

Evaluating Pharmacists' Pharmacological Knowledge and Views Regarding Pfizer-BioNTech COVID-19 Vaccine in Saudi Arabia

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Background: The Pfizer-BioNTech COVID-19 vaccine has been widely used and approved for the prevention of 2019 coronavirus disease (COVID-19) for individuals aged 16 years and older in Saudi Arabia. The emergency use authorization of this vaccine is crucial to managing the pandemic in the Kingdom. This vaccination strategy requires proper usage, knowledge, and management by pharmacists and other health professionals.

Methods: This cross-sectional study was conducted using several previously validated questionnaires. Pharmacists working in different health sectors in Saudi Arabia in March–July 2021 participated via an online questionnaire. Comparative and descriptive analyses were used to analyze the data, and a P-value < 0.05 was considered significant.

Results: A total of 145 pharmacists with a mean age of 35.2 years (SD ± 5.59) were included. The study sample showed adequate general knowledge of COVID-19 and its causative virus signs. Overall, the results showed good knowledge of Pfizer-BioNTech COVID-19 vaccine and its pharmacological application among pharmacists in Saudi Arabia with significant chi square values ($p < 0.0001$).

Conclusion: Pharmacists have good knowledge and understanding of the Pfizer-BioNTech COVID-19 vaccine; interestingly, the majority expressed a high level of awareness and agreed that Pfizer-BioNTech COVID-19 vaccine is a valuable vaccine for COVID-19 management.

Keywords: COVID-19, Pfizer-Biontech, vaccination, pharmacists

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and the resulting disease, coronavirus disease 2019 (COVID-19) has impacted over 180 million people worldwide in June 2021.¹ COVID-19 is contagious and transmittable among humans. Symptoms range from mild or no symptoms to severe symptoms including respiratory symptoms (difficulty breathing, cough, dyspnea, and acute respiratory distress syndrome); musculoskeletal symptoms (myalgia, joint pain, and fatigue); gastrointestinal symptoms; and anosmia/dysgeusia.^{2–5} Oral symptoms may also arise upon co-infection of SARS-CoV2 and other bacterial infection that increases the severity of COVID-19. Symptoms such as oral lesion was found to be related to SARS-CoV2 infection.⁶ One study in 2017 mentioned that viral infections commonly bring ulceration of the oral mucosa as a direct manifestation. Tongue ulcers were also found present on some COVID-19 patients from France and Iran and they actually indicated early stages of the disease.⁷ On another study, specific oral complications such as perioral pressure ulcers, oral candidiasis, herpetic and hemorrhagic oral ulcers, and acute macroglossia were noted in patients under severe COVID-19.⁸

COVID-19 spreads mainly through droplets of saliva or discharge when coughing and sneezing as well as the subsequent inhalation of aerosol particles that contain infectious virus.^{9,10} In Saudi Arabia, COVID-19 posed a risk of about ten-fold higher in healthcare workers than those that are non-HCWs. As an effect of rampant infection among HCWs with the virus,

shortage of available frontliners was observed and then eventually led to inefficiency on managing the pandemic and collapse of the Saudi Arabian health care system.¹¹

The global response and emergency authorization were crucial to saving lives. Multiple vaccine candidates are under development. On December 10, 2020, the Saudi Food and Drug Authority (SFDA) approved the registration and use of Pfizer-BioNTech COVID-19 Vaccine in the Kingdom of Saudi Arabia. The Pfizer-BioNTech COVID-19 Vaccine (BNT162) is comprised of a nucleoside modified messenger RNA (mRNA) encoding an optimized viral full-length spike (S) glycoprotein of SARS-CoV-2.¹² The vaccine enhances human immunity system to identify the virus and then deal with it via creation a protein from the virus.¹³ The vaccine is administered by intramuscular injection into the deltoid muscle.^{14,15} It is contraindicated in people with severe allergic reactions (eg, anaphylaxis), immediate allergic reaction of any severity to polyethylene glycol (PEG), or polysorbate.¹⁶ Current reports on vaccine safety and efficacy from Saudi Ministry of Health are promising. However, a two-dose regimen of BNT162b2 will provide 95% protection against COVID19 in people aged 16 years or older.¹⁷ No deaths were reported after first receipt of Pfizer-BioNTech COVID-19 vaccine.¹⁶ Booster shots of the vaccine are still controversial, and more clinical research is urgently needed to monitor the immunity level of the patients post-vaccination.^{18,19}

However, some side effects were found after the vaccination: fatigue, headache, mild-to-moderate pain at the injection site, chills, and joint pain.^{17,20} One study also mentioned that the most common side effects of the mRNA-based vaccines on young adults are injection site pain, followed by fatigue, headache, and muscle pain.²¹ While oral side effects that occur are usually linked with headache, nausea, muscle pain, fever and lymphadenopathy.²² Local side effects occur after first and second dose while the systemic side effects emerge on the second dose only. The longevity of these effects usually last up to three days,²³ with 99.6% of all reported are mild symptoms.²¹ On the other hand, antihistamine is the most common drug used as treatment for these side-effects.²² According to the manufacturer, the vaccine should be stored in an ultra-cold freezer between -80°C and -60°C (-112°F and -76°F).²⁰

In Saudi Arabia, the Ministry of Health (MOH) is responsible for COVID-19 management and plays a very important role in the vaccination program. The MOH plans to vaccinate citizens and residents aged over 18 years.²⁴

A knowledge of pharmacology which include understanding the present innovations and mechanisms of how drugs are work in the body, is chief for frontline medical staff including pharmacists who plays a vital role in increase public knowledge about the medications. The pharmacist's role during the pandemic is extremely important including OTC medications through proper management using new and novel COVID-19 vaccines. There are several questions about the vaccine and its content, mechanism of action, and side effects. Being current with the pharmacology of the vaccines is helpful. The ENG implant is a single rod implant measuring 40 mm long and 2 mm in diameter with a solid core of ethylene vinyl acetate (EVA) impregnated with 68 mg of etonogestrel, the biologically active metabolite of desogestrel.^{7,8} The EVA copolymer allows controlled release of hormone over three years of use.⁹ Each implant is provided in a disposable sterile inserter for subdermal application.

Materials and Methods

This cross-sectional study was conducted using a convenience sample of pharmacy staff (n=145) in Saudi Arabia. Following the STROBE guidelines,²⁵ the goal was to evaluate their knowledge about the Pfizer-BioNTech COVID-19 vaccine and its current usage in Saudi Arabia. A self-administered questionnaire was designed and used as a tool to collect the data from the participants (pharmacists in Kingdom of Saudi Arabia) for the period of March-July 2021. Inclusion criteria are pharmacists aged 21 and above while exclusion criteria are other medical health workers and pharmacists that do not wish to participate in this study or those who cannot communicate for any reason. Data was obtained over the period of March-July 2021. Confidentiality of data will be ensured. Before doing the study. The participants will be informed about the study purpose and steps. Participation in this study was voluntary. Each volunteer was given ample time to ask any questions regarding the research and verbal consent was taken from them in the presence of a witness. Upon agreement via verbal consent, the data collector and the witness signed written consent. The consent of Participants' privacy and confidentiality was maintained, and no identification was collected. All hard and soft copies of the data could only be accessed by the research team. No conflict of interest is associated with this study.

A 23-item questionnaire regarding the knowledge and perception of the Pfizer-BioNTech COVID-19 vaccine was developed after an extensive review of the available literature.^{26–31}

The questionnaire was delivered in English language in two sections: The first was multiple-choice and detailed demographic data such as gender, age, work experience, pharmacy qualification, region, and place of employment. The second part dealt with knowledge-related questions such as mechanism of action of the vaccine, causative agent, route of administration, doses, efficacy, side effects, contraindications, and symptoms; this second part had 19 items and were multiple-choice and true/false. Two assistant professors of pharmacology from Umm Al-Qura University reviewed the survey to ensure the validity of the survey.

In addition, the questionnaire was piloted online with ten pharmacists from East Jeddah hospital.

The study was approved by Umm Al-Qura University. Statistical analyses were performed using GraphPad Prism™ (v9.3.1; UK). The data were subjected to descriptive analysis and was statistically represented in terms of numbers and percentages. A comparison between groups within each category was made using the Chi-square test. Differences were considered statistically significant when the p-values were ≤ 0.05 .

Results

Demographic of the Participant

There were 145 pharmacists in the study; more than two-thirds of the participants (68.3%) were male. The mean (\pm SD) age of the participants was 35.20 years (± 05.59). Most of the participants (40.7%; $n=82$) had more than 11 years of experiences; 22.1% had worked for 1–5 years, and 37.2% had worked for 6–10 years ($n=54$ and 32 respectively). Almost two-third of participants work in hospitals ($n=100$) compared to 20.7% working in health care centers. In addition, 49% have bachelor's degree, and 22% have postgraduate qualifications. Most (59.6%) participants were in the western region ($n=86$). The participants from both central and southern regions were equal (7.6%; $n=11$). All details are shown in [Table 1](#) and [Figure 1](#).

General Knowledge of COVID-19 and Pfizer-BioNTech COVID-19 Vaccine

There were seven statements intended to capture the participants' broad knowledge about using the vaccine. The proportion of participants who correctly answered the question was high when asked about major characterization of Pfizer-BioNTech COVID-19 vaccine. Almost three quarters of participants were aware that the Pfizer-BioNTech COVID-19 Vaccine was not the only approved vaccine for subjects aged over 16 years. Almost 80% correctly reported that it can be offered to persons with evidence of a prior SARS-CoV-2 infection. Almost 75% of participants knew that the vaccine will not alter the genetic code of the patient ($n=106$). The proportion of participants stating that the Pfizer-BioNTech COVID-19 Vaccine contained viruses or human cells were 59.3% compared to 77% whose answer was true. There was no significant difference between both responses toward the content of the vaccine: This indicates a lack in knowledge about the drug's content. Overall, the results showed good knowledge of Pfizer-BioNTech COVID-19 vaccine and its application in Saudi Arabia; six out of seven answers had a high chi-squared values ($p < 0.0001$) indicating significant difference. A complete description of the participant's knowledge of the PfizerBioNTech COVID-19 Vaccine is in [Table 2](#).

Awareness of COVID-19 and the Basic Pharmacology of the Pfizer-BioNTech COVID-19 Vaccine

In the ten-question focusing on general pharmacology ([Table 3](#)), the participants were asked to assess their awareness about the source of COVID-19 and the basic pharmacology of the PfizerBioNTech COVID-19 vaccine. Almost 86% ($n=125$) were aware that COVID-19 is a viral disease. However, only 37% of them knew that SARS-CoV-2 caused the disease. Moreover, 82.2% of the participants recognized that respiratory symptoms were the main symptom of COVID-19. Among the pharmacists who participated, 75.2% were aware that the Pfizer-BioNTech COVID-19 vaccine can give 95% protection against COVID-19. Two doses were responsible for the higher efficacy rate ($n=124$). Intramuscular administration of the vaccine was reported by 84.1% of participants.

Table 1 Demographics of the Respondents (N)= 145 That Participated in the Study

Characteristics	N	Percentage (%)	Chi-Squared	P-Value
Gender			19.37	0.0001
Male	99	68.3		
Female	46	31.7		
Age			69.25	0.0001
21–26 year	2	1.4		
27–32 year	61	42.1		
> 32 years	82	56.6		
Work experience			8.63	0.0001
1–5 years	32	22.1		
6–10 years	54	37.2		
>11 years	59	40.7		
Pharmacy qualification			19.50	0.0001
Diploma	46	31.7		
Bachelor	71	49		
Postgraduate qualification	28	19.3		
Region			146.96	0.0001
South	11	7.6		
West	86	59.3		
Central	11	7.6		
East	27	18.6		
North	10	6.9		
Working place			86.04	0.0001
Hospital	100	69		
Health care center	30	20.7		
Others	15	10.3		

Another aspect of this study highlighted the participant' response on the contraindication of the vaccine; 44.1% of them reported that an allergic reaction to the vaccine is the most important contraindication for the drug.

Discussion and Conclusion

The aim of this questionnaire was to evaluate pharmacists' views and pharmacological knowledge toward using the new Pfizer-BioNTech COVID-19 Vaccine in Saudi Arabia. Understanding pharmacology knowledge and pharmacotherapy skills of pharmacists is important in maintaining and increasing their knowledge about new vaccines. This is the first cross-sectional study to measure knowledge of viral pharmacology among pharmacists in Saudi Arabia. This study found out that knowledge about the pharmacology of the vaccine in Saudi Arabia has not been previously assessed. There are

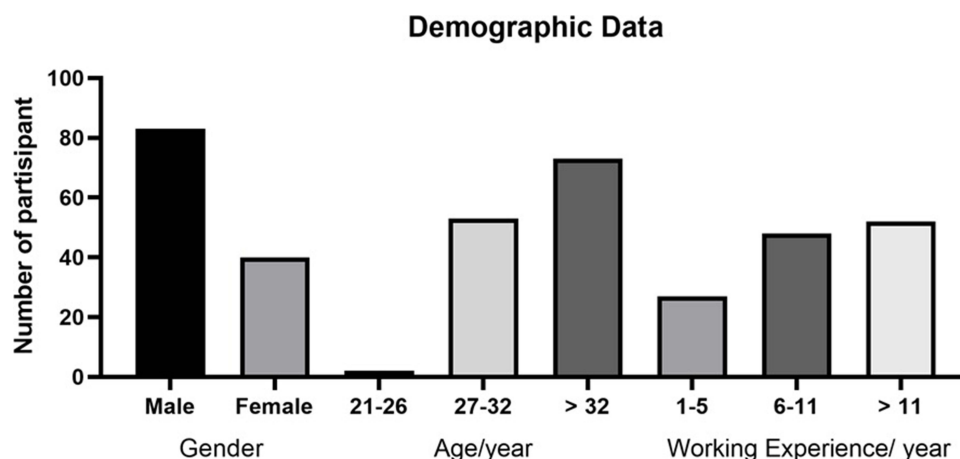


Figure 1 Demographics of the participants.

several studies about the role of pharmacists dealing with COVID-19 pandemic in USA, Jordan, Pakistan, Australia, and Poland.

Pharmacy departments across the globe had encountered several difficulties in handling the PfizerBioNTech vaccine. Prior to the pandemic, most did not have a large ultra-low temperature freezer that is needed for the storage of vaccine. Protocols on proper handling were not yet established as the pharmacists have little to no knowledge about it. This is aside from the fact that the medical frontliners have been limited and occupied from the battle of surge of COVID-19 cases. Thus, at the beginning, pharmacists also have less time to obtain enough knowledge about vaccine rollouts.

The results affirmed that pharmacists play a crucial role in managing the COVID-19 pandemic.^{32–36} Here, it was found that participants were fully aware of the vaccine's side effects, doses, efficacy, and contraindications. However, very few were fully aware of the exact mechanism of action of the vaccine.

There is a big variation in the rates of acceptance of COVID-19 vaccine administration on patients across the world. A low acceptance rate translates a serious problem as this poses a slower path towards herd immunity. In the Middle East, the acceptance rate was found to be low. The impression on COVID-19 vaccines in general must be improved to attain control of the pandemic.

Table 2 Questions Assessing Knowledge of Pharmacists Towards Pfizer-BioNTech COVID-19 Vaccine

Question Assessing Knowledge	Answer	Result Correctly % (n)	Chi Square	P-Value
Pfizer-BioNTech COVID-19 Vaccine is the only approved drug till date in Saudi Arabia used with patients below 16 years?	False	107 (73.8%)	32.83	0.0001
Pfizer-BioNTech COVID-19 Vaccine is used with patients below 16 years?	False	111 (76.6)	40.89	0.0001
Pfizer-BioNTech COVID-19 vaccine can be safely administered in persons with evidence of a prior SARS-CoV-2 infection.	True	113 (77.9)	45.25	0.0001
Pfizer-BioNTech COVID-19 Vaccine will alter your genetic code	False	106 (73.1)	30.96	0.0001
Pfizer-BioNTech COVID-19 Vaccine contains viruses or human cells	False	86 (59.3)	5.03	0.02
Pfizer-BioNTech COVID-19 Vaccine contains mRNA, sugar, fats, and other common chemical components	True	112 (77.2)	43.04	0.0001
Pfizer-BioNTech COVID-19 Vaccine is stored in a pharmacy at room temperature	False	90 (62.1)	8.45	0.003

Table 3 Questions Assessing the Knowledge of Pharmacology in COVID-19 and Pfizer-BioNTech 316 COVID-19 Vaccine

Questions Assessing the Knowledge of Pharmacology COVID-19 and Pfizer-BioNTech COVID-19 Vaccine	N	Percentage (%)	Chi-Squared	P-Value
Do you know the mechanism of action of Pfizer-BioNTech COVID-19 Vaccine?			1.99	0.15
Yes	64	44.1		
No	81	55.9		
Is COVID-19 caused by a virus or bacteria?			186.31	0.0001
Viral	125	86.2		
Bacterial	17	11.7		
I do not know	3	2.1		
Most commonly side effect of PfizerBioNTech COVID-19 Vaccine?			96.49	0.0001
Mild-to-moderate pain at the injection site	100	69		
Increased heart rate (tachycardia)	5	3.4		
I do not know	40	27.6		
What kind of virus induces COVID-19?			12.40	0.002
SARS-CoV-1	29	20		
SARS-CoV-2	54	37.2		
I do not know	62	42.8		
Most common symptoms of COVID-19?			164.79	0.0001
Respiratory symptoms	120	82.8		
GIT Symptoms	22	15.2		
I do not know	3	2.1		
Efficacy of Pfizer-BioNTech COVID-19 Vaccine?			118.06	
95% protection against COVID-19	109	75.2		
Partial efficacy	26	17.9		
I do not know	10	6.9		
How many doses of Pfizer-BioNTech COVID-19 Vaccine should be given to obtain highest efficacy?			181.84	0.0001
One	3	2.1		
Two	124	85.5		
I do not know	18	12.4		
What is the route of administration of Pfizer-BioNTech COVID-19 Vaccine?			170.97	0.0001
Intramuscular	122	84.1		
Intravenous	7	4.8		

(Continued)

Table 3 (Continued).

Questions Assessing the Knowledge of Pharmacology COVID-19 and Pfizer-BioNTech COVID-19 Vaccine	N	Percentage (%)	Chi-Squared	P-Value
I do not know	16	11		
What is the contraindication and excluded subjects from administration of Pfizer-BioNTech COVID-19 Vaccine?			12.31	0.002
Pregnancy	51	35.2		
Allergy reaction	64	44.1		
I do not know	30	20.7		
What is the ideal storage temperature of Pfizer-BioNTech COVID-19 Vaccine?			42.07	0.0001
Between -80°C and -60°C	82	56.6		
Below -20	44	30.3		
I do not know	19	13.1		

Pharmacists on the other hand, with enough knowledge can encourage patients can get vaccinated and it can only be done if they are properly informed about the vaccines' pharmacology.³⁷ One study also suggested that aside from the pharmacology of the vaccine, systematic approach must also be considered during vaccine rollout and administration because of other physical and environmental factors that may contribute to the efficacy and workability of the vaccine. In solution to provide ample knowledge and information about Pfizer-BioNTech COVID-19 vaccine, a strong pharmacy management team must be made to utilize well the vaccine, identify possible hindrances, set a clear timeline, and most importantly educate the staff regarding the whole process of vaccine rollout.³⁸ Other methods of lowering vaccine hesitancy is by introducing them, particularly the pharmacists conducting the vaccine rollouts, then the general public through implementation of epidemiology (infectious diseases) education within undergraduate dental curricula.³⁹

Institutional Review Board Statement

The study was conducted according to the guidelines for ethical scientific research at Umm Al-Qura University. The study was approved by the biomedical research ethics committee of Umm Al-Qura University (Approval No. (HAPO-02-K-012-2021-03-613)).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Johns Hopkins Coronavirus Resource Center. COVID-19 map. Available from: <https://pubmed.ncbi.nlm.nih.gov/11167664/>. Accessed June 26, 2021.
2. Carfi A, Bernabei R, Landi F. persistent symptoms in patients after acute COVID-19. *JAMA*. 2020;324(6):603–605. doi:10.1001/jama.2020.12603
3. Disser NP, De Micheli AJ, Schonk MM, et al. Musculoskeletal consequences of COVID-19. *J Bone Joint Surg Am*. 2020;102(14):1197–1204. doi:10.2106/JBJS.20.00847

4. Grasselli G, Tonetti T, Protti A, et al. Pathophysiology of COVID-19-associated acute respiratory distress syndrome: a multicentre prospective observational study. *Lancet Respir Med*. 2020;8(12):1201–1208. doi:10.1016/S2213-2600(20)30370-2
5. Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): the epidemic and the challenges. *Int J Antimicrob Agents*. 2020;55(3):105924. doi:10.1016/j.ijantimicag.2020.105924
6. Riad A, Klugar M, Krsek M. COVID-19-related oral manifestations: early disease features? *Oral Dis*. 2020;doi:10.1111/odi.13516
7. Riad A, Kassem I, Hockova B, Badrah M, Klugar M. Tongue ulcers associated with SARS-CoV-2 infection: a case series. *Oral Dis*. 2020;doi:10.1111/odi.13635
8. Hocková B, Riad A, Valky J, et al. Oral complications of ICU patients with COVID-19: case-series and review of two hundred ten cases. *J Clin Med*. 2021;10(4):581. doi:10.3390/jcm10040581
9. Marks M, Millat-Martinez P, Ouchi D, et al. Transmission of COVID-19 in 282 clusters in Catalonia, Spain: a cohort study. *Lancet Infect Dis*. 2021;21(5):629–636. doi:10.1016/S1473-3099(20)30985-3
10. World Health Organization. Coronavirus disease (COVID-19). Available from: https://www.who.int/healthtopics/coronavirus#tab=tab_1. Accessed June 26, 2021.
11. Noushad M, Nassani MZ, Alsalhani AB, et al. COVID-19 vaccine intention among healthcare workers in Saudi Arabia: a cross-sectional survey. *Vaccines*. 2021;9(8):835.
12. Sahin U, Muik A, Derhovanessian E, et al. COVID-19 vaccine BNT162b1 elicits human antibody and T(H)1 T cell responses. *Nature*. 2020;586(7830):594–599. doi:10.1038/s41586-020-2814-7
13. Mahase E. Covid-19: vaccine candidate may be more than 90% effective, interim results indicate. *BMJ*. 2020;371:m4347. doi:10.1136/bmj.m4347
14. Mulligan MJ, Lyke KE, Kitchin N, et al. Phase I/II study of COVID-19 RNA vaccine BNT162b1 in adults. *Nature*. 2020;586(7830):589–593. doi:10.1038/s41586-020-2639-4
15. Pilkington EH, Suys EJA, Trevaskis NL, et al. From influenza to COVID-19: lipid nanoparticle mRNA vaccines at the frontiers of infectious diseases. *Acta Biomater*. 2021;131:16–40. doi:10.1016/j.actbio.2021.06.023
16. CDC COVID-19 Response Team, Food and Drug Administration. Allergic reactions including anaphylaxis after receipt of the first dose of Pfizer-BioNTech COVID-19 vaccine - United States, December 14–23, 2020. *MMWR Morb Mortal Wkly Rep*. 2021;70(2):46–51. doi:10.15585/mmwr.mm7002e1
17. Polack FP, Thomas SJ, Kitchin N, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. *N Engl J Med*. 2020;383(27):2603–2615. doi:10.1056/NEJMoa2034577
18. Lopez Bernal J, Andrews N, Gower C, et al. Effectiveness of the Pfizer-BioNTech and Oxford-AstraZeneca vaccines on covid-19 related symptoms, hospital admissions, and mortality in older adults in England: test negative case-control study. *BMJ*. 2021;373:n1088. doi:10.1136/bmj.n1088
19. Meo SA, Bukhari IA, Akram J, Meo AS, Klonoff DC. COVID-19 vaccines: comparison of biological, pharmacological characteristics and adverse effects of Pfizer/BioNTech and Moderna vaccines. *Eur Rev Med Pharmacol Sci*. 2021;25(3):1663–1669. doi:10.26355/eurrev_202102_24877
20. Pfizer. Coronavirus facts, news & information. Available from: <https://www.pfizer.com/science/coronavirus/resources>. Accessed February 16, 2021.
21. Riad A, Hocková B, Kantorová L, et al. Side effects of mRNA-based COVID-19 vaccine: nationwide phase IV study among healthcare workers in Slovakia. *Pharmaceuticals*. 2021;14(9):873. doi:10.3390/ph14090873
22. Riad A, Pokorná A, Attia S, Klugarová J, Košík M, Klugar M. Prevalence of COVID-19 vaccine side effects among healthcare workers in the Czech Republic. *J Clin Med*. 2021;10(7):1428. doi:10.3390/jcm10071428
23. Riad A, Pokorná A, Klugarová J, et al. Side effects of mRNA-based COVID-19 vaccines among young adults (18–30 years old): an independent post-marketing study. *Pharmaceuticals*. 2021;14(10):1049. doi:10.3390/ph14101049
24. Ministry of Health. Various topics: COVID-19. Available from: <https://www.moh.gov.sa/en/AwarenessFigureform/VariousTopics/Pages/COVID-19.aspx>. Accessed June 26, 2021.
25. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening Of Reporting Of Observational Studies In Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Int J Surg*. 2014;12(12):1495–1499. doi:10.1016/j.ijsu.2014.07.013
26. Al Arifi MN. Evaluation of knowledge of Alzheimer disease among health university students in Riyadh, Saudi Arabia. *Saudi Pharm J*. 2020;28(8):911–915. doi:10.1016/j.jsps.2020.06.011
27. Al-Marshoudi S, Al-Balushi H, Al-Wahaibi A, et al. Knowledge, Attitudes, and Practices (KAP) toward the COVID-19 vaccine in Oman: a pre-campaign cross-sectional study. *Vaccines*. 2021;9(6). doi:10.3390/vaccines9060602
28. Ataş O, Talo Yildirim T. Evaluation of knowledge, attitudes, and clinical education of dental students about COVID-19 pandemic. *PeerJ*. 2020;8:e9575. doi:10.7717/peerj.9575
29. Dreher A, Pietrowsky R, Loerbroks A. Pandemic-related attitudes, stressors and work outcomes among medical assistants during the SARS-CoV-2 (“Coronavirus”) pandemic in Germany: a cross-sectional study. *PLoS One*. 2021;16(1):e0245473. doi:10.1371/journal.pone.0245473
30. Green CF, Mottram DR, Rowe PH, Pirmohamed M. Attitudes and knowledge of hospital pharmacists to adverse drug reaction reporting. *Br J Clin Pharmacol*. 2001;51(1):81–86. doi:10.1046/j.1365-2125.2001.01306.x
31. Kara E, Demirkan K, Ünal S. Knowledge and attitudes among hospital pharmacists about COVID-19. *Turk J Pharm Sci*. 2020;17(3):242–248. doi:10.4274/tjps.galenos.2020.72325
32. Basheti IA, Nassar R, Barakat M, et al. Pharmacists’ readiness to deal with the coronavirus pandemic: assessing awareness and perception of roles. *Res Social Adm Pharm*. 2021;17(3):514–522. doi:10.1016/j.sapharm.2020.04.020
33. Bukhari N, Rasheed H, Nayyer B. Pharmacists at the frontline beating the COVID-19 pandemic. *J Pharma Policy Pract*. 2020;13(1):8. doi:10.1186/s40545-020-00210-w
34. Falconer N, Monaghan C, Snoswell CL. The pharmacist informatician: providing an innovative model of care during the COVID-19 crisis. *Int J Pharm Pract*. 2021;29(2):152–156. doi:10.1093/ijpp/riaa017
35. Merks P, Jakubowska M, Drelich E, et al. The legal extension of the role of pharmacists in light of the COVID-19 global pandemic. *Res Social Adm Pharm*. 2021;17(1):1807–1812. doi:10.1016/j.sapharm.2020.05.033

36. Moreau C. The pharmacist as part of the primary care team during the COVID-19 pandemic. *J Am Board Fam Med*. 2021;34(Suppl):S21–s25. doi:10.3122/jabfm.2021.S1.200180
37. Sallam M. COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines*. 2021;9(2):160.
38. Li Q, Norman S, Guthrie P, et al. Strategies used to meet the challenges of mass COVID-19 vaccination by the pharmacy department in a large academic medical center. *Am J Health Syst Pharm*. 2021;78(18):1724–1731. doi:10.1093/ajhp/zxab184
39. Riad A, Abdulqader H, Morgado M, et al. Global prevalence and drivers of dental students' COVID-19 vaccine hesitancy. *Vaccines*. 2021;9(6):556.

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