AKDENİZ SAĞLIK BİLİMLERİ
GÜNCEL ARAŞTIRMALAR DERGİSİ
MEDITERRANEAN JOURNAL OF
HEALTH SCIENCES AND CURRENT RESEARCH
OPEN ACCESS

Evaluation of Permanent Damages Related to The Virus in Young Adults After the Covıd-19 Pandemic

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DOI: https://doi.org/10.5281/zenodo.10446726

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Received:
04.07.2023

Accepted:
28.9.2023

Online Publishing:
30.12.2023

Abstract

Aim: The aim of this study is to evaluate the mid- and long-term health effects of the COVID-19 virus and the COVID-19 vaccine on individuals after the COVID-19 pandemic. Material and Methods: The research was conducted with young adults studying at a university in Türkiye. A total of 468 individuals between the ages of 18-40, without any chronic illnesses, and willing to participate in the study were included. Research data were collected through a questionnaire, and the data were analyzed using SPSS (25th version). Results: The average age of the participants was 21.00±2.74 years, 63.5% were male, and 100% had no chronic illnesses before the COVID-19 pandemic. All participants (100%) received the COVID-19 vaccine, with 68.6% preferring the BioNTech vaccine. Of the participants, 28.4% had experienced COVID-19, and 2.6% reported ongoing side effects related to the vaccine. After the COVID-19 pandemic, 1.7% of participants experienced hypertension, 2.2% had conditions related to diabetes, and 1.9% reported persistent cough. Conclusion: The data obtained from the study suggest the occurrence of different health problems related to the COVID-19 virus and vaccination among participants. It is concluded that these effects may be associated with COVID-19, and further data are needed for the assessment of effects related to COVID-19 vaccines.

Key Words: COVID 19, Coronavirus, Pandemic, Health

Covıd-19 Pandemisinden Sonra Genç Yetişkinlerde Virüse Bağlı Kalıcı Hasarların Değerlendirilmesi

Öz

Amaç: Bu çalışmanın amacı, COVİD-19 salgını sonrasında, COVİD-19 virüsü ve COVİD-19 aşısının bireyler üzerindeki orta ve uzun vadeli sağlık etkilerini değerlendirmektir. Gereç ve Yöntemler: Araştırma, Türkiye'de bir üniversitede öğrenim gören genç yetişkinlerle gerçekleştirilmiştir. Araştırmaya 18-40 yaş arası, herhangi bir kronik hastalığı olmayan ve katılmak isteyen toplam 468 kişi dahil edildi. Araştırma verileri anket aracılığıyla toplanmış ve veriler SPSS (25. versiyon) kullanılarak analiz edilmiştir. Bulgular: Katılımcıların yaş ortalaması 21,00±2,74 yıl olup, %63,5'i erkek olup, %100'ünün COVİD-19 salgını öncesinde herhangi bir kronik hastalığı yoktu. Katılımcıların tamamı (%100) COVID-19 aşısını alırken, %68,6'sı BioNTech aşısını tercih etti. Katılımcıların yüzde 28,4'ü COVID-19 yaşadı ve yüzde 2,6'sı aşıyla ilgili yan etkilerin devam ettiğini bildirdi. COVİD-19 salgını sonrasında katılımcıların %1,7'sinde hipertansiyon, %2,2'sinde diyabetle ilgili rahatsızlıklar görüldü ve %1,9'unda inatçı öksürük bildirildi. Sonuç: Araştırmadan elde edilen veriler, katılımcılar arasında COVİD-19 virüsü ve aşıya bağlı farklı sağlık sorunlarının ortaya çıktığını düşündürmektedir. Bu etkilerin COVİD-19 ile ilişkili olabileceği, COVİD-19 aşılarına ilişkin etkilerin değerlendirilmesi için daha fazla veriye ihtiyaç duyulduğu sonucuna varılmıştır.

Anahtar Kelimeler: COVID 19, Koronavirüs, Pandemi, Sağlık

Introduction

The COVID-19 pandemic emerged in December 2019 in China, and on March 12, 2020, it was declared a pandemic by the World Health Organization (WHO, 2020). The first official case in Türkiye as reported in March 2020 (Ciotti et al., 2020).

With the rapid spread of the disease, putting a large number of people in hospitals for treatment simultaneously, public authorities had to take new measures. The isolation of the COVID-19 virus led to an acceleration of vaccine development efforts, and effective vaccines helped slow down the spread of the pandemic. As vaccination rates increased, the number of hospitalizations and treated individuals decreased, and hospitals returned to normal capacity (Duque et al., 2023; Lee and Suzuki, 2023; Paul et al., 2023).

In Türkiye approval was given for the use of four different COVID-19 vaccines, but only Pfizer-BioNTech, Sinovac CoronaVac, and TurkoVac were utilized. The initiation of vaccination resulted in a significant decrease in hospitalizations and deaths, but this cannot be solely attributed to the vaccines. Increased and intensified public measures, mask and distancing practices, social isolation, and greater public awareness also contributed to reducing the severity of the pandemic and deaths (Mitze et al., 2020; Rzymski et al., 2023; Silva et al., 2023).

However, with the use of vaccines, some individuals began experiencing various side effects. Most of these side effects were short-term and temporary, such as pain, redness, fever, weakness, and fatigue at the vaccine site (Akarsu, 2022; Niebel et al., 2021). According to some studies, the number of side effects was reported to increase proportionally with the number of people vaccinated (Aldali et al., 2023; Komici et al., 2023). Nevertheless, there are also studies reporting that some side effects persist for a long time and lead to different complications. Some of these include thyroid eye disease (Muller et al., 2023), various neurological disorders (Hosseini and Askari, 2023), myocarditis (Munjal et al., 2023), thrombocytopenia (Abukhalil et al., 2023), and pregnancy complications (Lam et al., 2023). However, it has been reported that only about 5% of vaccinated individuals were significantly affected to the extent of requiring hospital treatment due to these side effects (Yaamika et al., 2023).

Due to COVID-19's tendency to increase the duration of illness-related deaths and hospitalizations, governments took various actions and imposed some restrictions to encourage vaccination and reduce the density in hospital services. However, low immunity levels in the general population, allergic reactions to vaccine components, and various health problems occurring after vaccination led to hesitations among those who would be vaccinated in the future, resulting in a gradually decreasing desire to get vaccinated. Therefore, due to the partial trust issues arising against

the vaccine, it is necessary to reveal the medium to long-term effects of both the vaccine and the virus.

This research aims to identify individuals among young adults who experienced health issues related to the COVID-19 virus or its vaccine after the pandemic period.

Materials and Methods

Research Type

This research was cross-sectional and planned to determine the health problems experienced by young adults living in Türkiye who had no health issues before the COVID-19 pandemic, both related to the COVID-19 virus and its vaccine, after the pandemic period.

Participants

The research was conducted on the campus of a state university located in the central Anatolia region of Türkiye. The research was completed with 468 students who volunteered to participate in the research and met the inclusion criteria.

Data Collection

The research was conducted on December 2023, through face-to-face interviews using a questionnaire prepared by the researcher. Individuals aged 18-40, without chronic illness or physical disability, being a student in university, who could speak and understand Turkish, were included in the study without gender distinction. People who refused to participate in the study, who were under 18 years of age, over 40 years of age, had chronic and physical illnesses, were not university students, and did not speak Turkish were not included. The research was completed with a total of 468 participants during the specified period. All questions in the survey were determined by the researcher through a literature review. The questionnaire included inquiries about participants' demographic characteristics (age, gender, economic status, etc.) and 34 questions aimed at determining their health problems before and after the COVID-19 pandemic.

Statistical Analysis

The data were analyzed using the SPSS 25 software package. The data were evaluated using numbers, percentages, means, and standard deviations.

Results

The demographic features of the participants in the study are provided in Table 1. The participants had a mean age of 21.00±2.74 years, 63.5% were male. About 66.2% were receiving

education at the undergraduate level, 49.8% were residing in city centre 60.5% were living in nuclear families, 87.6% were unemployed, 63% had a moderate income level, 90.4% were single, and all participants (100%) did not have a chronic illness before the COVID-19 pandemic.

Table 1. Demographic characteristics of the participants in the study (n=468).

Characteristic's		**n**	**%**
Age average	21.00 ±2.74 (min.18-max.35)		
Gender	Male	297	63.5
	Female	171	36.5
Education levels	High School	137	29.3
	Undergraduate	309	66.2
	Master and Above	21	4.5
Place of residence	Village-district	127	27.1
	City Centre	233	49.8
	Metropolis	108	23.1
Family type	Nuclear	283	60.5
	Big family	185	39.5
Working status	Employed	58	12.4
	Unemployed	410	87.6
Income status	Income lower than expenses	119	25.4
	Income equal to expenses	295	63.0
	Income more than expenses	54	11.5
Marital status	Single	45	9.6
	Married	423	90.4
Chronic disease status before vaccination	Yes	0	0
	No	468	100

In Table 2, we posed questions related to the participants' COVID-19 vaccinations. All participants (100%) had received the COVID-19 vaccine. The majority (68.6%) had opted for the BioNTech vaccine. About 70.9% of the participants had received two doses of the COVID-19 vaccine. Various side effects (such as weakness, fever, redness and pain at the injection site, cough, etc.) were reported in 29.9% of the participants after vaccination. When asked about ongoing side effects after vaccination, 2.6% of the participants reported that these side effects were still persisting. The data for Table 2 are provided below.

Table 2. Data related to the COVID-19 vaccine (n=468).

Questions		**n**	**%**
COVID-19 vaccination status of participants		468	100
Vaccine brand	Biontech	321	68.6
	Sinovac	123	26.3
	Biontech+Sinovac	3	0.6
	TurkoVac	19	4.1
	Biontech+ TurkoVac	2	0.4
Dose of vaccine	1st Dose	56	12.0
	2nd Dose	332	70.9
	3rd Dose	72	15.4
	4th Dose	8	1.7
Side effect	Yes	140	29.9
	No	328	70.1
COVID-19 test positivity status?	Yes	133	28.4
	No	335	71.6
Does the side effect still continue?	Yes	12	2.6
	No	456	97.4
Do you have a complaint of hypertension?	Yes	8	1.7
	No	460	98.3
Have you been diagnosed with hypertension?	Yes	0	0
	No	468	100.0
Do you have any diabetes-related complaints?	Yes	10	2.2
	No	458	97.8
Have you been diagnosed with Diabetes Mellitus?	Yes	8	1.7
	No	460	98.3
Did you have a cough after vaccination?	Yes	9	1.9
	No	459	98.1
Have you been to the doctor for a cough?	Yes	5	1.1
	No	463	98.9

Discussion

Due to the measures taken with the COVID-19 epidemic and the increase in vaccinated people after the vaccination campaign, the situation in 2020 is no longer possible. Although there are still patients with COVID-19, the general situation is much better and it does not cause as many deaths as

before. However, it can be said that the viral effects of the COVID-19 virus continue to make life difficult. Although there are still individuals recovering from COVID-19, the overall situation is much better, and it does not lead to deaths as much as it used to. However, it can be stated that the virulent effects of the COVID-19 virus continue to make life difficult.

Even though the COVID-19 virus can spread to all individuals equally, it cannot be said that it affects everyone equally. In a study conducted by Davies et al. (2020), it was reported that the risk of children contracting and developing complications from COVID-19 is relatively lower compared to older individuals, and children are much less affected (Davies et al., 2020). Therefore, priority was given to vaccinating the elderly, considered the most vulnerable group to the virus. In the subsequent period, vaccination campaigns targeting the entire population were initiated. The inclusion of children in vaccination is stated to be due to the risk of transmission, somewhat indicating that children are vaccinated to protect the elderly. This has been the subject of numerous studies from both legal and ethical perspectives (Giubilini et al., 2020; Husted et al., 2023; Offit, 2023).

During the COVID-19 pandemic, there were reported increases in cases of myocarditis and pericarditis. Research has shown that the number of these cases has increased by at least 15 times (Fairweather et al., 2023). However, participants in our study did not report any discomfort related to myocarditis or pericarditis. The median age of our study group being 21.00±2.74 years and the youthfulness of the participants may be considered factors reducing the risk of myocarditis and pericarditis (Rivera-Torres et al., 2023). However, there are studies indicating myocarditis cases occurring seven days after vaccination in young adults (Amodio et al., 2023).

Another study reported that the COVID-19 virus affects the liver. When deaths related to COVID-19 were examined, it was reported that 2-11% of patients had liver-related complications. The importance of the liver in COVID-19 lies in the fact that ACE2 receptors are sensitive to COVID-19, and one of the places where these receptors are most abundant is the liver (Jothimani et al., 2020).

Another organ affected by COVID-19 is the kidneys. In a study by Wang et al. (2020), it was reported that among non-critical COVID-19 patients, 10.6% experienced an increase in serum creatinine or urea nitrogen within the first 48 hours of hospitalization (Wang et al., 2020). Adamczak et al. (2022) reported that the cause of acute kidney disease is related to hemodynamic abnormalities, cytokine storms, and hypoxia (Adamczak et al., 2022).

The impact of COVID-19 on women has also been evaluated. During the COVID-19 pandemic, deviations in menstrual cycles and an increase in menstrual symptoms in women were reported (Demir et al., 2021). It should be noted that this may be due to intense anxiety related to

COVID-19. There are also studies reporting temporary decreases in antimüllerian hormone and irregularities in menstruation due to COVID-19 vaccines (Hasdemir et al., 2023).

There are studies indicating that the effects of the COVID-19 virus are more severe in individuals with diabetes. Additionally, adverse effects from COVID-19 vaccines are reported to be more common in individuals with diabetes (Khan et al., 2023). In another study, it was reported that vaccinating diabetic patients did not result in the same high levels of general antibody response as in healthy individuals. This may be related to the duration and severity of diabetes, as prolonged uncontrolled diabetes can disrupt cellular responses and alter necessary responses.

In a study by Matsumoto et al. (2023), it was reported that COVID-19 changed the clinical course of hypertension-related diseases such as cardiovascular diseases, kidneys, and endocrine disorders. It also emphasized that women and the elderly are more affected by COVID-19. However, most of the studies on hypertension and COVID-19 were conducted in the early stages of the pandemic, and there is currently insufficient research evaluating the long-term effects of COVID-19 on hypertension (Matsumoto et al., 2023). Due to the restrictions of the pandemic, it has accelerated the already increasing trend of obesity, leading to various diseases, especially cardiovascular diseases (El-Battrawy et al., 2021; Nogueira-de-Almeida et al., 2020).

Vaccination is crucial to prevent diseases. However, the relationship between the number of vaccinations and the establishment and maintenance of immunity can be determined in the future through screenings. It has been reported that two doses of the COVID-19 vaccine are necessary for protection against COVID-19 and strengthen immunity. Protective doses as the 3rd and 4th doses have been recommended for later stages. However, due to the limited number of studies evaluating the impact of additional doses on COVID-19, definitive statements about the harm or beneficial efficacy of the 3rd and 4th doses cannot be made at this stage (Kai et al., 2021; Notarte et al., 2022).

There are many complaints about persistent cough after COVID-19, and research indicates that non-infected individuals continue to struggle with cough for an extended period. When evaluated separately from other complications, persistent cough may be considered to be possibly related to vagus nerve neuropathy (García-Vicente et al., 2023).

Conclusion

Since the participants in our study were young and did not have any chronic diseases before or after COVID-19, we cannot evaluate whether the COVID-19 epidemic may lead to new diseases. However, it is conceivable that the COVID-19 virus and/or vaccines cause different health problems in some participants. We think that this is due to the young age of the participants and the fact that

the study was conducted with a relatively small number of participants. More data is needed to evaluate long-term effects.

Limitations of Research

Since the research was conducted in one region and the participants were young adults, the results of the research cannot be generalized to society. Conducting research with young and healthy adults in one region cannot help evaluate the impact of the COVID-19 virus and its vaccines on individuals with chronic diseases. For this reason, it is recommended to evaluate different regions and large patient groups.

Ethical Approval

Approval was obtained from the local ethics committee where the study was conducted (Ethical Number:09/61) Participants were informed about the study, and written and verbal consent were obtained from them.

Acknowledgement

We thank all participants who participated in the research.

Conflict the Interest

There is no conflict of interest with any person or institution.

Funding Status

There is no financial support for conducting the research.

References

Abukhalil, A. D., Shatat, S. S., Abushehadeh, R. R., Al-Shami, N. m., Naseef, H. A., & Rabba, A. (2023). Side effects of Pfizer/BioNTech (BNT162b2) COVID-19 vaccine reported by the Birzeit University community. *BMC Infectious Diseases*, *23*(1), 5.

Adamczak, M., Surma, S., & Więcek, A. (2022). Acute kidney injury in patients with COVID-19: Epidemiology, pathogenesis and treatment. *Advances in Clinical and Experimental Medicine*, *31*(3), 317-326.

Akarsu, G. D. (2022). Determining the health problems experienced by young adults in Turkey, who received the COVID-19 vaccine. *Vaccines*, *10*(9), 1526.

Aldali, H. J., Aldali, J. A., Alotaibi, B. A., Alasiri, G. A., Alromih, A. M., Elsokkary, E. M., Aldali, A. Z., & Almeziny, A. (2023). Evaluating the Adverse Events Associated with Three Doses of the COVID-19 Vaccination in Adults in the Western Region of Saudi Arabia: A Cross-Sectional Study. *Vaccines*, *11*(2), 266.

Amodio, D., Pascucci, G. R., Cotugno, N., Rossetti, C., Manno, E. C., Pighi, C., Morrocchi, E., D'Alessandro, A., Perrone, M. A., & Valentini, A. (2023). Similarities and differences between myocarditis following COVID-19 mRNA vaccine and multiple inflammatory syndrome with cardiac involvement in children. *Clinical Immunology*, *255*, 109751.

Ciotti, M., Ciccozzi, M., Terrinoni, A., Jiang, W.-C., Wang, C.-B., & Bernardini, S. (2020). The COVID-19 pandemic. *Critical reviews in clinical laboratory sciences*, *57*(6), 365-388.

Davies, N. G., Klepac, P., Liu, Y., Prem, K., Jit, M., & Eggo, R. M. (2020). Age-dependent effects in the transmission and control of COVID-19 epidemics. *Nature medicine*, *26*(8), 1205-1211.

Demir, O., Sal, H., & Comba, C. (2021). Triangle of COVID, anxiety and menstrual cycle. *Journal of Obstetrics and Gynaecology*, *41*(8), 1257-1261.

Duque, J. S. R., Leung, D., Yip, K. M., Lee, D. H., So, H.-k., Wong, W. H., & Lau, Y. L. (2023). COVID-19 vaccines versus pediatric hospitalization. *Cell Reports Medicine*, *4*(2).

El-Battrawy, I., Nuñez-Gil, I. J., Abumayyaleh, M., Estrada, V., Manuel Becerra-Muñoz, V., Uribarri, A., Fernández-Rozas, I., Feltes, G., Arroyo-Espliguero, R., & Trabattoni, D. (2021). COVID-19 and the impact of arterial hypertension—An analysis of the international HOPE COVID-19 Registry (Italy-Spain-Germany). *European Journal of Clinical Investigation*, *51*(11), e13582.

Fairweather, D., Beetler, D. J., Di Florio, D. N., Musigk, N., Heidecker, B., & Cooper Jr, L. T. (2023). COVID-19, myocarditis and pericarditis. *Circulation research*, *132*(10), 1302-1319.

García-Vicente, P., Rodríguez-Valiente, A., Górriz Gil, C., Márquez Altemir, R., Martínez-Pérez, F., López-Pajaro, L. F., & García-Berrocal, J. R. (2023). Chronic cough in post-COVID syndrome: Laryngeal electromyography findings in vagus nerve neuropathy. *PloS one*, *18*(3), e0283758.

Giubilini, A., Savulescu, J., & Wilkinson, D. (2020). COVID-19 vaccine: vaccinate the young to protect the old? *Journal of Law and the Biosciences*, *7*(1), lsaa050.

Hasdemir, P. S., Senol Akar, S., Goker, A., Kosova, F., Ucar, D., Ozalp Ates, F. S., & Akcali, S. (2023). The effect of COVID-19 vaccinations on menstrual cycle and serum anti-Mullerian hormone levels in reproductive age women. *Human Fertility*, *26*(1), 153-161.

Hosseini, R., & Askari, N. (2023). A review of neurological side effects of COVID-19 vaccination. *European Journal of Medical Research*, *28*(1), 1-8.

Husted, M., Gibbons, A., Cheung, W.-Y., & Keating, S. (2023). COVID-19 vaccination hesitancy in adults in the United Kingdom: Barriers and facilitators to uptake. *Health Psychology*.

Jothimani, D., Venugopal, R., Abedin, M. F., Kaliamoorthy, I., & Rela, M. (2020). COVID-19 and the liver. *Journal of hepatology*, *73*(5), 1231-1240.

Kai, X., Xiao-Yan, T., Miao, L., Liang, Z.-W., Jiang-Nan, C., Jiao-Jiao, L., Jiang, L.-G., Fu-Qiang, X., & Jiang, Y. (2021). Efficacy and safety of COVID-19 vaccines: a systematic review. *Chinese Journal of Contemporary Pediatrics*, *23*(3), 221.

Khan, F., Khan, M. T., Zaman, S., Mujtaba, S., Batool, A., Ghanghro, Z., Anwar, A., & Hashmi, A. A. (2023). Side effects of COVID-19 vaccines among diabetic subjects and healthy individuals. *Cureus*, *15*(3).

Komici, K., Verderosa, S., D'Amico, F., & Guerra, G. (2023). Self-reported side effects following COVID-19 vaccination in athletes: a retrospective study. *Human Vaccines & Immunotherapeutics*, *19*(2), 2234788.

Lam, J. N., Nehira, J., Phung, O., & Deng, B. (2023). Systematic Review: Safety and Efficacy of mRNA COVID-19 Vaccines in Pregnant Women. *Journal of Pharmacy Practice*, 08971900231196065.

Lee, C. Y., & Suzuki, J. B. (2023). COVID-19: variants, immunity, and therapeutics for non-hospitalized patients. *Biomedicines*, *11*(7), 2055.

Matsumoto, C., Shibata, S., Kishi, T., Morimoto, S., Mogi, M., Yamamoto, K., Kobayashi, K., Tanaka, M., Asayama, K., & Yamamoto, E. (2023). Long COVID and hypertension-related disorders: a report from the Japanese Society of Hypertension Project Team on COVID-19. *Hypertension Research*, *46*(3), 601-619.

Mitze, T., Kosfeld, R., Rode, J., & Wälde, K. (2020). Face masks considerably reduce COVID-19 cases in Germany. *Proceedings of the National Academy of Sciences*, *117*(51), 32293-32301.

Muller, I., Consonni, D., Crivicich, E., Di Marco, F., Currò, N., & Salvi, M. (2023). Increased risk of Thyroid Eye Disease following Covid-19 Vaccination. *The Journal of Clinical Endocrinology & Metabolism*, dgad501.

Munjal, J. S., Flores, S. M., Yousuf, H., Gupta, V., Munjal, R. S., Anamika, F., Mendpara, V., Shah, P., & Jain, R. (2023). Covid-19 Vaccine-induced Myocarditis. *Journal of Community Hospital Internal Medicine Perspectives*, *13*(5), 44.

Niebel, D., Novak, N., Wilhelmi, J., Ziob, J., Wilsmann-Theis, D., Bieber, T., Wenzel, J., & Braegelmann, C. (2021). Cutaneous adverse reactions to COVID-19 vaccines: insights from an immuno-dermatological perspective. *Vaccines*, *9*(9), 944.

Nogueira-de-Almeida, C. A., Del Ciampo, L. A., Ferraz, I. S., Del Ciampo, I. R., Contini, A. A., & Ued, F. d. V. (2020). COVID-19 and obesity in childhood and adolescence: a clinical review. *Jornal de pediatria*, *96*, 546-558.

Notarte, K. I., Catahay, J. A., Velasco, J. V., Pastrana, A., Ver, A. T., Pangilinan, F. C., Peligro, P. J., Casimiro, M., Guerrero, J. J., & Gellaco, M. M. L. (2022). Impact of COVID-19 vaccination on the risk of developing long-COVID and on existing long-COVID symptoms: A systematic review. *EClinicalMedicine*, *53*.

Offit, P. A. (2023). COVID-19 Vaccines in Young Children—Reassuring Evidence for Parents. *JAMA pediatrics*, *177*(4), 333-334.

Paul, P., El-Naas, A., Hamad, O., Salameh, M. A., Mhaimeed, N., Laswi, I., Abdelati, A. A., AlAnni, J., Khanjar, B., & Al-Ali, D. (2023). Effectiveness of the pre-Omicron COVID-19 vaccines against Omicron in reducing infection, hospitalization, severity, and mortality compared to Delta and other variants: A systematic review. *Human Vaccines & Immunotherapeutics*, *19*(1), 2167410.

Rivera-Torres, J., Girón, N., & San José, E. (2023). COVID-19: A Comprehensive Review on Cardiovascular Alterations, Immunity, and Therapeutics in Older Adults. *Journal of Clinical Medicine*, *12*(2), 488.

Rzymski, P., Kasianchuk, N., Sikora, D., & Poniedziałek, B. (2023). COVID-19 vaccinations and rates of infections, hospitalizations, ICU admissions, and deaths in Europe during SARS-CoV-2 Omicron wave in the first quarter of 2022. *Journal of Medical Virology*, *95*(1), e28131.

Silva, T. C., Anghinoni, L., Chagas, C. P. d., Zhao, L., & Tabak, B. M. (2023). Analysis of the Effectiveness of Public Health Measures on COVID-19 Transmission. *International Journal of Environmental Research and Public Health*, *20*(18), 6758.

Wang, L., Li, X., Chen, H., Yan, S., Li, D., Li, Y., & Gong, Z. (2020). Coronavirus disease 19 infection does not result in acute kidney injury: an analysis of 116 hospitalized patients from Wuhan, China. *American journal of nephrology*, *51*(5), 343-348.

Yaamika, H., Muralidas, D., & Elumalai, K. (2023). Review of adverse events associated with COVID-19 vaccines, highlighting their frequencies and reported cases. *Journal of Taibah University Medical Sciences*.