



TSF Journal of Biology

Volume 1 Issue 2, 2023



www.tsfjb.com

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Muhammad Umar¹, Maryam Tahir^{1*}, Chaudhry Ahmed Shabbir²

Article History:

Received: 11-10-2023

Revised: 20-10-2023

Accepted: 25-10-2023

Available online: 30-10-2023

To Cite: Umar M, Tahir M, Shabbir CA. A Biochemical Analysis of Detrimental Effects of COVID-19 Severity on Multiple Organ Systems. TSF Journal of Biology. 2023; 1(2):28-45. Available from: <https://tsfjb.com/ojs/index.php/tsfjb/article/view/15>



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*Correspondence: maryamtahir6@gmail.com

¹Department of Life Sciences, School of Science, University of Management and Technology, Lahore, Pakistan

²Graduate School of Medicine Department of Molecular Pathology, Osaka Metropolitan University, Japan

A Biochemical Analysis of Detrimental Effects of COVID-19 Severity on Multiple Organ Systems

Muhammad Umar¹, Maryam Tahir^{1*}, Chaudhry Ahmed Shabbir²

Abstract

To understand the impact of the COVID-19 pandemic on multiple organ system research and review is required. While the primary symptoms of COVID-19 are respiratory distress and lung injury. This study investigates liver and kidney involvement and blood parameter changes among different groups of patients. Understanding these changes is crucial because COVID-19-induced liver and renal injuries, can complicate medication dosing and increase the risk of severe drug reactions. Despite the abundance of literature on COVID-19, information is lacking regarding the prevalence and clinical significance of liver injury, renal injury, and CBC alterations in COVID-19 patients from regions with low mortality and severity rates. This study aims to report and characterize changes in these parameters during the disease, and assess the relationship between them in a cohort of 354 confirmed COVID-19 patients (198 males and 156 females) in Lahore. Chi-square and T-test were used to evaluate the hypothesis. Several parameters showed significant changes, including the RBC count in normal patients, PLT levels in normal patients, ALT levels in normal, moderate, and severe patients, AST level in moderate patients, and Creatinine amount in moderate COVID-19 patients. These results highlight COVID-19's systemic impact on these parameters, enhancing our understanding of disease severity and progression. Furthermore, this knowledge guides clinical management, aiding in the prevention of severe illness and the reduction of serious health issues like renal failure and liver damage.

KEYWORDS

COVID-19, Biochemical tests, Kidney Disease, Lung Damage, C-reactive protein (CRP)

INTRODUCTION

High-throughput sequencing identified a novel beta coronavirus, "Severe Acute Respiratory Syndrome Coronavirus 2" (SARS-CoV-2). The World Health Organization (WHO) named the disease "Coronavirus Disease 2019" (COVID-19)

on February 11, 2020. Even individuals with no prior history of kidney problems can exhibit evidence of renal impairment following severe COVID-19 infections [1]. While the virus primarily affects the respiratory tract, it can also directly or indirectly disturb other body organs, including the liver and kidneys [2]. The

*Correspondence: maryamtahir6@gmail.com

¹Department of Life Sciences, School of Science, University of Management and Technology, Lahore, Pakistan

²Graduate School of Medicine Department of Molecular Pathology, Osaka Metropolitan University, Japan

unique coronavirus can attach to, enter, and replicate within the kidney cells, potentially causing tissue damage. Notably, similar receptors facilitating viral entry are also present in heart and lung cells, organs to be affected by the virus [3]. The body's inflammatory response to the infection itself might also contribute to kidney injury [4]. A rapid influx of cytokines, immune signaling molecules, can trigger severe inflammation [5]. While this inflammatory response aims to eradicate the invading virus, it can also inadvertently damage healthy tissues, including kidney tissue [6]. Additionally, COVID-19 can induce the formation of small blood clots, which have the potential to obstruct the tiniest blood vessels in the kidneys, impairing their function. [7].

Effect of COVID-19 on Creatinine Level

This study suggests a lower threshold (0.05 mg/dL in serum creatinine) for worsening or improving renal function in COVID-19 patients compared to earlier reports. While this change might appear insignificant in clinical practice, it significantly impacted their risk stratification and survival rates [8]. This highlights the importance of considering nuanced changes in kidney function, recognizing that the established AKI criteria developed by the Acute Kidney Injury Network and Kidney Disease Improving Global Outcomes, while valuable, may not capture the full picture in COVID-19 patients [9]. Additionally, factors like intravascular volume status and fluid balance can influence short-term creatinine fluctuations, necessitating careful interpretation beyond isolated values [10].

Abnormal liver function tests (LFTs) in COVID-19 patients require cautious medication management to avoid exacerbating liver damage [11]. The

severity can range from mild transaminase elevations to severe hepatitis and liver necrosis, with worse outcomes in patients with pre-existing liver conditions. Firstly, the liver enzyme imbalance was identified by Chen [12], [13]. According to research by Chaibi [14] in a Chinese population, the development of severe COVID-19 was linked to the presence of abnormal liver tests and liver damage. Saini [15] revealed that 89 patients (58.5%) had elevated levels of any liver enzyme, of which 43 (48.31%) had a liver impairment that was more severe enough to require ICU care. In this study, the severity of the disease and COVID-19 mortality were both linked to aberrant liver parameters with the highest correlations seen in them [16], [17]. Immune-mediated inflammation including cytokine storm and hypoxia from pneumonia are potential contributors to liver damage and even liver failure in critically ill COVID-19 patients, further raising concerns for those with immunocompromised states like liver cirrhosis or cancer [18].

This study aimed to identify complete blood count (CBC) parameters as potential predictors of COVID-19 test positivity among emergency room patients presenting with suspicious symptoms [19], [20]. By analyzing their CBCs, the researchers sought to reveal blood-based markers associated with a positive swab test.

Platelet Count and COVID-19

In multiorgan dysfunction syndrome, the platelet (PLT) count is a crucial indicator that determines the severity of the illness, and is often included in the categorization system [21].

There are three possible mechanisms to explain thrombocytopenia in COVID-19 patients:

- 1) The virus can directly infect the bone marrow cells and inhibit the synthesis of PLT.
- 2) The immune system can destroy PLTs.
- 3) PLTs can aggregate in the lungs and form microthrombi which cause further PLT consumption.

White Blood Cells Lymphocytes and COVID-19

Lymphopenia, a decrease in lymphocyte count, is the most common hematological abnormality in COVID-19 patients, affecting up to 84% of severe cases and demonstrating a clear correlation with studies [22]. Studies have observed a link between significant lymphopenia, neutrophilia (elevated neutrophil count), and worse outcomes, with these changes intensifying in critically ill individuals [22]. Inflammatory mediators triggered by the virus can directly harm lymphocytes. The virus may indirectly cause lymphopenia by attaching to and affecting other immune cells involved in lymphocyte production [23]. Twenty peer-reviewed studies reported lymphocyte subset counts and COVID-19 severity confirmed that lymphocyte depletion is a consistent feature of the disease, despite variations in how studies define disease severity [24]. Notably, effective chloroquine therapy was associated with an increase in T cells and natural killer (NK) cells, suggesting their potential role in controlling the infection [25]. Additionally, it has been discovered that severe cases have a decreased amount of regulatory T cells. Lymphocyte reconstitution may be a crucial element in healing. Clinicians may use low lymphocyte counts in risk stratification to tell severe or fatal cases of COVID-19 [26].

Neutrophils and COVID-19

Neutrophil, a type of white blood cell, has a crucial role in COVID-19. While their

presence increases in lung tissue and circulation, its activation can worsen the COVID-19 host response. Neutrophils found in lung capillaries, extravagantly entered into the alveolar space during lung autopsy. Through increased degranulation and cytokine production, neutrophils play a critical role as the primary initiators of the hyperinflammation associated with COVID-19 illness. The neutrophil count in severe cases was greater than the moderate and mild cases on the day of admission to the hospital. Additionally, there was evidence of a rise in neutrophils from day 7 to 9. If these results are confirmed, COVID-19 severity could be lessened by targeting neutrophils and the factors that influence their recruitment [27].

Monocytes and COVID-19

Monocytes make up roughly 5-9% of all peripheral leukocytes overall. They circulate for one to two days before differentiating into tissue-resident macrophages. Through the angiotensin-converting enzyme (ACE2), SARS-CoV2 infects CD14⁺ monocytes. Patients who are in the early stages of recovery showed a predominant fraction of CD14⁺⁺IL1⁺ monocytes, according to Wen [28].

Red Blood Cells, Hemoglobin, and COVID-19

The infection has a sizable effect on the protein and lipid levels of the structural membrane homeostasis of red blood cells (RBCs). Increased quantities of glycolytic intermediates were seen in the RBCs of COVID-19 patients, along with membrane protein oxidation and fragmentation. Nitric oxide (NO) levels in RBC are higher in COVID-19 patients than in non-COVID-19 hypoxemic individuals, however, it is still unclear what mechanism(s) is (are) responsible for this accumulation. In COVID-19 patients, autoimmune hemolytic anemia (AIHA) has been

described [29]. Anemia may occur from a pattern of anemia that is similar to sideroblastic anemia. Hemoglobin and iron metabolism biomarkers are linked to inflammation in COVID-19 infection [30]. However, anemia and inflammation-related changes in iron levels are both significant clinical indicators for risk assessment of COVID-19-infected individuals. Patients with COVID-19 may also experience bleeding issues due to thrombocytopenia. The disease is caused by the zoonotic positive-strand RNA virus known as SARS-CoV-2 (Respiratory Syndrome Coronavirus 2).

CRP and Severity of Disease

C-reactive protein (CRP) in serum has been identified as a key marker that alters dramatically in severe COVID-19 patients among various clinical parameters. CRP concentration decreases when tissue damage or inflammation is repaired, making it a helpful marker for gauging the severity of the disease [31]. Patients with COVID-19 showed a considerable rise in CRP, with values averaging 20 to 50 mg/L and in severe COVID-19 patients increased up to 86%. Severe disease courses showed significantly higher levels of CRP, as compared to the patients experiencing mild or non-severe disease courses [32]. According to a study, patients with more severe symptoms had an average CRP concentration of 39.4 mg/L, whereas patients with milder symptoms had 18.8 mg/L. Compared to the patients in the moderate group, the severe group's initial CRP levels were higher [33]. Additionally, it was shown that patients with low oxygen saturation (SpO_2 90%) had considerably greater levels of CRP (median 76.5 mg/L) than patients with high oxygen saturation (SpO_2 > 90%) (Median 12.7 mg/L), 22 suggesting a correlation between greater lung damage and elevated CRP levels [34].

Higher CRP levels are associated with lung injury, more severe disease, and worse prognosis, therefore, they can be a valuable indicator. Because of the strong relation between CRP levels and the intensity of symptoms in COVID-19 individuals, this marker may be useful in evaluating a patient's condition in addition to other clinical findings. The objectives are to find out parameters that are affected frequently by the severity of the disease and to find the link between metabolic disorders with COVID-19 [12].

This study calls to attention the need for regular monitoring of liver and kidney function in older patients in order to start a speedy recovery process. Furthermore, studies like these allow one to understand the challenges and effects caused by the pandemic.

METHOD

This retrospective study was conducted at Chughtai Medical Center (CMC) in Lahore, Pakistan, analyzing confirmed COVID-19 cases diagnosed between June 2021 and June 2022. The study population consisted of the individuals who met specific inclusion criteria, including confirmed COVID-19 cases and underwent biochemical testing. Exclusion criteria involved COVID-19-negative cases and patients who did not undergo biochemical testing. The sample size was 354 confirmed COVID-19 patients, including 198 males and 156 females, selected using a convenient sampling technique from CMC's online portal. Data collection included demographic information, medical history, and clinical data, such as Complete Blood Count (CBC), Liver Function Tests (LFT), Renal Function Tests (RFT), and C-reactive protein (CRP) levels. Data analysis involved entering the collected data into an Excel spreadsheet

and using SPSS for cleaning and statistical analysis. Various statistical tests, including t-tests and chi-square tests, were applied to assess differences and correlations in biochemical parameters between genders, age groups, and disease severity categories. COVID-19 confirmation was based on history, clinical manifestations, and pharyngeal swab specimen nucleic acid amplification test via reverse transcription-polymerase chain reaction (RT-PCR) [35]. The study adhered to ethical norms, and informed consent was obtained from all participants.

Laboratory investigations included:

- *Tests for hemoglobin (Hb)*: This test utilized the Cyanmethemoglobin (HiCN) method. [36].
- *Tests for Red Blood Cells (RBC)*: RBCs were counted using a particular type of chamber, known as a Hemocytometer or Neubauer's chamber [37].
- *Tests for Total Leukocyte Count (TLC)*: The blood is diluted with a fluid that makes the RBCs' hemolysis whereas WBCs remain intact, and then they are counted in a Neubauer chamber [37].
- *Tests for Complete Blood Count (CBC)*: An automated hematological analyzer typically performs the CBC, counting cells and gathering data on their size and composition [38].
- *Tests for Creatinine*: In an alkaline solution, creatinine reacts with picric acid to generate a reddish color complex. The reaction is known as the Jaffe reaction [39].
- *Tests for Urea*: Blood urea level was measured using the Berthelot method.
- *Tests for ALT and AST*: ALT/AST levels were measured in the liver function test of the patient.
- *Tests for C-reactive protein (CRP)*: The blood serum and CRP, were measured

using the Alinity c latex spectrometric assay.

The study provided a comprehensive analysis of COVID-19 cases in the Lahore region and the associated laboratory tests, contributing to the understanding of the disease's impact on patients in this area.

RESULTS

The study consisted of 354 COVID-19 patients, of which 198 were male and 156 were female. The data was further distributed based on age and three categories were formed. The first category ranged from 16 to 40 years (36 male and 35 female patients), the second category ranged from 41 to 65 years (116 male and 100 female patients), and the last category ranged from 66 to 90 years (46 male and 21 female patients). To accurately measure the biochemical parameters, the data was analyzed by dividing into three groups: Normal, Moderate, and Severe, based on disease severity.

Patients having CRP levels less than 1 were placed in the normal category, comprising 31 male and 32 female patients. The patients having CRP levels between 1-10 were placed in the moderate group and it comprised 99 male and 82 female patients and the severe category had patients whose CRP level was above 10 and comprised 68 males and 42 female patients (Figure 1).

CRP and COVID-19

Statistical analysis through T-tests revealed that males in the age group 66 to 90 exhibit a significant impact in terms of C-reactive protein (CRP), as shown in Table 2. Conversely, in the female age group 41-65, there is a notable impact, as indicated in Table 1.

HB and COVID-19

In the normal range classification, 29 (39.7%) male and 41 (56.2%) female

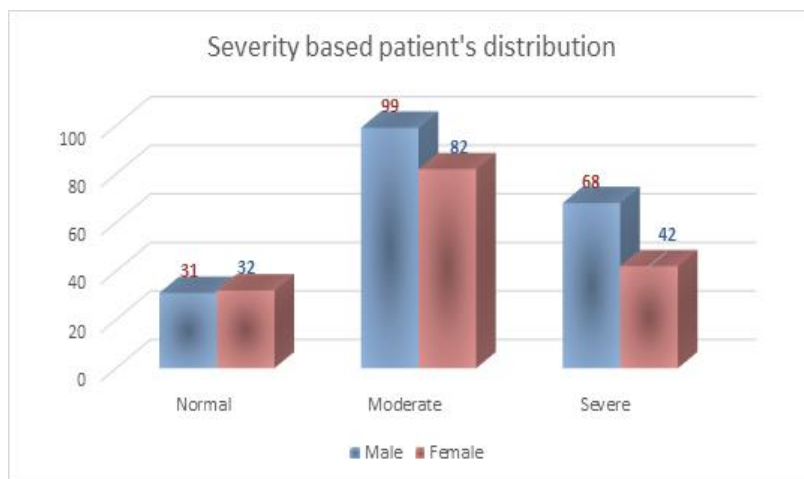


Figure 1. Graphical representation of patients based on severity in C-reactive protein levels (CRP)

Table 1. T-test Value for Female Patients

Biochemical Parameter	AGE GROUP	N	Mean	T -value	df
1.CRP	16-40	35	4.81	-5.42	34
	41-65	100	8.68	-1.53	99
	66-90	21	6.48	-2.84	20
2.HB	16-40	35	13.20	-4.92	34
	41-65	100	13.68	-7.38	99
	66-90	21	13.49	-3.60	20
3.PLT	16-40	35	258.86	-9.69	34
	41-65	100	262.49	-18.20	99
	66-90	21	257.95	-8.83	20
4.RBC	16-40	35	4.89	-4.69	34
	41-65	100	4.92	-9.32	99
	66-90	21	5.00	-2.95	20
5.TLC	16-40	35	9.83	-1.63	34
	41-65	100	11.81	1.52	99
	66-90	21	9.81	-1.42	20

patients exhibited normal hemoglobin (HB) levels. Conversely, 2 (2.7%) male and 1 (1.4%) female patients demonstrated elevated HB levels, as depicted in Figure 2.A(i). In the moderate category, 95 (52.49%) male and 77 (42.54%) female patients registered normal HB levels, while 4 (2.21%) male and 5 (2.76%) female patients exhibited elevated HB levels, as illustrated in Figure 2.A(ii). While in the

severe category, 62 (56.36%) male and 31 (37.27%) female patients displayed normal HB levels. Conversely, 6 (5.45%) male and 1 (0.91%) female patients presented elevated HB levels, as shown in Figure 2.A(iii). Furthermore, statistical analysis through T-test revealed that male (Table 2), and female patients (Table 1) in the 41 - 65 age group were significantly affected.

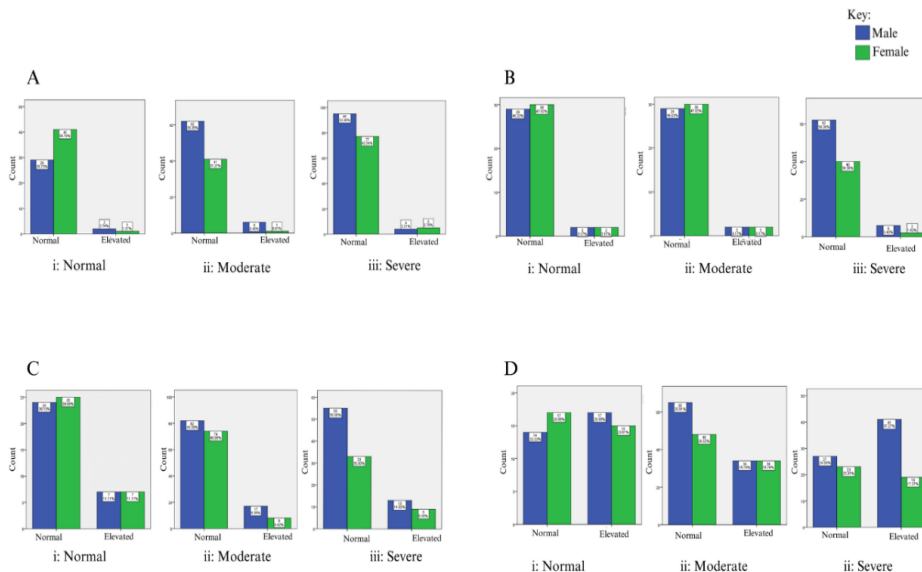


Figure 2. Graphical Comparison of various Biochemical Parameters: (A) HB (B) PLT (C) RBC (D) TLC

Table 2. T-test Value for Male Patients

Biochemical Parameter	AGE GROUP	N	Mean	T -value	df
1.CRP	16-40	36	6.88	-2.73	35
	41-65	116	8.52	-2.27	115
	66-90	46	13.11	1.95	45
2.HB	16-40	36	14.11	-2.88	35
	41-65	116	16.05	0.67	115
	66-90	46	12.45	-8.82	45
3.PLT	16-40	36	258.50	-10.49	35
	41-65	116	258.31	-20.02	115
	66-90	46	295.74	-8.49	45
4.RBC	16-40	36	5.03	-5.15	35
	41-65	116	5.11	-5.56	115
	66-90	46	4.69	-9.17	45
5.TLC	16-40	36	9.36	-2.72	35
	41-65	116	11.40	0.96	115
	66-90	46	12.58	1.60	45

PLT and COVID-19

Firstly, in normal category, 29 (46.03%) male and 30 (47.62%) female patients exhibited normal platelet (PLT) levels, while 2 (3.17%) male and 2 (3.17%) female

patients demonstrated elevated PLT levels (P-value = 0.001*), as illustrated in Figure 2.B(i). Secondly, in the moderate category, 95 (52.49%) male and 78 (43.09%) female patients displayed normal PLT levels,

whereas 4 (2.21%) male and 4 (2.21%) female patients presented elevated PLT levels, as depicted in Figure 2.B(ii). Thirdly, in the severe category, 62 (56.36%) male and 40 (36.36%) female patients manifested normal PLT levels, while 6 (5.45%) male and 2 (1.82%) female patients exhibited elevated PLT levels, as shown in Figure 2.B(iii). Moreover, a statistical analysis using a T-test demonstrated significant effects on male patients aged 66-90 (Table 2), while female patients aged 41-65 experienced a substantial impact (Table 1).

RBC and COVID-19

In the normal category, 24 (38.10%) male and 25 (39.68%) female patients displayed normal red blood cell (RBC) levels, while 7 (11.11%) male and 7 (11.11%) female patients exhibited elevated RBC levels (P -value = 0.005), as depicted in Figure 2.C(i). Within the moderate category, 82 (45.30%) male and 74 (40.88%) female patients showcased normal RBC levels, while 17 (9.39%) male and 8 (4.42%) female patients presented elevated RBC levels, as illustrated in Figure 2.C(ii). Finally, in the severe category, 55 (50.00%) male and 33 (30.00%) female patients demonstrated normal RBC levels, whereas 13 (11.82%) male and 9 (8.18%) female patients displayed elevated RBC levels, as shown in Figure 2.C(iii). T-test analysis depicted significant effects on male patients aged 41-65 (Table 2), whereas female patients aged 66-90 experienced a substantial impact (Table 1).

TLC and COVID-19

In the normal category, 14 (22.22%) male and 17 (26.98%) female patients exhibited normal total leukocyte count (TLC) levels, while 17 (26.98%) male and 15 (23.81%) female patients demonstrated elevated TLC levels, as illustrated in Figure 2.D(i). Within the moderate category, 65 (35.91%)

male and 48 (26.52%) female patients displayed normal TLC levels, whereas 34 (18.78%) male and 34 (18.78%) female patients presented elevated TLC levels, as shown in Figure 2.D(ii). Lastly, in the severe category, 27 (24.55%) male and female patients had normal TLC levels, while 41 (37.27%) male and 19 (17.27%) female patients exhibited elevated TLC levels, as depicted in Figure 2.D(iii). Furthermore, a significant effect on male patients aged 66-90 was indicated through T-test analysis (Table 2), on the other hand, female patients aged 41-65 experienced a considerable impact (Table 1).

ALT and COVID-19

In the normal category, 1 (1.59%) male and 1 (1.59%) female patients demonstrated normal alanine aminotransferase (ALT) levels, while 30 (47.62%) male and 31 (49.21%) female patients exhibited elevated ALT levels (P -value = 0.001*), as depicted in Figure 3.A(i). Furthermore, in the moderate category, 7 (3.87%) male and 6 (3.31%) female patients displayed normal ALT levels, while 92 (50.83%) male and 76 (41.99%) female patients presented elevated ALT levels (P -value = 0.004*), as shown in Figure 3.A(ii). Lastly, in the severe category, 6 (5.45%) male and 4 (3.64%) female patients showcased normal ALT levels; however, 62 (56.36%) male and 38 (34.55%) female patients had elevated ALT levels (P -value = 0.015*), as illustrated in Figure 3.A(iii). T-test analysis indicated that both male (Table 3) and female patients in the age group 66 to 90 are significantly affected (Table 4).

AST and COVID-19

In the normal category, 2 (3.17%) male and 1 (1.59%) female patients exhibited normal aspartate aminotransferase (AST) levels, while 29 (46.03%) male and 31 (49.21%) female patients demonstrated elevated AST levels, as illustrated in Figure 3.B(i). Within

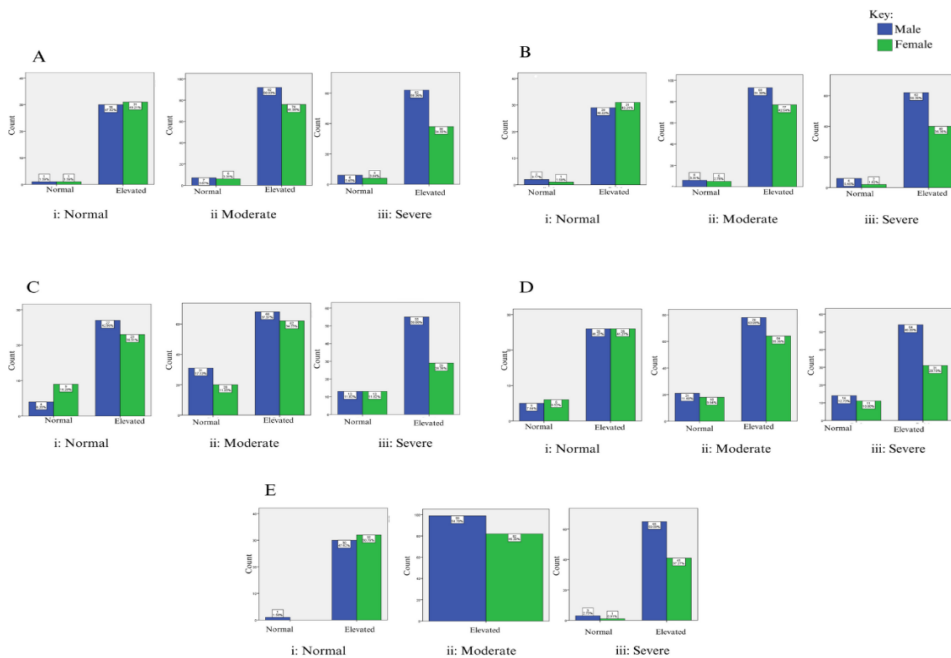


Figure 3 Graphical Comparison of various Biochemical Parameters: (A) ALT (B) AST (C) Bilirubin (D) Creatinine (E) Urea

Table 3. T-test Value for Male Patients

Biochemical Parameter	AGE GROUP	N	Mean	T – value	df
1. ALT	16-40	36	327.25	8.61	35
	41-65	116	346.01	16.29	115
	66-90	46	356.59	10.46	45
2. AST	16-40	36	379.03	7.85	35
	41-65	116	400.86	16.68	115
	66-90	46	432.20	11.74	45
3. Bilirubin	16-40	36	2.58	5.22	35
	41-65	116	3.00	6.07	115
	66-90	46	2.54	6.47	45
4. LDH	16-40	36	458.17	3.54	35
	41-65	116	496.60	8.11	115
	66-90	46	546.78	5.11	45
5. Creatinine	16-40	36	2.05	4.63	35
	41-65	116	2.27	8.02	115
	66-90	46	2.09	6.81	45
6. Urea	16-40	36	66.31	11.11	35
	41-65	116	66.59	12.35	115
	66-90	46	64.24	14.33	45

the moderate category, 6 (3.31%) male and 5 (2.76%) female patients showcased normal AST levels; conversely, 93 (51.38%) male and 77 (42.54%) female patients presented elevated AST levels, indicating a significant difference (P -value = 0.000*), as depicted in Figure 3.B(ii). Lastly, in the severe category, 6 (5.45%) male and 2 (1.82%) female patients displayed normal AST levels, while 62 (56.36%) male and 40 (36.36%) female patients exhibited elevated AST levels, as shown in Figure 3.B(iii). The independent samples T-test revealed that both male (Table 3), and female patients in the age group 66 to 90 were notably affected (Table 4).

Bilirubin and COVID-19

In the normal category, 4 (6.35%) male and 9 (14.29%) female patients displayed normal bilirubin levels, while 27 (42.86%) male and 23 (36.51%) female patients exhibited elevated bilirubin levels, as shown in Figure 3.C(i). Within the

moderate category, 31 (17.13%) male and 20 (11.05%) female patients showcased normal bilirubin levels; conversely, 68 (37.57%) male and 62 (34.25%) female patients presented elevated bilirubin levels, as depicted in Figure 3.C(ii). Finally, in the severe category, 13 (11.82%) male and 13 (11.82%) female patients had normal bilirubin levels, while 55 (50.03%) male and 13 (11.82%) female patients exhibited elevated bilirubin levels, as illustrated in Figure 3.C(iii). The independent samples T-test results highlighted that males in the age group 41-65 were significantly affected (Table 3), while females in the age group 66 to 90 were notably affected (Table 4).

LDH and COVID-19

Males in the age group 66 to 90 exhibit a substantial impact in terms of lactate dehydrogenase (LDH), as evidenced by independent samples T-test results (Table 3). Conversely, in females, those in age group 1, 16-40, experience a significant effect (Table 4).

Table 4. T-test Value for Female Patients

Biochemical Parameter	AGE GROUP	N	Mean	T -value	df
6. ALT	16-40	35	365.09	9	34
	41-65	100	322.85	15	99
	66-90	21	421.43	11	20
	16-40	35	431.57	9	34
7. AST	41-65	100	386.27	15	99
	66-90	21	507.10	11	20
	16-40	35	2.49	5	34
	41-65	100	2.42	9	99
8. Bilirubin	66-90	21	3.21	10	20
	16-40	100	453.58	4.95	99
	41-65	21	357.05	1.00	20
9. LDH	66-90	35	400.49	1.82	34
	16-40	35	1.87	5.43	34
	41-65	100	2.06	8.10	99
10. Creatinine	66-90	21	2.28	11.24	20
	16-40	35	64.23	15.91	34
	41-65	100	65.76	16.15	99
11. Urea	66-90	21	69.14	19.04	20

Creatinine and COVID-19

In the normal category, 5 (7.94%) male and 6 (9.52%) female patients exhibited normal creatinine levels, while 26 (41.27%) male and 26 (41.27%) female patients demonstrated elevated creatinine levels, as illustrated in Figure 3.D(i). Transitioning to the moderate category, 21 (11.60%) male and 18 (9.94%) female patients showcased normal creatinine levels; conversely, 78 (43.09%) male and 64 (35.36%) female patients presented elevated creatinine levels, indicating a significant difference ($P\text{-value} = 0.014^*$), as depicted in Figure 3.D(ii). Finally, in the severe category, 14 (12.73%) male and 11 (10.00%) female patients displayed normal creatinine levels, while 54 (49.09%) male and 31 (28.18%) female patients exhibited elevated creatinine levels, as shown in Figure 3.D(iii). The T-test results suggest that males in the age group 41-65 were significantly affected (Table 3). Conversely, in females, the age group 66 to 90 experienced a notable impact. (Table 4).

Urea and COVID-19

In the normal category, only 1 (1.59%) patient displayed normal urea levels, whereas 30 (47.62%) male and 32 (50.79%) female patients demonstrated elevated urea levels, as depicted in Figure 3.E(i). Within the moderate category, 99 (54.70%) male and 82 (45.30%) female patients showcased elevated urea levels; none of the patients had normal urea levels, as shown in Figure 3.E(ii). Finally, in the severe category, 3 (2.73%) male and 1 (0.91%) female patients exhibited normal urea levels, while 65 (59.09%) male and 41 (37.27%) female patients presented elevated urea levels, as illustrated in Figure 3.E(iii). Concerning the T-test, males in the age groups 16-40 and 41-65 were equally affected (Table 3). In contrast, females in

the age group 66 to 90 experienced a substantial impact (Table 4).

DISCUSSION

This study aimed to enrich the existing knowledge, particularly through local data, by highlighting liver abnormalities and their association with COVID-19. We explore the interconnections between virus, liver and kidney damage, and potential drug reactions, emphasizing the crucial need for close monitoring of liver and kidney functions in COVID-19 patients. Laboratory findings, such as complete blood counts (CBCs), play an essential role in managing infectious diseases, to highlight the critical function of some hematological indicators throughout the disease. This aligns with the existing reports suggesting a link between liver damage and increased risk of severe drug reactions in COVID-19 patients [40]. Therefore, careful and regular monitoring of liver function becomes even more critical in this vulnerable population. Statistical analysis employing the chi-square test, applied separately to gender and severity groups, provides a nuanced view of age distribution among COVID-19 patients. The analysis revealed significant demographic differences across genders, male: 18% aged 15-40, 58.5% aged 41-65, and 23.2% aged 66-90, while females: 22.4% aged 15-40, 64.1% aged 41-65, and only 13.4% aged 66-90. This discrepancy highlights the importance of considering both age and gender when assessing the impact of COVID-19 on liver function, suggesting potential variations in how the virus affects different patients' demographics.

C-reactive protein (CRP) levels revealed three distinct groups of patients: normal, moderate, and severe [41]. Statistical analysis showed that COVID-19 impacted

liver function in both male and female patients within the severe category, specifically through elevated alanine transaminase (ALT) and aspartate transaminase (AST) levels. Interestingly, age within this group emerged as a potential contributing factor, with male aged 66-90 exhibiting a greater degree of liver impairment [42]. Bilirubin levels also displayed age- and gender-specific nuances. While males aged 41-65 were more prone to bilirubin elevation, females in the 66-90 age group demonstrated a higher likelihood of the same [43]. These findings underscore the complex and multifaceted nature of liver function abnormalities in COVID-19 patients. It has also been observed that elements associated with emotional stress are also a contributing factor in influencing lactate dehydrogenase (LDH), especially in young women [44]. Beyond the liver, our study explores how COVID-19 affects the kidney function [45]. Similar to liver function, age and gender played differential roles. Both male and female patients aged 66-90 displayed higher creatinine levels. However, for urea levels, the pattern diverged. Male patients in the younger age groups (16-40 and 41-65) exhibited higher urea levels, whereas in females, the highest levels were observed in the 66-90 age group [46]. This aligns with findings from other studies, further highlighting the intricate relationship between kidney function and COVID-19, influenced by both age and gender.

Effective biomarkers play a crucial role in disease prevention, early diagnosis, and targeted treatment. Recognizing the importance, our study investigated the complete blood counts (CBC) as a potential tool for identifying key changes associated with COVID-19 infection. CBC has long been valued as an essential diagnostic tool

[47]. Our analysis revealed a consistent association between COVID-19 and lower platelet and lymphocytes counts across various demographics, regardless of age or gender [48]. Similarly, a decreased eosinophil count was observed in infected individuals [49]. Furthermore, we found an elevated neutrophil-to-lymphocyte ratio in COVID-19 patients [50]. These findings highlight the significant impact of the virus on CBC parameters and suggest the potential of this ratio as a valuable marker for physicians and scientists. Monitoring these specific parameters may enable early diagnosis, prevention of complications, and development of proper therapeutic interventions.

Our research significantly expands our understanding of COVID-19's impact on liver and kidney functions, as well as changes in complete blood count CBC parameters. These findings highlight the crucial roles of age and gender in the manifestation of these abnormalities. Furthermore, our study underscores the potential of CBC parameters as valuable biomarkers for COVID-19. This emphasizes the need for regular liver and kidney monitoring, especially in older patients, to facilitate early detection of abnormalities and potentially reduce the risk of adverse medical reactions. Ultimately, studies like this aim to contribute to a more comprehensive understanding of the COVID-19 virus and its effects on the human body. Through such research, we can equip the global scientific community with better tools and knowledge to tackle the challenges presented by the pandemic.

CONCLUSION

Our analysis demonstrates that COVID-19 adversely affects liver function tests (LFTs) and renal function tests (RFTs), and to a

moderate extent, complete blood count (CBC) parameters. Notably, COVID-19-associated abnormalities in these systems are more prevalent in patients with severe or critical presentations, particularly among older individuals. In elderly population, susceptibility to the adverse effects of COVID-19 increases with disease severity. Therefore, vigilant monitoring of biochemical parameters plays a crucial role in managing the disease, potentially mitigating its severity and reducing mortality rates, especially in older patients. This study not only helps address current challenges but also lays the groundwork for future exploration and development. It paves the way for long-term longitudinal studies, as well as the discovery and development of novel molecular mechanisms and biomarkers for early disease detection.

Author Contributions: Mr. M. Umer designed the study and did the initial data entry and write-up, and Miss Maryam designed the figures and worked on the manuscript writing.

Conflict of Interest: There's no conflict of interest.

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