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A Laboratory Study on the Most Important Tests for COVID-19 Patients and their Interrelationships

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The coronavirus has spread to all countries around the world and has become a global pandemic, which has caused significant human and economic losses worldwide, international organizations have developed a mechanism for early diagnosis of this epidemic through the use of appropriate laboratory tests, contributing to the control of its spread. This study was conducted on 150 patients infected with COVID-19 between September to October 2021, ranging in age from 11 to 80 years. Laboratory analyses were conducted on them, including ferritin, D-dimer, C-reactive protein(CRP), and Leukocytes counts (WBCs). Statistical analysis used Correlations were assessed using Pearson's method at significance levels of p = 0.01 and p = 0.05to assess the relationship among the variables. The results indicated a significant statistical relationship between the studied variables. Specifically, a relationship was observed between patients' age and gender and their likelihood of contracting COVID-19, indicating that individuals of all age groups are affected by the virus. While the laboratory tests used in this study showed variation in results, the statistical relationship between elevated Leukocytes counts, Ferritin and C-reactive protein demonstrated significance at the p = 0.01 level. On the other hand, findings revealed a statistically significant relationship (p = 0.01) between CRP, ferritin and D-dimer . D-dimer was significantly correlated with CRP and ferritin at the p = 0.01 level. The results demonstrated that there is an association between elevated levels of tested biomarkers (WBCs, ferritin ,D-dimer and CRP) in individuals infected with The novel coronavirus.

Keywords: COVID-9; CRP; D-dimer; ferritin; WBCs.

COVID-19 is a serious infection affecting the respiratory system and it first identified in Wuhan, China, in late 2019, results from infection with the novel coronavirus,[1] and quickly became a global pandemic, prompting the WHO to declare a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, and then a global pandemic on March 11, 2020. COVID-19 belongs to a larger family of coronaviruses, which comprises the viruses that cause respiratory illness. [2] Unlike its predecessors, SARS-CoV-2 has demonstrated an unprecedented ability to transmit and adapt, resulting in widespread human-to-human transmission and significant

morbidity and mortality rates globally. COVID-19 exhibits diverse clinical features, ranging from silent infection to critical illness involving severe pneumonia, ARDS, organ failure, and mortality. Frequent symptoms are coughing ,fever, loss of taste , tiredness or smell, and difficulty breathing.[3] As the pandemic has evolved, emerging variants of the virus have raised concerns about the efficacy of vaccines, the possibility of reinfection, and global containment strategies. Governments, health systems, and the scientific community have responded with a multifaceted approach that includes public health interventions, lockdowns, social distancing, mandatory mask-wearing, widespread testing, and, most importantly, the rapid development and distribution of vaccines[4] Despite significant progress in managing the pandemic, its long-term consequences—health, social, and economic—remain a subject of ongoing research and attention. The COVID-19 pandemic has fundamentally shifted global health priorities and highlighted the need for resilient health infrastructure, international collaboration, and continued investment in epidemiological research and pandemic preparedness.[5] Based on the above, this search aimed to demonstrate the relationship between a group of laboratory tests and their relationship with the age and gender of the patient when infected with COVID-19.

MATERIALS AND METHODS

Experimental samples

Samples of this research were collected from a private microbiology laboratory in Babylon, Iraq, included 150 COVID-19 patients, 82 males and 68 females, from September to October 2021. All participants were of Arab nationality (Iraqi) and ranged in age from 11 to 80 years. For patients who underwent multiple tests, the first positive result for the novel coronavirus (SARS-CoV-2) was used, excluding all other results.

Study Design

The current study was designed based on the statistical relationship between the variables studied, which included [Age, Gender, ferritin, D-dimer, C-reactive protein(CRP), and Leukocytes counts (WBCs)]. The patients were categorized by age group, and by gender (male and female). Pearson's correlation analysis was used to determine the relationship between the variables.

Blood collection

A three ml disposable syringe was used to draw blood from the Median cubital vein. The blood was then divided into two parts: one part was transferred to a sterile test tube containing EDTA for WBC assessment, and the other part was centrifuged to obtain serum for CRP, D-dimer, and ferritin assessment.

Blood analysis

Laboratory tests were performed according to the technical guidelines for laboratory tests issued by the Central Health Laboratory of the Iraqi Ministry of Health.

Statistical analysis

Data analysis was carried out using SPSS version 26.0. Statistical analysis were used include standard deviation, median, and frequency distributions were computed. The data distribution was evaluated, and Pearson's correlation coefficient was used to investigate relationships among variables. Differences were regarded as statistically significant if the p-value was d" 0.05 or d" 0.01.

RESULTS

The outcomes of the present study, which included 150 patients infected with COVID-19, found the average age of infected individuals to be 42.466±1.037 years, while the number of infected males was 82 (54.66%) and infected females was 68 (45.33%). Patients aged 31 to 40 years recorded The largest number of COVID-19 infections, followed by the age group of 41-50 years, 21-30years, 51-60years 61-70years 11-20years , 71-80years respectively as presented in the table 1.

The results of this study also showed different statistical relationships applying Pearson's correlation with significance thresholds of pd"0.01 and pd"0.05, where Tables 2 and 3 showed a statistical correlation between patient gender and age, while neither showed any statistical relationship with laboratory tests. This suggests that COVID-19 affects all ages and both gender.

The data in Table 4 demonstrated a statistically significant difference among COVID-19 cases when studying the relationship

between the increase in the number of WBCs and the increase in CRP and ferritin in the blood of infected patients, while WBCs did not show any statistical relationship with the rest of the other laboratory tests.

This study demonstrated significant differences at the statistical level (p d" 0.01) between CRP and WBCs in patients with COVID-19, and at the level (p d" 0.05) between CRP, D-dimer, and ferritin, as presented in Table 5.

D-dimer showed a statistically significant correlation at the p d" 0.05 level in COVID-19 infected patients, when compared with CRP and ferritin , as shown in Table 6.

Ferritin showed a statistically significant correlation at the pd"0.01 level in COVID-19 infected patients, when compared with WBCs and at the level (pd" 0.05) with CRP and D-dimer, as shown in Table 7.

DISCUSSION

Given the scarcity of scientific studies and research on COVID-19 conducted in Iraq, this

Table 1. Frequency and ratio of patient COVID-19 infection according to Age and gender

Criteria	Category	Frequency	%	M±SE
Gender	Male	82	54.66%	1.453±0.040
	Female	68	45.33%	
Age groups (years)	11-20	3	2%	42.466±1.037
	21-30	25	16.66%	
	31-40	43	28.66%	
	41-50	40	26.66%	
	51-60	23	15.33%	
	61-70	14	9.33%	
	71-80	2	1.33%	

Table 2. Relationships between age, gender, and laboratory markers in individuals with COVID-19

Criteria	Pearson –Correlation	Significant two-tailed	Number of patients
Gender	0.231**	0.004	150
WBCs	0.146	0.075	150
C-Reactive protein	0.010	0.907	150
D-dimer	0.031	0.708	150
Ferritin	0.016	0.847	150

** The result is statistically significant at a p-value of ≤ 0.01.

Table 3. Age-gender relationship and laboratory tests in COVID-19 patients

Criteria	Pearson Correlation	Significant two-tailed	Number of patients
Age	0.231**	0.004	150
WBCs	0.084	0.304	150
C-Reactive protein	0.101	0.220	150
D-dimer	0.024	0.775	150
Ferritin	-0.048	0.557	150

** The result is statistically significant at a p-value of ≤ 0.01.

study aimed to examine the relationship between a patient's age and gender and their risk of infection with the virus, as well as the relationship between laboratory tests and the ability of doctors and healthcare staff to determine appropriate treatment and reduce the number of deaths from this disease. Since its emergence in the Wuhan - Chinese, the Coronavirus has demonstrated a real threat to the survival of humanity, causing signs and symptoms ranging from mild or sometimes asymptomatic to severe, life-threatening symptoms, and the possibility of its transmission from one person to another.[6] The COVID-19 virus causes severe lung damage. In addition, this virus, during its development and the emergence of more than one disease strain, showed cellular damage in other organs of the body, such as the liver, kidneys, and heart,[7] Therefore, several types of laboratory tests have been used to diagnose COVID-19 infection., and these tests differed due to differences in the severity of infection, the duration of infection, and age.[8,9]

During this study, it was found that all ages and genders can be infected with COVID-19,

Table 4. The relationship between WBCs, age, gender, and other laboratory tests in COVID-19 patients

Criteria	Pearson Correlation	Significant two-tailed	Number of patients
Age	0.146	0.075	150
Gender	0.084	0.304	150
C-Reactive protein	0.166*	0.042	150
D-dimer	0.090	0.274	150
Ferritin	0.205*	0.012	150

* The result is statistically significant at a p-value of≤ 0.05.
** The result is statistically significant at a p-value of≤ 0.01.

Table 5. The relationship between CRP, age, gender, and other laboratory tests in COVID-19 patients

Criteria	Pearson Correlation	Significant two-tailed	Number of patients
Age	0.010	0.907	150
Gender	0.101	0.220	150
WBCs	0.166*	0.042	150
D-dimer	0.560**	0.000	150
Ferritin	0.512**	0.000	150

* The result is statistically significant at a p-value of ≤ 0.05.
** The result is statistically significant at a p-value of ≤ 0.01.

Table 6. The relationship between D-dimer, age, gender, and other laboratory tests in COVID-19 patients

Criteria	Pearson Correlation	Significant two-tailed	Number of patients
Age	0.031	0.708	150
Gender	0.024	0.775	150
WBCs	0.090	0.274	150
C-Reactive protein	0.560**	0.000	150
Ferritin	0.567**	0.000	150

** The result is statistically significant at a p-value of ≤ 0.01.

Table 7. Correlation of Ferritin with age, gender, and other laboratory markers among COVID-19 patients

Criteria	Pearson Correlation	Significant two-tailed	Number of patients
Age	0.016	0.847	150
Gender	-0.048	0.557	150
WBCs	0.205*	0.012	150
C-Reactive protein	0.512**	0.000	150
D-dimer	0.567**	0.000	150

* The result is statistically significant at a p-value of ≤ 0.05.
** The result is statistically significant at a p-value of ≤ 0.01.

However, the highest infection rates appearing between 21 and 60 years old. At the same time, the infection rate is low in ages over 60 years old due to deaths resulting from advanced age,[10] as a result of the increased rate of Catabolism and the decrease in the body's Anabolism processes, in addition to the decrease in immunity, especially lymphocytes.[11,12] Smoking, obesity, alcohol consumption, and an unhealthy lifestyle, which also play a role in increasing the death rate from COVID-19.[13]

The coronavirus causes an inflammatory response in the body, resulting in an increase in the number of inflammatory cells and inflammatory cytokines. This has helped detect COVID-19 infection through the use of Blood tests such as Erythrocytes counts and CRP.[14] Increased WBCs plus CRP are important indicators of infections that occur in the human body, especially Microbes infections and immune diseases.[15] CRP is an important indicator of body inflammation. It is a protein produced by the hepatic, and when its levels increase, it indicates inflammation.[16] Elevated levels of CRP were also observed in COVID-19 infected patients, which is an indicator of the severity of the virus infection.[17] This supports the findings of the current study, which found an increase in white blood cell counts and CRP as a result of infection. A direct relationship was found between them, Both showed an Observed difference was significant at the 0.05 level. Another test used in this study is D-dimer is a laboratory test performed on COVID-19 patients.[18] It is an indirect indicator of fibrin degradation and fibrin turnover in the body, and an indicator of vascular thrombosis.[19] Previous research has shown that people infected with COVID-19 develop blood clots in different body parts, particularly in the blood vessels and lungs, leading to their death. This has been attributed to a cytokine storm, secondary infections, and organ damage. This finding is consistent with the findings of this research, in which elevated D-dimer levels were observed in patients infected with COVID-19.[20] The results of the current study are also consistent with those of,[21] which found that the increased incidence of thromboembolic complications in COVID-19 patients is due to disturbances in platelet counts and prothrombin time, and elevated D-dimer levels. These clots, which form in the body, cause persistent clotting, leading to either myocardial infarction or pulmonary embolism, which ultimately leads to death. The coronavirus attacks Erythrocytes and damages hemoglobin, causing it to lose its ability to bind oxygen, resulting in cellular damage. As a result of oxygen deficiency, the body increases hemoglobin production and iron stores. The increased free iron contributes to Blood coagulation in among COVID-19 patients via hydroxyl radical-induced non-enzymatic transformation of fibrinogen into fibrin clots. Therefore, we observe an increase in ferritin levels during COVID-19 infection.[22] The tests for Ferritin , D-dimer and C-reactive protein, also showed a significant statistical relationship at the p d" 0.01 level, as a direct increase was observed between the aforementioned tests when infected with Covid-19. The reason for this, as they indicated.[23] is due to the increase in hyperinflammation as a result of infection with COVID-19, resulting from a cytokine storm that affected the physiological functions of the patient's body and caused pathological changes

that led to a malfunction in the body's functions. The occurrence of a cytokine storm will lead to an increase in the level of interleukin (IL2,6,7), Granulocyte colony stimulating factor (GCSF), CRP , Tumor necrosis factor á (TNF-á) and Macrophage inflammatory protein 1-á in the body, which leads to hyperinflammation and then to the collapse of multiple organs in the body such as the liver, heart, and lung.[24,25] Based on the progress, this study confirmed the existence of a relationship at the statistical level of pd"0.01 between COVID-19 infection and an elevated in the levels of D-dimer and Ferritin.

CONCLUSION

The current study found a statistically significant correlation between blood tests assessing leukocyte count, ferritin, C-reactive protein and D-dimer, which are considered laboratory indicators of COVID-19 infection, across all ages and both genders. On the other hand, the above tests show variation in determining infection with this virus due to the difference in disease severity.

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Conflict of interest

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Data availability statement

This statement does not apply to this article.

Ethics statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical trial registration

This research does not involve any clinical trials.

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Not applicable.

Author contributions

Abbas Razzaq Abed: Conceptualization, Methodology, and Writing – Original Draft; Aleem Mardas Khudhair: Data Collection, Analysis, and Writing – Review and Editing; Ibtisam Mohammed Hussein: Methodology, and Data Collection.

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