[6] In response to COVID-19, the WHO described COVID-19 as a pandemic.[7]

The causative agent in COVID-19 is mainly transmitted through respiratory droplets from infected people; by contact with contaminated surfaces; through healthcare-associated exposure among those who provide direct care for COVID-19 patients, work together, share the same environments, are transported along with others who have COVID-19, and are involved with patients in any kind of transportation; and by people who live in the same houses as COVID-19 patients. A confirmed COVID-19 case is defined as a suspected case with laboratory confirmation of COVID-19 infection.[7,8]

Important knowledge gaps exist such as pre-symptomatic and asymptomatic transmission, the effects of COVID-19 transmission on different age groups, conditions leading to super-spreading events, epidemiological time delays (onset to illness, to case detection delays or to hospitalisation), environmental conditions related to increased transmission (temperature, humidity, and seasonality), the spectrum of clinical complications, the clinical manifestations of slight to severe disease, the severity that is mediated by demographic factors (gender, age, or other groupings), groups that are at high risk of severe infection, social distancing measures, the effectiveness of international travel in slowing the spread, and community mitigation measures to reduce local disease transmission. The application of precautionary and preventive measures in the Kingdom of Saudi Arabia has successfully controlled the spread, reduced the emergence of new cases, and improved recovery rates compared to other regions and countries.[9,10]

Significance for public health

COVID-19 pandemic posed a new lifestyle of population in many countries, the variation depends on the level of communities' knowledge, attitude and practice. Assessing public knowledge, attitude and practices helps the health authorities in each country to find out the gap for health education efforts. Subsequently, the ministry of health will prioritize the actions needed accordingly. The current study identifies the general people knowledge, attitude and practice on COVID-19 in Saudi Arabia.

In Saudi Arabia, the Ministry of Health (MOH) has set out specific measures to prevent and mitigate the COVID-19 transmission such as lockdown of cities, restrictions of both domestic and international travel, physical distancing, using protective medical or fabric masks, hand washing, and limits on the size of gatherings.[10-12] The COVID-19 pandemic is a significant recent global crisis that has had devastating effects on all societies worldwide, leading to a large number of cases and deaths within a short period of time. The major challenges in this pandemic are largely related to matters concerning behaviour and lifestyle of people as well as managing health services to combat disease spread. However, the sustainability of such success requires combined efforts, and the public must be attentive and immediately change attitudes and practices to be aligned with the health authorities' effort.[13,14]

Therefore, this study aims to obtain useful information about knowledge levels, attitudes, and practices (KAP) towards COVID-19 in the general population.

Design and Methods

This was a community-based cross-sectional survey that was conducted from 24 April to 27 May 2020 after a full day curfew and lockdown were imposed across the Kingdom to combat COVID-19. This survey aimed to study the knowledge, attitude, and practices of the participants towards COVID-19 preventive and precautionary measures in relation to containment of the pandemic in the Kingdom of Saudi Arabia by determining the participants' socio-demographic characteristics, measuring participants' knowledge about major facts concerning the virus, determining participants' practices to prevent the spread of the infection, and measuring the response rate and participants' level of adherence to MOH preventive and precaution measures.

All citizens and residents living in Saudi Arabia who were 18 years of age or older were invited to respond to the online questionnaire, which was distributed through social media (Twitter and WhatsApp groups).

CDC/US EPI IFO ver. 7-STATISTICAL (CDC, Atlanta, 2020)[14] was used to calculate the sample size using the total population of 48 million including all residences. The expected frequency was 50, confidence interval was 99.99%, marginal error was 5%, and the sample was 1513 participants. All provided data were entered to the software which automatically calculated the sample size to be 1513.

Informed consent for participation was obtained using the interface of the online questionnaire *via* a statement that informed the respondents that their response assumed that they provided informed consent. To ensure data confidentiality, no personal identifiers were collected.

Eighty-three questionnaire items were developed by the researchers using Google Forms. The online questionnaire consisted of four sections and 83 items overall. The first section contained assessed the sociodemographic demographic characteristics of respondents, including gender, age, occupation, marital status, nationality, educational level, and province of residence. The second section consisted of 9 items that assessed the participants' knowledge of COVID-19. The third section included respondents' attitudes related to COVID-19. The fourth section focused on participants' practices and behaviour toward COVID-19. The questionnaire was piloted among 30 participants from the target population to assess the validity of the questionnaire and to ensure that the questions were understandable. The pilot study responses were excluded from the main analysis.

The study was approved by the King Khalid University Research Ethics Committee. Consent for participation was provided by completion and submission of the questionnaire.

The data was collected by the developed Google form online questionnaire which sent to the public by social media using WhatsApp, Twitter, Facebook.

SPSS ver. 22 was used for data analysis and presentation. For statistical testing, the frequency and percentage were applied while a *t*-test and one-way ANOVA were used to test for statistical significance, and the percentage was used to test for statistical significance between study variables; $p>0.05$ was considered to be statistically significant. In addition, the regression tests were used to test the relationship between the knowledge level, attitude, and practice and their relationship to demographic variables.

Results

The study included 1513 participants who completed the questionnaire. Socioeconomic characteristics of the participants are shown in Table 1. Over half the population was female (833, 55%), most respondents (1249, 82.5%) were between 18 and 50 years of age, and there were 42 (2%) of participants who were over 60 years of age. Most participants (1261, 83%) were of Saudi ethnicity and 1112 (73.5%) of them were married. Overall, literacy was a dominant feature, with two-thirds (993, 65.6%) who were graduates and 183 (12.1%) who were postgraduates.

Table 1. Demographic characteristics of the participants (n=1513).

Age group	Frequencies	Percentage
<18 years old	51	3.4%
From 18-40 years old	795	52.5%
From 41-50 years old	454	30%
From 51 to 60 years old	171	11.3%
>60 years old	42	2.8%
Nationality		
Saudi	1261	83.3%
Non-Saudi	252	16.7%
Occupation		
Students	203	13.4%
Governmental employee	758	50.1%
Private employee	179	11.8%
Labour	28	1.9%
Other	345	22.8%
Marital status		
Married	1112	73.5%
Unmarried	401	26.5%
Education level		
Primary	20	1.3%
Secondary	317	21.0%
University	993	65.6%
Postgraduate	183	12.1%
Gender		
Male	681	45%
Female	833	55%

Figure 1 shows the distribution of participants according to administrative regions, as follows: 44% from Mecca, 9% from the Eastern province, 2% from Al-jouf, 1% from the Northern border, 1% from the Riyadh region, 2% from the Qassim region, 1% from the Tabouk region, 3% from the Jazan region, 22% from the Asser region, and 2% from the Najran region.

Participants' knowledge levels, attitude, and practices regarding COVID-19 are shown in Figure 2. The rate of sound knowledge was 81.3% and the rate of a positive attitude was 86.6%, and preventive practices were reported among 81.9% of participants.

Table 2 presents participants' responses about knowledge on the major epidemiological features of the virus. Most (n=1496; 98.9%) knew that the respiratory system is targeted most frequently by the virus, and they properly identified the causative agent and symptoms (96.2%, 97.3%, respectively). Additionally, 1501 (99.2%) of them knew that the disease is highly contagious, and

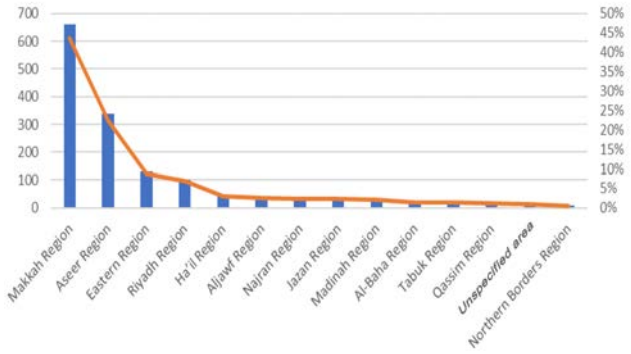
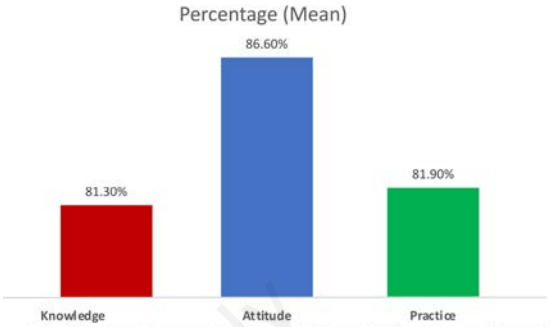


Figure 1. Regions of participants (n=1513).



Variable	Percentage (mean)	Minimum	Maximum	SD
Knowledge	81.3%	25.00	100.00	12.90
Attitude	86.6%	30.00	100.00	16.50
Practice	81.90%	60.00	100.00	16.32

Figure 2. Levels of knowledge, attitude, and practices on COVID-19 of participants (n=1513).

Table 2. Responses to study questions - Level of knowledge (n=1513).

What are the body systems targeted by the disease	Frequencies	Percentage
Respiratory system	1496	98.9%
Digestive system	10	0.7%
Nervous system	7	0.5%
What is the cause of COVID-19?		
Viral	1456	96.2%
Bacterial	40	2.6%
Parasite	17	1.1%
Do you know the symptoms of COVID-19?		
Yes	1472	97.3%
No	41	2.7%
What are the symptoms of COVID-19?		
Correct	1387	91.6%
Not correct	120	7.9%
Is emerging COVID-19 contagious?		
No	12	0.8%
Yes	1501	99.2%
If yes, specify how the disease is transmitted (n=1501)		
Correct	783	52.2%
Not correct	718	47.8%
What are the complications of COVID-19?		
Correct	696	46.0%
Not correct	817	54.0%
What are the preventive measures against COVID-19?		
Correct	1197	79.1
Not correct	316	20.9

Knowledge level	Percentage (mean)	Minimum	Maximum	SD
	81.3%	25.00	100.00	12.90

696 (46.0%) participants reported correct knowledge of the complications. Moreover, 783 (52.2%) participants knew all the proper modes of virus transmission, and 1197 (79.1%) participants mentioned that the disease is preventable.

Table 3 shows the participants' attitudes on different issues related to COVID-19. Most (n=1457; 96.3%) participants believed that they are susceptible to the infection, while 1465 (96.5%) showed positive attitudes if any of their family members were infected, 1451 (95.9%) reported positive attitudes towards isolation in health facility when infection was confirmed, 1195 (97.0%) believed that hand washing with water and soap for 40 s is significant for preventing transmission, and 1387 (91.7%) believed that home delivery providers can contribute to the spread of the virus. Table 4 shows the practises and/or behaviour of participants towards adherence, compliance, and responses to preventive and precaution measures. The participants' scores were as follows: 1505 (99.5%) participants properly disposed of the used gloves and tissues, and 1347 (89.0%) participants recorded safe practices when coughing or sneezing if they were not wearing a mask or using a tissue.

Compliance with and adherence to staying at home was mentioned by most of the participants (1383, 91.4%). The correct responses of participants in dealing with the health messages delivered by MOH through the different social media channels were mentioned by 973 (64.3%) participants. Near two-thirds of the participants (984, 65.0%) reported safe practices in the case of early onset COVID-19 signs and symptoms. More than three-quarters of the participants (1180, 78%) mentioned that they will continue to adhere to preventive health practices after the end of the coronavirus pandemic.

Table 5 cross-tabulated the demographic independent variables with the mean dependable variables of knowledge, attitude, and practices related to COVID-19 to test their level of association using a 5% significance level.

Across age categories, there was a statistically significant difference in knowledge scores (p=0.02) and there was no significant difference in attitudes and practices scores (p=0.1, p=0.08, respectively). According to nationality, statistics revealed a very strong relationship with knowledge scores (p=0.001) and a statistical difference compared with the attitude items (p=0.02), although this non-significant correlation was interpreted between this undependable variable and the variables related to practices (p=0.5). Similarly, a high significance was shown for the occupational status of respondents and knowledge items (p=0.001) and a non-significant relationship was shown for attitude and practices (p=0.08, p=0.1, respectively).

Across marital status, there was a strong correlation with knowledge scores (p=0.001) and there was no significant difference in attitudes and practices scores (p=0.1, p=0.5, respectively). A strong significant difference was found with participants' educational status for all the KAP variables (p= 0.001, p=0.03, p=0.003, respectively).

With respect to gender distribution, there were slight significant differences with knowledge scores (p=0.04) and non-significant differences with the attitude and practice variables (p=0.1). Between regions, knowledge and practice scores were not significantly different (p=0.1, p=0.3), but the significance was strong for attitude (p=0.001). Table 6 shows the multivariate regression results for knowledge, attitude, and practice-related factors for COVID-19; β represents the average change in the dependent vari-

Table 3. Responses to study questions - Level of attitude (n=1513).

Attitudes	Frequencies	Percentage
Do you think you are susceptible to infection with COVID-19?		
Yes	1457	96.3%
No	56	3.7%
Do you feel anxious if you or any of your family members have contracted COVID-19?		
Yes	1460	96.5%
No	53	3.5%
If you are infected with COVID-19, do you accept isolation in health facility?		
Yes	1451	95.9%
No	62	4.1%
In what cases do you have to wash hands with soap and water?		
Appropriate attitude	1195	79.0%
Inappropriate attitude	318	21.0%
To prevent COVID-19, hands should be washed with water and soap every		
Appropriate attitude	991	65.5%
Inappropriate attitude	522	34.5%
Do you think home delivery providers can contribute to		
Yes	1387	91.7%
No	126	8.3%
Do you think people recovering from coronavirus (COVID-19) could be transferred		
Yes	516	34.1%
No	997	65.9%

Attitude	Percentage (mean)	Minimum	Maximum	SD
	86.6%	30.00	100.00	16.50

able (knowledge, attitude, or practice) for one change in the demographic variable, while f represents the standard error associated with this change.

Discussions

The COVID-19 pandemic is a global crisis that has had devastating effects on all countries worldwide, and there have been a huge number of cases and deaths within short period of time. The major challenges related to fighting this pandemic are largely related to matters concerning the behaviour and lifestyle that people have for combatting the disease spread. In the absence of a vaccine and prompt treatment, the public's compliance with preventive measures and legislation is required to contain or reduce the burden of the COVID-19 pandemic. This was found to be strongly linked to people's knowledge, attitudes, and practices.[15-20] Similarly, this study revealed that the general population's knowledge towards COVID-19 improves their attitude, and the attitude level then leads to proper implementation of practice.

The present study showed satisfactory knowledge levels towards COVID-19, and the greater frequency of correct answers regarding knowledge about COVID-19 was almost satisfactory. These findings are consistent with those of other studies that were conducted in the Kingdom of Saudi Arabia.[6,16] One study conducted in Saudi Arabia by Al-Hanawi *et al*. reported that the overall accuracy rate for the knowledge test was 81.64%,[16] which is similar to our findings. The findings of this study were also consistent with another study that was conducted by Azlan *et al.* in Malaysia, which showed that overall public knowledge was 80.5%.[21,22] However, a multinational study that was conducted in the three Middle East countries of Saudi Arabia, Kuwait, and Jordan and that enrolled 1,208 participants revealed that the overall knowledge score among the three countries was 66.1%. The highest score was among Jordanians (70.3%), while the level of public knowledge in Saudi Arabia was less than 70.3%;[15,20] compared to our study findings, the public level of knowledge in our study was higher (81.3%), and this may be attributed to later intense cam-

Table 4. Responses to study questions - Level of practice (n=1513).

How to get rid of used gloves and tissues	Frequencies	Percentage
Correct	1505	99.5%
Not correct	8	.5%
How to behave when coughing or sneezing in the absence of a tissue		
Correct	1347	89.0%
Not correct	166	11.0%
Do you stay at home after health measures?		
Correct	1383	91.4%
Not correct	130	8.6%
How to deal with messages that contain information about the disease in general		
Correct	973	64.3%
Not correct	540	35.7%
If you complain of a high fever, cough, shortness of breath - what are you going to do?		
Correct	984	65.0%
Not correct	529	35.0%
What is the distance that you must leave between you and others to prevent COVID-19		
Correct	951	62.8%
Not correct	562	37.2%
Will you continue in preventive health practices after the end of the Corona pandemic?		
Maybe	301	20%
No	33	2%
Yes	1180	78%
What are the preventive measures that you will take care of after health emergency?		
Complete correct answers	1130	74.7%
Incomplete or incorrect answers	383	25.3%
In the event of complacency or indulgence in prevention and not to maintain the spacing		
Corona virus disappeared	61	4%
The virus spread further	1452	96%
How to receive food orders in a safe way		
Complete correct answers	1396	92.3%
Incomplete or incorrect answers	117	7.7%

Practice	Percentage (mean)	Minimum	Maximum	SD
	81.90%	60.00	100.00	16.32

paigns to raise awareness that were launched by the Saudi MOH through its effective wide-scale communication networks and effective health system.

The knowledge level subscales in the current study also showed high scores towards the causative agent and the clinical symptoms of the disease (96.2% and 91.6%, respectively). However, only half of the participants knew the correct viral route of transmission. There was only a small percentage of participants who seemed to be unaware of disease complications, and they were only slightly aware of how the virus was transmitted. This is similar to a previous study that was conducted in three countries including Saudi Arabia, which revealed the lowest public knowledge regarding transmission (43.3%).[15] A similar proportion (91.5%) had correct knowledge regarding clinical symptoms of the disease, and distinctly poor knowledge (43.3%) concerning the possible viral route of transmission was also reported in the same study that was conducted in three countries in the Middle East.[23]

In our study and a Malaysian study, subjects over the age of 50

Table 5. Comparison of demographic variables, and the mean of knowledge, attitude, and practice on COVID-19 (n=1513).

Variable	Frequence	%	Knowledge			Attitude			Practice		
Age group			**Mean**	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**
<18 years old	51	3.4%	77.4	14.4	0.02*	89.4	15.6	0.1	76.8	16.2	0.08
18-40 years old	795	52.5%	81.2	12.6		86.7	16.7		82.1	16.4	
41-50 years old	454	30%	81.9	12.7		87.1	15.0		81.2	16.2	
51-60 years old	171	11.3%	82.6	13.2		85.5	18.2		83.8	16.3	
>60 years old	42	2.8%	77.38	15.2		81.4	19.9		81.4	15.6	
Nationality											
Saudi	1261	83.3%	80.7	12.9	0.001*	86.2	16.6	0.02*	81.9	16.2	0.5
Non-Saudi	252	16.7%	84.1	12.4		88.8	15.3		81.3	16.5	
Occupation											
Students	203	13.4%	77.70	12.0	0.001*	84.6	19.0	0.08	79.6	15.9	0.1
Governmental Employee	758	50.1%	82.68	12.6		86.9	15.9		81.9	15.9	
Private Employee	179	11.8%	83.24	12.7		88.9	14.5		83.6	15.6	
Labour	345	22.8%	81.69	13.3		88.5	14.8		81.4	17.9	
Other	28	1.9%	79.52	13.4		85.7	16.9		81.9	17.4	
Marital status											
Married	1112	73.5%	82.0	12.6	0.001*	87.0	16.1	0.1	82.0	16.5	0.5
Unmarried	401	26.5%	79.5	13.5		85.5	17.6		81.4	15.8	
Education level											
Primary	20	1.3%	67.5	13.0	0.001*	78.0	12.8	0.03*	70.0	22.0	0.003*
Secondary	317	21.0%	78.78	13.3		85.8	16.5		80.8	16.2	
University	993	65.6%	81.7	12.6		86.6	16.7		82.5	16.2	
Postgraduate	183	12.1%	84.9	11.8		88.6	15.1		81.2	15.7	
Gender											
Male	681	45%	82.4	12.8	0.04*	87.3	17.6	0.1	82.6	16.2	0.1
Female	833	55%	80.5	12.9		86.1	15.5		81.2	16.4	
Region of stay											
Aseer Region	339	22.4%	80.78	13.2	0.1	86.5	18.1	0.001*	83.6	16.2	0.3
Makkah Region	662	43.8%	81.19	13.1		84.5	16.8		80.6	16.7	
Eastern Region	131	8.7%	82.34	12.7		90.5	12.7		82.4	15.6	
Aljouf Region	39	2.6%	83.65	11.1		92.3	10.8		80.5	15.5	
Qassim Region	19	1.3%	76.31	15.5		82.1	22.0		77.8	16.1	
Madinah Region	32	2.1%	84.76	12.1		87.5	16.6		85.6	12.6	
Tabuk Region	21	1.4%	79.16	13.8		97.1	7.17		80.9	23.2	
Jazan Region	36	2.4%	81.94	12.8		92.2	11.9		84.4	15.2	
Riyadh Region	103	6.8%	83.00	10.4		86.7	17.1		81.5	16.0	
Hail Region	47	3.1%	82.71	11.8		88.5	16.0		83.8	14.8	
Al-Baha Region	23	1.5%	79.89	13.4		90.4	13.3		80.8	12.7	
Najran Region	37	2.4%	76.35	12.0		88.6	10.0		81.6	16.5	
North Borders Region	9	.6%	86.11	9.77		97.7	6.66		77.7	18.5	
Unspecified area	15	1.0%	82.50	12.3		84.0	13.5		86.6	14.4	

*<0.05 level of significance

years had higher knowledge scores, which possibly resulted from a higher risk perception of contracting COVID-19 and complications of the disease.[23-25] A Chinese study also reported surprisingly high COVID-19 knowledge in an epidemiological survey in the early stages of the epidemic, and these authors suggested that it was because the study participants had higher academic degrees,[26] which was similar to our findings. In the present work, respondents were educated from the secondary level to the post graduate level. A study performed to assess knowledge and perceptions about COVID-19 among healthcare workers reported that the awareness varied based on the category of healthcare worker, and there was also insufficient knowledge of participants, but they have a positive attitude.[27]

The present study showed satisfactory attitudes towards COVID-19. This finding was consistent with other previous studies that were conducted in Saudi Arabia by Al-Hanawi *et al.* who reported that the overall attitudes were satisfactory.[16] The present study showed satisfactory positive attitudes in the main matters related to COVID-19 because most (96.3%) believed that they were at risk of catching the infection and 95.9% would respond positively to isolation in a health facility if they were diagnosed with or had a suspected or confirmed case of COVID-19. Similar findings were reported by Al-Hanawi. In another study that enrolled students and staff from Alghad Private College in Jeddah, Saudi Arabia, more than 90% of participants exhibited a positive attitude toward COVID-19.[28] The attitude scores were significantly correlated with some demographic variables including nationality and education level (p=0.02 and p=0.03, respectively). However, a satisfactory or good level of knowledge related to the virus does not necessarily lead to a high level of positive attitudes that are consistent with participants' knowledge. In contrast to our findings, a study conducted by Haque *et al.* in Bangladesh reported that half of the participants had good knowledge, while their attitude and practices towards COVID-19 during the pandemic were not impressive.[29] Additionally, the knowledge level does not necessarily end up with a high level of negative attitudes. This was observed in a Chinese study in which the level of participants' COVID-19 knowledge was reported to be low compared to a high positive attitude, and the authors attributed this positive attitude to the drastic measures that were implemented by the Chinese government to mitigate the spread of the virus.[26] In our study, the participants had a positive attitude towards COVID-19 pandemic prevention and control. The perception of infection susceptibility for a person and their family was higher and preventative measures such as hand-washing were correctly reported by most participants. Noticeable positive attitudes were also found in the KAP study that was conducted in China.[17,26] Studies have shown that improved knowledge can affect adverse attitudes and behaviours and thereby suppress the epidemic.[19,30] In Ethiopia, one study revealed that poor knowledge and misconceptions worsened the conditions during the Ebola virus outbreak in 2015.[31] Roy *et al.* observed moderate awareness with adequately informed preventive measures for COVID-19 in the participants.[27]

The present study showed that the practices toward COVID-19 were good. This finding was consistent with similar KAPs in a COVID-19 study that was conducted in Saudi Arabia by Al-Hanawi *et al*., which reported that the participants' score for practices concerning COVID-19 was 4.34 out of 5 (SD 0.87; range 0-5); this indicated good practices.[16] Theoretically, participants' attitude and practices towards COVID-19 are supposed to be linearly correlated with the education attained. For a study of general KAP outcomes (81.3%, 86.6%, and 81.9%, respectively), the present study realised this theoretical assumption. The statistical analysis that was performed including linear regression supported this assumption because the relationship between the participants' educational level and their corresponding KAPs for COVID-19 as dependent variables were mainly significant (p=0.001, p=0.03, p=0.003, respectively).

The highest practice subscales that were reported by the study were covering the nose and mouth while coughing or sneezing, staying at home, and maintaining the advisable social distance. This was interpreted as highly significant with educational levels and non-significant with the other demographic variables. Similar observations were reported in the multinational Middle East study in which 94% of participants avoided crowded places and 88% of participants avoided shaking hands.[23] These findings are similar to the findings of another study conducted by Zhong *et al.* (2020) in China in which 96.4% of participants avoided crowded areas and 98.0% used masks outside their homes during the COVID-19 outbreak.[26]

However, this study is not the first study that was conducted in the Kingdom, and it is considered to represent ongoing monitoring of the pandemic situation. It shows the progression in the knowledge level, attitude, and practices compared to previous published works, and thus, it provides profile data for later meta-analysis inquires. The improvement in KAP levels that was revealed by this study is reflected in the control of the reported daily cases, even after removing lockdown measures within cities and allowing travel between cities. This may have occurred because the population became aware of COVID-19 prevention measures. In addition, the outcomes of this study are promising for sound planning of health education and promotion programs that are targeted toward COVID-19 containment strategies.

The limitations of this study include that it is confined to the people using smartphones, e-mail IDs and most of the respondents were educated, therefore the responses perhaps not common in all population including uneducated people. The knowledge, attitude, and practice may differ in uneducated people from the findings of our study. Another restriction is method of data collection in the critical time amid lockdown, using an online questionnaire may

Table 6. Regression of knowledge, attitude, and practice related factors to COVID-19 (n=1513).

Variable	Knowledge β (SE)	Attitude β(SE)	Practice β(SE)
Age group			
< 18 years old	0.026 (0.395)*	-0.046 (0.505)*	0.029 (0.500)*
Nationality			
Saudi	0.096 (0.887)	0.059 (1.137)	-0.014 (1.127)*
Occupation			
Students	-0.007 (.862)*	0.014 (0.407)*	0.032 (0.403)*
Marital status			
Married	-0.085 (1.004)	-0.042 (0.961)*	-0.017 (0.951)*
Education level			
Primary	0.171 (0.538)	0.063 (0.696)	0.044 (0.689)*
Gender			
Male	-0.074 (1.083)	-0.039 (0.852)*	-0.039 (0.843)*
Region of stay			
Aseer Region	0.012 (0.101)*	0.075 (0.129)	0.010 (0.127)*
Knowledge to attitude			
		0.132 (0.033)*	
Attitude to practice			
			0.045 (0.025)*

*p<0.05.

results the biased responses. The strengths of this study include that it is conducted during very critical period. The knowledge, attitude, and practice of general public were assessed together. Another strength is the sample size of 1513 people. However, the study contributes to the literature of a Saudi Arabia by conducting the in-depth survey of knowledge, awareness practical implementation to overcome the situation.

Conclusions

The current study assessed the knowledge, attitude, and practices of the general population, and it showed a satisfactory knowledge level, attitude, and practical implementation of practices to overcome the COVID-19 pandemic in Saudi Arabia. Additionally, demographic variables such as the educational level and age were significantly related to improved knowledge, attitudes, and practices in the population. Continuous monitoring of KAPs in the general population of Saudi Arabia improved over time because of the measures taken by government to generate awareness and the strict follow-up of preventive measures to improve the people's understanding of COVID-19.

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