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REVIEW

COVID-19 and Saudi Arabia: Awareness, Attitude, and Practice

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Abstract: The Severe Acute Respiratory Syndrome-CoronaVirus-2 (SARS-CoV-2) pandemic has transformed our appreciation of healthcare awareness worldwide. The amount of related data accumulated during this time has surpassed any other outbreak of a viral pathogen. Healthcare awareness is related to one of the nine pillars of the "World health organization (WHO) operational planning guidelines to support country preparedness and response". This review is structured around the awareness/knowledge, attitudes, and practices (KAP)-related publications in Saudi Arabia up to date to understand the impact of COVID-19 on these domains. The excellent communication effort response from governments, international, and individuals to keep the public informed about the outbreak is highlighted. Unraveling such impacts on the Saudi communities, including healthcare workers (HCWs)/professionals (HCPs), students, patients with different diseases, and non-professional individuals, is essential in containing the outbreak and planning preventive measures in case of future outbreaks.

Keywords: attitude, COVID-19, healthcare awareness, knowledge, practices, SARS-CoV-2

Introduction

Coronavirus disease 2019 (COVID-19) is a highly contagious disease caused by a novel strain of outbreak-related coronavirus, which emerged in Wuhan, China, in December 2019.[1,2] It has since been recognized as a zoonotic coronavirus, "severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)" and was also referred to as "2019-nCoV". Most uncomplicated cases with COVID −19 have mild symptoms such as fever, cough, sore throat, nasal congestion, headache, fatigue, and myalgia, and some patients develop severe symptoms such as acute respiratory distress that need hospitalization.[3,4] In Saudi Arabia, the first COVID-19 case was confirmed on 2nd March 2020 (a female case in the Qatif region in the eastern area of Saudi Arabia had a history of returning from Iraq) to be followed by the announcement of the Ministry of Health for disaster declaration on 4th March in line with the WHO guidelines to promote significant concerns about the healthcare awareness, public mass gatherings, and preventive measurements such as "Umrah suspension, tourism, suspension to several countries, suspension of domestic/international flights, partial curfew for 21 days, Madinah and Makkah lockdown".[5] After a while, these instructions followed by the closure of educational institutes, the non-essential business and "stay at home" call.[6,7] Despite these restrictions, Saudi Arabia had the highest number of COVID-19 cases compared with the other Gulf countries.[8]

At present, managing the epidemics is not depending only on the announced and/or applied restriction rules, however; it also depends largely on individual's adherence to recommended healthcare measurements which are highly influenced by the people's awareness and good practice.[9]

In this sense, this review was conducted to summarize the articles that explore and/or evaluate the healthcare awareness of COVID-19 among the Saudi population during the COVID-19 outbreak. This literature review is expected to give deeper insights into the existing healthcare awareness identified by the published work in this region, thereby

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helping to identify attributes that influence this awareness and highlight misperceptions/malpractices related to preventive measurements for future analysis, prevention of new airborne disease outbreaks, and mitigations implementation.

The Searched Outcomes

The outcomes evaluated by the original investigators, such as sufficient knowledge, positive feelings, worrying about the COVID-19 pandemic and following the good practice such as wearing a mask, handwashing, and social distancing, were searched. The included studies were summarized in Table 1, and the overlay visualization map of the related terminology in the enrolled studies is presented in Figure 1. The column titles of the table included the name of the first author/month/year of publication, study title, sample size, data collection protocol, and the study's primary outcome. Significant growth in literature was observed from the beginning of May 2020 to Feb 2022. A total of 116 studies were enrolled in this review.[9–124]

COVID-19 is a Public Health Emergency

Saudi Arabia has 750,179 cases, with 732,939 recoveries and 9036 deaths on 25th March 2022 (Figure 2) and (Supplementary File 1: the full dataset used in generating Figure 2).[125] It employed policies of "availability of personal protective equipment, stay-at-home, social distancing, and quality hospital care to the people".[126] The Saudi Arabian Ministry of Health (MOH) has performed an exhaustive awareness campaign communicated via its website (https://www.moh.gov.sa/en/awarenessplateform/) or direct public awareness sessions, national television programs, several platforms of social media, and mobile phone SMS messages.[91] In collaboration with the "Saudi Center for Disease Control", the MOH has launched a COVID-19-related guide and health education in more than ten languages to provide all citizens, Saudi and non-Saudi ones, with scientific facts and preventive measurements. This early engagement of the public in prevention/control measures, and the efforts paid to combat claims/misinformation, have been greatly extended.[8] Various community-based measurements, including

> the provision of facemasks, hand gloves, and hand sanitizers in all workplaces/markets, cleaning and disinfecting public places, community surveillance to prevent the movement and gathering of people, closure of masjids/community halls, and hefty fines for those who did not comply with wearing facemasks and social distancing

were implemented.[51] Additionally, the impact of the incidence and fatality ratio-related reports shown on electronic/social media 24 hrs. for seven days on an individual's psychosocial responses also was acknowledged by Al-Shammary et al.[51]

COVID-19 Awareness Among the Health-Related Professions

Well-informed health care professionals on COVID-19 may not only be an essential source to disseminate sound knowledge but also to create a safe environment for coworkers and patients. As health-related professions are invariably at a higher risk of developing COVID-19, several recent studies worldwide unraveled the knowledge and/or good practice on COVID-19 among these professions.[127–130]

Quadri et al found that knowledge was related to the qualification level "interns vs auxiliaries vs specialists" of the study participants regardless of the source of OVID-19-related information. In addition, the overall mean knowledge score and the number of enrolled individuals with correct responses had significantly increased after the intervention.[13] Similarly, Al-Khalifa et al showed that dental consultants/specialists with prolonged experience had higher awareness of the latest news of the COVID-19 pandemic.[16] Although Tripathi et al found that age, sex, and regional area were insignificant COVID-19 awareness predictors among healthcare workers, their findings confirm that residents who are less educated and "non-healthcare professionals" had less knowledge of COVID-19 and preventive measurements than their counterparts. Meanwhile, significant percentages of participants in their study showed substantial knowledge of the COVID-19 and good preparedness for the prevention/control of the disease.[15] By applying 32 concern statements in five different domains-related scales about COVID-19 severity, governmental efforts to contain it, and disease outcomes for HCWs, Abolfotouh et al identified moderate level of concern with Saudi nationality, younger age, undergraduate education, living with others, working in the western region, and direct contact with patients, were identified as

Table 1 Brief Characteristics of the Enrolled Studies* in This Review

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Al-Hanawi/ May 2020[10]	Knowledge, Attitude, and Practice Toward COVID-19 Among the Public in the Kingdom of Saudi Arabia: A Cross-Sectional Study	3388 participants	Online self-reported questionnaire	- They found a relatively high level of knowledge (K), positive attitudes (A), and good practices (P) in the study sample. - Males showed less KAP toward COVID-19 than females. - Older adults were likely to have better K/P than younger participants.
Siddiqui/ 2020[11]	Knowledge and practice regarding prevention of COVID-19 among the Saudi Arabian population.	443 Saudi/non-Saudi	Online self-designed, structured/ validated questionnaire	- High level of knowledge/practice among the majority of the participants about COVID-19 prevention - A significant association between knowledge and practice has been identified.
Elgzar/Jun 2020[12]	COVID-19 Outbreak: Effect of an Educational Intervention Based on Health Belief Model on Nursing Students' Awareness and Health Beliefs at Najran University, Kingdom of Saudi Arabia.	164 nursing students	Self-administrated questionnaire	- This intervention study shows that the health belief model (HBM) effectively increases nursing students' awareness of COVID-19. - There were direct, significant correlations between participants' total HBM score and their total awareness score.
Quadri/Jun 2020[13]	Novel coronavirus disease (COVID-19) awareness among the dental interns, dental auxiliaries, and dental specialists in Saudi Arabia: A nationwide study.	706 dental health care workers	Self-administrated questionnaire	Using a two-stage cluster sampling technique, this nationwide cross-sectional study showed that COVID-19-related knowledge was significantly related to the qualification level of the enrolled participants, and about 206 participants showed adequate knowledge after the intervention.
Almofada/Jun 2020[14]	Knowledge, Attitudes, and Practices Toward COVID-19 in a Saudi Arabian Population: A Cross-Sectional Study.	6000 participants	Online questionnaire.	The Saudi population is aware of the attitudes/practices of prevention and the mode of viral transmission. The efforts by the MOH were effective in increasing this type of awareness.
Tripathi/ Aug 2020[15]	Awareness and Preparedness of COVID-19 Outbreak Among Healthcare Workers and Other Residents of South-West Saudi Arabia: A Cross-Sectional Survey.	1000 participants	A community-based, self-developed structured questionnaire	Most respondents were aware of the knowledge/preventive measurements and well prepared to fight against COVID-19. Few misconceptions regarding the mode of COVID-19 transmission need to be addressed.
Al-Khalifa/ Aug 2020[16]	Pandemic preparedness of dentists against coronavirus disease: A Saudi Arabian experience	287 responses from 1000 surveys	Online survey 26 closed-ended questions	The response of most dentists regarding the preparedness/perception of infection control measures against the COVID-19 pandemic was positive.
Temsah/ Aug 2020[17]	Knowledge, attitudes, and practices of healthcare workers during the early COVID-19 pandemic in a main, academic tertiary care center in Saudi Arabia	582/800 HCWs response rate	Questionnaire	Previous experience with MERS-CoV was associated with increased knowledge/adherence to protective hygienic practices and reduced COVID-19-related anxiety.

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Table 1 (Continued).

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Alanezi/Sep 2020[18]	Implications of Public Understanding of COVID-19 in Saudi Arabia for Fostering Effective Communication Through Awareness Framework.	741/1881 responders with a final 591 complete the survey	Online questionnaire-based survey	The awareness levels of the participants were moderate to high (60–80%). Fifteen types of information were identified as highly relevant/necessary, which need to be effectively disseminated among the public through effective communication channels.
Alhazmi/Sep 2020[19]	Knowledge, attitudes, and practices among people in Saudi Arabia regarding COVID-19: A cross-sectional study	1513 participants	Online survey	An acceptable KAP toward COVID-19 in Saudi Arabia has been identified. Also, the educational level is a major influencing factor for KAP.
Abolfotouh/Sep 2020[20]	Perception and attitude of healthcare workers in Saudi Arabia with regard to Covid-19 pandemic and potential associated predictors.	844 HCWs at three tertiary hospitals	Survey via email with an anonymous link	A moderate level of concern score has been found. High concern scores-related predictors were: "Saudi nationality, younger age, undergraduate education, living with others, working in the western region, and direct contact with patients".
Bdair Sep-Oct 2020[21]	Public Awareness Toward Coronavirus Disease-2019.	575 participants	A closed-ended Arabic questionnaire	Participants showed good knowledge, positive attitudes, and good practices toward COVID-19. However, areas of low knowledge and negative attitudes were noticed.
Alahdal/Oct 2020[22]	An analytical study on the awareness, attitude, and practice during the COVID-19 pandemic in Riyadh, Saudi Arabia.	1767 participants	Online-distributed questionnaire	A moderate public awareness and high levels of attitude/practice were identified. A significant positive correlation between awareness/attitude and attitude/practice was found.
Alduraywish/ Oct 2020[23]	A Countrywide Survey in Saudi Arabia Regarding the Knowledge and Attitude of Health Care Professionals about Coronavirus Disease (COVID-19)	1040 HCPs	Twenty-nine close-ended questionnaire	The participants have displayed a better knowledge over attitude. Females, Diploma degrees and 7–10 yrs' experience were at higher risk of inadequate knowledge than their counterparts.
Qadah T/ Oct 2020[24]	Knowledge and attitude among healthcare workers towards COVID-19: a cross-sectional study from Jeddah city, Saudi Arabia.	1023 HCWs	Online questionnaire	About >88% of participants displayed a positive knowledge/attitude towards COVID-19. Social media platforms and the workplace were the primary sources of knowledge for most participants.
Alnajashi/Oct 2020[25]	Behavioral practices of patients with multiple sclerosis during Covid-19 pandemic.	176 patients with multiple sclerosis	Structured interview questionnaire in electronic Google form	Although overall good knowledge/attitudes have been determined among patients with multiple sclerosis, a substantial healthcare impact was identified as 32% of the participants missed their hospital appointments, and another 15% had a relapse.
Al-Dossary/ Nov 2020[26]	Awareness, Attitudes, Prevention, and Perceptions of COVID-19 Outbreak among Nurses in Saudi Arabia.	500 nurses from 5 regions in KSA	Online questionnaire	Female/married and bachelor's degree nurses had greater awareness, better attitude, and prevention clinical experience towards COVID-19.
Doumani/Nov 2020[27]	The knowledge about coronavirus (COVID-19) among populations in two different Arab countries.	790 participants	Online questionnaire	The knowledge level of Syrian/Saudi populations about the general information/symptoms and methods of coronavirus prevention was very good to excellent except in minimal points.

Hassen/Nov 2020[28]	Impact of COVID-19 outbreak on rheumatic patients' perceptions and behaviors: A cross-sectional study.	637 rheumatic patients	Patient-centered electronic survey	Patients' knowledge about COVID-19 was correlated with social media use. The pandemic and the related public health measures could impact rheumatic patients' health management which might contribute to disease flare-ups with subsequent further challenging healthcare systems.
Zakout/ Nov 2020[29]	Role of the Coronavirus Disease 2019 (COVID-19) pandemic in the upgrading of personal hygiene. A cross-sectional study in Saudi Arabia.	211 respondents	Online questionnaire	An improvement in the personal hygiene habits in Saudi Arabia, mainly those related to COVID-19 prevention, was evident.
Bazaid/Dec 2020[30]	Knowledge and practice of personal protective measures during the COVID-19 pandemic: A cross-sectional study in Saudi Arabia	5105 Saudi residents	Online self-reported survey	Although the authors found a high public knowledge of SARS-CoV2 transmission routes and adherence to personal protective measures, however, public awareness campaigns with an emphasis on the youth and individuals with low education/income are required to improve the general practice.
Shahin/ Dec 2020[31]	Knowledge of dentists, dental auxiliaries, and students regarding the COVID-19 pandemic in Saudi Arabia: a cross-sectional survey	1033 respondents	Online and social media outlets	Knowledge of viral survivability and recommended hand-soap washing time was significantly variable among the professionals
Mustafa/ Dec 2020[32]	Dentists' Knowledge, Attitudes, and Awareness of Infection Control Measures during COVID-19 Outbreak: A Cross-Sectional Study in Saudi Arabia.	269 respondents	Online questionnaire	Dentists in Saudi Arabia showed adequate knowledge/positive attitude towards COVID-19. Improving dentists' level of knowledge could be achieved through increasing their accessibility to materials provided by dental health care authorities.
Alsukah/Dec 2020[33]	Individuals' Self-Reactions Toward COVID-19 Pandemic in Relation to the Awareness of the Disease and Psychological Hardiness in Saudi Arabia	1272 participants	Online questionnaire	A high level of COVID-19 awareness (91.50%) was identified among studied Saudi participants.
Aljameel/Dec 2020[34]	A Sentiment Analysis Approach to Predict an Individual's Awareness of the Precautionary Procedures to Prevent COVID-19 Outbreaks in Saudi Arabia.	242,525 Arabic tweets	A dataset of Arabic COVID-19-related tweets	The awareness prediction model showed that the south region observed the highest level of awareness towards COVID-19 containment measures, whereas the middle region was the least. This can assist the medical sectors/decision-makers in deciding the fair practices for each region based on their attitudes towards COVID-19.
Aldrees/Dec 2020[35]	Medical Students' Awareness of Smell Loss as a Predictor for Coronavirus Disease 2019.	494 medical students	Online questionnaire	Saudi medical students realized that smell/taste dysfunction could be a COVID-19 potential symptom, but this knowledge was not as prevalent as the knowledge regarding the most common COVID-19 symptoms.
Albaqawi/Dec 2020[36]	Nursing Students' Perceptions, Knowledge, and Preventive Behaviors Toward COVID-19: A Multi-University Study.	1226 student nurses	Online survey	Being female/in the 4th year and getting good perceived knowledge were associated with high actual COVID-19-related knowledge. University, sex, age, academic level, and perceived COVID-19 knowledge were the associated factors.
Srivastava/Dec 2020[37]	Knowledge, attitudes, and practices regarding COVID-19 among dental health care professionals: a cross-sectional study in Saudi Arabia.	318 respondents	Online questionnaire	Although dental health care professionals showed a positive attitude/an acceptable level of practice, they displayed an average level of knowledge that needs to be enhanced through continuing education programs.

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Table 1 (Continued).

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Alnasser/Dec 2020[38]	The positive impact of social media on the level of COVID-19 awareness in Saudi Arabia: a web-based cross-sectional survey	3204 participants	Online survey	Saudi participants >18 years old and medical practitioners showed a high level of awareness. Social media platforms have a positive impact on COVID-19-related information in Saudi Arabia.
Baig/Dec 2020[39]	Predictors of misconceptions, knowledge, attitudes, and practices of COVID-19 pandemic among a sample of Saudi population	2006 participants	Online questionnaire	The study participants had good knowledge, positive attitudes, and good practices, but several myths were also prevalent.
Alanezi/ 2021[40]	Investigating healthcare practitioners' attitudes towards the COVID-19 outbreak in Saudi Arabia: A general qualitative framework for managing the pandemic	102/336 respondents	Online questionnaire	The parameters considered by the authors in their constructed qualitative framework for managing the COVID-19 pandemic in Saudi Arabia included "communication, effective leadership, coordination, and work planning, adequate treatment for patients, strict compliance with hospital rules/ procedures, preventive/regulatory measures, and training/support for health professionals".
Shrivastava/ 2021[41]	Assessment of knowledge and attitude of allied healthcare professionals about COVID-19 across Saudi Arabia	195 AHPs	Online questionnaire	- Allied healthcare professionals (AHPs) displayed a moderate level of knowledge and a good attitude towards COVID-19. - Continuous professional development to enhance the knowledge is highly recommended. Also, strategies should be developed in the private sector to reinforce the attitude of AHPs positively.
El-Masry/ Jan 2021[42]	Novel coronavirus disease-related knowledge, attitudes, and practices among the residents of Al-Jouf region in Saudi Arabia	422 participants	Online questionnaire	The participants had satisfactory levels of knowledge/optimistic attitudes and good practice during the rapid rise period of the pandemic. Awareness campaigns are recommended to improve any misbeliefs and/or risky behaviors.
Al-Rasheedi/Jan 2021[43]	Public and healthcare providers awareness of Coronavirus (COVID-19) in Qassim Region, Saudi Arabia	130 participants from shopping malls	In-person using a structured questionnaire	General public/HCPs from Qassim Region showed adequate awareness of COVID-19. Implementing periodic educational interventions and training programs on infection control practices for COVID-19 across all healthcare professions is highly recommended.
Bashir/Jan 2021[44]	Healthcare workers' knowledge and attitudes towards COVID-19 in Saudi Arabia	597 adults	Online survey on social media	In general, HCWs had high levels of knowledge about and positive attitudes towards COVID-19.
Tarakji/Jan 2021[45]	COVID-19-Awareness and Practice of Dentists in Saudi Arabia.	177/ 627 dentists	Online questionnaire on social media	Practicing dentists are aware of COVID-19. Their practices followed the known regulations/recommendations for infection control of COVID-19 in the dental clinic. Some drawbacks in knowledge and some inappropriate practices can be identified and require the attention of health authorities.

Alsoghair/Jan 2021[46]	Medical Students and COVID-19: Knowledge, Preventive Behaviors, and Risk Perception.	323/710 respondents	Online questionnaire on WhatsApp.	Medical students showed sufficient knowledge and preventive behaviors toward COVID-19 and an average level of risk perception. Otherwise, the younger medical students displayed lower scores suggesting that they should improve their COVID-19 knowledge/risk perception.
Shaikhain/Jan 2021[47]	COVID-19-Related Knowledge and Practices Among Health Care Workers in Saudi Arabia: Cross-sectional Questionnaire Study.	563 participants	Online questionnaire on social media	Most health care workers displayed acceptable levels of general knowledge related to COVID-19, but they lack awareness of some essential details that may prevent the disease spread.
Malaekah/Jan 2021[48]	Attitudes and Preparedness of Non-Frontline Physicians in Saudi Arabia Toward the COVID-19 Pandemic.	6209 physicians	Electronic questionnaire	The level of willingness (attitude) to participate in COVID-19 patient management was directly related to higher knowledge levels about personal protective equipment (PPE) use and confidence in airway management skills. Certain specialties warrant urgent pieces of training on PPE use/airway management to enable their frontline support of severely ill COVID-19 patients.
Javed/Jan 2021[49]	Dental health care providers' concerns, perceived impact, and preparedness during the COVID-19 pandemic in Saudi Arabia.	320/350 participants	Self-administered questionnaire	Most dental health care providers felt concerned about their risk of exposure and getting infected and infecting their friends/family
Alnasser/Feb 2021[50]	Public Knowledge, Attitudes, and Practice towards COVID-19 Pandemic in Saudi Arabia: A Web-Based Cross-Sectional Survey.	4305 participants	Web-based survey	Most participants displayed good knowledge of COVID-19, positive attitudes, and good practices for preventing the spread of SARS-CoV-2 infection.
Al-Shammary/ Feb 2021[51]	Role of community-based measures in adherence to self-protective behaviors during first wave of COVID-19 pandemic in Saudi Arabia.	400 participants	Online survey	Findings indicate that participants aged 25–34 were 25% less likely to comply with hand hygiene and social distancing, and COVID-19-related misconceptions could significantly decline compliance with self-protective behaviors by up to 27%.
Al Naam Feb 2021[52]	Community practice of using face masks for the prevention of COVID-19 in Saudi Arabia.	3572 participants	Online questionnaire on social media	Generally, the findings revealed a good attitude among participants towards wearing face masks. However, some barriers were identified to have the potential of decreasing the desire for this positive attitude. These barriers include "difficulty in breathing, discomfort, face irritation, and ear pain".
Al-Saleh/Feb 2021[53]	Population healthy lifestyle changes in Abha city during COVID-19 lockdown, Saudi Arabia.	1641 respondents	Electronic questionnaire	Covid-19 pandemic lockdown modified nearly all aspects of daily lifestyle, including dietary habits/behaviors, social interactions, and life sharing.
Rabbani/ Mar 2021[54]	Knowledge, Attitude and Practices of Health Care Workers about Corona Virus Disease 2019 in Saudi Arabia.	398 HCWs	Online questionnaire on social media	Although there was poor knowledge about the causative agent/role of antibiotics for COVID-19, there was good knowledge regards the mode of transmission/prevention. Overall, there were good infection control practices among the HCWs.
Natto/Mar 2021[55]	Are Saudi healthcare students aware of COVID-19, and do they behave safely during viral outbreaks?	223 healthcare students	Online questionnaire	Most students were knowledgeable about aspects of COVID-19, but some did not follow the recommended precautions. Inclusion of such information in students' academic programs is warranted.

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Table 1 (Continued).

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Almatari/Mar 2021[56]	Measuring Awareness of Infection Control Guidelines for Patients with COVID-19 in Radiology Departments in Saudi Arabia.	128 responders	Online questionnaire on social media	The knowledge of HCPs in the radiology department regarding infection control needs to be continually assessed.
Abolfotouh/ Mar 2021[57]	Behavior Responses and Attitude of the Public to COVID-19 Pandemic During Movement Restrictions in Saudi Arabia.	2470 adults	Online questionnaire	The levels of compliance to behavior response and attitude to the COVID-19 pandemic were less than satisfactory due to socio-demographic impacts. COVID-19 awareness programs are recommended.
Alqahtani/Mar 2021[58]	General Public Knowledge of Coronavirus Disease 2019 (COVID-19) at Early Stages of the Pandemic: A Random Online Survey in Saudi Arabia.	1006 participants	Online questionnaire	Generally, study participants showed excellent knowledge levels. The provision of COVID-19 facts/knowledge tools should be focused on younger generations to enhance compliance with governmental restrictions.
Gosadi/Mar 2021[59]	Community-based observational assessment of compliance by the public with COVID19 preventive measures in the south of Saudi Arabia.	1096 individuals	Field observations using a standardized checklist	There is variability in the compliance levels with specific preventive measures against COVID-19. Further assessment is needed to explore factors associated with the limited observed compliance.
Syed/Mar 2021[60]	Preventive Practices of Ophthalmologists During COVID-19 Pandemic.	126 respondents	Online questionnaire	Participants were generally compliant with recommended preventive measures. Creating awareness of and monitoring for COVID-19 infection control measures in healthcare settings are recommended.
Alshammari/ April 2021[61]	Factors Associated with Adherence to COVID-19 Preventive Measures Among Saudi Arabians.	1568 participants	Online questionnaire	During the early phase of the pandemic, participants' perception of susceptibility was low, which resulted in a lack of awareness of some citizens to take the COVID-19 infection seriously.
Alqahtani/Apr 2021[62]	Public Response, Anxiety and Behaviour during the First Wave of COVID-19 Pandemic in Saudi Arabia.	90,421 participants	A national phone survey	Knowledge about COVID-19 among participants was acceptable Trust in authorities, being anxious/worried, and levels of knowledge were the most common factors affecting adherence to the recommended practices.
AlNajrany/ Apr 2021[63]	The Commonly Utilized Natural Products during the COVID-19 Pandemic in Saudi Arabia: A Cross-Sectional Online Survey.	1473 participants	Online questionnaire on social media	The utilization rate of herbal and dietary supplements among the Saudi public during the COVID-19 pandemic is high. The impact of different public awareness campaigns aimed at improving the public knowledge of the risk/ benefits associated with using different commonly utilized herbal and dietary products should be investigated.
Al-Rahimi/Apr 2021[64]	Levels and predictors of fear and health anxiety during the current outbreak of COVID-19 in immunocompromised and chronic disease patients in Saudi Arabia: A cross-sectional correlational study	1030 patients	Online questionnaire	Immunocompromised/chronic disease patients are vulnerable to fear and anxiety during epidemic infectious diseases. Optimizing this population's compliance with proper infection prevention/control strategies is essential during the outbreaks.

AlRasheed/Apr 2021[65]	Assessment of Knowledge, Attitude, and Practice of Security and Safety Workers Toward the COVID-19 Pandemic: A Cross-Sectional Study	712 participants	Online questionnaire	A high level of knowledge was reflected in both the attitude and practice of the participants. The significant predictors of their knowledge were their educational level, age, marital status, parenthood status, and employment sector (private or government).
Aldhahri/Apr 2021[66]	Awareness of COVID-19 Before and After Quarantine Based on Crowdsourced Data From Rabigh City, Saudi Arabia: A Cross-Sectional and Comparative Study.	448 participants	Online questionnaire	This cross-sectional/comparative study shows that a good level of knowledge about COVID-19 has been detected and relatively increased after quarantine.
Alqahtani/May 2021[67]	Knowledge, Attitude, and Practice (KAP) toward the Novel Coronavirus (COVID-19) Pandemic in a Saudi Population-Based Survey.	5483 respondents	Online questionnaires on social media and emails	A high level of knowledge about COVID-19 was identified. Providing more education/awareness for the public to comply with WHO's recommendation is warranted.
Temsah/May 2021[68]	Changes in healthcare workers' knowledge, attitudes, practices, and stress during the COVID-19 pandemic.	957/ 1500 HCWs	Online questionnaire	HCWs' anxiety levels regarding COVID-19 have increased since a pandemic was declared. Healthcare facilities must provide more emotional/ psychological support for all HCWs.
Aldhmadi/ May 2021[69]	Depressive Symptomatology and Practice of Safety Measures among Undergraduate Students during COVID-19: Impact of Gender	3044 undergraduates	Online questionnaire	Although female undergraduates were more vulnerable to developing depressive symptoms, they were more likely to implement COVID-19 protective measures.
Aleanizy/May 2021[70]	Awareness and knowledge of COVID-19 infection control precautions and waste management among healthcare workers: Saudi cross-sectional study.	710 HCWs	Online questionnaire	Most participants realized the importance of their role in infection control/ surveillance and monitoring of the ongoing safety practices in their patients and their facilities and communities.
Elagib/May 2021[71]	Knowledge, attitude, and practice regarding infection control measures among dental students during COVID-19 pandemic	969 dental students	Self-administered questionnaire	Dental students had good knowledge and positive attitudes regarding infection control in general but showed moderate compliance with the recommended infection control guidelines.
Mahdi/ Jun 2021[72]	Hand Hygiene Knowledge, Perception, and Practices among Domestic Visitors to the Prophet's Mosque in Al Madinah City Amid the COVID-19 Pandemic: A Cross-Sectional Study	400 participants	Online questionnaire	Al Madinah visitors had moderate knowledge about hand hygiene but demonstrated some knowledge gaps and negligence in practice that are important to curb the spread of COVID-19.
Alkhaldi/ Jun 2021[73]	Perceptions towards COVID-19 and adoption of preventive measures among the public in Saudi Arabia: a cross-sectional study.	2393 respondents	Online questionnaires on social media and emails	High levels of adoption of preventive measures, willingness, and perceived ability to self-isolate during the early phase of the pandemic were reported. Vulnerable groups such as the elderly and those with low socioeconomic status reported lower adoption levels/willingness to self-isolate.
Almoayad/ Jun 2021[74]	Preventive practices against COVID-19 among residents of Riyadh, Saudi Arabia	886 Riyadh residents	Online questionnaire on social media	Practicing preventive measures during the COVID-19 pandemic was significantly associated with one's complete knowledge and attitude scores.

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Table 1 (Continued).

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Alsaif/ Jun 2021[75]	Assessing the Level of Awareness of COVID-19 and Prevalence of General Anxiety Disorder among the Hail Community, Kingdom of Saudi Arabia.	412 participants	Online questionnaire	A sufficient combination of relatively good levels of KAP serves as a good approach to preventing the spread of COVID-19.
Alotiby AA, Al-Harbi/ Jun 2021[76]	Attitudes towards COVID-19-Related Medical Misinformation among Healthcare Workers and Non-Healthcare Workers in Saudi Arabia during the Pandemic: An Online Cross-Sectional Survey.	1294 participants	Online questionnaire	The Saudi Arabian population has a "Neutral" attitude toward COVID-19-related misinformation.
Sharanesha/Jun 2021[77]	Knowledge and Attitude Regarding COVID-19 among Students from Multiple Professional Background in Riyadh Region, Saudi Arabia: A Cross-sectional Study	753 students	Online questionnaire	The findings are mostly uniform among different professional students. As the internet was a significant source of data acquisition, more COVID-19-related awareness via social media is necessary.
Binsaleh/ Jun 2021[78]	Awareness and Practice of COVID-19 Precautionary Measures Among Healthcare Professionals in Saudi Arabia.	674 HCWs	Online questionnaire	Saudi HCWs showed high knowledge/practice of protective measures for COVID-19. Customized education and training courses for low scores in both domains are recommended.
Albeladi/ Jun 2021[79]	Level of Adherence to COVID-19 Preventive Measures Among Health Care Workers in Saudi Arabia.	214 HCWs	Dual-language (Arabic and English) online questionnaire	The HCWs in Saudi Arabia have an acceptable level of adherence to COVID-19 preventive measures during the pandemic.
Alassaf/Jul 2021[80]	Perceptions and Preventive Practices Regarding COVID-19 Pandemic Outbreak and Oral Health Care Perceptions during the Lockdown: A Cross-Sectional Survey from Saudi Arabia.	2013 participants	Online questionnaire	The Saudi population has good attention to COVID-19, but preventive practice and oral health perception need better awareness to control.
Alshareef/ Jul 2021[81]	The Influence of COVID-19 Information Sources on the Attitudes and Practices Toward COVID-19 Among the General Public of Saudi Arabia: Cross-sectional Online Survey Study.	3358 participants	Online questionnaire	There were different sources of information that influenced participants' attitudes and the preventive actions during the pandemic. Health authorities should use suitable sources and social media platforms to disseminate information to the public effectively.
Almarwani/ Jul 2021[82]	Perceived quarantine competence, attitudes, and practices among the public during the coronavirus pandemic: A Saudi descriptive study	1022 participants	Online questionnaire	COVID-19 awareness programs should focus more on male and non-Saudi populations. Screening protocols/education programs for asthmatic patients to avoid confusing COVID-19 symptoms with asthma are recommended.
AlHadi/ Jul 2021[83]	Mental health and its association with coping strategies and intolerance of uncertainty during the COVID-19 pandemic among the general population in Saudi Arabia: cross-sectional study.	3032 respondents	Online questionnaire on social media	Mental health is a crucial concern during the COVID-19 pandemic, especially for the identified vulnerable groups. Targeted policies/ interventions based on the studied associated factors of mental health symptoms could be generated by the related authorities.

Almohammed/ Jul 2021[84]	Knowledge, Attitude, and Practices Associated With COVID-19 Among Healthcare Workers in Hospitals: A Cross-Sectional Study in Saudi Arabia	510 HCWs	Online questionnaire	Females HCWs had better knowledge and attitude, whereas the males were more likely to practice most of the time appropriately. Continuous specific infection control training/emotional well-being supporting programs, especially for HCWs with a low education level, is recommended.
Mohsin Jul/ 2021[85]	Knowledge towards COVID-19 among healthcare students in the central region of Saudi Arabia: a cross-sectional observational study.	612 health care students	Online questionnaire	There was sufficient student knowledge but a lack of awareness about the background/mode of transmission of this disease. More health education and training programs are warranted.
Al-Rayes/Jul 2021[86]	Public Awareness and Utilization of 937-Telephone Health Services in the Kingdom of Saudi Arabia Before and During the COVID-19 Pandemic: Longitudinal Study.	1961 participants	Online questionnaire on social media	This longitudinal study shows that there were significant increases in the awareness/utilization of 937-telephone health services during the early days of the COVID-19 pandemic.
Alghamdi/Jul 2021[87]	Association Between Educational Status and Awareness of Adherence to Preventive Measures for COVID-19 in Saudi Arabia.	4707 participants	Online questionnaire	The studied Saudi individuals were knowledgeable, optimistic, and adherent to preventive measures. Patients with chronic illnesses may need further education and follow-up with psychiatrists.
Alotiby/Jul 2021[88]	The Impact of Media on Public Health Awareness Concerning the Use of Natural Remedies Against the COVID-19 Outbreak in Saudi Arabia.	1300 participants	Online questionnaire	The Saudi MOH's usage of social media platforms positively affected public health awareness concerning the reliability of natural remedies used during the pandemic.
Mushi/Jul 2021[89]	Knowledge, Attitude, and Perceived Risks Towards COVID-19 Pandemic and the Impact of Risk Communication Messages on Healthcare Workers in Saudi Arabia.	1691 responses	Online questionnaire	HCWs have fair knowledge/attitude towards the COVID-19 pandemic. Risk communication is an effective strategy to improve the attitude and practice of HCWs toward COVID-19 in Saudi Arabia.
Almaghrabi/ Aug 2021[9]	Public Awareness, Attitudes, and Adherence to COVID-19 Quarantine and Isolation in Saudi Arabia.	1998 respondents	Online questionnaire	The Saudi population had very high levels of awareness/adherence regarding COVID-19 quarantine and isolation measures
Meisha/Aug 2021[90]	Comparison of Compliance with Infection Control Practices Among Dental Students in Saudi Arabia Before and During the COVID-19 Pandemic.	622 dental students	Observing the students during their clinical sessions	Dental students' adherence to infection control measures improved during the COVID-19 pandemic compared with before the pandemic. Compliance with personal protective equipment standards was higher than with hand hygiene practices.
Al-Wutayd/ Aug 2021[91]	Handwashing knowledge, attitudes, and practices during the COVID-19 pandemic in Saudi Arabia: A non-representative cross-sectional study	1323 adults	Online questionnaire on social media	Handwashing knowledge was associated with positive attitudes toward this practice in Saudi adults during the COVID-19 lockdown.
Alotaibi/ Aug 2021[92]	The Extent of Commitment of Saudis During Holy Ramadan to Social Distancing Measures Required for the Prevention of Transmission of COVID-19.	1515 participants	Online questionnaire on social media	Excellent adherence to all social distance measures was observed. However, attitudes regarding reduced physical contact were poor in the Makkah region. Hence more significant efforts to educate people about the related risks are recommended.

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Table 1 (Continued).

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Algahtani/Aug 2021[93]	Coping during COVID-19 Pandemic in Saudi Community: Religious Attitudes, Practices, and Associated Factors.	464 participants	Online questionnaire	The findings highlighted some risk groups with less preventative practices. Targeted health education interventions are highly recommended to enhance the commitment to government instructions.
Khathlan/Aug 2021[94]	Adherence to COVID-19 Appropriate Behavior Among Respiratory Therapists: A Cross-Sectional Study in the Kingdom of Saudi Arabia.	215 participants	Online questionnaire	Adherence to COVID-19 appropriate behavior was high at hospitals. However, the same practice was inconsistent in non-healthcare settings among the respiratory therapists.
Ashgar/Aug 2021[95]	Health-promoting behaviour during the COVID-19 pandemic among Saudi Adults: A cross-sectional study	305 adults	Online questionnaire	COVID-19 is associated with Saudi adults' adoption of health-promoting behavior.
Aldhmadi/Sep 2021[96]	Feelings, Behavioral Actions, and Depressive Symptoms Related to COVID-19 among Undergraduates in Hail, Saudi Arabia	418 students	Online questionnaire	About half of the participants reported depressive symptoms, although the practice of COVID-19 precautionary measures by the participants was satisfactory.
Almoslem/Sep 2021[97]	Handwashing Knowledge, Attitudes, and Practices among Students in Eastern Province Schools, Saudi Arabia	271 students	Self-administrated questionnaire/ observational checklist	Handwashing knowledge/practices among school students in the Eastern Province are acceptable interventions in preventing the transmission of COVID-19.
Alsharqi/Oct 2021[98]	Inequalities in Knowledge About COVID-19 in the Kingdom of Saudi Arabia	3388 participants	Online questionnaire	There is inequality in the level of knowledge about COVID-19 among the more socioeconomically privileged population. Improving knowledge among the lower income/less educated individuals is highly recommended.
Alagili/Oct 2021[99]	The Health Belief Model as an explanatory framework for COVID-19 prevention practices.	1027 participants	COVID-19 Snapshot MOnitoring (COSMO) questionnaire	The model can be applied to understand adherence to COVID-19 prevention practices. Recognizing perceived health beliefs/practices is essential for developing effective COVID-19 health intervention strategies.
Shaikhain/Oct 2021[100]	Knowledge and attitude toward coronavirus disease 19 pandemic among Saudi Arabia population: A cross-sectional study	2071 participants	Online questionnaire on social media	The Saudi population showed a high level of knowledge related to COVID-19. Frequent communication between healthcare authorities and the public is highly recommended.
Alkhalifah/Nov 2021[101]	COVID-19 impact, knowledge, and preparedness among dental hygienists in Saudi Arabia: A cross-sectional study.	131 dental hygiene professionals	Online questionnaire	Knowledgeable dental hygienists were significantly more prepared to treat patients during the pandemic. The related stress positively influenced the COVID-19 knowledge acquisition.

Almoayad/Nov 2021[102]	Stigmatisation of COVID-19 in Riyadh, Saudi Arabia: A cross-sectional study	847 participants	Online questionnaire on social media	A significant association was identified between stigma, older age groups, being married, and lower levels of education. Future awareness programs should educate patients and their families about stigma and the consequences of stigmatizing COVID-19.
Alomari/Nov 2021[103]	Public perception towards medical waste generated in the environment during the COVID-19 pandemic in Eastern Province, Saudi Arabia	572 respondents	Online questionnaire on social media	The study showed that most participants were aware of the availability of regulations for the collection/disposal of biomedical waste. Effective management of these wastes significantly protects the public against the improper practices of waste disposal generated during the COVID-19 pandemic.
Almomen/Nov 2021[104]	Awareness and Knowledge of Different Types of Face Masks amid the COVID-19 Pandemic among Health-Care Professionals across Kingdom of Saudi Arabia an Original Research	1000 participants	Online questionnaire	The awareness had increased among the HCWs, who were conscious of the types of masks.
Alghalyini/Nov 2021[105]	Perception of the COVID-19 Pandemic Among Members of Saudi Society: Solidarity, Humility, and Connectivity.	920 participants	Online questionnaire	The authors suggested their results could prove the importance/power of the Saudi Vision (2030) represented by "the National Transformation Program on enhancing the healthcare system, facilitating access to healthcare, and integrating technology among government parties" addressed during the COVID-19 pandemic.
Syed/Nov 2021[106]	Application of the Health Belief Model to assess community preventive practices against COVID-19 in Saudi Arabia.	900 participants	Online questionnaire	The health belief model's constructs of perceived susceptibility, severity, benefits, and cue to action can be adopted to help strengthen COVID-19 limiting behaviors and prevention programs.
Abalkhail/Nov 2021[107]	Hand Hygiene Knowledge and Perception among the Healthcare Workers during the COVID-19 Pandemic in Qassim, Saudi Arabia: A Cross-Sectional Survey.	301 HCWs	Online questionnaire	The results identified gaps in hand hygiene knowledge, perception, and practice among HCWs in Qassim, Saudi Arabia, and the importance of training in this regard.
Almalki/Dec 2021[108]	Knowledge, Attitudes, and Practices Toward COVID-19 Among the General Public in the Border Region of Jazan, Saudi Arabia: A Cross-Sectional Study	597 participants	Online questionnaire	Most study participants had good knowledge, positive attitudes, and effective practices toward COVID-19.
AbuAlhommos/ Dec 2021[109]		577 individuals	Online questionnaire	A good level of knowledge/positive attitudes towards COVID-19 was observed. Continuous efforts should be maintained to sustain awareness among the public.
Bin Abdulrahman/ Dec 2021[110]	Response of Saudi Population to Strict Preventive Measures against COVID-19.	2958 participants	Online questionnaire	Most participants adhere to the strict government instructions regarding COVID-19 as they have to obey the law.
Alshammary/ Dec 2021[111]	Prevention Knowledge and Its Practice Towards COVID-19 Among General Population of Saudi Arabia: A Gender-based Perspective.	627 participants	Online questionnaire	Females were more compliant with the WHO public health COVID-19 prevention advice than males.

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Table 1 (Continued).

First Author/ Month-Year	Study Title	Sample Size	Data Collection Protocol	Reported Outcome(s)
Almalki/Dec 2021[112]	Awareness about Coronavirus (COVID-19) and challenges for blood services among potential blood donors.	3841 persons	Online questionnaire on social media	Fear of contracting COVID-19 while donating blood is an essential concern for blood donors. Blood collection facilities are encouraged to communicate the precautionary measures-related efforts to potential donors for reassurance.
Alassaf/Dec 2021[113]	Compliance Toward Protective Precautions During and After the Lockdown Among Citizens of Riyadh.	1108 residents	Online questionnaire	The findings indicate that compliance toward personal protective measures was high for "those who did not have direct contact with COVID-19 positive people after lockdown, those planning for inoculation, and those insuring applications of precautionary measures by their children". Also, higher compliance was noted in participants who sought information from official sites.
Sadaf/Dec 2021[114]	COVID-19 Myth Busters: Comparing knowledge and perceptions amongst the dental workforce at an institution in the Eastern Province, Saudi Arabia.	810 participants	Online questionnaire	The findings indicate that the Faculty could correctly identify the facts/myths related to COVID-19 followed by the prep year students, then the dental students. Preparatory year students showed a higher level of COVID-19-related knowledge than dental students. Student/faculty knowledge score was not significantly different.
Almalki/Jan 2022[115]	A Cross-Sectional Study of the Satisfaction with Adherence to, and Perspectives toward COVID-19 Preventive Measures among Public Health Students in Jazan, Saudi Arabia.	200 participants	Online questionnaire	Efforts are needed to improve the students' satisfaction with COVID-19 preventive measures. Steps are also required to ensure that the procedures and actions introduced by the college extend to all students.
Meo/ Jan 2022[116]	Face Masks Use and Its Role in Restraining the Spread of COVID-19 Pandemic in Saudi Arabia: Knowledge, Attitude, and Practices Based Cross-Sectional Study.	1356, respondents	Online questionnaire on social media	Saudi citizens have above-average knowledge/optimistic attitudes toward using face masks during the COVID-19 pandemic
Hagag/Jan 2022[117]	Exploration of Community Care Awareness about COVID-19 Sterilization.	504 participants	Online questionnaire	Knowledge and practice gaps among the population, especially in the young age group, had to be covered by the execution of training programs through workshops or include courses in the curriculum of MOH.
Alshahrani/Jan 2022[118]	Knowledge, Attitude, and Practice among Physical Therapists toward COVID-19 in the Kingdom of Saudi Arabia-A Cross-Sectional Study	287/1179 physical therapists	Online questionnaire	Physical therapists in Saudi Arabia exhibit good knowledge, attitude, and practice toward COVID-19.
Moussa/Jan 2022[119]	Association of Fear of COVID-19 and Health Literacy Among the General Public in Saudi Arabia: A Cross-Sectional Assessment.	848 participants	Online questionnaire	An above-average level of COVID-19 -related fear of the general public in Saudi Arabia and its association with a low level of functional health literacy was reported. Timely/comprehensive health interventions should be promoted to enhance health literacy and decrease the level of COVID-19-related fear in the community.
Alkhotani/Jan 2022[120]	Public awareness of the neurological manifestation of COVID-19 in Saudi Arabia.	831 participants	Online questionnaire	Awareness of COVID-19's neurological symptoms could help detect an atypical case, which can help in early intervention and its medical treatment.

Alrefaei/Jan-Feb 2022[121]	Assessment of health awareness and knowledge toward SARS-CoV-2 and COVID-19 vaccines among residents of Makkah, Saudi Arabia.	600 participants	Online questionnaire	An excellent awareness level was noted among the residents of Makkah for SARS-CoV-2 in terms of transmission, disease symptoms, and prevention of viral spread.
Basheer/Feb 2022[122]	Knowledge of COVID-19 Infection Guidelines among the Dental Health Care Professionals of Jazan Region, Saudi Arabia.	363 participants	Online questionnaire	Most DHCP had a high knowledge of general COVID-19 infection prevention/control guidelines. Dentists, males, and those who read the guidelines had higher levels than their counterparts.
Ayat/Feb 2022[123]	Infection prevention and control practices among primary healthcare nurses regarding COVID-19 in Saudi Arabia: A cross-sectional study.	198/207 participants	A self-administered questionnaire	Overall, practicing preventive measures by HCPs in Saudi PHCs to encounter the COVID-19 pandemic was generally significant.
Alanazi/Feb 2022[124]	Knowledge, Attitude, and Psychological Impacts of COVID-19 in Saudi Arabia.	482 participants	Online questionnaire on social media	Promoting access to mental health services is critical, as well as finding creative and suitable strategies to deliver mental health services to those who need them.

Notes: Author/year; first author surname/year of publication. *All the included studies are "cross-sectional" type of study design unless otherwise indicated.

Abbreviations: AHPs, allied healthcare professionals; COVID-19, coronavirus disease-2019; DHCP, dental health care professionals; HCPs, health care professionals; HCWs, health care workers; KAP, knowledge, attitudes, and practices; KSA, Kingdom of Saudi Arabia; MERS-CoV, The Middle East respiratory syndrome coronavirus; MOH, Ministry of Health; PHCs, primary health care centers.

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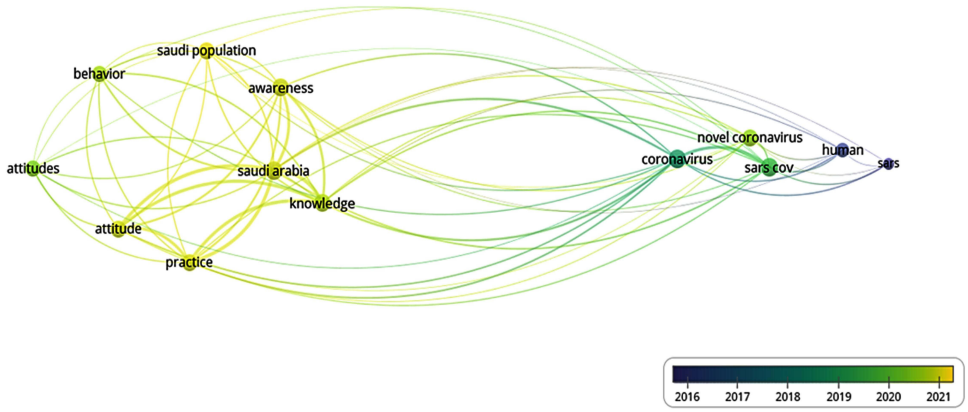

Figure 1 The overlay visualization map of the included studies in this review. Each circle represents an item (term) mentioned in the included literature. Curved lines that link (connect or relate) two items indicate co-occurrence of the items in the enrolled studies. There are 13 items in this map arranged into two clusters and linked by 64 lines with a total link strength of 872. The color bar indicates the year of publication in which the item is mentioned in the included literature. The VOSviewer tool version 1.6.15 was applied to generate, visualize, and explore this map after importing the bibliographic citation list in an endnote file.

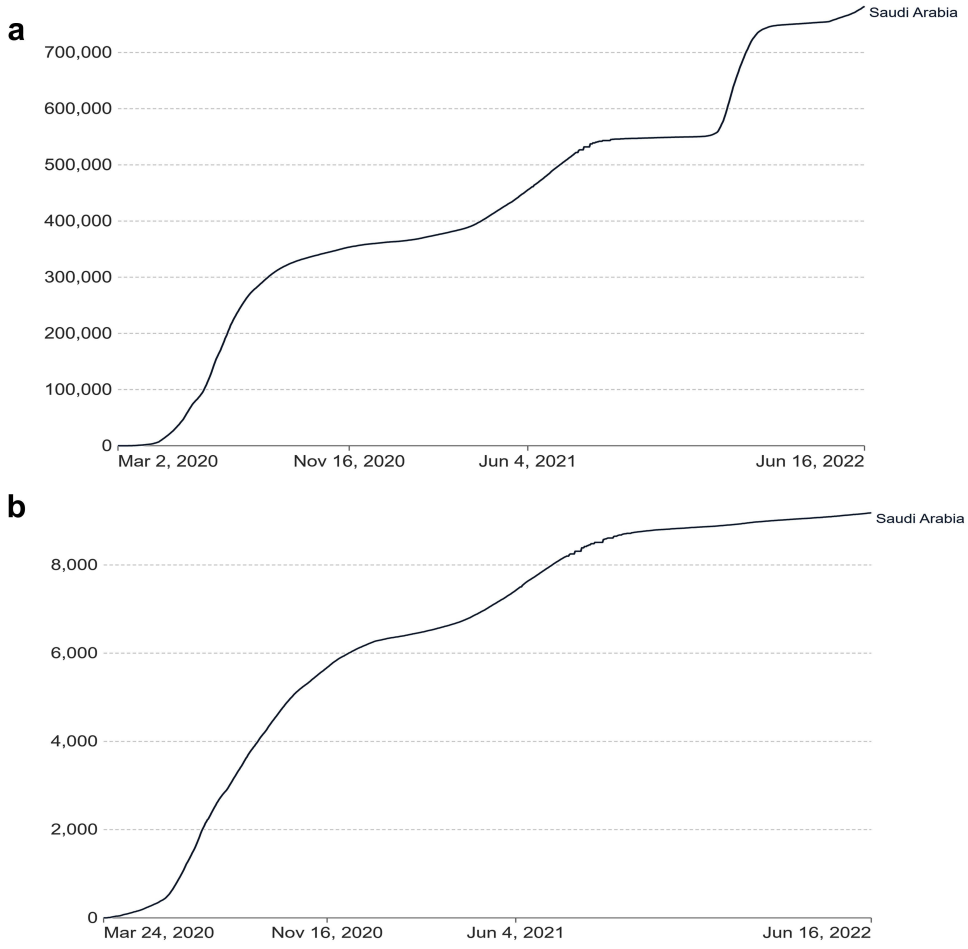

Figure 2 Cumulative confirmed COVID-19 cases (**A**) and deaths (**B**) in Saudi Arabia. Adapted from Ritchie H, Mathieu E, Rodés-Guirao L, et al. Coronavirus pandemic (COVID-19). Our world in data; 2020.[125]

"predictors of high concern scores". They recommended that measures are required to improve the protection of the HCWs and reduce the psychological effect of the perceived risk of infection.[20] Also, Alduraywish et al determined a relatively good level of knowledge over the attitude of HCPs regarding COVID-19, and this trend was similar across all

regions of Saudi Arabia. They recommended "continuing education programs" to fill the potential gap in knowledge for HCPs in higher-risk groups.[23] Interestingly, Temsah et al found that previous experience in their study of healthcare workers with "MERS (Middle East respiratory syndrome-related coronavirus)" was associated with increased knowledge/adherence to protective practices and reduced anxiety towards COVID-19. Similarly, Al-Dossary et al confirmed this issue, stating that "lessons learned treating these previous infections may strengthen nurses' ability to prepare, adapt, and effectively respond to any disease outbreak".[26]

Taken together, increasing the accessibility to materials provided by health care authorities, intensive training programs for all categories of the healthcare workers, rigorous attentive protocols, and a commitment to change behavior/practice, will significantly benefit the spread of the outbreaks.[24,31,32,37,40–45,47,48,60,78,84,131] Mushi et al suggested that "risk communication as an effective strategy to improve the attitude and practice of HCWs towards COVID-19 in Saudi Arabia".[89] Measures to enhance protection for HCPs and minimize psychological consequences/potential social stigmatization should be recognized in the planning stage before any pandemic.[49,54,102] Also, it is essential that healthcare facilities provide more emotional/psychological support for all HCWs.[68]

COVID-19-Related KAP Among Patients Residents in Saudi Arabia

Assessment of KAP related to COVID-19 among populations at high risk of acquiring SARS-CoV-2 infection and to whom the COVID-19 course would be worrisome, such as patients with different diseases play an essential role in the control of the impact of the COVID-19 pandemic.[25]

For example, Alnajashi and Jabbad identified that out of 176 patients with multiple sclerosis, 95.5% realized the COVID-19 symptoms, 90% followed preventive measures introduced by the MOH, and 83% were complying with quarantine guidelines. These findings indicate a high level of knowledge/practice of preventive measures among these patients, although still some anxiety has been identified. Also, about 32% of the patients missed their hospital appointments, and another 15% had a relapse. In this sense, the investigators recommended that actions to relieve the impact of COVID-19 on healthcare service delivery to patients, such as telemedicine, should be encouraged.[25] Similarly, Hassen et al found that "fear of disease deterioration if contracting the infection correlated with the rheumatic patients' levels of knowledge and patients' perceptions of worsened disease activity were correlated with unplanned healthcare visits, non-adherence to medication, and difficulty accessing medication".[28] Effective positive psychological interventions/support strategies also are required to be immediately implemented to increase psychological resilience and improve the mental health of patients, in particular, immunocompromised and those with chronic diseases,[64] as well as who have a history of mental illness.[83]

Discussion

The compliance of the general public in following preventive measures plays a critical factor in reducing the widespread transmission of COVID-19. Therefore, the public's awareness and good practice are fundamental elements in the overall public health response to the COVID-19 pandemic.[132]

It was evident that Saudi Arabia took extreme measures, including the awareness campaigns to respond to COVID-19, which contributed to limiting the spread and the burden of the disease.[133] This action is unsurprising as Saudi Arabia has a unique experience dealing with two previous virus family-related outbreaks.[134–137] This unique history assessed the government in considering the rapid response and precautionary measurements against COVID-19 to control its spread.[10]

Most enrolled studies indicate the significant impact of age, sex, educational level, and income on the knowledge domain of assessed KAP, in which elders, females, more educated participants, and those with relatively higher income levels showed higher scores and/or mean of knowledge levels (Table 1). This finding is consistent with similarly assessed domains in other nations like the Chinese population.[128] Previously, females were reported to show more concern/positivity toward their families and society concerning any infectious pandemic.[39,138,139] Education and marriage modify individual responses resulting in KAP improvement and overall positiveness.[140] These observations could be helpful for future handling of similar epidemics to emphasize the mass media's role in running targeted awareness-raising intervention programs, particularly for young men, lower-income, and less educated subgroups.

Regarding attitudes, most studies showed a positive/optimistic attitude toward COVID-19 among citizens/residents or health workers during curfew/country closures and/or movement restrictions.[10,44,57] This positive attitude was sometimes correlated to the educational level[19] or related to some myths.[39] Large percentage of study participants realized that the virus could be successfully controlled, and they were confident in the Saudi government's precautionary measures toward the pandemic (detailed in the previous sections).[62] This attitude is in line with findings from other countries worldwide, where most contributors were convinced that COVID-19 is treatable, several governmental authorities have a social responsibility to implement safety/preventive measures to control the spread of this infection, and that their country will be able to control the disease.[128,141,142]

Regards the practice domain of KAP, most studies, in general, found good practices, and these findings are similar to other studies worldwide.[143,144] Being male and having a divorced status were correlated to low practice scores, and older participants, students, and private-sector jobs were associated with high practice scores (Table 1). These findings are similar, more or less, to other reports.[128,142,145,146] Implementing strict curfew/lockdown across the country could contribute, in part, to this good practice, as individuals were not allowed to navigate the neighboring areas and other cities during lockdown breaks. All mass media platforms have been full of COVID-19 news, and the short message services have also been swiftly disseminating information. Thus, the KAP domains were relatively good in a positive direction among most of the included studies (Figure 3).

Limitations

Although this review covered many studies conducted during 2020–2022 throughout a broad range of Saudi Arabia regions, one of the limitations of this work is that data used in the analysis of included studies were self-reported, which could have some reporting bias. Also, most studies' design was cross-sectional and hence, cannot be used to infer causality because a temporal sequence cannot be established. Nevertheless, this study design is used to "generate descriptive statistics regarding the disease/outcome burden in a population or determine background exposure rates",[147] which can be very useful, especially during pandemics.

Conclusion and Future Perspective

The findings of this review indicate that residents of Saudi Arabia have basic knowledge, awareness, and relatively good practice about the way of SARS-CoV-2 transmission, how to protect themselves from the virus, and the highly susceptible age groups at risk of COVID-19. More specifically, most included studies indicate the significant impact of age, sex, educational level, and income on the knowledge domain of assessed KAP, in which elders, females, more

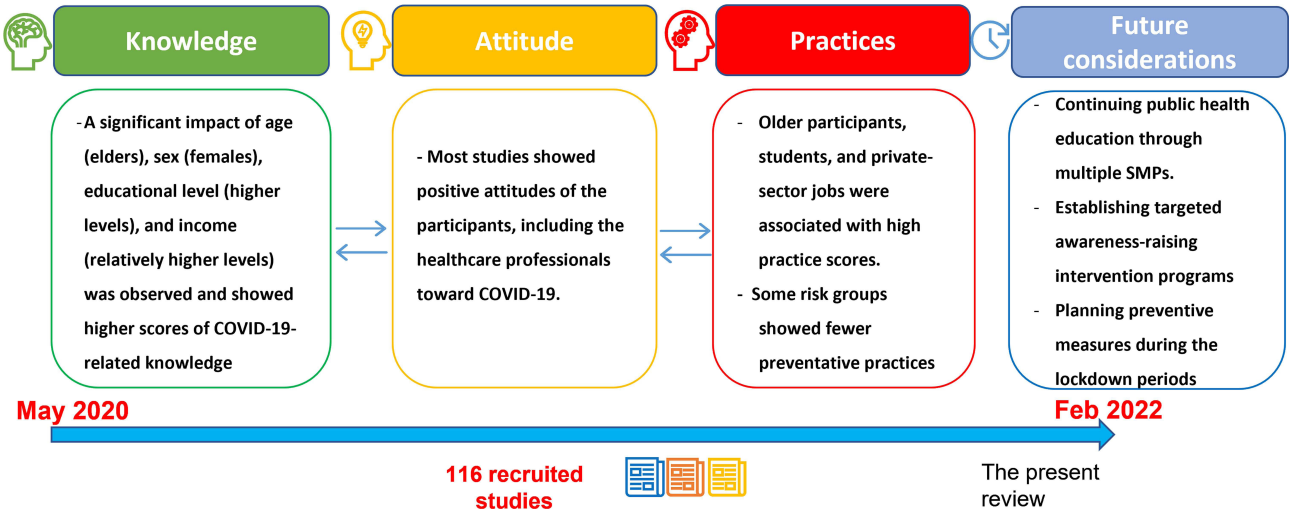

Figure 3 A summary of the main determinants of knowledge, attitude, practice (KAP), and healthcare awareness in the current review. The KAP domains were relatively good in a positive direction among most of the included studies. The two-directional arrows indicate that significant mutual relations between knowledge/attitude and attitude/practice were found. SMPs: social media platforms.

educated participants, and those with relatively higher income levels showed higher scores and/or mean level of knowledge. Furthermore, most studies showed a positive attitude toward COVID-19 among citizens/residents or healthcare workers during curfew/country closures and/or movement restrictions. Meanwhile, older participants, students, and private-sector jobs were associated with high practice scores (Figure 3). Collectively, the KAP domains reviewed in this work were relatively good in a positive direction among most of the included studies.

Most concerted efforts organized by the MOH were efficient/effective, with an observable influence on public education towards preventive measurements through multiple media platforms. Based on these findings, Alanezi et al proposed an interesting conceptual framework for augmenting public awareness with elements, including "information sources, types of information, communication channels, and the outcomes" formulated according to the Saudi Arabian lifestyle.[18] The yielded observations can provide baselines to the Saudi government(s) and other health associations for keeping the strict measures during the handling of similar epidemics, updating public awareness creation strategies, including the "targeted awareness-raising intervention programs", expanding targeted populations' attitudes toward the pandemic, and planning preventive measures during the lockdown periods in case of future outbreaks.

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Disclosure

The authors report no conflicts of interest in this work.

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