Original Article

Evaluation of the Knowledge and Attitude of COVID-19 Vaccines Among Pilgrims

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Abstract

Although vaccines are recognized as one of the most successful public health measures, some individuals consider vaccination unsafe, ineffective, and unnecessary. The study aimed to evaluate knowledge and attitude of COVID-19 vaccines among pilgrims at a Hajj event (pilgrimage). A survey was conducted to assess knowledge and attitude toward COVID-19 vaccines among 251 pilgrims in Makkah City, Saudi Arabia. The results showed a moderate level of knowledge, with a mean of 76.1%. The majority (94.8%) of the participants know that "the COVID-19 vaccines are effective" followed by their knowledge "about the purpose of the vaccine" (84.5%). There was poor knowledge regarding the different types of COVID-19 vaccines (66.1%) and how they should be stored (66.1%). There was a strong agreement about the effectiveness of COVID-19 vaccines and to be taken during pilgrimage with a mean value of 4.4382 and 4.2311 respectively. Most pilgrims (46.6%) get awareness about COVID-19 vaccines from the official media, and social media (29.0%). There was a significant association between gender and the type of vaccines ($P < 0.05$). The Pfizer BioNTech vaccine was the most common vaccine used during the Hajj event (50.4%), followed by AstraZeneca (29.0%), Johnson & Johnson (24.7%), and Moderna (23.1%). It was concluded that there was a moderate level of knowledge and positive attitude regarding COVID-19 vaccines. Also, there was a strong agreement among pilgrims about the effectiveness of COVID-19 vaccines and the fact that they should be taken by all pilgrims.

Keywords: Knowledge, Attitude, COVID-19, Vaccines, Pilgrims

Introduction

The Hajj (pilgrimage) is considered one of the largest human gatherings in the world, as millions of Muslims from all over the world gather annually to perform this duty. Reports from the Kingdom of Saudi Arabia (KSA) indicate that some pilgrims may be exposed, while performing the rituals, to some infectious diseases that usually abound in the Hajj event such as influenza and colds, gastroenteritis, cholera, and food poisoning [1, 2]. Infectious diseases and epidemics such as coronavirus disease (COVID-19) are among the most important health risks in large communities. Since the outbreak of the COVID-19 pandemic, which was first reported in Wuhan, China, on December 31, 2019, until the end of January 2023, it has infected approximately 67 million cases while over 6.8 million deaths have been reported globally [3] suggesting the importance of vaccination to stop virus infection. As a result, the health authorities in KSA requested those who wished to perform Hajj must complete the necessary vaccinations for COVID-19, in addition to other vaccines against other infectious diseases such as meningitis and the seasonal influenza vaccine. A vaccine is a biological preparation that typically contains a weakened pathogen or a micro-organic-like component of the same infection-causing organism [4]. It is one of the active aspects of immunity acquired against infectious diseases in general, whether bacterial or viral (COVID-19) [5]. Vaccines have been shown to reduce the severity of the disease and prevent hundreds of deaths per day. They also reduce the possibility of community transmission of COVID-19 among individuals or the public [6, 7]. Despite minor effects, vaccination is very important because non-vaccination increases the risk of infectious and other diseases and their transmission to others, as is the case in the COVID-19 pandemic. The COVID-19

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vaccines have saved the global economy significant human and financial losses and helped control the pandemic.

Although COVID-19 vaccines are recognized as one of the most successful public health measures, an increasing number of individuals consider vaccination unsafe and unnecessary [8]. In addition, anxiety associated with COVID-19 vaccines, health concerns, and various side effects that appeared for some vaccines were associated with frequency or acceptance of vaccines, while fear of social, economic, and psychological consequences showed the same result [9, 10]. Thus, conspiracy theories and misinformation about the COVID-19 vaccine could lead to an increase in the number of vaccine hesitators [10-12]. As pilgrims from different countries with different knowledge and attitudes toward COVID-19 vaccination, there may be a divergence of opinions on COVID-19 vaccines, about the effectiveness and the fact that vaccination may be harmful. Lack of confidence among pilgrims in vaccines may pose a threat to the success of pilgrimage trips due to the COVID-19 infection. Therefore, the present study was conducted to assess knowledge and attitude of COVID-19 vaccines among a sample of pilgrims during Hajj season 1443 (2022) in Makkah City, Saudi Arabia.

Materials and Methods

A cross-sectional survey was conducted for pilgrims about their knowledge, and attitude toward COVID-19 vaccines from September to October 2022. The draft questionnaire was tested on a small sample of pilgrims through face-to-face interviews, during which participants were first asked to complete the questionnaires alone. Questionnaires were finalized and digitalized to be completed on mobile devices after adjusting the contents and wording based on the feedback collected from interviewees. The study participants were offered the questionnaire in one of two languages: Arabic and English. The questionnaire covered 3 domains: (i) Demographics and Practices among pilgrims, (ii) Knowledge of pilgrims regarding the COVID-19 Vaccine, and (iii) Attitudes of pilgrims regarding the COVID-19 Vaccine. Knowledge had three options: Yes/No/somewhat. Similarly, the attitude section had 5 options on the Likert scale (strongly agree to strongly disagree). Knowledge questions had the following scoring system: correct answer (Yes) =٢ and wrong answer (No) =0. Partial answer (somewhat) =1. The contents evaluated in Knowledge of, the importance, effectiveness, side effects, content doses, and recipients' ages of COVID-19 vaccines. Evaluation knowledge, and attitude, of COVID-19 vaccines among pilgrims was assessed on a 5-point Likert scale (1: Strongly disagree, 2: disagree, 3: neutral, 4: agree, 5: Strongly agree). The questions used a five-point Likert scale on knowledge and attitudes about COVID-19 vaccines. The mean in the domains of the five-point Likert scale was as follows; From 1 to 1.80 (Strongly disagree), from 1.81 to 2.60 (disagree), from 2.61 to 3.40 (neutral), from 3.41 to 4.20 (agree), from 4.21 to 5.0 (Strongly agree). Verbal consent was obtained from each participant. The confidentiality and privacy of the subjects were maintained.

Data Analysis

SPSS (Statistical Package for the Social Sciences version 22) software was used for data analysis. Descriptive statistics including frequency, mean, and standard deviation were used to describe different characteristics. The chi-square test was used to test whether the demographic variables are related to each other. A *p*-value of less than 0.05 was considered "statistically significant.

Results and Discussion

Table 1 shows the demographical characteristics of a total of 251 respondents **(Table 1)**. The sample of the study was composed of 189 (75.3%) male respondents and 62 (24.7%) female respondents. Of the 251 respondents, the most participating age group was the group (41-60) years (55%), followed by the age group (21-40) (38.6%) and the “above 60 years” category (6%). The most popular nationalities that participated in this study were Saudi Arabia (30.3%), followed by Egyptian (16.3%), Indian (13.6%), Sudanese (6.8%), and Bangladeshi (6%). The highest level of education among the participating groups was the graduate (university) level (57.8%), followed by the secondary level (30.7%) and post-graduate level (10.8%). Almost all (except the unknown one) the respondents were also vaccinated (97.6%). **Table 2** shows the demographics of participants.

Table 1. Demographics of the participants

	Variable	No.	%
Sex	Male	189	**75.3**
	Female	62	**24.7**
	Total	251	**100**
Age	=< 20 years	1	**0.4**
	21-40 years	97	**38.6**
	41-60 years	138	**55.0**
	over 60 years	15	**6.0**
	Total	251	**100**
Education level	Illiterate	2	**0.8**
	secondary or less	77	**30.7**
	collegiate	145	**57.8**
	Postgraduate education	27	**10.8**
	Total	251	**100**
Nationality	Saudi	76	**30.3**
	Egypt	41	**16.3**
	India	34	**13.6**
	Sudan	17	**6.8**
	Bangladesh	15	**6.0**
	Yemen	9	**3.6**
	Algeria	8	**3.2**
	Syria	8	**3.2**

Tunisia	7	**2.8**
Malaysia	6	**2.4**
Jordan	5	**2**
Pakistan	5	**2**
Nepal	3	**1.2**
Turkish	3	**1.2**
Somalia	2	**0.8**
Sri Lanka	2	**0.8**
Indonesia	2	**0.8**

Table 2 shows COVID-19 vaccine knowledge among the participants (pilgrims sample). The participants in the study population expressed a moderate level of knowledge, with a mean of 76.1%. The majority (94.8%) of the participants know that "the COVID-19 vaccines are effective" followed by their knowledge "about the purpose of the vaccine" (84.5%) and that the vaccine is useful for all ages of people (78.9%). Also, the knowledge of participants was poor (less than 70%) in terms of the knowledge about (i) The different types of COVID-19 vaccines (66.1%); (ii) how should vaccines be stored (66.1%); and (iii) how the vaccine works (66.9%).

Table 2. COVID-19 vaccine knowledge among the pilgrims' sample

	Knowledge	Yes		Somewhat		No		
		No.	%	No.	%	No.	%	
1	Do you know what is the vaccine in general?	177	70.5	46	18.3	28	11.2	0.802
2	Do you know the purpose of the vaccine?	212	84.5	32	12.7	7	2.8	0.445
3	Do you know how the vaccine works?	173	68.9	21	8.4	57	22.7	0.717
4	Do you know how should vaccines be stored?	171	68.1	55	21.9	25	10. 0	0.786
5	Do you know that vaccines are safe?	191	76.1	41	16.3	19	7.6	0.628
6	Do you know the importance of the booster doses of COVID-19 vaccines?	186	74.1	53	21.1	12	4.8	0.521
7	Do you know that the vaccine is useful for all ages of people?	198	78.9	31	12.4	22	8.8	0.504
8	Do you know the different types of COVID-19 vaccines?	166	66.1	46	18.3	39	15.5	0.705
9	Do you know that the COVID-19 vaccines are effective?	238	94.8	11	4.4	2	0.8	0.519
10	Do you know the COVID-19 vaccine has low side effects?	186	74.1	37	14.7	28	11.2	0.649
	Mean	190.9	76.1	37.2	14.8	22.9	9.1	

Table 3. COVID-19 vaccine attitude among the pilgrims' sample

	Study variables	Strongly agree		Agree		Uncertain		Disagree		Strongly disagree	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	The vaccines are effective against COVID-19	126	50.1	112	44.6	11	4.4	1	0.4	1	0.4
2	All pilgrims should have COVID-19 vaccine	114	45.4	100	39.8	20	8	15	6	2	0.8
3	The side effects of the COVID-19 vaccine are not serious	63	25.1	123	49	37	14.7	20	8.0	8	3.2
4	COVID-19 vaccines do not affect fertility	66	26.3	106	42.2	54	21.5	19	7.6	6	2.4
5	More than one vaccine can be taken for COVID-19	82	32.7	119	47.4	35	13.9	14	5.6	1	0.4
6	Those who have taken the COVID-19 vaccine can get infected	81	23.3	121	48.2	36	14.3	12	4.8	1	0.4
7	A booster (additional) dose of COVID-19 vaccines is important	86	34.3	105	41.8	41	16.3	16	6.4	3	1.2
8	In general, the vaccine is useful for people of all ages	81	32.3	117	46.6	31	12.4	15	6.0	7	2.8
9	COVID-19 vaccines do not contain a live version of the COVID-19 virus	87	34.7	90	35.9	46	18.3	22	8.8	6	2.4
10	COVID-19 vaccine may cause fever	65	25.9	88	35.1	48	19.1	38	15.1	12	4.8
11	COVID-19 vaccine may cause musle pain	68	27.1	90	35.9	46	18.3	40	15.9	7	2.8

Table 4 shows that awareness about COVID-19 vaccines among the respondents was from the official media (46.6%), followed by social media (29.0%) and the Ministry of Health websites (7.2%). Most of the participants used the Pfizer BioNTech vaccine against COVID-19 (50.4%), followed by AstraZeneca (29.0%), Johnson & Johnson (24.7%), and Moderna (23.1%).

Table 4. Practices of COVID-19 vaccines among the participants

		No	%
Received the vaccination	Yes	246	97.9
	No	6	2.4
Total		251	100
COVID-19 Vaccine type	Total		
	Pfizer BioNTech	126	50.2
	AstraZeneca	73	29.0
	Johnson & Johnson	62	24.7
	Moderna	58	23.1
	Other	45	17.9
The main information sources of COVID-19 vaccine	Official media	117	46.6
	Social networking	76	30.3
	Ministry of Health website	18	7.2
	others	42	16.7

Table 4 shows a strong agreement of the participants' agreement with the effectiveness of COVID-19 vaccines and the necessity to have them with a mean value of 4.4382 and 4.2311 respectively. There was an overall agreement regarding; the possibility of a vaccinated person getting infected (with a mean of 4.0717), the possibility of taking two different vaccines (with a mean of 4.0637), the importance of booster dose of COVID-19 vaccines (with a mean of 4.0159), the usefulness of the vaccine for all ages (with mean= 3.9960), COVID-19 vaccines lack live version of the virus (with mean= 3.9163), the low side effects of COVID-19 vaccines (with mean= 3.8486), uneffectiveness to fertility (with mean= 3.8247), COVID-19 vaccine may cause musle pain (with mean= 3.6853), and COVID-19 vaccine may cause fever (mean= 3.6215).

Table 5. Statistical analysis including mean, standard deviation, T-test, and direction of variables

Order		Mean	Std. Dev.	T-test	%	Direction
1	The vaccines are effective against COVID-19	4.4382	.63810	35.709	88.764	Strongly agree
2	All pilgrims should have COVID-19 vaccine	4.2311	.89129	21.883	84.622	Strongly agree
3	Those who have taken the COVID-19 vaccine can get infected	4.0717	.83117	20.428	81.434	Agree
4	Two different vaccines can be taken for COVID-19	4.0637	.85084	19.807	81.274	Agree
5	A booster dose of COVID-19 vaccines is important	4.0159	.93367	17.239	80.318	Agree
6	In general, the vaccine is useful for people of all ages	3.9960	.96953	16.276	79.92	Agree
7	COVID-19 vaccines do not contain a live version of the virus.	3.9163	1.04545	13.886	78.326	Agree
8	The side effects of the COVID-19 vaccine are not serious	3.8486	.99247	13.547	76.972	Agree
9	COVID-19 vaccines do not affect fertility	3.8247	.98445	13.272	76.494	Agree
10	COVID-19 vaccine may cause musle pain	3.6853	1.11738	9.716	73.706	Agree
11	COVID-19 vaccine may cause fever	3.6215	1.16111	8.480	72.43	Agree
	Total	43.7131	6.94647	24.434	79.4784	Agree

Table 5 shows degrees of association between participants' demographics and some analyzed variables. The findings reveal that gender is significantly associated with COVID-19 vaccine type and non-COVID-19 vaccine ($P < 0.05$). No significant association was found between education and age with the type of COVID-19 and non-COVID-19 vaccines, and the COVID-19 vaccine types ($P > 0.05$).

Table 6. Degrees of association between demographic and variables

Pearson Chi-Square	Gender		Education		Age	
	Value	p-value	Value	p-value	Value	p-value
COVID-19 vaccine type	49.119	0.001	70.634	0.326	49.402	0.973
No of COVID-19 vaccines	6.960	0.073	15.736	0.073	12.778	0.173
Non covid-19 vaccine	21.286	0.00	10.929	0.091	1.323	0.970

The annual Hajj pilgrimage is one of the most known mass gathering events. During the COVID-19 pandemic, it was requested that the pilgrims must be under 65 years, must be fully vaccinated against COVID-19, and must have a negative PCR test [11]. One of the challenges that arise with the COVID-19 vaccine is its acceptability at both a country level and an individual level [12]. The present study was conducted to assess knowledge and attitudes of COVID-19 vaccines among pilgrims. Our sample was composed of 251, most of them were males (75.3%) and 55% of them belonged age group (41-60) years, 57.8% of them were graduate (University) level (57.8%). Similar studies found that 50% of the study participants belong to the age group 40-60 years and nearly most of them were educated [13, 14]. Also, our study found that the major source for knowledge and awareness about COVID-19 vaccines among the respondents was from the official media (46.6%), followed by social media (29.0%) and the Ministry of Health websites (7.2%). Oppositly one study found that 22.8% and 28.7% of the respondents had heard about the COVID-19 vaccine from their family members, friends, and neighbors respectively [15]. Another study showed that most of the participants used search engines (57.6%) to seek information about vaccines [16].

The present study expressed a moderate level of knowledge about COVID-19 vaccines, with a mean of 76.1%. The majority of the participants knew that the COVID-19 vaccines were effective and understood the purpose of the vaccines and their common usefulness for all ages of people. However, our study showed a low rate of knowledge among participants about the presence of different types, storage, and the work of COVID-19 vaccines.

The present study showed a strong agreement between the participants' knowledge of the effectiveness of COVID-19 vaccines and the necessity to have them. Many similar studies have shown that vaccines were effective and protective against infection, severe disease, hospitalization, and death [12, 17, 18]. Other studies showed that high knowledge was significantly associated with a more positive attitude and perception [19, 20]. The study showed an overall agreement regarding; the possibility of a vaccinated person getting infected, the possibility of taking two different vaccines, importance of booster doses of COVID-19 vaccines. In addition, our study showed a positive attitude towards the usefulness of the vaccine for all ages, the vaccines lack a live version of the virus, and the low side effects of COVID-19 vaccines. Other studies showed that the vast majority of participants received their vaccinations with an overall positive attitude toward the COVID-19 vaccination [21-23]. Similar studies showed the usefulness of the vaccine for small ages [24], COVID-19 vaccines lack a live version of the virus [25], and the low side effects of COVID-19 vaccines [26].

Furthermore, one study indicated that those who received the first dose of COVID-19 vaccines and were infected after three weeks had a lower risk of transmitting the virus to others by 38 percent to 49 percent compared to people who did not get the vaccine yet [27]. Although vaccines are not 100 percent effective in preventing severe symptoms or transmission of infection, they are necessary to help return to normal life, especially in crowds (Hajj). One study reported that a total of 677 participants (from 7563) showed an intention to refuse COVID-19 vaccination due to the fear of adverse reactions to the COVID-19 vaccine [16].

Our study showed that most of the participants used the Pfizer BioNTech vaccine, followed by AstraZeneca, Johnson & Johnson, and Moderna.

A study used sentiment analysis towards Pfizer/BioNTech, AstraZeneca/Oxford, and Moderna COVID-19 vaccines indicated that the sentiment regarding Pfizer/BioNTech and Moderna vaccines remained positively stable, whereas that of the AstraZeneca/Oxford vaccine seems to be decreasing in positivity [28]. Moreover, a study conducted in Saudi Arabia confirmed the low side effects of Pfizer-BioNTech which were the typical symptoms of most previous vaccines [29].

The most two available COVID-19 vaccines in the world are Pfizer and AstraZeneca which are highly effective with very rare side effects [30, 31]. It also found that using different vaccines produced a higher level of immune cells primed to attack the coronavirus than did giving two doses of the same vaccine [32, 33] in addition, the doses of COVID-19 vaccines can reduce the risk of transmission within the community [34]. Previous studies by the Public Health Authority in England have confirmed the effectiveness of the "Pfizer-Biontech" and "Oxford-AstraZeneca" vaccines in reducing COVID-19 infection among the elderly (over 60 years of age) and preventing a large number of deaths, including death for those over 60 years of age [35, 36]. Our findings there was a significant association of gender with COVID-19 vaccine type and non-COVID-19 vaccine ($P < 0.05$) which is very close to many studies [37, 38].

Generally, vaccination makes it possible to travel and feel safe, thus preventing and reducing health risks [39] that pilgrims may face. It prevents deaths due to COVID-19, saves time [9] and money on treatment, and vaccines help to return to normal life and feel safe [40] while performing rituals. Despite the great importance and benefits of vaccines, they are not 100 percent effective in preventing severe symptoms or transmission of infection [41].

Conclusion

It could be concluded that there was generally moderate knowledge and positive attitude of pilgrims towards COVID-19 vaccines. There was a strong agreement among pilgrims about the effectiveness of COVID-19 vaccines and hence should be taken by all pilgrims. The Pfizer BioNTech followed AstraZeneca vaccines were the most commonly used vaccines during the Hajj event. Gender was significantly associated with all types of vaccines (COVID-19 and non-COVID-19 vaccines) with P-value < 0.05).

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REFERENCES

1. Alzahrani AG, Choudhry AJ, Al Mazroa MA, Turkistani AH, Nouman GS, Memish ZA. Pattern of diseases among visitors to Mina health centers during the Hajj season, 1429 H (2008 G). J Infect Public Health. 2012;5(1):22-34.
2. Fatani MI, Al-Afif KA, Hussain H. Pattern of skin diseases among pilgrims during Hajj season in Makkah, Saudi Arabia. Int J Dermatol. 2000;39(7):493-6.
3. Hillary VE, Ceasar SA. An update on COVID-19: SARS-CoV-2 variants, antiviral drugs, and vaccines. Heliyon. 2023;9(3):e13952.
4. Calina D, Docea AO, Petrakis D, Egorov AM, Ishmukhametov AA, Gabibov AG, et al. Towards effective COVID-19 vaccines: Updates, perspectives and challenges (Review). Int J Mol Med. 2020;46(1):3-16.
5. Zhang C, Wang H, Wen Z, Bao Z, Li X. Collective and individual assessment of the risk of death from COVID-19 for the elderly, 2020-2022. China CDC Wkly. 2023;5(18):407-12.
6. Gupta A, Singh AP, Singh VK, Sinha RP. Recent developments and future perspectives of vaccines and therapeutic agents against SARS-CoV2 using the BCOV_S1_CTD of the S protein. Viruses. 2023;15(6):1234.
7. Tian Y, Hu D, Li Y, Yang L. Development of therapeutic vaccines for the treatment of diseases. Mol Biomed. 2022;3(1):40.
8. Finsterer J. SARS-CoV-2 vaccinations are unsafe for those experiencing post-vaccination Guillain-Barre syndrome. Ann Med Surg (Lond). 2021;68:102584.
9. Gotlib J, Sobierajski T, Jaworski M, Wawrzuta D, Borowiak E, Dobrowolska B, et al. "Vaccinate, Do Not Hesitate!" Vaccination readiness against COVID-19 among polish nursing undergraduate students: A national cross-sectional survey. Vaccines (Basel). 2021;9(9):1029.
10. Widdess-Walsh P. Don't hesitate to vaccinate-The safety of covid-19 vaccination and epilepsy. Epilepsy Curr. 2023;23(1):18-9.
11. Al-Tawfiq JA, Kattan RF, Memish ZA. Escalating the 2022 Hajj during the third year of the COVID-19 pandemic. J Travel Med. 2022;29(6):taac059.
12. Yarlagadda H, Patel MA, Gupta V, Bansal T, Upadhyay S, Shaheen N, et al. COVID-19 vaccine challenges in developing and developed countries. Cureus. 2022;14(4):e23951.
13. Bhartiya SKN, Singh T, Murugan S, Rajavel S, Wadhwani M. Knowledge, attitude and practice towards COVID-19 vaccination acceptance in West India. Int J Community Med Public Health. 2021;8(3):1170-6
14. Sengupta M, Dutta S, Roy A, Chakrabarti S, Mukhopadhyay I. Knowledge, attitude and practice survey towards COVID-19 vaccination: A mediation analysis. Int J Health Plann Manage. 2022;37(4):2063-80.
15. Abebe H, Shitu S, Mose A. Understanding of COVID-19 vaccine knowledge, attitude, acceptance, and determinates of COVID-19 vaccine acceptance among adult population in Ethiopia. Infect Drug Resist. 2021:2015-25.
16. Del Riccio M, Bechini A, Buscemi P, Bonanni P. On behalf of the working group D, Boccalini S. Reasons for the intention to refuse COVID-19 vaccination and their association with preferred sources of information in a nationwide, population-based sample in Italy, before COVID-19 vaccines roll out. Vaccines (Basel). 2022;10(6):913.
17. Chirico F, Teixeira da Silva JA, Tsigaris P, Sharun K. Safety & effectiveness of COVID-19 vaccines: A narrative review. Indian J Med Res. 2022;155(1):91-104.
18. Chen J, Huang B, Deng Y, Wang W, Zhai C, Han D, et al. Synergistic immunity and protection in mice by co-immunization with DNA vaccines encoding the spike protein and other structural proteins of SARS-CoV-2. Vaccines (Basel). 2023;11(2):243.
19. Papagiannis D, Malli F, Raptis DG, Papathanasiou IV, Fradelos EC, Daniil Z, et al. Assessment of knowledge, attitudes, and practices towards new coronavirus (SARS-CoV-2) of health care professionals in Greece before the outbreak period. Int J Environ Res Public Health. 2020;17(14):4925.
20. Al-Marshoudi S, Al-Balushi H, Al-Wahaibi A, Al-Khalili S, Al-Maani A, Al-Farsi N, et al. Knowledge, attitudes, and practices (KAP) toward the COVID-19 vaccine in Oman: A pre-campaign cross-sectional study. Vaccines (Basel). 2021;9(6):602.
21. Bakdash T, Marsh C. Knowledge, attitudes, and beliefs regarding the COVID-19 pandemic among women in Kansas. J Community Health. 2021;46(6):1148-54.
22. Gibbons E, Stein C, Springer J, Roemhild E, Meadows E, Dowling J. Knowledge, attitudes, and beliefs of pediatric health care workers: Understanding the response to COVID-19. J Pediatr Health Care. 2022;36(4):305-9.
23. Mahmud S, Mohsin M, Khan IA, Mian AU, Zaman MA. Knowledge, beliefs, attitudes and perceived risk about COVID-19 vaccine and determinants of COVID-19 vaccine acceptance in Bangladesh. PLoS One. 2021;16(9):e0257096.
24. Amarin JZ, Hayek H, Halasa NB. COVID-19 vaccines protect children of all ages. J Clin Invest. 2022;132(17):e164102.
25. Krug PW, Wang L, Shi W, Kong WP, Moss DL, Yang ES, et al. EV-D68 virus-like particle vaccines elicit cross-clade neutralizing antibodies that inhibit infection and block dissemination. Sci Adv. 2023;9(20):eadg6076.
26. Riad A, Alsaad SS, Almurikhi AA, Alzahrani FA, Alghamdi AM, Alzaid EH, et al. Side effects of COVID-19 vaccines primer doses: Experience of Saudi healthcare workers participating in CoVaST-SA. Vaccines (Basel). 2022;10(12):2137.
27. Vasileiou E, Simpson CR, Shi T, Kerr S, Agrawal U, Akbari A, et al. Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: A national prospective cohort study. Lancet. 2021;397(10285):1646-57.
28. Marcec R, Likic R. Using Twitter for sentiment analysis towards AstraZeneca/Oxford, Pfizer/BioNTech and Moderna COVID-19 vaccines. Postgrad Med J. 2022;98(1161):544-50.
29. El-Shitany NA, Harakeh S, Badr-Eldin SM, Bagher AM, Eid B, Almukadi H, et al. Minor to moderate side effects of Pfizer-BioNTech COVID-19 vaccine among Saudi residents: A retrospective cross-sectional study. Int J Gen Med. 2021:1389-401.
30. Atanasov V, Barreto N, Whittle J, Meurer J, Weston BW, Luo QE, et al. Selection effects and COVID-19 mortality risk after Pfizer vs. moderna vaccination: Evidence from linked mortality and vaccination records. Vaccines (Basel). 2023;11(5):971.
31. Katoto PD, Tamuzi JL, Brand AS, Marangu DM, Byamungu LN, Wiysonge CS, et al. Effectiveness of COVID-19 Pfizer-BioNTech (BNT162b2) mRNA vaccination in adolescents aged 12-17 years: A systematic review and meta-analysis. Hum Vaccin Immunother. 2023;19(1):2214495.
32. Wolszczak Biedrzycka B, Bienkowska A, Smolinska-Fijolek E, Biedrzycki G, Dorf J. The influence of two priming doses of different anti-COVID-19 vaccines on the production of Anti-SARS-CoV-2 antibodies after the administration of the Pfizer/BioNTech booster. Infect Drug Resist. 2022;15:7811-21.
33. Kudlay D, Svistunov A, Satyshev O. COVID-19 vaccines: An updated overview of different platforms. Bioengineering (Basel). 2022;9(11):714.
34. Rodrigues CMC, Plotkin SA. Impact of Vaccines; health, economic and social perspectives. Front Microbiol. 2020;11:1526.
35. Baden LR, El Sahly HM, Essink B, Kotloff K, Frey S, Novak R, et al. Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine. N Engl J Med. 2021;384(5):403-16.
36. Dagan N, Barda N, Kepten E, Miron O, Perchik S, Katz MA, et al. BNT162b2 mRNA Covid-19 vaccine in a nationwide mass vaccination setting. N Engl J Med. 2021;384(15):1412-23.
37. Green MS, Abdullah R, Vered S, Nitzan D. A study of ethnic, gender and educational differences in attitudes toward COVID-19 vaccines in

Israel - implications for vaccination implementation policies. Isr J Health Policy Res. 2021;10(1):26.
38. Shapiro JR, Privor-Dumm L, Rosser EN, Leng SX, Klein SL, Morgan R. The intersection of gender and race in older adults' decision to receive COVID-19 vaccines. Vaccine. 2023;41(1):211-8.
39. Fleming JA, Baral R, Higgins D, Khan S, Kochar S, Li Y, et al. Value profile for respiratory syncytial virus vaccines and monoclonal antibodies. Vaccine. 2023.
40. Hajissa K, Mutiat HA, Kaabi NA, Alissa M, Garout M, Alenezy AA, et al. COVID-19 Vaccine acceptance and hesitancy among migrants, refugees, and foreign workers: A systematic review and meta-analysis. Vaccines (Basel). 2023;11(6):1070.
41. Shinjoh M, Furuichi M, Tsuzuki S, Iqbal A, Fukushima N, Soen S, et al. Effectiveness of inactivated influenza and COVID-19 vaccines in hospitalized children in 2022/23 season in Japan - The first season of co-circulation of influenza and COVID-19. Vaccine. 2023;41(33):4777-81.