

**Research Article****Evaluation of vaccines effective against coronavirus****Salma Ebrahimi Shah Abadi<sup>1</sup>, Ali Rahmanian<sup>2</sup>, Melika Asadsangabi<sup>3</sup>, Faezeh yousefie<sup>4</sup>, Seyedeh Mahsa Mortazavi<sup>5</sup>, Shaqayeq Keshtgar<sup>6</sup>, Ashkan Rezvani Joybari<sup>7</sup>, Hossein Esmacili<sup>8\*</sup>**<sup>1,4,5,6</sup> Student Research Committee, Islamic Azad University , Zahedan branch , Zahedan , Iran<sup>2,3</sup> Molecular cell biology student, Department of biology, Shiraz university, Iran<sup>7,8</sup> Medical Student, Department of Medicine, Islamic Azad University Zahedan Medical Sciences, Iran**Received: 04 January, 2022****Accepted: 15 February, 2022****Published: 28 March 2022****Abstract:**

Given the COVID-19 virus epidemic and vaccination increment all around the world, after surveying the vaccination side effects it was clarified that 72.6% of individuals reported at least one symptom after the first and second injection of Pfizer-BioNTech vaccine which pain at injection site, fever and myalgia/arthralgia were most common among these symptoms. Furthermore, most common severe side effects like fever > 39 °C were perceived more after the second dose of vaccine. In the study of identifying body's physiologic changed, heart rate variability (HRV) decreased after the first dose and the second dose without having considerable changes in resting heart rate (RHR) and respiratory rate (RR) and the duration of sleep also declined up to 4 days of both vaccination doses. Plus, Local and systemic reactogenicity were more intense after the second dose. Following the COVID-19 vaccination, various allergic reactions also started to promote all around the countries, a questionnaire was adjusted in Toronto-Canada and 65 patients had PEG-ASNase allergy. Rapid reactions like anaphylaxis occur following the first dose of Pfizer mRNA COVID-19 vaccine. In a study consisted of 175 individuals, 21 of them were afflicted with anaphylaxis and a number of 83 individuals experienced non-anaphylaxis allergic reactions but still further studies are required in order to identify the relation between anaphylaxis and COVID-19 vaccines. Disease background is an outstanding factor to intensify COVID-19 infection. In a research, a 40-year old woman who had experienced left peripheral facial nerve palsy 4 years ago and in another research 8 adolescents who visited Nicklaus Children's Hospital with perimyocarditis within 4 days of receiving the second dose of BNT162b2 vaccine, were investigated in this context. In terms of gender and age relation, a study was carried out on German residents of Bavaria between Jan 9 to Apr 11, 2021 and, it was clarified that both doses of the BioNTech-Pfizer's BNT162b2 are highly effective against the infection and adverse events of COVID-19 virus in elder people and according to another report, 82% of individuals experienced at least one symptom Following the first dose of Comirnaty vaccine which was more common in women under the age 55 (64%). In a study which was carried out among the workers of Mazandaran University of Medical Sciences in order to identify the side effects of the Sputnik V vaccine, a number of 3236 individuals in the 19-78 age range with the mean age of 38 years old submitted their report. According to a research which was conducted in Bavaria, Germany, the mortality rate was considerably lower in individuals who had received vaccination in relation to not vaccinated individuals, however, 3 death cases were reported in individuals who suffered from comorbidities after receiving the Sputnik vaccine which was considered to be irrelevant to vaccination. A research was conducted to evaluate the effectiveness of Robust antibody after the first and second dose in individuals aged between 70 and 90. From 99 individuals who received the first dose of their vaccination after 3 weeks the existence of Robust antibody was proven in 95% of them and from 86 individuals who received their vaccine's second dose after 3 weeks, all of them showed a positive result in the test. Furthermore, in another study from 75% of old individuals who were vaccinated at least once, the first dose led into COVID-19 infection decrease and had an effectiveness of 52% in clinical experiments. According to another report, the antibody was observed in 92% of individuals 21 days after the first dose and also in 97% of them 21 days after the second dose it was concluded that Symptoms following vaccination are not unusual and they occur because of body's immune system response.

**Keywords: covid-19, vaccines effective covid19, vaccines and covid-19****1. Introduction**

It was at the end of December 2019 that the COVID-19 virus (SARS-CoV-2) was primarily identified in the Chinese city of Wuhan and the spread rate of this novel human coronavirus was so high that only by April 20, 2020 a number of 1,364 counties of 3,020 US counties reported the detection of COVID-19 cases [1,2].

Vaccination promotion is currently the most reliable approach to end the COVID-19 pandemic and that's because increasing the proportion of eligible persons who are vaccinated decreases the risk for high community-wide transmission, and as a consequence reduces the risk for the appearance of new variants that could have the potential to overcome vaccine-

induced immunity, however, some individuals may not opt for it due to various reasons thus it is essential for public health departments to enhance trust and acceptance of the COVID-19 vaccination [3,4].

That is to say, one of the major causes of many individual's fear to receive SARS-CoV-2 vaccine is the health related consequences and the appearance of various short term and long term symptoms after the first and second dose [5].

For this reason, we are going to set a comparison between two well-known vaccines, Pfizer-BioNTech and Sputnik V, and survey the effectiveness of both vaccines along with their reported symptoms and also the possibility of experiencing several significant allergic reactions including Anaphylaxis after receiving both vaccine doses [6,7].

The immunogenicity and antibodies detection following the administration of vaccine doses is also an outstanding context which is discussed in this article [8].

## **2. What symptoms can be predicted after receiving COVID-19 vaccine doses?**

A study was carried out among the workers of Mazandaran University of Medical Sciences in order to identify the side effects of the Sputnik V vaccine and a number of 3236 individuals in the 19-78 age range with the mean age of 38 years old submitted their report for this research [8].

After the first administration of the Comirnaty vaccine 82% of individuals experienced at least one side effect which was more frequent among women under the age of 55 (64%). Mild adverse events (98.6%) and moderate events including myalgia/arthralgia, lymphadenopathy, diarrhoea and local urticaria generally manifested themselves after 4-12 hours after the first dose and resolved by 24 hours. A small proportion of individuals reported other symptoms. Symptoms after the second dose were stated by 82.6% of individuals who were mainly women and people with the age of 40-41 and 97.2% of these side effects were mild pain, redness and swelling at the injection site. Most common severe side effects like fever  $> 39^{\circ}\text{C}$  were perceived more after the second dose of vaccine. Generally, 72.6% of individuals reported at least one symptom after the first and second injection of Comirnaty vaccine. Similar side effects of both doses were mainly relevant to sex, SARS-CoV-2 infection history and COVID-19 symptoms progress [9].

In another research a number of 705 individuals participated in an online survey. 196 of whom had received Pfizer vaccine and 506 individuals had administrated AstraZeneca vaccine, [10] reported at least one side effect after the injection such as pain at injection site, fever and myalgia. As a result, symptoms after vaccination are natural phenomena and indicate the body immunization response to vaccine [11].

In another study a group consisted of 19 individuals (mean age 28.8) who had received both vaccine doses were surveyed via a portable device with the aim of characterizing physiologic changes of body [12].

Changes in heart rate variability (HRV), resting heart rate (RHR), respiratory rate, rapid eye movement, deep sleep and

also local and systemic reactivity following each dose were measured and as a conclusion, HRV decreased after the first dose (mean: 13.44%) and the second dose (mean: 9.25%) without having considerable changes in RHR and RR. The duration of sleep also declined up to 4 days of both vaccination doses. Plus, Local and systemic reactivity were more intense after the second dose [13].

This research was conducted in order to identify the changes in certain physiologic features such as heart rate variability (HRV), resting heart rate (RHR), respiratory rate (RR) and sleep stage duration after the first and second dose of Pfizer-BioNTech COVID-19 Vaccine. These changes were tracked by the WHOOP device after the first and second dose of the vaccine. The average baseline was reported as follows: RHR 63.09 (SD 6.36) bpm, HRV 52.09 (SD 21.58) ms, and RR 16.27 (SD 1.23) rpm. HRV percentage declined following the first and second dose but it returned to baseline after a few days, however, there was no specific shift in the percentage of RHR and RR after both doses. The percentage of sleep duration after both vaccine doses went above baseline in day 1 but it passed the mean percentage in day 2 and 3 and returned to baseline in day 5. Other than that, majority of people reported symptoms including arm soreness, fatigue and body aches. The intensity and frequency of which were higher after the second dose [15].

Generally vomiting [16], local pain, joint pain, fatigue, fever, arthralgia, myalgia, headache and palpitation were reported as the vaccination side effects [11,17].

### **2.1. Allergic reactions**

Following the COVID-19 vaccination, various allergic reactions also started to promote all around the countries [18]. Women and individuals with a history of allergic reactions (food, medicine, ...) made up a high percentage of the total vaccinated people [19]. Most reported allergic reactions were respectively related to inhaled allergens, food allergens, drugs and insect venoms. Individuals with the history of a specific allergic reaction submitted more reports of post-vaccination local symptoms like redness and swelling than non-allergic individuals. The duration of symptoms lasted longer in allergic people than non-allergic ones and they needed specific medications more frequently. Allergic people experienced more intense adverse events after the second dose, however, high severe symptoms were rare in both allergic and non-allergic people [17,20].

Currently in North America, only the Pfizer-BioNTech vaccine is available for 12-17 year-old individuals. The mRNA vaccines contain PEG-asparaginase and individuals who are afflicted with acute lymphoblastic leukemia, develop allergic reactions when they receive PEG-asparaginase [21].

A questionnaire was adjusted in Toronto-Canada and all the patients who had an age of 12 or older in The Hospital for Sick Children (SickKids) participated in it. A small number of adult patients in Princess Margaret Cancer Centre also took part in this questionnaire. They were asked to confirm their history of PEG-ASNase allergic reaction before receiving

vaccination. A total number of 65 individuals were identified to have PEG-ASNase allergy and 32 of them were eventually present at the vaccination clinic and all of them had documented the grade 2 and 4 PEG-ASNase allergy and none of these individuals had taken the anti-allergy medicines. Consequently, no allergic reaction to BNT162b2 were observed in these individuals but since the number of patients were small, findings may not be reducible across a larger cohort [21,22].

## **2.2. Anaphylaxis**

Rapid reactions like anaphylaxis occur following the first dose of Pfizer mRNA COVID-19 vaccine but biphasic anaphylaxis were not observed after the second dose. Other studies demonstrate that delayed phase reaction is because of uneven antigen absorption and in order to prevent severe events and anaphylaxis, the administration of epinephrine is recommended [18,23,24].

In a study consisted of 175 individuals, 21 of them were afflicted with anaphylaxis. The mean period between the first injection of vaccine and occurrence of anaphylaxis was 13 minutes. 20 of these 21 individuals recovered without any serious problem and no death case were reported. Meanwhile, 13 of them had a history of allergic reactions. A number of 83 individuals experienced non-anaphylaxis allergic reactions and 87% of them had no specific problem. Most common reported symptoms are pruritus, rash, itchy and scratchy sensations in the throat, and mild respiratory symptoms [7].

Anaphylaxis and anaphylactoid symptoms were reported commonly in Japan and factors like reporting bias and differences in the demography of the vaccinee population can be associated with that. The possibility of anaphylaxis has been highly publicized in the context of the attention given to coronavirus vaccines by the media. Further studies are required in order to identify the relation between anaphylaxis and COVID-19 vaccines [19].

## **2.3. Disease background**

Disease background was an outstanding factor to intensify COVID-19 infection in one quarter of individuals [6].

The most common reported diseases among people who had received both doses of their vaccination were cardio-vascular diseases (9.43%), asthma (6.21%) and thyroid disease (7.53%) [17].

5 workers in healthcare facilities were hired secretly to record necessary patient's information and the relation of the vaccination side effects (mild and severe) via Chi square and Fisher's exact test. Some of the participants were under treatment for diabetes, thyroid and allergic diseases and they received such as antihistamines, antihypertensive, blood pressure medications (most common) and etc [9].

The administration of Pfizer-BioNTech COVID-19 vaccine can be associated with several nervous system diseases, whereas there is a slight relation between vaccination and the risk of developing multiple sclerosis (MS) disease [25]. Certain reports has been published in this context and one of

them was a 40-year old woman who had experienced left peripheral facial nerve palsy 4 years ago but she was fully recovered. Nevertheless, she developed numbness and sensory disturbance in her right hand after receiving the second dose of BNT162b2 vaccine and it gradually advanced to her right shoulder after one week and she got transferred to Department of Neurology, Tohoku Medical and Pharmaceutical University Hospital. She was afflicted with 38.5-degree fever after the vaccination. MRI scan of the head on admission revealed left periventricular and bilateral frontal subcortical high-intensity lesions and it was estimated that the patient had pre-existing subclinical inflammatory CNS disease before vaccination. However, it can't be evaluated if this occurrence is relevant to vaccination or it is merely coincidental [26].

There was a study on 8 adolescents who visited Nicklaus Children's Hospital with perimyocarditis within 4 days of receiving the second dose of BNT162b2 vaccine. All the patients were males and aged 15 to 17 years old they had visited the children hospital for the reason of chest pain or irregular heartbeat.

Disease backgrounds of the patients are noted below:

Patient 1: Vitiligo

Patient 3: Mild perimyocarditis

Patient 4: Marfan syndrome

Patient 6: Insulin resistance and dyslipidemia

Patients number 2, 5, 7, 8 had no record of background diseases.

Two patients had been already infected with COVID-19 virus and except patient 4 and 3 which respectively experienced Perimyocarditis after the first dose and both doses, other patients visited the hospital only after two days. The increment of Troponin-I was observed in all the patients. SARS-CoV-2 PCR was negative in all of the individuals and SRAS CoV-2 nucleocapsid IgG was positive in patient 1 and 3. Chest radiography didn't show anything unusual in patients. Aside from patient number 4 and 6 who had normal sinus rhythm, the electrocardiogram demonstrated irregularity in other patients [27,28].

## **2.4. Gender and age effect**

A study was carried out on 707187 individuals older than 80 years old (mean age 81.1 and 35.5% male) between Jan 9 to Apr 11, 2021. They were all the residents of Bavaria, Germany. As a result, it was clarified that both doses of the BioNTech-Pfizer's BNT162b2 are highly effective against the infection and adverse events of COVID-19 virus in elder people. The effectiveness of this vaccine seems to be equal in both genders [29].

But according to studies which were conducted in the US in December 14-23, 2020, after the administration of the BioNTech-Pfizer's first dose 21 of 175 individuals were inflicted with anaphylaxis and they had an age range of 27 to 60 and 90 percent of them were women [7].

Following the first dose of Comirnaty vaccine, 82% of individuals experienced at least one symptom which was more

common in women under the age 55 (64%) [30,9].

## **2.5. Mortality**

According to a research which was conducted in Bavaria, Germany between 9 Jan and 19 Apr, 2021, a number of 1349 individuals were hospitalized and 1731 patients died because of Corona virus infection. Being vaccinated didn't make a noticeable difference in not getting hospitalized after the vaccination but the mortality rate was considerably lower in individuals who had received vaccination in relation to not vaccinated individuals [11].

None of the vaccinated cases in this study faced severe respiratory side effects after the vaccination and only one none-vaccinated individual died during the infection. 8 of 9 infected individuals who hadn't receive vaccination, experienced severe symptoms thus even a single dose of the BioNTech-Pfizer vaccine is proven to be beneficial for elder people [31].

Nonetheless, 3 death cases were reported in individuals who suffered from comorbidities after receiving the Sputnik vaccine which was considered to be irrelevant to vaccination [6].

## **3. The relation between antibody and vaccine doses gap**

A research was conducted to evaluate the effectiveness of Robust antibody after the first and second dose in individuals aged between 70 and 90. They took blood sample of 99 individuals who received the first dose of their vaccination after 3 weeks and Roche anti-S test proved the existence of Robust antibody in 95% of them. This percentage was slightly lower among individuals older than 80 years old. Then they took blood sample of 86 individuals who received their vaccine's second dose after 3 weeks and they observed that all of them showed a positive result in the test [6,32].

HRV percentage decreased following the first and second dose but it returned to its normal condition after a few days. No specific changes in RHR and RR were observed after both doses. Sleep duration went below the normal degree 1 day after both doses but it went over the mean percentage on days 2 and 3 and turned back to normal on day 5. Other than that, most of the cases had arm soreness, fatigue and body aches. Pain intensity and its frequency were higher after the second dose [15].

In a study in which 75% of old individuals were vaccinated at least once, the first dose led into COVID-19 infection decrease and had an effectiveness of 52% in clinical experiments and after surveying 20000 individuals older than 60 years old, it was revealed that a 33 percent decrease occurred in positive tests of COVID-19 virus [33].

Antibody density after receiving both doses was much higher in individuals who had already been infected with COVID-19 virus than the ones who hadn't been infected [6].

Sputnik vaccine generates immunity only after the first dose, however, further immunization requires more doses of vaccination. Human body generates immediate antibodies

against Sputnik protein which inhibits the virus binding to its receptor. T-cells also make immune response that should not wane quickly. The results show that essential body immunity formed 18 days after the first dose. The vaccine effectiveness after the first dose was reported to be 91.6% after 21 days and despite the criticisms about the hastiness in its production, the results were quite satisfactory [6].

According to another report, the antibody was observed in 92% of individuals 21 days after the first dose and also in 97% of them 21 days after the second dose [8].

## **4. COVID-19 vaccine comparison**

A research through an online questionnaire was conducted among 705 individuals in which 196 of them had received the Pfizer-BioNTech vaccine and 506 of them had injected the AstraZeneca vaccine. A percentage of 93.9 of individuals who were vaccinated by the Pfizer-BioNTech and 96.5% of individuals who had received the AstraZeneca, reported at least of side effect after vaccination. As a result, Symptoms following the vaccination are not rare and they occur because of body's immune system response. Studies also suggest that the first dose of the AstraZeneca vaccine lead into more side effects than both doses of the Pfizer-BioNTech vaccine [11].

## **5. Conclusion**

Given the increasing trend of vaccination in the world and due to the epidemic of COVID-19 disease, complications after vaccination have also increased which include side effects after the first and the second doses of Pfizer vaccine, physiological changes and allergic and immediate reactions. Also, the history of the disease and the effect of age and sex on the adverse events after vaccination can be observed, however, these complications can also be the result of the immune system's reaction to vaccination.

## **6. References**

1. Noorimotlagh, Zahra, et al. "A systematic review of possible airborne transmission of the COVID-19 virus (SARS-CoV-2) in the indoor air environment." *Environmental research* 193 (2021): 110612.
2. Basu, Anirban. "Estimating The Infection Fatality Rate Among Symptomatic COVID-19 Cases In The United States: Study estimates the COVID-19 infection fatality rate at the US county level." *Health Affairs* 39.7 (2020): 1229-1236.
3. Christie, Athalia, et al. "Guidance for implementing COVID-19 prevention strategies in the context of varying community transmission levels and vaccination coverage." *Morbidity and Mortality Weekly Report* 70.30 (2021): 1044.
4. Lazarus, Jeffrey V., et al. "A global survey of potential acceptance of a COVID-19 vaccine." *Nature medicine* 27.2 (2021): 225-228.
5. Bendau, Antonia, et al. "COVID-19 vaccine hesitancy and related fears and anxiety." *International immunopharmacology* 97 (2021): 107724.

6. Jones, Ian, and Polly Roy. "Sputnik V COVID-19 vaccine candidate appears safe and effective." *The Lancet* 397.10275 (2021): 642-643.
7. COVID, CDC, and Response Team. "Allergic reactions including anaphylaxis after receipt of the first dose of Pfizer-BioNTech COVID-19 vaccine—United States, December 14–23, 2020." *Morbidity and Mortality Weekly Report* 70.2 (2021): 46.
8. Babamahmoodi, Farhang, et al. "Side effects and Immunogenicity following administration of the Sputnik V COVID-19 vaccine in health care workers in Iran." *Scientific Reports* 11.1 (2021): 1-8.
9. Ripabelli, Giancarlo, et al. "Active Surveillance of Adverse Events in Healthcare Workers Recipients After Vaccination with COVID-19 BNT162b2 Vaccine (Pfizer-BioNTech, Comirnaty): A Cross-Sectional Study." *Journal of Community Health* (2021): 1-15.
10. Østergaard, Søren Dinesen, et al. "Thromboembolism and the Oxford–AstraZeneca COVID-19 vaccine: side-effect or coincidence?." *The Lancet* 397.10283 (2021): 1441-1443.
11. Fujimori, Juichi, Kouichi Miyazawa, and Ichiro Nakashima. "Initial clinical manifestation of multiple sclerosis after immunization with the Pfizer-BioNTech COVID-19 vaccine." *Journal of Neuroimmunology* (2021): 577755.
12. Miller, Joseph, et al. "The Impact of Sociodemographic Factors, Comorbidities, and Physiologic Responses on 30-Day Mortality in Coronavirus Disease 2019 (COVID-19) Patients in Metropolitan Detroit." *Clinical Infectious Diseases* 72.11 (2021): e704-e710.
13. Hajduczuk, Alexander G., et al. "Physiologic Response to the Pfizer-BioNTech COVID-19 Vaccine Measured Using Wearable Devices: Prospective Observational Study." *JMIR formative research* 5.8 (2021): e28568.
14. Benedict, Christian, and Jonathan Cedernaes. "Could a good night's sleep improve COVID-19 vaccine efficacy?." *The Lancet Respiratory Medicine* 9.5 (2021): 447-448.
15. Hajduczuk, Alexander G., et al. "Physiologic Response to the Pfizer-BioNTech COVID-19 Vaccine Measured Using Wearable Devices: Prospective Observational Study." *JMIR formative research* 5.8 (2021): e28568.
16. Zhang, Tongyue, et al. "The roles of nausea and vomiting in COVID-19: did we miss something?." *Journal of Microbiology, Immunology and Infection* 54.4 (2021): 541-546.
17. Nittner-Marszalska, Marita, et al. "Pfizer-BioNTech COVID-19 Vaccine Tolerance in Allergic versus Non-Allergic Individuals." *Vaccines* 9.6 (2021): 553
18. Daou, Christophe Abi Zeid, Mohammad A. Natout, and Nadine El Hadi. "Biphasic anaphylaxis after exposure to the first dose of Pfizer-BioNTech COVID-19 mRNA vaccine." *Journal of medical virology* (2021).
19. Iguchi, Toyotaka, et al. "Cumulative adverse event reporting of anaphylaxis after mRNA COVID-19 vaccine (Pfizer-BioNTech) injections in Japan: the first-month report." *Drug Safety* (2021): 1-6.
20. Mahase, Elisabeth. "Covid-19: People with history of significant allergic reactions should not receive Pfizer vaccine, says regulator." *BMJ: British Medical Journal* (Online) 371 (2020).
21. Mark, Catherine, et al. "Safety of administration of BNT162b2 mRNA (Pfizer-BioNTech) COVID-19 vaccine in youths and young adults with a history of acute lymphoblastic leukemia and allergy to PEG-asparaginase." *Pediatric Blood & Cancer* 68.11 (2021): e29295
22. Breidenbaugh, M. "M044 POLYETHYLENE GLYCOL ALLERGY TESTING AN ADOLESCENT WITH ANAPHYLAXIS TO PEG-ASPARAGINASE BEFORE ADMINISTERING PFIZER-BIONTECH COVID-19 VACCINE." *Annals of Allergy, Asthma & Immunology* 127.5 (2021): S70.
23. Simons, Keith J., and F. Estelle R. Simons. "Epinephrine and its use in anaphylaxis: current issues." *Current opinion in allergy and clinical immunology* 10.4 (2010): 354-361.
24. Sellaturay, Priya, et al. "Polyethylene glycol (PEG) is a cause of anaphylaxis to the Pfizer/BioNTech mRNA COVID-19 vaccine." *Clinical and Experimental Allergy* 51.6 (2021): 861.
25. Kim, Hyun Joo, Ji-Young Kim, and Seong-Karp Hong. "Myelination and Demyelination of Schwann cells and Neuron cells." *Proceedings of the Korean Institute of Information and Communication Sciences Conference. The Korea Institute of Information and Communication Engineering*, 2015.
26. Fujimori, Juichi, Kouichi Miyazawa, and Ichiro Nakashima. "Initial clinical manifestation of multiple sclerosis after immunization with the Pfizer-BioNTech COVID-19 vaccine." *Journal of Neuroimmunology* (2021): 577755.
27. Tano, Eric, et al. "Perimyocarditis in adolescents after Pfizer-BioNTech COVID-19 vaccine." *Journal of the Pediatric Infectious Diseases Society* (2021).
28. Ioannou, A. "Myocarditis should be considered in those with a troponin rise and unobstructed coronary arteries following Pfizer-BioNTech COVID-19 vaccination." *QJM: An International Journal of Medicine* 1 (2021): 1.
29. Gomes, Delphina, et al. "Is the BioNTech-Pfizer COVID-19 vaccination effective in elderly populations? Results from population data from Bavaria, Germany." *medRxiv* (2021)
30. Lustig, Yaniv, et al. "Neutralising capacity against Delta (B. 1.617. 2) and other variants of concern following Comirnaty (BNT162b2, BioNTech/Pfizer) vaccination in health care workers, Israel." *Eurosurveillance* 26.26 (2021): 2100557.
31. Schwarzer, Rolf, et al. "A single dose of the Biontech/Pfizer BNT162b2 vaccine protected elderly residents from severe COVID-19 during a SARS-coronavirus-2 outbreak in a senior citizen home in

- Germany." *Immunity, Inflammation and Disease* (2021)
32. Racine-Brzostek, Sabrina E., et al. "Rapid, robust, and sustainable antibody responses to mRNA COVID-19 vaccine in convalescent COVID-19 individuals." *JCI insight* 6.20 (2021).
33. [https://www.clalit.co.il/he/your\\_health/family/Pages/pfizer\\_covid\\_vac\\_effect.aspx](https://www.clalit.co.il/he/your_health/family/Pages/pfizer_covid_vac_effect.aspx)

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