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Estimation of Selected Parameters in Iraqi Mothers and Their Infants with SARS-CoV-2 Infection

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Abstract: This study aimed to estimate some parameters in pregnant mothers and their infants with COVID-19. This is a case-control study done at the Saint Raphael Hospital (Al-Rahibat) in Baghdad, Iraq. During the period from October 20, 2022, to March 1, 2022, 148 Iraqi pregnant women were included in this study. One hundred and twenty-two women have previously suffered from COVID-19 disease, with an age range of 18–37 years, and 26 healthy women. Diagnosis of patients based on clinical characteristics and PCR results. Ten milliliters of venous blood were collected from mothers and newborns by using a 10-ml disposable syringe. The blood sample was taken immediately. Distribute in a sodium citrate tube of 3 ml for the D. dimer test, EDTA tubes of 2.5 ml for a complete blood picture, and 5 ml of blood was transformed into a gel tube and left to clot for 15 minutes at room temperature (20–25 °C). This study included the following parameters: complete blood count (CBC), blood group (ABO), D-dimer, and levels of vitamin D. The results showed that the most prevalent blood group was O^+ at 38.5%, followed by A+ at 29.5%. The levels of RBS in mothers were 90.12 and in infants were 52.75%. The vitamin-D level in mothers was 18.94, while D-dimer levels were 1499.87. The hemoglobin levels in mothers were 111.71, PCV 35.11%, WBCs 9.8, and RBCs 4.05.
In conclusion, infection with COVID had effects on all body parameters, like hematological and biomarkers.

Keywords: COVID-19, pregnant women, Vitamin- D, D-dimer, Blood group.

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Introduction

An outbreak of pneumonia caused by severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2), named coronavirus disease 2019 (COVID-19), that started in Wuhan, China, has become a global pandemic. SARSCoV-2 enters host cells via the angiotensin-converting enzyme 2 (ACE2) receptor, which is expressed in various human organs after binding to spike a surface glycoprotein on the virus [1]. The virus-induced inflammatory responses, including the excessive expression of proinflammatory cytokines (PICs) and chemokines such as IL-1, IL-6, IL-12, and IL-8, were found in COVID-19 patients, especially in severe cases [2]. The host immune system is essential for the resolution of infection, but on the other hand, it can serve as a crucial player in the pathogenesis of the major clinical complications of the disease. Several studies have shown various changes in selected immune parameters during the pneumonia infection by comparing infected and healthy, severe and non-severe patients. Over 1.4 million new cases of COVID-19 and over 1800 fatalities were reported to WHO between July 31 and August 27, 2023, representing a 38% and 50% rise

and decline, respectively, over the preceding 28 days. Over 6.9 million people have lost their lives, and there have been over 770 million confirmed cases as of August 27, 2023. There were recorded increases in three WHO areas, while there were declines in two others. However, the Eastern Mediterranean and Western Pacific areas also saw rises in mortality rates, while three other WHO regions saw declines [3].

Since SARS-CoV-2 is a new virus, there is a lack of data on the effects of infection in pregnant women, including whether there is any difference with other adult infections, the risk of vertical transmission to the fetus, and the effects on the fetus, if any. The majority of pregnant women with COVID-19 disease will have mild or moderate flu-like symptoms. However, there is still a lack of research on maternal and baby SARS-CoV-2 immunity [4]. A newborn SARS-CoV-2 infection has been reported, but little is known about the immunological response of infants who get the virus during pregnancy or shortly after birth [5].

D3 [1,25(OH)2D3]. UV exposure causes 7-dehydrocholesterol to be converted to vitamin D in the skin. Vitamin D is delivered to the liver after binding to the vitamin D-binding protein, where it is hydroxylated to the main circulating form of vitamin D (25(OH)D) by at least one cytochrome P450 (CYP) hydroxylase. The hormonally active form of vitamin D (1,25 (OH)2D3) is generated after 25 (OH)D is transported to the kidney by another CYP hydroxylase [6]. Vitamin D, in its active state, plays a role in calcium and phosphate metabolism and has other biological effects. Vitamin D3 promotes insulin production and innate immunity and inhibits parathyroid hormone secretion, adaptive immunity, and cell proliferation [7].

The fibrin degradation product (or FDP) D-dimer is a small protein. Fragment found in the blood after a blood clot is degraded by fibrinolysis. A blood test can be used to measure its concentration in order to detect thrombosis [8].

It has not yet been known what percentage of COVID-19 patients would have thrombosis; however, in SARS instances, deep venous thrombosis (DVT) and pulmonary embolism (PE) were reported to be 20.5% and 11.4%, respectively. Thromboembolisms, which are similar to SARS and MERS coronavirus infections, were also discovered by pathologic studies centered on autopsies or biopsies [9]. The association between D-dimer and COVID-19 suggests that D-dimer could be a symptom of severe virus infection, in addition to thrombosis and pulmonary embolism. A virus infection can lead to sepsis and coagulation problems, which are normal in the development of serious diseases [10].

Many patients also show a normal or lowered white blood cell count (and lymphopenia), which is often thought to portend a worse prognosis. Aspartate amino-transferase and alanine amino-transferase, as well as lactate dehydrogenase and C-reactive protein, are all elevated [11]. Some individuals have an increased ratio of neutrophils to lymphocytes and an elevated D-dimer level [12].

This study aimed to estimate selected parameters (complete blood count (CBC), blood group (ABO), D-dimer, and levels of vitamin D) in mothers and their infants with COVID-19.

Materials and Methods

This case-control study included the women admitted for delivery at Saint

Raphael Hospital (Al-Rahibat) in Baghdad, Iraq, from October 20, 2022, to March 1, 2023, irrespective of SARS-CoV-2 status or symptoms. One hundred and forty-eight (148) Iraqi pregnant women were included in this study, whose ages ranged from 18 to 37 years old. Upon admission, all women were screened for SARS-CoV-2 infection by a NP swab. Shortly before delivery, a venous blood sample was drawn from the mother. The diagnosis of patients was based on clinical characteristics and PCR results. This study was carried out after obtaining the requisite ethics committee permission from the Department of Biology (University of Baghdad), which approved the study protocol CSEC/1022/0126 on October 17, 2022, and to get patients' consent.

Included criteria:

All mothers who give a negative result for the SARS-CoV-2 PCR test (previously infected) are considered the patient group, and mothers that didn't have an infection are considered the control group.

Excluded criteria:

- 1: All mothers that give a positive result for the SARS-CoV-2 PCR test
- Cancer history
- autoimmune disease history

Sample Collection:

Ten milliliters of venous blood were collected from mothers and newborns by using a 10-ml disposable syringe. The blood sample was taken immediately. Distribute in a sodium citrate tube of 3 ml for the D. dimer test, EDTA tubes of 2.5 ml for a complete blood picture, and 5 ml of blood was transformed into a gel tube and left to clot for 15 minutes at room temperature (20–25 °C). Then the gel tube was centrifuged from 2500 to 3000 rpm for a 10-minute period to isolate. The isolated serum was distributed into aliquots (0.5 ml) in tightly closed Eppendorf tubes, and then the tubes were stored at -20 ^{o}C until the time of analysis.

Complete blood count

The blood was taken in an EDTA tube and analyzed by an automated blood analyzer device.

Blood Group:

Two drops of blood were taken from each of the sample members mentioned in the first axis in paragraphs 3–3. It was placed on a glass slide, with the first drop of antiserum A (serum A Anti) and the second of antiserum B (serum B Anti). The two types of serum in an individual's blood group are AB. As for the lack of clumping of blood cells for both types of serum, the blood of an individual is O. And if hemoglobinemia occurs with antibody B and it does not occur with antibody A, the blood group of the individual is B, and in the case of the occurrence of agglutination of blood cells in serum A and it does not occur in serum B, the blood group of the individual is A.

Estimation of some parameters:

Dimer:

Particle-enhanced immuno-turbidimetry on a Cobas Integra 400 Plus was also used to provide an estimate of D-dimer concentration. The procedure was done according to the instructions of the company.

Vitamin D:

Human serum and plasma may be tested using this technique to see how much 25-hydroxyvitamin D is present. It is intended that this test will be used to help determine whether or not an individual is getting enough vitamin D. For optimal results, run the binding test on a Cobas e411 immunoassay analyzer.

Blood sugar:

The cobas system determines an eAG, or estimated average glucose

level. Those working in a clinical laboratory or at the point of care (PoC) are the target audience for this system. Hemoglobin A1c testing is used to detect diabetes and track how well the disease is managed over time. The procedure was done according to the instructions of the company.

Statistical analysis:

The statistical analysis was done using the SPSS program version 27.0, the patients' frequency, ANOVA and Chi-Square, as well as ROC curve for sensitivity and specificity, and Pearson correlation for certain parameters [13].

Results and Discussions

The characteristics of women and their infants are presented in Table 1.

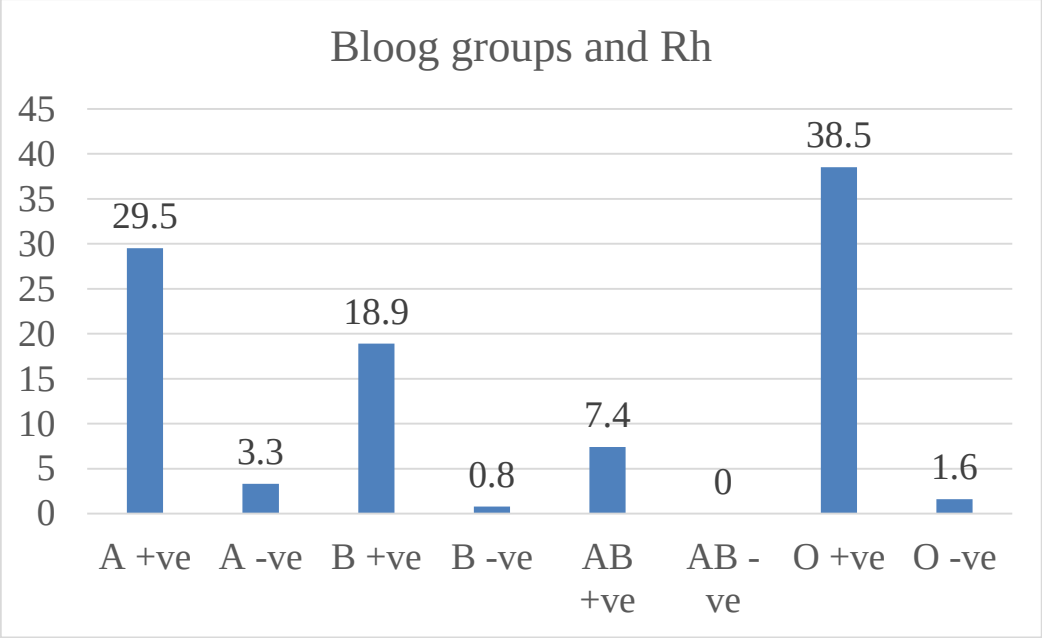
Table (1): Characteristics of SARS-CoV-2 mothers (n = 122) and their infants at birth

		Mothers' group		Probability	Infants' group		Probability
		Patients' group	Control group		Patients' group	Control group	
Age mean ± SE (Years)		28.99 ± 0.49	28.50 ± 0.49	P > 0.05	-	-	-
Pregnancy	1st time	48 (39.3%)	0(0.0%)	Uncountable	-	-	-
	2nd times	32 (26.2%)	0(0.0%)		-	-	
	3rd times	23 (18.9%)	0(0.0%)		-	-	
	4th times	12 (9.8%)	0 (0.0%		-	-	
	5th times	6 (4.9%)	0 (0.0%		-	-	
	More than 5 times	1 (0.8%)	0 (0.0%		-	-	
Previous abortions	Yes	37 (30.3%)	0 (0.0%)	P < 0.001	-	-	-
	No	85 (69. %7)	26(100 %)		-	-	
Previous abortions	Non	85 (69.7%)	26(100 %)	P > 0.05	-	-	-
	1 time	22 (18.0%)	0 (0.0%)		-	-	
	2 times	8 (6.6%)	0 (0.0%)		-	-	
	3 times	2 (1.6%)	0 (0.0%)		-	-	
	4 times	2 (1.6%)	0 (0.0%)		-	-	
	More than 4 times	3 (2.5%)	0 (0.0%)		-	-	
Weight (Kg)		-	-	-	3.25 ± 0.03	3.26 ± 0.03	P > 0.05
Infants' sex	Males	-	-	-	67 (54.9%)	19 (73.1%)	P < 0.001
	Females	-	-	-	55 (45.1%)	7 (26.9%)	
Smoking status	Yes	9 (7.4%)	0 (0.0%)	P < 0.001	-	-	-
	No	113 (92.6%)	26 (100%)		-	-	
Chronic diseases	Nil	114 (93.4%)	26 (100.0)	P < 0.001	-	-	-
	Diabetes	2 (1.6%)	0 (0.0%)		-	-	
	Asthma	5 (4.1%)	0 (0.0%)		-	-	
	Epilepsy	1 (0.8%)	0 (0.0%)		-	-	
Type of feeding	Artificial	9 (7.4%)	19 (73.1%)	P < 0.001	-	-	-
	Natural	105 (86.1%)	7 (26.9%)		-	-	
	Mixed	8 (6.6%)	0 (0.0%)		-	-	

		Mothers' group		Probability	Infants' group		Probability
		Patients' group	Control group		Patients' group	Control group	
Infants' status	Intact	-			121 (99.2%)	26 (100%)	P < 0.05
	Premature	-			1 (0.8%)	0(0.0%)	
Birth type	Natural	9 (7.4%)	6 (23.1%)	P < 0.001	-	-	-
	Caesarean	113 (92.6%)	20 (76.9%)		-	-	
Blood groups	A +ve	36 (29.5%)	10 (38.5%)	P > 0.05	-	-	-
	A -ve	4 (3.3%)	0 (0.0%)		-	-	
	B +ve	23 (18.9%)	4 (15.4%)		-	-	
	B -ve	1 (0.8%)	0 (0.0%)		-	-	
	AB +ve	9 (7.4%)	2 (7.7%)		-	-	
	AB -ve	0 (0.0%)	0 (0.0%)		-	-	
	O +ve	47 (38.5)	10 (38.5%)		-	-	
	O -ve	2 (1.6%)	0 (0.0%)		-	-	

All patients in the current study had an epidemiological history and had been exposed to COVID-19. Most patients showed negative features on chest CT images. 113 (92.6%) of the pregnant women delivered their babies by cesarean section, and nine of them delivered vaginally. No maternal death has been reported.

The results showed that the most prevalent blood group was O+ at 38.5%, followed by A+ at 29.5% (Figure 1).



Figure(1): Blood groups and Rh

The severity of SARS-CoV-2 infections is frequently unexpected; making the identification of risk factors associated with infection and outcomes a top research goal. The first correlation between COVID-19 and ABO blood

groups prompted a slew of investigations to look into the possible associations between ABO blood groups and COVID-19 incidence, illness severity, and death [14,15]. Our results showed that patients with blood group O+ were more affected than other groups; these were only in agreement with the results of Mohammed *et al*. (2023) [16], who found the same results, while our results disagreed with most results, which showed that individuals with blood group A have higher risks of SARS-CoV-2 infection and severe outcomes, whereas people with blood group O are protected against the infection to some extent. One main hypothesis to explain these findings is that people in blood groups O and B have naturally occurring anti-A antibodies that might act as a partial defense against SARS-CoV-2 virions because of differences in the nature of these anti-A antibodies [17, 18, 19].

The levels of random blood sugar (RBS) in mothers were 90.12 and in infants were 52.75% (Table 2).

Table (2): Means of RBS of mothers previously infected with the SARS-CoV-2 virus and healthy controls

	RBS level mean ± SE (mg/dl)		Probability
	Patients' group	Control group	
Mothers N.Value (up to 160) per mg/dL	90.12 ± 1.37	92.92 ±1.11	P > 0.05
Infants N.Value (60-100) per mg/dL	52.75 ± 1.10	65.85 ± 0.78	P < 0.001

The RBS showed no significant differences between the two studied groups; this was in agreement with only one study that showed the same results [20]. While the presented results disagreed with many studies that showed a significant increase in blood sugar in patients with COVID-19 [21, 22].

The levels of vitamin D were decreased in previously infected mothers (18.94) as compared with the control group, while the D-dimer level was increased (149.87) in previously infected mothers as compared with the control group (Table 3).

Table (3): Means of vitamin D and D-dimer of mother's infected with SARS-CoV-2 virus and healthy control

	Mean ± SE for Mothers' group		Probability
	Patients' group	Control group	
Vitamin D level (ng/ml) (N.value = 30-100)	18.94 ± 0.84	37.35 ± 0.79	P < 0.001
D-dimer level (ng/ml) (N.value = up to 550)	1499.87 ± 92.08	741.04 ± 25.52	P < 0.001

Many local studies showed the same current result [23, 24,25]. While the studies of Ibrahim (2022) and Motlag (2022) showed higher levels of vitamin D in patient groups than in control groups [26, 27], serum vitamin D (25-hydroxyvitamin D, 25(OH)D) levels are typically higher in the summer, and epidemiological studies have demonstrated a substantial inverse association between these levels and the occurrence of some viral illnesses [28]. Vitamin D increases the anti-inflammatory Th1 to Th2 phenotype

ratio and promotes cathelicidin and beta-defensin transcription and production in macrophages. One of the leading causes of death in patients with COVID-19 is a condition called cytokine storm; however, vitamin D has been shown to have a protective effect against this pathology [29]. *In vitro* studies have also shown that vitamin D has a significant effect on SARS-CoV 2 [30].

During the study, serum D-dimer levels were significantly higher in the severe COVID-19 group. These parameters have been shown to be crucial biomarkers for disease severity in many studies. Currently, clinicians classify the severity of disease according to the values of D-dimer and the management plan based on their levels [31, 32].

The effect of the SARS-CoV-2 infection on the complete blood count

Table 3 exhibits the Hb, PCV, RBC, and WBC levels of mothers infected with the SARS-CoV-2 virus and a healthy control group. The results showed a significant decrease in Hb, PCV, and RBCs in the infected group as compared with the control, while the levels of WBCs showed a non-significant increase in the infected group as compared with the control (table 4).

Table (4): Means of Hb, PCV, RBC, and WBC levels of mothers infected with the SARS-CoV-2 virus and the control group

	Mean ± SE for mothers' group		Probability
	Patients' group	Control group	
Hb level (g/dl) (N.value = 120-160)	111.71 ± 0.91	127.85 ± 1.28	P < 0.001
PCV (%) (N value= 37-50)	35.11 ± 0.26	39.77 ± 0.41	P < 0.001
WBCs count (x 10^9/L) (N value= 4.0-11.0)	9.80 ± 0.250	9.51 ± 0.13	P > 0.05
RBCs count (m/µl) (N value= 3.80-6.50)	4.05 ± 0.04	4.68 ± 0.05	P < 0.001

The current results were in agreement with the other local results of Khalaf (2021); and Mahmood (2022) [23, 24], who found a decrease in the levels of Hb, RBCs, and PCV, but disagreed with Ibrahim (2022); and Motlag (2022) [26, 27], who found that there were no significant differences in these parameters between the patients and control groups. Also, this study shows increments in WBC levels, and this result is consistent with other local studies mentioned above.

The current results were in agreement with the other universal results of Wang *et al*. (2020) [33], who documented a significant decrease in RBCs, PCV, and HB levels. This may originate from immune damage leading to bone marrow suppression, which sets off a chain reaction that includes, among other things, a release of a large number of immature red blood cells into the peripheral blood, activation of red blood cell apoptosis, and peripheral phagocytosis. All of these things add up to wider red blood cell dispersion [34].

Conclusion:

Infection with COVID had effects on all body parameters, like hematology and biomarkers.

Conflict of interest

The authors declare no conflict of interest regarding this paper.

References

1. Synowiec, A.; Szczepański, A.; Barreto-Duran, E.; Lie, L. K.; and Pyrc, K. (2021). Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): a systemic

infection. Clinical microbiology reviews, 34(2): 10-1128

2. Huang, L.; Li, X.; Gu, X.; Zhang, H.; Ren, L.; Guo, L.; and Cao, B. (2022). Health outcomes in people 2 years after surviving hospitalisation with COVID-19: a longitudinal cohort study. The Lancet Respiratory Medicine, 10(9): 863-876.
3. World Health Organization. (2003). Diet, nutrition and the prevention of chronic diseases. World Health Organ Tech Rep Ser, 916(i–viii): 1-149
4. Flannery, P.; Yang, I.; Keyvani, M.; and Sakoulas, G. (2021). Acute psychosis due to anti-N-methyl D-aspartate receptor encephalitis following COVID-19 vaccination: a case report. Frontiers in Neurology, 12: 764197.
5. Woodworth, K. R.; Olsen, E. O. M.; Neelam, V.; Lewis, E. L.; Galang, R. R.; Oduyebo, T.; and Whitehill, F. (2020). Birth and infant outcomes following laboratory-confirmed SARS-CoV-2 infection in pregnancy. Morbidity and Mortality Weekly Report, 69(44): 1635.
6. Rybchyn, M. S.; De Silva; W. G. M.; Sequeira, V. B.; McCarthy, B. Y.; Dilley, A. V.; Dixon, K. M.; and Mason, R. S. (2018). Enhanced repair of UV-induced DNA damage by 1, 25-dihydroxyvitamin D3 in skin is linked to pathways that control cellular energy. Journal of Investigative Dermatology, 138(5): 1146-1156
7. Akgül, H.; Mohammed, F. S.; Kına, E.; Uysal, İ.; Sevindik, M.; and Doğan, M. (2022). Total Antioxidant and Oxidant Status and DPPH Free radical activity of Euphorbia eriophora. Turkish Journal of Agriculture-Food Science and Technology, 10(2): 272-275
8. Tasic, H.; Akseer, N.; Gebreyesus, S. H.; Ataullahjan, A.; Brar, S.; Confreda, E.; and Bhutta, Z. A. (2020). Drivers of stunting reduction in Ethiopia: a country case study. The American journal of clinical nutrition, 112(Supplement_2): 875S-893S
9. Xu, Z.; Shi, L.; Wang, Y.; Zhang, J.; Huang, L.; Zhang, C. (2020). Pathological findings of COVID-19 associated with acute respiratory distress syndrome. Lancet Respir Med. 8:420–2.
10. Yu, Y.; and Chen, P. (2020). Coronavirus Disease 2019 (COVID-19) in Neonates and Children From China: A Review. Front. Pediatr. 8:287.
11. Cascella, M.; Rajnik, M.; Aleem, A.; Dulebohn, S. C.; and Di Napoli, R. (2020). Features, evaluation, and treatment of coronavirus (COVID-19
12. Yang, X.; Yu, Y.; Xu, J.; Shu, H.; Liu, H.; Wu, Y.; and Shang, Y. (2020). Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. The lancet respiratory medicine, 8(5): 475-481
13. Alan, L. A.; Stolpen, A. H.; Berbaum, K. S.; Fajardo, L. L.; and Reinhardt, J. M. (2007). Breast MRI lesion classification: Improved performance of human readers with a backpropagation neural network computer-aided diagnosis (CAD) system. Journal of Magnetic Resonance Imaging: An Official Journal of the International Society for Magnetic Resonance in Medicine, 25(1): 89-95.
14. Kim, Y.; Latz, C.A.; DeCarlo, C.S.(2021). “Relationship between blood type and outcomes following COVID-19 infection”. Semin Vasc Surg 34: 125–131.
15. Almashhadani, A.; AL-Thwani, A.; (2022). Determination of AngiotensinConverting Enzyme 2 (ACE2) Receptor Level in Samples of Iraqi Patients Infected with COVID-19. Iraqi Journal of Biotechnology, 21 (2): 178-182.
16. Mohammed, S. W.; Sameer, F. O.; Nayyef, H. J.; Jabbar, F.; and Jasim, I. A. (2023). The most ABO blood group susceptibility to COVID-19 infections in Baghdad city. In AIP Conference Proceedings, 2593(1). AIP Publishing.
17. Focosi, D.; Anderson, A. O.; Tang, J. W.; and Tuccori, M. (2020). Convalescent plasma therapy for COVID-19: state of the art. Clinical microbiology reviews, 33(4): 10-1128
18. Shibeeb, S.; and Khan, A. (2022). ABO blood group association and COVID-19. COVID-19 susceptibility and severity: a review. Hematology, Transfusion and Cell Therapy, 44: 70-75
19. Khudhr E.; Shehab Z. (2022). Rapid Identification of sometypical and atypical Pneumonia co-infections associated with COVID-19 patients by a real-time PCR assay. Iraqi Journal of Biotechnology,21 (2): 331-340.
20. Ramon, E.; Triginer, G.; Escur, J.; Pumarola, A.; Garcia, J.; Giro-i-Nieto.; X., and Moreno-Noguer, F. (2021). H3d-net: Few-shot high-fidelity 3d head reconstruction. In Proceedings of the IEEE/CVF International Conference on Computer Vision : 5620-5629

21. Ceriello, A.; De Nigris, V.; and Prattichizzo, F. (2020). Why is hyperglycaemia worsening COVID-19 and its prognosis?. Diabetes, obesity & metabolism, 22(10):1951
22. Chander, A.; and Schwartz, P. (2023). Privacy and/or Trade. U. Chi. L. Rev., 90: 49
23. Khalaf, O.A. (2021). Immunological Markers in Severe SARS-CoV-2 Patients in Iraq.MSc.thesis. University of Baghdad, College of Science, Department of Biology.
24. Mahmood, H.A. (2022). Evaluation of Some Factors Associated with SARS-CoV-2 Infections. MSc.thesis. University of Baghdad, College of Science, Department of Biotechnology.
25. AL-Nuaimi, B.N; and Al-azzawi, R.H. (2025). Correlation between MicroRNA-155 Expression and Some Inflammatory Biomarkers of Covid-19 Infection. Iraqi Journal of Biotechnology, 24(1): 161-172
26. Ibraheem, Z. Kh.; and AL-azzawy R. H. (2022). Comparative Study of Immunoglobulin G and Gender between COVID-19 Patients and Vaccinated Iraqi Individuals with Pfizer, AstraZeneca and Sinopharm Vaccine. The Egyptian Journal of Hospital Medicine. 89: 5758- 5763.
27. Motlag, S.T. (2022). Immunoglobulin G and CD-8 Response After COVID-19 Vaccine in Iraqi Individuals. MSc.thesis. University of Baghdad, College of Science, Department of Biology.
28. Fares, A. (2013). Winter cardiovascular diseases phenomenon. North American journal of medical sciences, 5(4): 266
29. Aranow, C. (2011). Vitamin D and the immune system. Journal of investigative medicine, 59(6): 881-886
30. Mok, T.; Camidge, D. R.; Gadgeel, S. M.; Rosell, R.; Dziadziuszko, R.; Kim, D. W.; and Peters, S. (2020). Updated overall survival and final progression-free survival data for patients with treatment-naive advanced ALK-positive non-small-cell lung cancer in the ALEX study. Annals of oncology, 31(8): 1056-1064
31. Yao, H.; Song, Y.; Chen, Y.; Wu, N.; Xu, J.; Sun, C.; and Li, S. (2020). Molecular architecture of the SARS-CoV-2 virus. Cell, 183(3): 730-738
32. Ye, Z.; Zhang, Y.; Wang, Y.; Huang, Z.; and Song, B. (2020). Chest CT manifestations of new coronavirus disease 2019 (COVID-19): a pictorial review. European radiology, 30: 4381-4389
33. Wang, B., Li, R., Lu, Z., & Huang, Y. (2020). Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. Aging (albany NY), 12(7): 6049.
34. Liu, Y.; Gayle, A. A.; Wilder-Smith, A.; and Rocklöv, J. (2020). The reproductive number of COVID-19 is higher compared to SARS coronavirus. Journal of travel medicine, 13;27(2):taaa021.