Biochemical Study for The Effect of Pfizer-BioNTech COVID-19 Vaccine

Umer A. H. Al-Dolaimy¹ and Rafah R. H. Al-Samarrai²

1- Department of Pathological Analysis, College of Applied Science, University of Samarra, Samarra, Iraq
2-Department of Applied Chemistry, College of Applied Science, University of Samarra, Samarra, Iraq

*E. Mail: dr.rafah_alsamarrai@uosamarra.edu.iq

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ABSTRACT

The present study aimed to evaluate the biochemical effect of COVID-19 vaccines (Pfizer-BioNTech COVID-19 vaccine). 90 samples were included in the study from people in the vaccine center in Al-Dhuluiya general hospital-Salah Al-Din who was vaccinated with the Pfizer vaccine during the period from 1/11/2021 until 1/2/2022. The samples were collected before receiving the 1st dose and after 24-48 hours of taking the 1st and 2nd doses. The collected samples were divided into three groups: -First group-G1: Before taking the first dose of the Pfizer vaccine, -Second group-G2, and Third group-G3: After taking the first and second doses of the Pfizer vaccine respectively. The study includes the determination of different biochemical parameters such as serum Troponin, Lactate dehydrogenase-LDH, D-dimer, Lipid profiles (Cholesterol, Triglycerides, High-density lipoprotein cholesterol-HDL-C, Low-density lipoprotein cholesterol-LDL-C), Total iron, Transferrin, ferritin, Glutathione-GSH, Malondialdehyde-MDA, and peroxynitrate-PON.

The results showed that LDH, D-dimer, and MDA levels were significantly elevated after the first and second doses of the Pfizer vaccine as compared with their levels before receiving doses vaccine. While the level of troponin, lipid profile, total iron, and transferrin didn’t show any significant difference after vaccination as compared with their levels before receiving the vaccine. So, we can conclude that the vaccination with the Pfizer-BioNTech COVID-19 vaccine may affect the cardiac marker and the oxidative stress state.

INTRODUCTION

In Wuhan (China) in December 2019 first identified a novel coronavirus-recently named SARS-CoV-2, which causes a disease named COVID-19 or Coronavirus disease 2019, which then pandemic worldwide and affected all territories and countries (Wang et al., 2020; Sintema., 2020). The infections with coronavirus in humans may be asymptomatic or can cause cough, illnesses, fever, gastrointestinal irritation, and shortness of breath (Huang et al., 2020; Gupta et al., 2020). The coronavirus infection may lead to severe pneumonia and death, especially in immune-compromised individuals and the elderly (Sharma et al., 2021). Since the beginning of the pandemic, enormous efforts have been directed to find effective vaccines and safe ones, and those efforts culminated in finding 184 COVID-19 vaccines in July 2021 nominees in pre-clinical development. These vaccines involve viral vectors, protein-based vaccines, the whole virus inactivated or live attenuated, and nucleic acid vaccines.

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The vaccination supply hopes for an end to the pandemic in all countries around the world (Ndwandwe and Wiysonge., 2021).

On 11/11/2020 the Administration of Food and Drugs issued authorization to use the Pfizer-BioNTech COVID-19 vaccine in an emergency to prevent the prevalence of COVID-19, which has been given in two doses discrete by 21 days (Oliver et al., 2020). The most ordinary symptoms after vaccination with the Pfizer vaccine include headaches, pain in the injection site, fever, tiredness, and mild flu-like symptoms while fast heartbeat, joint pain, drowsiness, aches in the body, chills, and difficulty breathing were less common symptoms as a side effect of the vaccine (El-Shitany et al., 2021), and also some rare side effects were reported after vaccination with the 1st dose of Pfizer vaccine such as acute kidney injury and nephrotic (increase the concentration of serum creatinine) (Lebedev et al., 2021), myocarditis after 2nd dose (Viskin et al., 2021; Marshall et al., 2021; Chatterjee et al., 2021; Aye et al., 2021) and acute Myocardial Infarction within twenty-two hours after the 1st dose (Aye et al., 2021; Sung et al., 2021; Jabagi et al., 2022). So many people all over the world have anxiety about the side effect of vaccines. Thus, the present study was conducted to evaluate the side effects of the Pfizer vaccine.

MATERIALS AND METHODS
Subjects and Study Design:

Ninety serum and plasma samples were collected from people in the vaccine center in Al-Dhululuya general hospital-Salah Al-Din which vaccinated with the Pfizer-BioNTech COVID-19 vaccine approved by the Iraqi ministry of health during the period from 1/11/2021 until 1/2/2022 with age ranged from 18-55 years. The samples were collected before receiving the 1st dose and after 24-48 hours of taking the 1st and 2nd doses. The collected samples were divided into three groups:
- First group-G1: Before taking the first dose of the Pfizer vaccine.
- Second group-G2: After taking the first dose of the Pfizer vaccine.
- Third group-G3: After taking the second dose of the Pfizer vaccine.

The study includes the determination of serum Troponin (McNeil., 2007), Lipid profiles (Cholesterol, Triglycerides, High-density lipoprotein cholesterol-HDL-C, Low-density lipoprotein cholesterol-LDL-C), Total iron-TI (Garcie., 1979), Transferrin, ferritin (Worwood., 1986), Glutathione-GSH (Sedlak and Lindsay., 1968), Malondialdehyde-MDA and peroxy nitrate-PON (Abi., 1974) concentration and also serum Lactate dehydrogenase-LDH activity (Vassiault, 1986) and plasma D-dimer concentration (Kaplan & Pesce., 1989) by using standard methods.

Statistical Analysis:
The results were analyzed by using SPSS V.25 using the completely randomized design method through the Duncan test for identifying the variance between groups under investigation at probability p≤0.05.

RESULTS
Levels of Serum Cardiac Indicator and Plasma D-dimer
The results of troponin, LDH, and D-dimer obtained from the current study were summarized in Table 1.

Table 1 showed that the activity of LDH and D-dimer levels significantly elevated at probability p≤0.05 in G1 and G2 after taking the vaccine as compared with the group before taking vaccine G1, with no significant difference in troponin after and before vaccination.
Table 1: Mean±Standard deviation of the level of Troponin, D-dimer and LDH activity before and after taking the vaccine.

| Parameters       | G1                  | G2                  | G3                  |
|------------------|---------------------|---------------------|---------------------|
| Troponin (ng/ml) | 0.019±0.009 a       | 0.024±0.012 a       | 0.020±0.007 a       |
| LDH (U/L)        | 234.93±56.065 b     | 299.80±72.531 a     | 296.22±74.140 a     |
| D-dimer (mg/dl)  | 178.97±64.568 b     | 269.37±143.362 a    | 235.33±96.973 a     |

Levels of Serum Lipids:
The study also includes an evaluation of the serum levels of lipid profile in sera of samples under investigation before and after taking of vaccine, the results obtained from the current study were summarized in Table 2. No significant difference in the level of serum lipid profile at probability p≤0.05 was shown in Table 2 between groups after vaccination as compared with G1 before taking the vaccine.

Table 2: Mean±Standard deviation of serum lipid profile level before and after taking the vaccine.

| Parameters       | G1                  | G2                  | G3                  |
|------------------|---------------------|---------------------|---------------------|
| Cholesterol (mg/dl) | 152.97±38.400 a | 141.27±34.372 a | 137.00±38.460 a |
| Triglycerides(mg/dl)| 170.37±86.744 a | 158.83±92.590 a | 163.74±94.033 a |
| HDL-C(mg/dl)     | 42.03±6.494 a      | 39.53±5.283 a      | 40.93±4.463 a      |
| LDL-C(mg/dl)     | 67.27±27.483 a     | 71.13±28.352 a     | 73.67±28.866 a     |

Levels of Serum Iron Indicator:
The level of ferritin was significantly elevated in G3 as compared with its level in G1 and G2, with no significant difference in the levels of total iron and transferrin after taking 1st and 2nd dose of the vaccine as compared with their levels before taking the vaccine, Table 3.

Table 3: Mean±Standard deviation of Total iron, Transferrin and Ferritin levels before and after taking the vaccine.

| Parameters       | G1                  | G2                  | G3                  |
|------------------|---------------------|---------------------|---------------------|
| Total iron (µg/dl) | 85.89±38.575 a | 67.86±38.595 a | 70.35±36.054 a |
| Transferrin (µg/dl) | 348.33±77.505 a | 347.80±61.819 a | 310.19±67.423 a |
| Ferritin (µg/dl)  | 18.19±8.115 b      | 21.19±10.756 b     | 32.29±19.094 a     |

Levels of Antioxidant Parameters in Serum:
The study also evaluates the oxidative stress state after administration of vaccine doses, the results showed that the level of glutathione significantly decreased after taking the doses of vaccine with increasing the level of MDA as compared with the group before taking the vaccine, while the level of peroxynitrite significantly increased in groups taking the first dose of vaccine and slightly increased in G2(Non-significant increased) as shown in Tabl.

Table 4: Mean±Standard deviation of GSH, MDA and PON levels before and after taking the vaccine.

| Parameters       | G1                  | G2                  | G3                  |
|------------------|---------------------|---------------------|---------------------|
| GSH (mole/L)     | 3.607±1.2904 a     | 2.503±1.1095 b     | 2.256±0.9674 b     |
| MDA (mole/L)     | 53.50±23.008 b     | 69.21±29.285 a     | 78.62±33.001 a     |
| PON (mole/L)     | 118.17±57.272 b    | 157.24±68.675 a    | 149.73±66.463ab    |
DISCUSSION

The results of the current study showed that the level of troponin was not affected by the Pfizer vaccine, this result was in disagreement with the finding of (Acharya et al., 2021) which indicates that the level of troponin significantly elevated among Pfizer vaccinators, and they interpreted this increase to the inflammatory and immune response to mRNA vaccine which may be cause myocarditis as one of the confirmed side effects of Pfizer vaccine (Marshall et al., 2021; Aye et al., 2021). The increase in LDH activity in the present study may be a marker for myocarditis, and this result agreed with the finding of (Fatima et al., 2022) who indicated that the activity of LDH significantly elevated in sera of individuals who take Pfizer vaccinators. In addition, (Smadja et al, 2021) showed that the level of D-dimer was significantly elevated in the plasma of people who received doses of the Pfizer vaccine, these results agree with the finding of the current study, and this finding indicates that elevated level of D-dimer represents one of the side effects of Pfizer vaccine which activate the coagulation pathways.

The study also includes evaluating the effect of the Pfizer vaccine on the level of lipid profile, and the results showed that the vaccination didn’t affect the concentration of lipids, this finding was agree with the finding of (Davido et al., 2021). Also, the level of total iron and Transferrin was not affected after vaccination, and this finding was agreed with the finding of (Singh et al., 2021) who indicated that the vaccine did not affect the level of total iron. While the elevated level of ferritin after receiving the second dose of the vaccine may be due to iron loss by lack of iron consumption or bleeding or other reasons (Worwood., 1990). The elevated the level of MDA and PON with reducing in the level of antioxidants represent in GSH in the present study indicate that vaccinations under oxidative stress, in which the antioxidants in the cells such as glutathione run out in removing the toxic materials in the cells such as peroxides or free radicals and improve the immune system and prevent the oxidative processes in the body (Horowitz et al., 2020).

The infection with Coronavirus may be affected by many biochemical parameters such as D-dimer, transferrin, MDA, ferritin, lipid profile, LDH which are significantly elevated, with a significant reduction in the level of total iron and GSH, (Kadhim et al., 2022, July; Kadhim et al., 2022, November; Al-Samarra & Al-Samarrai, 2022, July; Szarpak et al., 2022; Kadhim et al., 2022; Al-Samarra & Al-Samarrai, 2022; Mahat et al., 2021). So, the interactions between the change (increasing or decreasing) in the level of the parameters under investigation in sera of infected patients with COVID-19 and also the same change in vaccination individuals may be increased anxiety about the side effect of vaccines.

Conclusion:

From the results of the present study, we can conclude that the Pfizer vaccine may have some side effects on the cardiac and oxidative stress state.

REFERENCES

Abi,H.(1974). Method of enzymatic analysis. New York Academic press ,2: Pp. 674-684.
Acharya, S., Brand, M., Lee, J., Macqueen, D., & Arbach, A. (2021). COVID-19 mRNA Vaccine In-duced Troponinemia-Is the Vaccine a Cardiac Stressor. International Journal of Clinical Cardiology,8: 232.
Al-Samarra, E. A. A. K., & Al-Samarrai, R. R. H. (2022, July). Evaluation of the correlation between D-dimer and total L-fucose, fucose binding protein and fucose binding lipids in type 2 diabetes patients infected with COVID-19. In AIP Conference Proceedings, (Vol. 2450, No. 1, p. 020038). AIP Publishing LLC.
Al-Samarra, E., & Alsamarai, R. (2022). Evaluation the level of Serum cytokines as risk factor for COVID-19 complication in patients with
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Type-2 diabetes mellitus. *International Journal of Medical Sciences*, 5(2), 85-104.

Aye, Y. N., Mai, A. S., Zhang, A., Lim, O. Z. H., Lin, N., Ng, C. H., ... & Chew, N. W. (2021). Acute myocardial infarction and myocarditis following COVID-19 vaccination. *QJM: An International Journal of Medicine*. 29:hcab252.doi: 10.1093/qjmed/hcab252.

Chatterjee, S., Ojha, U. K., Vardhan, B., & Tiwari, A. (2021). Myocardial infarction after COVID-19 vaccination - casual or causal?. *Diabetes & metabolic syndrome*, 15(3), 1055.

Davido, B., Mascitti, H., Fortier-Beaulieu, M., Jaffal, K., & de Truchis, P. (2021). ‘Blue toes’ following vaccination with the BNT162b2 mRNA COVID-19 vaccine. *Journal of Travel Medicine*, 28(4), taab024.

El-Shitany, N. A., Harakeh, S., Badr-Eldin, S. M., Bagher, A. M., Eid, B., Almukadi, H., ... & El-Hamamsy, M. (2021). Minor to moderate side effects of Pfizer-BioNTech COVID-19 vaccine among Saudi residents: a retrospective cross-sectional study. *International journal of general medicine*, 14, 1389.

Fatima, S., Zafar, A., Afzal, H., Ejaz, T., Shamim, S., Saleemi, S., & Subhan Butt, A. (2022). COVID-19 infection among vaccinated and unvaccinated: Does it make any difference?. *PloS one*, 17(7), e0270485.

Garcie A(1979): *Inorganica Chimica Acta*,94:115.

Gupta, N., Agrawal, S., Ish, P., Mishra, S., Gaind, R., Usha, G., ... & Safdarjung Hospital COVID 2019 working group. (2020). Clinical and epidemiologic profile of the initial COVID-19 patients at a tertiary care centre in India. *Monaldi archives for chest disease*, 90(1).

Horowitz, R. I., Freeman, P. R., & Bruzzese, J. (2020). Efficacy of glutathione therapy in relieving dyspnea associated with COVID-19 pneumonia: A report of 2 cases. *Respiratory medicine case reports*; 30, 101063.

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., ... & Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The lancet*, 395(10223), 497-506.

Jabagi, M. J., Botton, J., Bertrand, M., Weill, A., Farrington, P., Zureik, M., & Dray-Spira, R. (2022). Myocardial infarction, stroke, and pulmonary embolism after BNT162b2 mRNA COVID-19 vaccine in people aged 75 years or older. *Journal of the American Medical Association (JAMA)*,327(1), 80-82.

Kadhim, K. A. S., Al-Samarrai, R. R. H., & Husain, W. N. (2022, July). Evaluation of the correlation between D-dimer and iron indicators in patients with COVID-19. In *AIP Conference Proceedings* (Vol. 2450, No. 1, p. 020043). AIP Publishing LLC.

Kadhim, K. A. S., Husain, W. N., & Al-Samarrai, R. R. H. (2022, November). Evaluation the correlation between C-reactive protein and oxidative stress state in patients with COVID-19. In *AIP Conference Proceedings* (Vol. 2394, No. 1, p. 040004). AIP Publishing LLC.

Kadhim, K. A. S., Husain, W., & Alsamarai, R. (2022). Evaluation of the level of the immunoglobulin Hepcidin and Interleukin-6 in the blood serum of patients infected with Covid-19 virus. *International Journal of Medical Sciences*, 5(2), 66-84.

Kaplan, L. A. & Pesce, A. J. (1989). Interferences in chemical analysis. *Clinical Chemistry. Theory. Analysis and Correlation.*, 808-819.

Lebedev, L., Sapojnikov, M., Wechsler, A., Varadi-Levi, R., Zamir, D., Tobar,
A., & Yagil, Y. (2021). Minimal change disease following the Pfizer-BioNTech COVID-19 vaccine. *American Journal of Kidney Diseases, 78*(1), 142-145.

Mahat, R. K., Rathore, V., Singh, N., Singh, N., Singh, S. K., Shah, R. K., & Garg, C. (2021). Lipid profile as an indicator of COVID-19 severity: a systematic review and meta-analysis. *Clinical Nutrition ESPEN, 45*, 91-101.

Marshall, M., Ferguson, I. D., Lewis, P., Jaggi, P., Gagliardo, C., Collins, J. S., & Guzman-Cotrill, J. A. (2021). Symptomatic acute myocarditis in 7 adolescents after Pfizer-BioNTech COVID-19 vaccination. *Pediatrics, 148*(3).

McNeil, A. (2007). The trouble with troponin. Heart, Lung and Circulation, 16, S13-S16.

Ndwandwe, D., & Wiysonge, C. S. (2021). COVID-19 vaccines. *Current opinion in immunology, 71*, 111-116.

Oliver, S. E., Gargano, J. W., Marin, M., Wallace, M., Curran, K. G., Chamberland, M., & Dooley, K. (2020). The advisory committee on immunization practices’ interim recommendation for use of Pfizer-BioNTech COVID-19 vaccine—United States, *Morbidity and mortality weekly report, 69*(50), 1922.

Sedlak, J. and Lindsay, R. H (1968). Analytical biochemistry.; 192. Cited by Al-Zamyle2001).

Sharma, A., Ahmad Farouk, I., & Lal, S. K. (2021). COVID-19: A review on the novel coronavirus disease evolution, transmission, detection, control and prevention. *Viruses, 2021; 13*: 202.

Singh, B., Kaur, P., Cedeno, L., Brahimi, T., Patel, P., Virk, H., & Bikkina, M. (2021). COVID-19 mRNA vaccine and myocarditis. *European Journal of Case Reports in Internal Medicine; 8*(6).

Sintema E. J. (2020 April 7). Effect of COVID-19 on the performance of grade 12 students: Implications for STEM education. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(7). https://doi.org/10.29333/ejmste/7893

Smadja, D. M., Yue, Q. Y., Chocron, R., Sanchez, O., & Lillo-Le Louet, A. (2021). Vaccination against COVID-19: insight from arterial and venous thrombosis occurrence using data from VigiBase. *European Respiratory Journal, 58*(1).

Sung, J. G., Sobieszczyk, P. S., & Bhatt, D. L. (2021). Acute myocardial infarction within 24 hours after COVID-19 vaccination. *The American Journal of Cardiology, 156*, 129-131.16-

Szarpak, L., Ruetzler, K., Safiejko, K., Hampel, M., Pruc, M., Kanczuga-Koda, L., & Jaguszewski, M. J. (2021). Lactate dehydrogenase level as a COVID-19 severity marker. American Journal of Emergency Medicine,45, 638-639.

Vassault, A., Grafmeyer, D., Naudin, Cl., Dumont, G., Bailly. M., Henny, J., Gerhardt, M., Georges P. (1986). Protocole de validation de techniques? Annales de Biologie Clinique,44,686.

Viskin, D., Topilsky, Y., Aviram, G., Mann, T., Sadon, S., Hadad, Y., & Havakuk, O. (2021). Myocarditis associated with COVID-19 vaccination: echocardiography, cardiac tomography, and magnetic resonance imaging findings. *Circulation:Cardiovascular Imaging, 14*(9), e013236.

Wang C., Horby P.W., Hayden F.G., Gao G.F. (2020):A novel coronavirus outbreak of global health concern. *Lancet, doi*: 10.1016/S0140-6736 (20) 30185-9.

Worwood M., (1986) “Serum ferritin,” *Clinical Science;70*: pp. 215–220.

Worwood, M. (1990). Ferritin. *Blood reviews, 4*(4), 259-269.