ISSN: 2423-4923
eISSN: 2383-2819

Comparison of the Effects of Different COVID-19 Vaccine Platforms on the Hospitalization Rate

Abolfazl Gilani [1], Saeedeh Hajebi Khaniki [2], Fatemeh Khazaei Fard [3], Ehsan Baradaran Sirjani [4], Roham Sarmadian[5]*

[1]Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran. [2]Department of Mathematical Sciences, University of Nevada, Las Vegas, USA. [3]School of medicine, Mashhad University of Medical Sciences, Mashhad, Iran. [4]Clinical Research Development Unit, Ghaem Hospital, Mashhad University of Medical Sciences, Mashhad, Iran. [5]Infectious Diseases Research Center, Arak University of Medical Sciences, Arak, Iran.

A R T I C L E I N F O

Research Article

VacRes, 2022
Vol. 9, No.2, 42 - 46
Received: March 01, 2023
Accepted: May 21, 2023
Pasteur Institute of Iran

***Corresponding Author**
Roham Sarmadian;
Infectious Diseases Research Center, Arak University of Medical Sciences, Arak, Iran.
Email: rsarmadian@yahoo.com
Tel/Fax: +988631473521

KEYWORDS: Viral vector vaccines, COVID-19, Hospitalization, AstraZeneca, Sputnik-V, Covaxin

A B S T R A C T

Introduction: Several types of COVID-19 vaccines have been developed so far for the public use. In this study, we aimed to evaluate the effectiveness of different types of COVID-19 vaccines (*i.e.*, viral vector, conjugated and inactivated virus) and the effects of the number of injected doses on the associated risks. **Methods**: Patients with positive PCR test results for COVID-19 who had been admitted to the Infectious Disease Screening Center (IDSC) of Jiroft in Iran were included in this study. Information from the patients' medical records from February 2022 to June 2022 was collected, retrospectively. **Result:** In total, 309 COVID-19 patients (48.5% male and 51.5% female) with a mean age of 39.9±16.7 were included in this study. Our result showed that the viral vector vaccines reduced the chance of hospitalization by 67 % (14.3% in vaccinated patients vs. 73.3% in the unvaccinated group). Moreover, the odds of hospitalization in patients who had received the same type of vaccines as their first dose and their boosters were four times higher than the other patients (17.4% vs. 5.6%) (P=0.02). Also, the analysis of our data illustrated that as the number of the vaccines and the boosters increased, the chance of getting severe COVID-19 decreased (P<0.001), and none of the patients who had received 3 doses of the boosters were hospitalized due to COVID-19. However, There was no significant relationship between the status of the patients (inpatient or outpatient) and the time interval between COVID-19 vaccines and their boosters (P>0.05). **Conclusion:** Overall, the viral vector vaccines such as AstraZeneca and Sputnik-V were most successful in reducing the hospitalization rate of COVID-19 patients.

INTRODUCTION

The first case of Coronavirus disease 2019 (COVID-19) was diagnosed on December 31, 2019, in Wuhan, China (1) which rapidly spread all over the world. The World Health Organization (WHO) announced COVID-19 outbreak as a global pandemic on March 2020 (2).

COVID-19 symptoms are mostly fever, cough, dyspnea, fatigue, and diarrhea. Moreover, it can lead to critical complications like acute respiratory distress syndrome (ARDS) with arrhythmia, acute cardiac injury, heart failure, vascular thrombosis, acute kidney injury (AKI), and splenic infarction (3-5). Furthermore, a thirty-day mortality rate of patients with COVID-19 is estimated to be approximately one-fourth of the infected patients (6). The level of anti-SARS-CoV-2 IgG antibodies can remain high up to 5 months after COVID-19 (7) and T cells decrease between 6 and 15 months after the infection (8). Vaccination can stimulate the body's immune response by exposing the immune system to the viral antigens in order to produce specific antibodies without triggering COVID-19 (9). Therefore, to make long-term immunity and control the spread of the disease, using an effective and safe vaccine with the right dosage and schedule seemed to be necessary (10, 11).

Up to now, several types of COVID-19 vaccines, including CureVac, Pfizer-BioNTech, Moderna, Janssen-Johnson & Johnson, Astra-Zeneca, Sputnik-V, CanSino, Bharat Biotech, Sinopharm and Sinovac have been developed around the world (12). COVID-19 vaccination can significantly affect infection prevention and reduce non-intensive care unit (ICU) hospitalizations, ICU hospitalizations, and deaths (13, 14). Moreover, a study on Iranian population has shown that vaccination with AstraZeneca and Sputnik lead to the highest and lowest reductions in the infection, hospitalization, and death risk, respectively (15). So far, few studies have investigated the efficiency of the number of COVID-19 vaccine doses on the hospitalization rate in Iran. Therefore, we aimed to evaluate the effectiveness of different types of vaccines and the number of injected doses on the risk of hospitalization.

[DOI: 10.61186/vacres.9.2.42]

MATERIALS AND METHODS

Ethics Statement

This study was performed in accordance with the Helsinki Declaration and was approved by the IDSC, Jiroft University of Medical Sciences, Jiroft, Kerman Province, Iran. (Reference number: JR-IDSC-2022/888556).

Data Collection

In this retrospective study, we collected information from the medical records of 309 patients admitted to the Infectious Disease Screening Center (IDSC) in Jiroft, Kerman Province, Iran. Patients admitted from February 2022 to June 2022 with a positive COVID-19 PCR result were included in the study and those with incomplete records were excluded. Demographic data (age, gender, job), vaccine information (vaccine injection, vaccine platforms, number of vaccine doses, the time interval between doses, and comorbidity data) were gathered. According to the orders of the physicians of our center, samples were taken from all the patients for PCR testing. The samples were sent to the reference laboratory of Jiroft City. Samples were taken from hospitalized patients on the first day of hospitalization and from outpatients on their first visit. Following the manufacturer's instructions, the One Step Plus Real-Time PCR system tool (Applied Biosystems, USA) was used to detect SARS-CoV-2 in the samples using SARS-CoV-2 Test Kit (Pishtazteb, Iran). The PCR test results were included in the patients' records used for this study. The vaccinated patients had been injected using different platforms of COVID-19 vaccines. These platforms included viral vector (AstraZeneca, Sputnik-V), conjugated (SpikoGen, Soberana02), and inactivated virus (Sinopharm, Covaxin, COVIran Barakat) of COVID-19 vaccines.

Statistical Analysis

To describe continuous variables, the central tendency statistic of mean and dispersion statistics like standard deviation, minimum and maximum were used. The data of categorical variables were described by frequency and percent. The possible relationship between the outcome of hospitalization and potential risk factors was assessed by logistic regression and the effect size of the odds ratio (OR) presented. Furthermore, the differences between inpatients and outpatients regarding time intervals between receiving the COVID-19 vaccine and its boosters were analyzed by t-test. All statistical analysis was performed using IBM SPSS 25.0 (SPSS Inc., Chicago, and Illinois., USA), and the significance level was set at P <0.05.

RESULTS

Demographics of the Studied Group

A total of 309 patients infected with COVID-19 were included in this study. Of those, 247 (79.9%) were outpatients, and 62 (20.1%) were hospitalized. In terms of gender, 48.5% of individuals were males. The mean age of the patients was 39.9±16.7 years (with a range of 1 to 98 years old). In terms of age, 232 patients (75.1%) were under 50, while 73 (23.6%) were older than 50. Among all the patients, 15.2% had some underlying disease like diabetes mellitus (DM), hypertension (HTN), hypothyroidism, obesity, hyperlipidemia (HLP), and nephrotic syndrome. Also, 7.8% of patients were hospital staff.

Demographic Variables and COVID-19 Vaccination Status

The frequency of patients who did not receive COVID-19 vaccine was 9.7%. Of all the patients, 4.5% received just their first vaccine dose. In contrast, 33.7% were vaccinated with one booster dose, 50.8% with two booster doses, and 11% with three booster doses. Table 1 demonstrates the relationship between the status of patients and demographic variables. Based on the result, the age category was associated with being hospitalized. The odds of being hospitalized was 3.14 times (OR 95% CI: 1.71-5.77) higher in patients older than 50 years than the younger ones. For patients with any medical conditions, the chance of hospitalization increased by 114% (OR=2.14, 95%CI: (1.08-4.27)). Among vaccinated patients, the frequency of hospitalization was 14.3%, while it increased to 73.3% in unvaccinated patients group. The result of the binary logistic model confirmed the association between getting vaccinated and hospitalization (OR=16.4, 95%CI: (6.84 - 39.44)). The result remained the same after adjustment for the effect of all other variables (adjusted odds ratios are demonstrated in Table 1.)

Table 1. Final Status of patients based on demographic variables and vaccination status.

Variable		Status: Inpatient	Status: Outpatient	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)	*P*-value
Gender	Male	27 (18.0%)	123 (82.0%)	Reference	0.379	Reference	0.332
	Female	35 (22.0%)	124 (78.0%)	1.29 (0.73– 2.52)		1.34 (0.71- 7.65)	
Age	< 50 years	33 (14.2%)	199 (85.8%)	Reference	<0.001	Reference	<0.001
	> 50 years	25 (34.2%)	48 (65.8%)	3.14 (1.71-5.77)		3.69(1.78-7.6)	
History of medical disease	Negative	47 (17.9%)	215 (82.1%)	Reference	0.030	Reference	0.026
	Positive	15 (31.9%)	32 (68.1%)	2.14 (1.08-4.27)		2.52(1.12-5.69)	
Job	Hospital Staff	1 (4.2%)	23 (95.8%)	Reference	0.075	Reference	0.125
	Non-Hospital Staff	61 (21.4%)	224 (78.6%)	6.26 (0.83 – 47.3)		5.43 (0.63- 47.2)	
Vaccinated	Yes	40 (14.3%)	239(85.7%)	Reference	<0.001	Reference	<0.001
	No	22 (73.3%)	8 (26.7%)	16.4 (6.84- 39.44)		24.72 (9.20- 66.46)	

[DOI: 10.61186/vacres.9.2.42]

Based on the result illustrated in Fig. 1, as the number of the vaccines and the boosters injections increased, the chance of getting severe COVID-19 decreased (*P*<0.001).The average time between the patients' last vaccination dose and the beginning of the study was 4 months. None of the patients who received 3 doses of the boosters were hospitalized due to COVID-19.

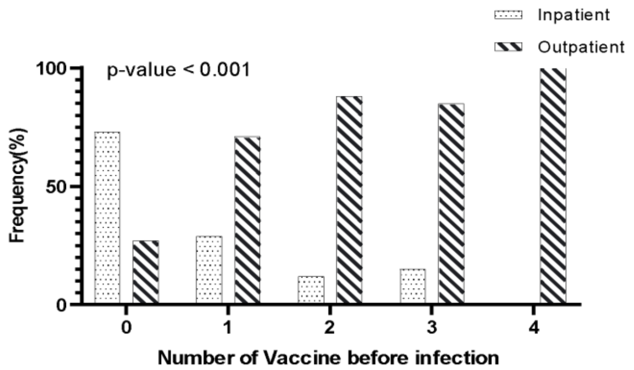

Fig. 1. Final status of patients based on number of vaccinations before infection.

Table 2 shows the relationship between vaccine platforms and the status of the patients. As indicated, the specific type of vaccine in each time was not associated with severe disease. However, the odds of hospitalization in patients who received the same type of the vaccines as their first dose and their boosters was 4 times higher than the other patients (17.4% vs. 5.6%) (*P*=0.02). Moreover, receiving a viral vector vaccine decreased the chance of hospitalization by 67%, compared to those getting the inactivated COVID-19 vaccines.

We also assessed the potential influence of timing between receiving the vaccines. However, we did not find any significant relationship between the status of patients (inpatient or outpatient) and the time interval between COVID-19 vaccines and their boosters (*P*>0.05) (Fig. 2).

Table 2. Final status of patients based COVID-19 vaccine platforms.

COVID-19 vaccine platforms		Status		Crude OR (95% CI)	*P*-value
		Inpatient	Outpatient		
1st dose	Viral vector	8 (10.4%)	69 (89.6%)	0.61 (0.27-1.34)	0.243
	Conjugate	0 (0%)	1 (100.0%)	-	
	Inactivated	32 (15.9%)	169 (84.1%)	Reference	
2nd dose	Viral vector	5 (7.5%)	62 (92.5%)	0.41 (0.15-1.09)	0.074
	Conjugate	0 (0%)	1 (100.0%)	-	
	Inactivated	33 (16.5%)	167 (83.5%)	Reference	
3rd dose	Viral vector	4 (8.9%)	41 (91.1%)	0.33 (0.11-1.04)	0.058
	Conjugate	0 (0%)	35 (100.0%)	-	
	Inactivated	20 (22.7%)	68 (77.3%)	Reference	
platforms in 3 doses	Same	36 (17.4%)	171 (82.6%)	3.58 (1.3-10.4)	0.020
	different	4 (5.6%)	68 (94.4%)	Reference	
Same platform types in 3 doses	Viral vector	4 (7.8%)	47 (92.2%)	0.33 (0.11-0.97)	0.045
	Inactivated	32 (20.6%)	123 (79.4%)	Reference	

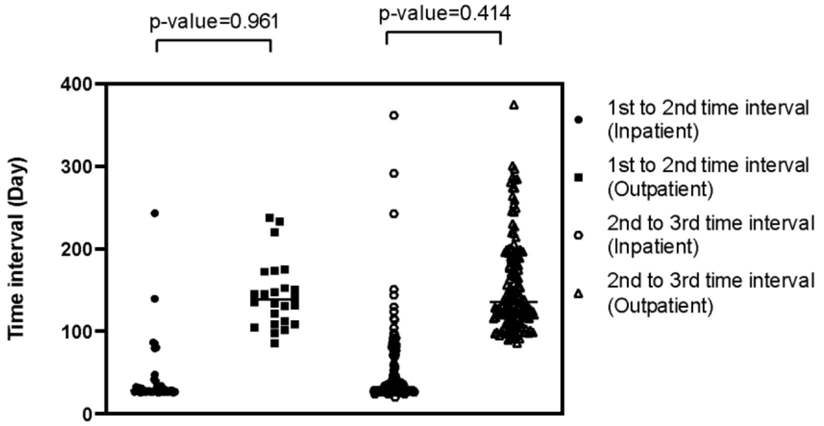

Fig. 2. Final status of patients based on time interval between doses in

DISCUSSION

This study compared the demographics and outcomes of 309 vaccinated and unvaccinated patients with respect to COVID-19 vaccines administered in a medical center in Kerman province of Iran. The correlation between hospitalization rate and factors such as vaccination frequency, vaccine type, and vaccination intervals, was also investigated. This investigation demonstrated that from individuals who received the same type of vaccine as their initial dose and booster injection, those who were administered viral vector vaccines had a 67% lower likelihood of hospitalization in contrast to those who received inactive virus vaccines. Viral vector vaccines were considered crucial for controlling COVID-19 outbreaks (16). In addition, other clinical studies have shown that the viral vector vaccine could prevent the severe symptoms of COVID-19 in most patients and reduce the risk of COVID-19-related death and hospitalization (17). In a study by Tan et al., it was shown that in people who had previously received BNT162b2 vaccine, heterologous Ad26.COV2.S boosting was linked with long-lasting humoral and cellular immune responses (18). For recipients of CoronaVac and AZD1222 primary vaccinations, homologous boosting with CoronaVac and AZD1222 was less effective than heterologous boosting (19). Likewise, our results indicated that the odds of hospitalization are lowered by 3.58 times among individuals who had received different types of vaccines as compared to those who receive the same vaccine for both their initial and booster doses. Hence, it is advisable to employ diverse vaccine platforms for vaccination of individuals in similar situations.

The study by Ozdemir et al. suggests that the booster vaccination should not be delayed, especially in those with comorbidities, since these patients have a poor prognosis for survival (20). In our investigation, it was observed that the time interval between the first and second dose, as well as the interval between the second and the third dose, for hospitalized patients was comparatively shorter than that of outpatients. Nonetheless, this disparity was not statistically significant, which may be attributed to the limited sample size. Studies conducted in Costa Rica, Canada, Israel, and Qatar have revealed that administering two doses of the vaccine can considerably improve its effectiveness in preventing hospitalization and death, compared to a single dose (21-24). Several studies have also demonstrated that receiving the third dose is more beneficial than two doses in reducing COVID-19-related hospitalization and mortality rates (25, 26).

The present investigation revealed that the probability of hospitalization was mitigated by the administration of a third dose of the vaccine, compared to a reduced number of doses. The proportion of individuals who required hospitalization following the administration of a single booster dose was 14%, whereas for those who received two booster doses, this figure decreased to 12%. Notably, none of the individuals who received three booster doses required hospitalization. Investigations show that third or subsequent COVID-19 vaccine doses have the potential to increase neutralizing antibody titter against SARS-CoV-2 and its variants, particularly in the immunocompromised patients, those with underlying comorbidities, and those at a higher risk of COVID-19 exposure (27).

One of the limitations of this study was its small sample size; therefore, the current study's results should be generalized to COVID-19 patients with caution. Also, since this study was performed on patients who were vaccinated with viral vector (AstraZeneca, Sputnik-V), conjugated (SpikoGen, Soberana02) and inactivated (Sinopharm, Covaxin, COVIran Barekat) vaccines, the obtained results cannot be generalized to the whole community and other types of viral vector vaccine such as Janssen Jcovden (Johnson & Johnson) vaccine. In conclusion, based on the current study, viral vector vaccines such as AstraZeneca and Sputnik-V played a critical role in controlling COVID-19 pandemic by reducing the hospitalization rate of the patients. Also, receiving the third dose of the viral vector vaccines decreased the probability of hospitalization compared to those who had received only two doses. Future studies from other countries are needed to evaluate the effects of COVID-19 viral vector vaccines on hospitalization rate of the patients.

ACKNOWLEDGMENTS

None.

CONFLICT OF INTEREST

The authors declare they have no conflict of interests.

REFERENCES

1. Mann S, Frasca K, Scherrer S, Henao-Martínez AF, Newman S, Ramanan P, et al. A Review of Leishmaniasis: Current Knowledge and Future Directions. Curr Trop Med Rep. 2021;8(2):121-32. doi: 10.1007/s40475-021-00232-7.
2. Organization WH. WHO Director-General's opening remarks at the media briefing on COVID-19. (No Title). 2020.
3. Vakili K, Fathi M, Pezeshgi A, Mohamadkhani A, Hajiesmaeili M, Rezaei-Tavirani M, et al. Critical complications of COVID-19: a descriptive meta-analysis study. Reviews in cardiovascular medicine. 2020;21(3):433-42.
4. Karimi H, Sarmadian R, Gilani A, Salajegheh P, Nejad Biglari H, Gholizadeh M. Cerebrovascular accident in a child with precursor B-cell acute lymphoblastic leukemia and coronavirus disease 2019: a case report. Journal of Medical Case Reports. 2022;16(1):452.
5. Sarmadian R, Ghasemikhah R, Sarmadian H, Khosravi M, Hassani S. Post-COVID-19 splenic infarction in a patient with chronic atrial fibrillation: A case report. Clinical Case Reports. 2022;10(7):e6011.
6. Alirezaei T, Hooshmand S, Irilouzadian R, Hajimoradi B, Montazeri S, Shayegh A. The role of blood urea nitrogen to serum albumin ratio in the prediction of severity and 30-day mortality in patients with COVID-19. Health Science Reports. 2022;5(3):e606.
7. Moradveisi B, Behzadi S, Zakaryaei F, Jalili A, Rahmani K, Karimi A. Evaluation of Anti-SARS-CoV-2 IgG Antibody in Healthcare Professionals Infected with COVID-19. Jundishapur Journal of Microbiology. 2021;14(11).
8. Marcotte H, Piralla A, Zuo F, Du L, Cassaniti I, Wan H, et al. Immunity to SARS-CoV-2 up to 15 months after infection. IScience. 2022;25(2):103743.
9. Funk CD, Laferrière C, Ardakani A. A snapshot of the global race for vaccines targeting SARS-CoV-2 and the COVID-19 pandemic. Frontiers in pharmacology. 2020;11:937.
10. Calina D, Docea AO, Petrakis D, Egorov AM, Ishmukhametov AA, Gabibov AG, et al. Towards effective COVID-19 vaccines: Updates, perspectives and challenges. International journal of molecular medicine. 2020;46(1):3-16.
11. 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. International journal of general medicine. 2021:1389-401.
12. Levonorgestrel I. Drugs and Lactation Database (LactMed)[Internet]. Bethesda (MD): National Library of Medicine (US). 2019:63-7.
13. Moghadas SM, Vilches TN, Zhang K, Wells CR, Shoukat A, Singer BH, et al. The impact of vaccination on coronavirus disease 2019 (COVID-19) outbreaks in the United States. Clinical Infectious Diseases. 2021;73(12):2257-64.
14. Jara A, Undurraga EA, González C, Paredes F, Fontecilla T, Jara G, et al. Effectiveness of an inactivated SARS-CoV-2 vaccine in Chile. New England Journal of Medicine. 2021;385(10):875-84.

15. Taherian Z, Rezaei M, Haddadpour A, Amini Z. The effect of COVID-19 vaccination on reducing the risk of infection, hospitalization, and death in Isfahan Province, Iran. Iranian Journal of Public Health. 2022;51(1):188.
16. Deng S, Liang H, Chen P, Li Y, Li Z, Fan S, et al. Viral vector vaccine development and application during the COVID-19 pandemic. Microorganisms. 2022;10(7):1450.
17. Sadoff J, Gray G, Vandebosch A, Cárdenas V, Shukarev G, Grinsztejn B, et al. Final analysis of efficacy and safety of single-dose Ad26. COV2. S. New England Journal of Medicine. 2022;386(9):847-60.
18. Tan CS, Ai-ris YC, Yu J, Liu J, Chandrashekar A, McMahan K, et al. Durability of heterologous and homologous COVID-19 vaccine boosts. JAMA Network Open. 2022;5(8):e2226335-e.
19. Costa Clemens SA, Weckx L, Clemens R, Almeida Mendes AV, Ramos Souza A, Silveira MBV, et al. Heterologous versus homologous COVID-19 booster vaccination in previous recipients of two doses of CoronaVac COVID-19 vaccine in Brazil (RHH-001): a phase 4, non-inferiority, single blind, randomised study. The Lancet. 2022;399(10324):521-9. doi: https://doi.org/10.1016/S0140-6736(22)00094-0.
20. Ozdemir YE, Kizilcay B, Sonmezisik M, Tarhan MS, Borcak D, Sahin Ozdemir M, et al. Evaluation of clinical outcomes of vaccinated and unvaccinated patients with hospitalization for COVID-19. Acta Microbiol Immunol Hung. 2022. doi: 10.1556/030.2022.01860.
21. Fantin R, Herrero R, Hildesheim A, Barboza-Solís C, Aparicio A, Prevots DR, et al. Estimating vaccine effectiveness against SARS-CoV-2 infection, hospitalization and death from ecologic data in Costa Rica. BMC Infectious Diseases. 2022;22(1):767.
22. Haas EJ, Angulo FJ, McLaughlin JM, Anis E, Singer SR, Khan F, et al. Impact and effectiveness of mRNA BNT162b2 vaccine against SARS-CoV-2 infections and COVID-19 cases, hospitalisations, and deaths following a nationwide vaccination campaign in Israel: an observational study using national surveillance data. The Lancet. 2021;397(10287):1819-29.
23. Tang P, Hasan MR, Chemaitelly H, Yassine HM, Benslimane FM, Al Khatib HA, et al. BNT162b2 and mRNA-1273 COVID-19 vaccine effectiveness against the SARS-CoV-2 Delta variant in Qatar. Nature medicine. 2021;27(12):2136-43.
24. Chung H, He S, Nasreen S, Sundaram ME, Buchan SA, Wilson SE, et al. Effectiveness of BNT162b2 and mRNA-1273 covid-19 vaccines against symptomatic SARS-CoV-2 infection and severe covid-19 outcomes in Ontario, Canada: test negative design study. Bmj. 2021;374.
25. Barda N, Dagan N, Cohen C, Hernán MA, Lipsitch M, Kohane IS, et al. Effectiveness of a third dose of the BNT162b2 mRNA COVID-19 vaccine for preventing severe outcomes in Israel: an observational study. Lancet. 2021;398(10316):2093-100. doi: 10.1016/s0140-6736(21)02249-2.
26. Moreira Jr ED, Kitchin N, Xu X, Dychter SS, Lockhart S, Gurtman A, et al. Safety and efficacy of a third dose of BNT162b2 Covid-19 vaccine. New England Journal of Medicine. 2022;386(20):1910-21.
27. Shekhar R, Garg I, Pal S, Kottewar S, Sheikh AB. COVID-19 vaccine booster: to boost or not to boost. Infectious disease reports. 2021;13(4):924-9.

[DOI: 10.61186/vacres.9.2.42]