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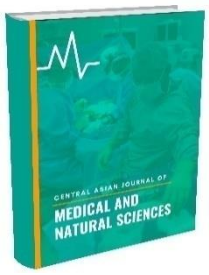

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The Study of Biomarkers in Patients Who Were Re-Infected With COVID-19 After Being Vaccinated With (Pfizer or Sinopharm) Vaccine in Basra, Iraq

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Abstract: Background: COVID-19 is a multisystem disease caused by complicated inflammatory, immunological, and coagulative pathways. Doctors must diagnose, hospitalize, apply intensive care, divide harm risks by severity, choose suitable treatment with supervision, and discharge patients during the COVID-19 pandemic. All COVID-19 vaccines stimulate adaptive and innate immunity. In response to vaccine, adaptive immunity stimulates B cells, which expand and increase to produce antibodies. Most COVID-19 vaccinations induce disease-fighting protein-specific antibodies. Objectives: the main objective is a discussion of the case of patients who were infected with the Coronavirus after taking a single dose of the Pfizer or Sinopharm vaccine. To determine the severity of the disease and make healthy and correct decisions to reduce deaths. Material and Methods: A total of participants in this study were (199), from them (81) healthy subjects as a control group, (78) COVID-19 patients and (40) of the participants recorded an infection for the second time after the vaccination, (13 of them was vaccinated with Pfizer and 27 of them was vaccinated with Sinopharm) who visited Al-Basra Teaching Hospital and Allmwanei Hospital in Al-Basra province between October 2021 and February 2022. The age average for the study population was (25-80) years. Serum and blood levels of human CBC, ESR, CRP, Ferritin, D-Dimer, IL 6,

Albumin, FBS, HbA1c, Troponin, Cholesterol, Triglyceride, HDL, LDL, VLDL, Creatinine, Urea, Uric acid and GFR were measured. Results: The results show a highly significant increase in (Wbcs), ESR, CRP, Ferritin, D-Dimer, IL-6, FBS, HbA1C, and LDL, a highly significant decrease in Lymp, albumin, HDL, Uric acid, Creatinine, and urea, and non-significant behavior for troponin and eGFR for patients compared to the control group as a total number and as males and females separately. A statistical comparison of biochemical markers in re-infected COVID-19 patients after Pfizer or Sinopharm vaccination compared to first-time infected patients showed a highly significant difference in creatinine, urea, Ferritin, D-dimer, troponin I, cholesterol, Tg, Wbcs, and eGFR. An ROC analysis was performed for the biomarkers utilized in the study to determine their diagnostic usefulness among all COVID-19 patients infected after vaccination with the (Pfizer or Sinopharm) vaccine. Conclusion: The research concluded COVID-19 patients after being vaccinated with Pfizer or Sinopharm vaccine, it was found that the elevation of inflammatory biochemical markers confirms, the severity of the disease and the disappearance of most immunity achieved by the vaccine. Also, the severity of reinfection was higher in patients who were vaccinated with the Pfizer vaccine compared to the patients who were vaccinated with the Sinopharm vaccine.

Key words: biometrics, COVID-19.

Introduction

At a time when many people assumed that infection with the COVID-19 virus meant greater protection from the virus in future confrontations. The recent wave of the virus has re-emerged and is becoming more common as the virus continues to evolve, similar to influenza viruses. Reinfection is associated with decreased immunity, so doctors urge their patients to be vigilant even after vaccination. For the importance of early diagnosis of the disease, blood tests play an important role in providing information to doctors regarding the inflammatory process, organ damage, severity of the disease, as well as predicting the risk of death or survival in the intensive unit[(1)].

COVID-19 infection is a multisystem disease rather than a localized respiratory infection, resulting from a systemic process involving complex interactions of inflammatory, immunological and coagulative cascades. The COVID-19 pandemic poses many challenges for doctors such as timely diagnosis of disease and hospitalization, use of intensive care services, division of injury risks according to the severity, selection of appropriate treatment with observation and timely discharge. All of these things are necessary in order to save the largest number of lives. Clinical assessment remains indispensable, however, as vital signs provide objective information that significantly impacts patient care[(2)].

When a person is exposed to a pathogen, then their immune system makes antibodies to fight off the disease. A person's immune system can also produce antibodies through vaccination. When a person gets sick, the antibodies can protect them from infection. The time period for this protection to last can vary from person to person or from disease to disease. These antibodies can be described as part of a person's immune response. People who have COVID-19 antibodies may become infected after recovering from a previous infection (vaccine breakthrough infection), as the antibodies are expected to diminish over time. In this case, the person becomes more susceptible to infection with the Coronavirus[(3)].

All COVID-19 vaccines activate both adaptive and innate immune responses. Adaptive immunity activates B cells, which in turn multiply and increase in response to vaccine so, as to support the production of antibodies. Most COVID-19 vaccines are designed to induce protein-specific antibodies that are effective in fighting the disease[(4)].

Chinese company Sinopharm has developed one of the COVID-19 vaccines, and it has been licensed in more than (50) countries for use, and tens of millions of doses of it have been given around the world. It also issued a recommendation from the World Health Organization (WHO) to use the vaccine and that it is safe and effective. Sinopharm vaccine contains killed coronavirus (it is an inactivated vaccine) and cannot reproduce. This approach differs from Moderna's and Pfizer's mRNA-based vaccines. However, cases of COVID-19 have been reported for the second time in some countries that have used it[(5)].

When infected with the COVID-19 virus or vaccinated, the body produces two types of protective immune responses. The immune response is represented by B cells responsible for producing antibodies. Antibodies (Y-shaped proteins) form the first line of defines against an infection or invader, such as a vaccine. The antibodies bind directly to the virus - or to the spike protein of COVID-19 (as in the case of a lock with a key), and prevent it from entering cells as it is. in the case of mRNA vaccines[(6)].

If the virus succeeds in entering the cells, then the antibodies become ineffective, and the virus begins to multiply inside infected cells and then spread to other cells. If the virus succeeds in invading the cells, the immune system calls for another type of immune cell, which represents the second line of defines and is known as killer T cells. Unlike antibodies, these cells cannot see the virus directly it prevents it from entering the cell, but they can identify the virus-infected cell and then destroy it immediately before the virus gets another chance to multiply and spread[(7)].

The main question that arises during the ongoing pandemic of COVID-19, is about the immune response that can protect against a second infection. Coronaviruses have short-term immunity, and

they have the ability to cause mutations that enable them to escape from host immunity. This, in turn, gives increased chances of reinfection[8].

A person is considered re-infected when they test positive (90) day or more after their last infection. The recurrence of infection with COVID-19 predicts negative effects and more health complications of complications in the various organ systems, with the possibility of the infection continuing for a long time. People's response to coronavirus infection varies, so it is difficult to predict how to respond to repeated infections and this depends on how each person's body reacts[9].

2. Materials and Methods

2.1. Samples Collection

A total of participants in this study were (199), from them (81) healthy subjects as a control group, (78) COVID-19 patients and (40) of the participants recorded an infection for the second time after the vaccination, (13 of them was vaccinated with Pfizer and 27 of them was vaccinated with Sinopharm), this is shown in table (1). All participants visited Al-Basra Teaching Hospital and Allmwanei Hospital in AL Basra province between November 2021 and May 2022. The Age average for the study population was (25-80) years. Hospital specialists examined all patients in this study. The practical study portion was completed at Southern Technical University/ Basra's Department of Medical Laboratory Technology.

Table (1): Basic characteristics of the participants, according to the number.

Study Groups/ Age (year)	Groups number		
	Gender		Total number
	Male	Female	
Control group (Healthy) Age = (30-80)	41	40	81
COVID-19 patients Age = (30-80)	40	38	78
C0VID-19 patients after vaccinated with Pfizer vaccine Age = (25-80)	-------	-------	13
COVID-19 patients after vaccinated with Sinopharm vaccine Age = (25-80)	-------	-------	27

The blood samples were drawn with more than 5 ml of blood from both (patients and controls), and then about 1.8 ml of the blood was put into anticoagulant tubes containing sodium citrate. The sample was then separated by centrifugation at 3000 rpm for 15 minutes, and the plasma was then isolated and stored at a low temperature (-20 °C) until it was needed for analysis. ESR test tubes and

EDTA-containing anticoagulant tubes are also available. Each patient's plasma and serum were divided among Eppendorf tubes and frozen Until the required number is completed and the laboratory examination begins. Too many individuals were excluded because they did not meet the inclusion criteria, such as patients with other diseases, such as hypertension, and all patients with hormonal imbalances, also, investigated verify the patient's information, age, gender, height, weight, vaccination or not, and the severity of the injury.

2.2. Statistical Analysis

Statistical analyses were performed in a statistical package for social sciences (SPSS) version 22. Means and SD were used for data representation, P-values ($P \leq 0.05$) are significant.

3. Results

A general statistical comparison was made for the biochemical markers in the patients infected with only Coronavirus compared to the control group according to gender and as a total number of (78) patients as shown in the statistical table (2), in order to monitor the role of different biomarkers in causing a disease, with an evaluation of the difference in their levels depending on the severity of the disease.

The results show highly significant increase in (Wbcs), ESR, CRP, Ferritin, D-Dimer, IL-6, FBS, HbA1C, and LDL, highly significant decrease in Lymp, albumin, HDL, Uric acid, Creatinine and urea, and the results show non-significant behavior for the troponin, and Estimated glomerular filtration rate (eGFR) for patients compared to the control group as a total number and as a number of males and females separately.

And then, a statistical comparison was made for the biochemical markers in the re-infected COVID-19 patients after being vaccinated with Pfizer or Sinopharm vaccine compared to the first-time infected patients, table (3) shows this comparison.

Table (2): Statistical analysis of biomarkers for COVID-19 patients, as a (total, male and female) number compared to the control group.

Bio-Markers		Groups						P-Value			
		Control			COVID-19 infected patients						
		Total = 81	Male = 41	Female = 40	Total = 78	Male = 40	Female = 38	Total C vs Total infected	Male C vs infected Male	Female C vs infected Female	Male infected vs Female infected
		Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD				
CBC	Wbcs	8.00±4.16	7.29±3.55	8.83±4.73	10.33 ± 8.19	9.99 ± 5.69	10.67 ± 10.18	0.043	0.026	0.042	0.731
	Lymp	2.51±0.54	2.59±0.45	2.40±0.62	1.23 ± 1.04	1.06 ± 0.77	1.40 ± 1.24	0.0001	0.0001	0.0001	0.181
ESR		14.10±9.62	12.04±6.24	16.52±12.19	58.27 ± 31.98	52.43 ± 28.71	58.27 ± 31.98	0.0001	0.0001	0.0001	0.010
CRP		5.31±1.70	5.404±1.784	5.209±1.650	94.31 ± 73.91	106.04 ± 85.16	94.31 ± 73.91	0.0001	0.0001	0.0001	0.186
Ferr		98.71±73.70	100.50±82.25	96.62±64.00	133.90 ± 26.93	134.86 ± 28.19	133.90 ± 26.93	0.0001	0.0001	0.0001	0.701
D-Dimer		257.04±106.31	263.19±98.18	249.83±116.96	1243.22± 1608.6	1702.7 ±2175.1	1243.22± 1608.6	0.0001	0.0001	0.0001	0.018
IL 6		6.09±3.37	6.25±3.06	5.909±3.766	28.41 ± 10.30	29.01 ± 9.44	28.41 ± 10.30	0.0001	0.0001	0.0001	0.626
Albumin		3.84±0.75	3.76±0.75	3.923±.759	3.05 ± 0.61	2.90 ± 0.61	3.203 ± 0.61	0.0001	0.0001	0.0001	0.769
FBS		94.98±9.31	97.70±8.77	91.78±9.07	130.90 ± 46.50	134.8 ± 28.1	132.90 ± 46.50	0.0001	0.0001	0.0001	0.584
HbA1c		4.73±0.91	4.65±0.91	4.81±0.92	5.63 ± 0.61	5.59 ± 0.57	5.63 ± 0.61	0.0001	0.0001	0.0001	0.280
Trop		0.019±0.007	0.019±0.007	0.020±0.007	0.03 ± 0.05	0.04 ± 0.07	0.014 ± 0.05	0.165	0.062	0.009	0.005
Cholesterol		132.2 ± 45.5	123.63 ± 34.11	142.5 ± 55.0	135.9 ± 46.4	131.5 ± 37.9	146.2 ± 49.5	0.864	0.388	0.787	0.048
TG		130.08 ± 45.5	128.270 ±49.20	132.213 ± 48.78	140.94 ± 86.35	138.540 ± 59.11	154.357 ± 103.84	0.776	0.289	0.280	0.048
HDL		63.20 ± 10.94	62.51 ± 8.99	64.13 ± 13.02	30.027 ± 11.56	30.029 ± 13.47	30.026 ± 9.48	0.0001	0.0001	0.0001	0.999
LDL		67.92 ± 38.42	60.704 ±35.13	76.391 ± 41.03	75.39 ± 35.67	68.057 ± 30.44	82.729 ± 39.30	0.029	0.391	0.055	0.086
Creatinine		0.706 ± 0.129	0.795 ± 0.069	0.602 ± 0.501	0.983 ± 0.465	1.058 ± 0.472	0.907± 0.451	0.0001	0.002	0.0001	0.175
Urea		26.780 ± 10.71	25.926 ±4.66	27.783 ± 15.103	47.424 ± 23.95	58.506 ± 25.64	36.343 ± 14.81	0.0001	0.0001	0.039	0.0001
Uric acid		4.258 ± 1.438	4.037 ± 1.49	4.517 ± 1.35	5.034 ± 2.38	5.365 ± 2.67	4.704 ± 2.04	0.043	0.016	0.678	0.249
eGFR		110.740 ± 14.56	109.148 ± 10.88	112.609 ± 18.04	88.557 ± 34.38	88.657 ± 31.35	88.457 ± 37.62	0.0001	0.001	0.002	0.981

Table (3): Statistical analysis of chemical biomarkers as total number of patients who were infected with COVID-19 after taking a single dose of Pfizer or Sinopharm vaccine compared to the first-time infected patients.

Biomarkers		Groups				*P*-value			
		Total first-time COVID-19 infected patients n = 78	Reinfected Patients after vaccinated						
			Patients Vaccinated with Pfizer n = 17	Patients Vaccinated with Sinopharm n = 23	Total Vaccinated Patients n = 40	Infected patients Vs Patients vaccinated with Pfizer	Infected patients with COVID Vs Patients vaccinated with Sinopharm	Total Infected patients Vs Total Vaccinated Patients	Patients vaccinated with Sinopharm Vs Patients vaccinated with Pfizer
		Mean± SD	Mean ± SD	Mean ± SD	Mean ± SD				
CBC	Wbcs	10.33 ± 8.19	13.16 ± 14.69	9.96 ± 5.06	11.32±10.27	0.453	0.800	0.602	0.050
	Lymp	1.23 ± 1.04	1.29 ± 0.71	1.45 ± 1.45	1.38±1.18	0.777	0.512	0.505	0.001
ESR		58.27 ± 31.98	65.18 ± 36.39	59.48 ± 34.23	61.90±34.82	0.480	0.882	0.590	0.0001
CRP		94.31 ± 73.91	103.71 ± 80.99	87.28 ± 65.14	94.26±71.78	0.667	0.667	0.997	0.0001
Ferr		133.90 ± 26.93	468.20 ± 38.36	438.06 ± 37.82	450.87±45.38	0.007	0.004	0.007	0.0001
D-Dimer		1243.2± 1608.6	1884.5 ± 1582.9	1755.5 ± 1508.8	1810.4±1296.9	0.003	0.012	0.017	0.0001
IL 6		28.41 ± 10.30	26.06 ± 7.73	29.22 ± 11.85	27.88±10.30	0.303	0.770	0.798	0.0001
Albumin		3.05 ± 0.61	3.09 ± 0.67	3.04 ± 0.54	3.06±0.59	0.842	0.923	0.945	0.0001
FBS		130.90 ± 46.50	147.71 ± 46.75	152.17 ± 39.19	150.28±42.05	0.256	0.046	0.031	0.0001
HbA1c		5.63 ± 0.61	5.63 ± 0.50	5.55 ± 0.54	5.58±0.52	0.993	0.557	0.675	0.0001
Trop		0.03 ± 0.05	0.170 ± 0. 055	0.084 ± 0.033	0.125±0.025	0.001	0.023	0.009	0.0001
Cholesterol		135.9 ± 46.4	157.88 ± 51.80	139.74 ± 47.49	147.45±49.56	0.062	0.846	0.089	0.256
Tg		140.94 ± 86.35	205.35 ± 190.03	137.5 ± 71.89	166.34±137.42	0.148	0.858	0.183	0.177
HDL		30.027 ± 11.56	33.41 ± 16.23	29.56 ± 10.48	31.20±13.18	0.457	0.919	0.641	0.022
LDL		75.39 ± 35.67	90.12 ± 43.57	74.50 ± 36.20	81.14±39.74	0.210	0.206	0.453	0.0001
Creatinine		0.983 ± 0.465	1.16 ± 0.726	0.85 ± 0.42	0.98±0.88	0.005	0.608	0.994	0.019
Urea		47.424 ± 23.95	71.28 ± 31.33	50.24 ± 34.06	59.19±73.51	0.031	0.276	0.331	0.026
Uric acid		5.034 ± 2.28	6.80 ± 4.65	4.77 ± 2.01	5.64±3.49	0.146	0.434	0.337	0.002
eGFR		88.557 ± 34.38	95.18 ± 44.97	97.30± 34.42	96.40±38.72	0.576	0.126	0.291	0.059

In table (3) the result show a highly significant difference in creatinine, urea, Ferritin, D-dimer, troponin I, cholesterol, Tg, and a significante in Wbcs & eGFR.

Also, the diagnostic value of the studied biomarkers among all COVID-19 patients infected after vaccination with the (Pfizer or Sinopharm) vaccine as a total number, an ROC analysis was conducted for the biomarkers used in the study. Table (4) represents the diagnostic ability of these indicators.

Table (4): Receiver-operating characteristic (ROC) curve analysis of biomarkers for patients who were re-infected with COVID-19 after vaccinated with (Pfizer or Sinopharm) vaccine and as a total number.

Biomarker		Area under the curve	*P*- value (AUC =0.5)	Sensitivity %	Specificity %	PPV	NPV
CBC	Wbcs	0.657	0.011	28	94	79	62
	Lymp	0.897	0.0001	33	100	100	65
ESR		0.951	0.0001	93	86	84	93
CRP		1.000	0.0001	100	100	100	100
Ferr		0.836	0.0001	58	96	92	74
D-Dimer		0.979	0.0001	90	100	100	93
IL 6		0.978	0.0001	98	84	83	98
Albumin		0.787	0.0001	70	68	64	74
FBS		0.942	0.0001	68	100	100	79
HbA1c		0.775	0.0001	3	100	100	56
Trop		0.426	0.231	3	77	64	56
Cholesterol		0.605	0.092	13	90	50	56
Tg		0.524	0.698	35	64	44	55
HDL		0.970	0.0001	98	8	46	80
LDL		0.593	0.132	35	78	56	60
Creatinine		0.519	0.756	18	100	100	60
Urea		0.711	0.001	75	60	60	75
Uric acid		0.619	0.056	30	88	67	61
eGFR		0.598	0.113	45	82	67	65

4. Discussion

COVID-19 disease has been characterized by a complex pathophysiology, and heterogeneous clinical presentation, with a wide range of imaging findings, depending on both disease severity and time course[(10)].

Table (3-2), shows the statistical comparison between the biomarkers in the patients infected with Coronavirus and the control group, where, the study of these biomarkers provides a dynamic approach to understanding the disease to diagnosis and follow-up, so to improve the development of patients' treatment[(11)].

Some COVID-19 patients were re-infected for the second time as the pandemic continued and as the virus continued to mutate, it was found that some of them were re-infected with the same strains and others were infected with different strains. New mutations appeared in the genetic sequence of the virus in the United States[12] the Netherlands[13], India[14] and other places. This raised concerns about the reliability of vaccines and the effectiveness of post-infection immunogenicity. The emergence of new strains of disease may affect severity, re-transmission, and physicians' ability to diagnose, treat, control, and prevent infections [15,16]. Other studies have shown that Omicron variants may pose an increased risk for a second infection [17].

In Table (2) the results showed a highly significant increase in (Wbcs) and a significant decrease in lymphocytes for patients compared to the control group as a total number and as a (male and female) number.

A high white blood cell count is an important indicator of the body's resistance to infection. Research has shown that people who tested positive for COVID-19 and had no symptoms had a higher white blood cell count([18]. Also, the results show a highly significant increase in (ESR & CRP) which are vital indicators used as routine to discover inflammation and monitor the effectiveness of treatment, they indicate the location of inflammation in the body. according to a study, the large increase in (CRP) over (100 mg / l) was linked to the critical path of the disease and entering the intensive care unit[19].

The results show a highly significant increase in (Ferritin and D-Dimer), in a cross-sectional study of a large number of COVID-19 patients, (D-dimer) was elevated, and its levels were associated with disease severity. Thus, it can be considered a reliable predictive biomarker for the mortality of patients in hospitals[20].

The results show a highly significant increase in (IL-6). In a recent cross-sectional study, IL-6 levels were estimated for COVID-19 patients in intensive care units and acute respiratory distress syndrome (ARDS). It was found an increase in (IL-6) levels compared to the healthy group. This proves the sensitivity of this inflammatory marker as an indicator in infection control and diagnosis. In the same study, it was found that the value (20.92 pg/ml) is an indicator of long-term injury (21).

In albumin, the results show a highly significant decrease studies indicated that, hypoalbuminemia was common in patients with (COVID-19), and that its levels were associated with the severity of the disease. Therefore, dynamic monitoring of albumin levels is necessary and should be followed up during the treatment of patients and used as a tool for evaluation and diagnosis of infection[22].

The results show a highly significant increase in (FBS & HbA1C), Creatinine and urea, uric acid, estimated glomerular filtration rate (eGFR) for patients compared to the control group as a total number, number of males and females separately.

Table (3), shows the biochemical markers, (Ferritin, D-dimer and troponin I) show highly significant differences when comparing the re-infected COVID-19 patients after being vaccinated with

(Pfizer or Sinopharm) vaccine compared to the first-time infected patients without diabetes complications. While (creatinine and urea) show highly significant differences when comparing the reinfected COVID-19 patients after being vaccinated with the Pfizer vaccine compared to the first-time infected patients without diabetes complications. This confirms the fading of most immunity achieved by the vaccine. This is consistent with other studies' results.

The results also show highly significant behaviour for all biochemical markers under the study except, for (cholesterol & Tg), for the infected patients after being vaccinated with the Pfizer vaccine compared to the infected patients after being vaccinated with the Sinopharm vaccine. Also, (Wbcs & eGFR) biomarkers were on the border of significance ($p = 0.05$). The difference in the level of biochemical markers for patients after vaccination indicates that the severity of reinfection was higher in patients who were vaccinated with the Pfizer vaccine, despite their small number (17), compared to the patients who were vaccinated with the Sinopharm vaccine, whose number was greater (23). penetrating reinfection occurs due to, mutations in the spike protein regions of the virus, which in turn increase immune escape, in addition to the decline in immunity caused by taking disease vaccines. Biochemical indicators such as inflammatory markers, coagulopathy, white blood cell count, C-reactive protein, erythrocyte sedimentation rates, serum creatinine, and albumin can be used to characterize second infection cases[(23)].

All COVID-19 vaccines activate both adaptive and innate immune responses. Adaptive immunity activates B cells, which in turn multiply and increase in response to vaccine so, as to support the production of antibodies. Most COVID-19 vaccines are designed to induce protein-specific antibodies that are effective in fighting the disease[(4)].

In extensive research that included (50) studies from different (20) different countries, it was found that the longest period between the first and second infection was (293) days and the shortest was (19) days. The most common symptoms were cough and fever respectively; however, the causes and risk of a second infection are still not understood, thus the hospital administration stressed the necessity of vaccination and maintaining social distancing to avoid infection again [(24)]. Chinese company Sinopharm has developed one of the COVID-19 vaccines, and it has been licensed in more than (50) countries for use, and tens of millions of doses of it have been given around the world. It also issued a recommendation from the World Health Organization (WHO) to use the vaccine and that it is safe and effective. Sinopharm vaccine contains killed coronavirus (it is an inactivated vaccine) and cannot reproduce. This approach differs from Moderna's and Pfizer's mRNA-based vaccines. However, cases of COVID-19 have been reported for the second time in some countries that have used it[(5)].

In table (4) the result of chemical biomarkers analysis for patients who were reinfected with COVID-19 after being vaccinated with Pfizer or Sinopharm vaccine shows the biomarkers (troponin, cholesterol, Tg, LDL, creatinine & GFR), shows non-significant statistical behaviour with a good characteristic of validity for some test as: (77% specificity, 64 PPV) in troponin, (90% & 64%) specificity in cholesterol and (Tg) respectively, (78% specificity & 60 NPV) in (LDL), (100% specificity, 100 PPV & 60 NPV) in creatinine, and (82% specificity, 67 PPV & 65 NPV) in (GFR).

This again indicates the using of these biochemical markers will not give definitive confirmation of the presence of the disease unless more biomarker is provided to improve the confirmation of the disease.

All the rest biomarkers (Wbcs, lymphocyte, ESR, CRP, ferritin, D-dimer, IL-6, albumin, FBS, HbA1C, HDL, urea & uric acid) show highly significant statistical behavior with an area under the curve ranged (61.9% - 100%). These biomarkers show also good characteristics of validity for all tests except the (sensitivity%) in (Wbcs, lymphocyte, ferritin, and uric acid), (sensitivity% & NPV in HbA1C), and (Specificity% & PPV) in (HDL). Therefore, these biomarkers will be very important in confirming infection and should be taken into consideration as they are biomarkers that reflect the presence and severity of the disease.

When infected with the Coronavirus occur, viral particles enter the host cells via (ACE-2) receptors. So, the host immune system responds to the infection by a combination of cytokine storms, inflammation and activation of coagulation. Ultimately, host responses may lead to serious complications and death[25]. This calls for searching for biomarkers that help predict the progression of the disease towards severity and/or mortality. These inflammatory biomarkers include (CRP), (ILs), blood counts, and coagulation parameters (D-dimer and fibrinogen). These biomarkers have also been highlighted as important and vital for prognosis and response to treatment [26] .

Currently, the re-infection with COVID-19 can be attributed to the high rate of COVID-19 genomic mutations. Some studies on patient's lungs infected with COVID-19 revealed that most recovered patients have exhibited abnormalities in thorax computed tomography (CT) after several months of infection. Although vaccination reduced intensive care support and infection severity, but still frequently reported [27].

The progression of COVID-19 is considered to result from a complex pathophysiological mechanism, which includes the downregulation of the angiotensin-converting enzyme 2 (ACE2) and subsequent the renin–angiotensin–aldosterone system disbalance, and dysregulated immune response which featuring a cytokine storm. Moreover, coagulopathy is associated with virus-induced endothelial injury [28, 29].

Conclusion

According to the study's findings, patients with COVID-19 who received either the Pfizer or Sinopharm vaccine afterwards experienced a decline in the majority of their immunity after vaccination. Patients who received the Pfizer vaccine experienced more severe reinfection than those who received the Sinopharm vaccine. In addition, various factors have been found that contribute to the early detection of COVID-19 pneumonia, thereby offering crucial insight into the inflammatory response, organ damage, illness severity, and length of intensive care unit (ICU) stay.

Author contributions

Contributors: Ahmed Jihad Abdulkadhim was responsible for material preparation, data collection and writing the draft, Dr. Nidhal Yousif Mohammed and Dr. Murtadha Allawi Jebur contributed to designing the study, analysing the collected data, and writing the manuscript. Both authors read and approved the final manuscript.

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