












## Research Article

# Complete Blood Count Alterations of COVID-19 Patients in Riyadh, Kingdom of Saudi Arabia

**Abozer Y. Elderderly** <sup>1</sup>, **Ahmed M. E. Elkhalfifa** <sup>2,3</sup>, **Abdullah Alsrhani** <sup>1</sup>,  
**Khalid I. Zawbae** <sup>4</sup>, **Saad M. Alsurayea** <sup>5</sup>, **Faisal K. Escandarani** <sup>5</sup>,  
**Abdulaziz H. Alhamidi** <sup>6</sup>, **Hadeil M. E. Idris** <sup>7</sup>, **Anass M. Abbas** <sup>1</sup>, **Manar G. Shalabi** <sup>1</sup>,  
and **Jeremy Mills** <sup>8</sup>

<sup>1</sup>Department of Clinical Laboratory Sciences, College of Applied Medical Sciences, Jouf University, Sakaka 42421, Saudi Arabia

<sup>2</sup>Department of Hematology, Faculty of Medical Laboratory Sciences, University of El Imam El Mahdi, Kosti, Aba Island, Sudan

<sup>3</sup>Department of Public Health, College of Health Sciences, Saudi Electronic University, Riyadh 13323, Saudi Arabia

<sup>4</sup>Central Blood Bank, Riyadh Regional Laboratory, Saudi Arabia/Laboratory Department, Directorate of Riyadh Health Affairs, Saudi Arabia

<sup>5</sup>Riyadh Regional Laboratory, Riyadh, Saudi Arabia

<sup>6</sup>Clinical Laboratory Sciences Department, College of Applied Medical Science, King Saud University, Riyadh, Saudi Arabia

<sup>7</sup>College of Applied Medical Sciences, Shaqra University, Saudi Arabia

<sup>8</sup>School of Pharmacy and Biomedical Sciences, University of Portsmouth, UK

Correspondence should be addressed to Abozer Y. Elderderly; [ayelderderly@ju.edu.sa](mailto:ayelderderly@ju.edu.sa) and Ahmed M. E. Elkhalfifa; [ahmedelnour2003@yahoo.com](mailto:ahmedelnour2003@yahoo.com)

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This study is aimed at evaluating the association between Coronavirus disease 19 (COVID-19) and the primary complete blood count (CBC) parameters in confirmed positive patients. In a retrospective cross-sectional study, 384 files of patients with confirmed COVID-19 diagnosis hospitalized at King Saud Medical City, Riyadh, were chosen randomly as a study group for hematological parameters, with another 384 non-COVID-19 files of patients without history of any disease which could influence the hematological profile were selected as a control group. The gender, age, and nationality of the control group were matched with those of the study group. Anemia and thrombocytopenia prevalence was significantly higher in COVID-19 positive patients compared with negative. However, the positive cases were 3.4 times more likely to be anemic and approximately 5.3 times as likely to be thrombocytopenic, while the prevalence of leukopenia showed no statistical significance between the two groups. However, the Mean Cell Volume (MCV), Total White Blood Cell (WBC) count, lymphocyte count, and basophil count median values showed a nonsignificant difference between the two groups. Anemia and thrombocytopenia may be highly developed in severe positive cases, and therefore, further studies are recommended to validate these findings.

## 1. Introduction

Over the last two decades, 3 new coronavirus subtypes have emerged, in outbreaks that provoke great concern at a global level. These are sequentially SARS-CoV, MERS-CoV, and SARS-CoV-2, respectively, the Severe Acute Respiratory Syndrome Coronavirus, Middle-East Respiratory Syndrome

Coronavirus, and Severe Acute Respiratory Syndrome Coronavirus-2 [1]. In manifestation, these exhibit broad similarities, including a shared tendency of progression to severe symptomatology, associated with high incidence of both morbidity and mortality. Having said this, comparing their clinical presentations and complications distinguishes clear variability of respective processes [2].

The contagious COVID-19 novel coronavirus is rapidly evolving and spreading throughout the world, significantly affecting millions of people worldwide [3]. The disease is caused by the zoonotic positive-strand RNA virus known as SARS-CoV-2 (Respiratory Syndrome Coronavirus 2) [4]. The disease has caused severe socioeconomic and health disruption [5, 6]. Symptomatic infected patients with COVID-19 usually present with mild clinical symptoms including but not limited to fever, dry cough, and alteration in taste and/or smell sensation, where they usually recover in a few days [7, 8]. However, patients with severe symptoms, especially those with comorbidities such as chronic diseases, may quickly progress to develop pneumonia and acute respiratory distress syndrome days after the onset of the disease, with an increased mortality rate [8, 9], suggesting that COVID-19 causes a multisystem disorder [10]. Since the initial reports considering COVID-19 as only pneumonia, accumulated data have revealed that intravascular coagulation and coagulopathy are common in severely infected patients, causing the rise in mortality rate [11, 12]. These data suggested that the coagulation pathway is very active in COVID-19-infected individuals [10, 13].

Interestingly, in several hematological laboratory investigations into lymphocytes, peripheral eosinophils and neutrophils were altered significantly in COVID-19 patients, thus being suggested as a potential indicator for both disease progression and effectiveness of therapy [14]. Importantly, some studies also suggest an association between COVID-19 infection and reduction in hemoglobin (Hb) levels [15, 16]. This suggested association had been previously reported with other types of pneumonia [17]. Therefore, we conducted a retrospective analysis to evaluate the association between COVID-19 and the main blood parameters including the Hb concentration, other red blood cell (RBC) indices, TWBCs, and platelet indices among COVID-19 hospitalized cases in Saudi Arabia compared with nonpositive cases.

## 2. Materials and Methods

**2.1. Study Design, Setting, and Population.** The investigation is retrospective, hospital-based, and cross-sectional, conducted at the King Saud Medical City, Riyadh Regional Laboratory Centre, KSA, from October to November 2020 to compare Hb concentration, RBC counts, RBC indices, WBCs, and platelet indices among confirmed positive hospitalized cases and negative subjects.

**2.2. Sample Size and Sampling.** Using EPI info software at a confidence level of 95%, 384 anonymous COVID-19 patients' files were selected randomly from electronic medical records and clinical laboratory databases, recruited as a study group for Hb, RBC counts, and red cell indices. The corresponding 384 files for COVID-19-negative patients matched for age, gender, and nationality without a history of blood diseases were chosen randomly as a control group. The COVID-19 diagnosis was confirmed by a positive Reverse-Transcriptase-Polymerase-Chain-Reaction (RT-PCR) SARS-CoV-2 assay result [18, 19]. The samples for the COVID-19 investigation were obtained using nasopharyngeal swab samples.

**2.3. Ethical Approval.** The Saudi Electronic University Institutional Review Board (SEU-IRB) issued ethical approval according to the Helsinki Declaration principles after the research protocol was reviewed before data collection began. The ethical approval number was SEUREC-CHS20113-REC.

**2.4. Inclusion and Exclusion Criteria.** Hospitalized positive cases and negative cases were identified and then excluded if they had a history of any disease, which could influence the hematological profile, were under treatment with drugs affecting complete blood count (CBC), and had cardiovascular disease or liver disease.

**2.5. Statistical Analysis.** The laboratory's findings, plus clinical and personal data extracted from the patient's files, were entered into the Statistical Package for the Social Sciences (SPSS Software version-25; IBM Corp., Armonk, NY, USA), then revised, and coded. Continuous data were expressed and presented as mean standard deviation ( $\pm$ SD) with the data distributed normally according to the significance of the test of normality. Median interquartile range (IQR) was applied for the nonnormally distributed data. Continuous variables were compared for the normally distributed data using independent Student's *t*-test and for nonnormally distributed data using the Mann-Whitney *U* test. A *p* value  $\leq$  0.05 was selected as the threshold of significance.

## 3. Results

**3.1. General Characteristics of the Patients (Table 1).** The gender profile of COVID-19 patients and the control group in this study showed 221 patients (57.6%) were males and 163 (42.4%) were females. The median age was  $49.0 \pm 23.75$  for the COVID-19 patient group and  $45.0 \pm 26.0$  for the non-COVID-19 patients (range 19-98 years) with a non-significant difference regarding age ( $p = 0.165$ ). The study and control group's nationalities included citizens from KSA (173, 45.1%) and non-Saudi (210, 54.9%).

**3.2. Laboratory Findings.** Table 2 represents the comparison of Hb concentration, RBC counts, and red cell indices between COVID-19 patients and the non-COVID-19 control group. Our findings stated that Hb concentration, RBC count, haematocrit (Hct), mean cell hemoglobin (MCH), and mean cell hemoglobin concentration (MCHC) median values are significantly decreased in COVID-19 patients compared with the control group ( $p \leq 0.01$ ,  $p \leq 0.01$ ,  $p = 0.041$ , and  $p \leq 0.01$ , respectively). The median values of the red cell distribution width (RDW) show a statistically significant increase in COVID-19 patients compared with the control group ( $p \leq 0.01$ ). However, the MCV median values showed no significant difference between the two groups ( $p = 0.264$ ).

Table 3 explains a significant decrease in the eosinophil count and platelet count median values among COVID-19 patients compared with controls ( $p \leq 0.01$  and  $p \leq 0.01$ , respectively).

The median values of Mean Platelet Volume (MPV) showed a statistically significant increase among COVID-19 patients compared with the control group ( $p \leq 0.01$ ).

TABLE 1: Distribution of age, gender, and nationality of the COVID-19 patients and the control group.

Variables	Category	COVID-19 patients Frequency N (%)	Non-COVID-19 patients Frequency N (%)	P-value
Gender	Male	221 (57.6)	221 (57.6)	0.165
	Female	163 (42.4)	163 (42.4)	
	Total	384 (100)	384 (100)	
Age	18-98	384 (100)	384 (100)	
	Median $\pm$ IQR	49.00 $\pm$ 23.75	45.0 $\pm$ 26.0	
Nationality				
Saudi	Male N (%)	71 (18.5)	116 (30.2)	
	Female N (%)	101 (26.3)	113 (29.4)	
None Saudi	Male N (%)	151 (39.3)	104 (27.1)	
	Female N (%)	61 (15.9)	51 (13.3)	
Total		384	384	

IQR: interquartile range.

TABLE 2: Comparison of hemoglobin concentration, RBC counts, and red cell indices of the COVID-19 patient and the non-COVID-19 patient control group.

Parameter	COVID-19 patients <i>n</i> = 384 Median IQR	Non-COVID-19 patients <i>n</i> = 384 Median IQR	<i>p</i> value
Hb (g/dL)	11.00 $\pm$ 3.50	12.30 $\pm$ 2.40	$\leq 0.01^*$
PCV (L/L)	34.40 $\pm$ 9.35	37.80 $\pm$ 7.28	$\leq 0.01^*$
RBCs ( $\times 10^{12}/L$ )	4.20 $\pm$ 1.30	4.49 $\pm$ 0.89	$\leq 0.01^*$
MCV (fL)	85.60 $\pm$ 9.30	85.7 $\pm$ 58.00	=0.264
MCH (pg)	27.60 $\pm$ 3.70	27.90 $\pm$ 3.20	$\leq 0.041^*$
MCHC (%)	32.20 $\pm$ 1.90	32.50 $\pm$ 1.70	$\leq 0.01^*$
RDW (%)	15.30 $\pm$ 3.78	14.90 $\pm$ 2.60	$\leq 0.01^*$

\*Significance at the level  $\leq 0.05$ . *N*: number; IQR: interquartile range.

TABLE 3: WBC and platelet indices of the COVID-19 patient and the non-COVID-19 patient control group.

Parameter	COVID-19 patients <i>n</i> = 384 Median IQR	Non-COVID-19 patients <i>n</i> = 384 Median IQR	<i>p</i> value
Total WBC count ( $\times 10^9/L$ )	7.79 $\pm$ 4.34	7.95 $\pm$ 4.38	0.983
Neutrophil (%)	62.4 $\pm$ 21.4	61.2 $\pm$ 25.42	0.173
Lymphocyte (%)	24.5 $\pm$ 18.3	24.65 $\pm$ 22.0	0.604
Monocyte (%)	8.1 $\pm$ 3.7	8.1 $\pm$ 3.97	0.591
Eosinophil (%)	1.6 $\pm$ 2.7	2.15 $\pm$ 3.08	$\leq 0.01^*$
Basophil (%)	0.5 $\pm$ 0.5	0.6 $\pm$ 0.5	0.124
Mean Platelet Volume (MPV)	9.3 $\pm$ 1.8	9.00 $\pm$ 1.8	$\leq 0.01^*$
Platelet count ( $\times 10^9/L$ )	249.0 $\pm$ 128.0	305.00 $\pm$ 161.0	$\leq 0.01^*$

\*Significance at the level  $\leq 0.05$ . *N*: number; IQR: interquartile range; WBC: White Blood Cell.

However, the Total White Blood Cell count, lymphocyte count, and basophil count median values showed no significant difference between the two groups.

According to WHO classification regarding anemia, leucopenia, and thrombocytopenia [20, 21], Table 4 illustrates the comparison of hematological cytopenias between

TABLE 4: Hematological cytopenia among the COVID-19 patients and non-COVID-19 patients.

Hematological abnormality	COVID-19 patients (N = 384) n (%)	Non-COVID-19 patients (N = 384) n (%)	OR (95% CI)	P value
Anemia	275 (62.8)	163 (37.2)	3.4 (2.53–4.61)	≤0.01
Leukocytopenia	17 (48.6)	18 (51.4)	0.94 (0.47–1.85)	=0.86
Thrombocytopenia	52 (82.5)	11 (17.5)	5.3 (2.72–10.34)	≤0.01

COVID-19 patients and non-COVID-19 patients. The prevalence of anemia among COVID-19 patients was significantly higher compared to non-COVID-19 patients (62.8% vs. 37.2%, respectively). However, the COVID-19 patients were 3.4 times more likely to be anemic. The prevalence of thrombocytopenia was also significantly higher in COVID-19 patients compared to non-COVID-19 patients (82.5% vs. 17.5%, respectively). COVID-19 patients were approximately 5.3 times to be thrombocytopenic. The prevalence of leukopenia showed a nonstatistical significance between the two groups (48.6% vs. 51.4%, respectively).

#### 4. Discussion

In this study, a majority of subjects (221, 57.6%) were male with a median age of  $49.0 \pm 23.75$ . This finding is consistent with other studies reporting similar results; 52.1% of the patients were males with a median age of 47 in a study by Usul and coworkers [22]. Liang et al. [18] found that about 56% of all cases were males and their median age was 59. Additionally, a study by Chen et al. [19] reported a median age of 41 and 56% of the patients being males. In another study, 72% were males and the mean age was  $61.67 \pm 15.60$ . Usul et al. [22] stated that 69.3% were males and the average age was  $46.2 \pm 15.5$  years. This finding could be explained by the fact that males are more vulnerable to infection with COVID-19 than females due to biological variation in the immune system and genetic factors, as reported by epidemiological studies [23, 24]. Additionally, lifestyle also contributes to the higher infectivity in males, for example, smoking, drinking alcohol, and less commitment to social distancing [18]. Besides that, females were acting more responsibly toward the COVID-19 crisis than males as reported by Bwire and coworkers [23]. However, other authors reported an equal male to female ratio [25].

We found that Hb concentration, RBC count, HCT, MCH, and MCHC median values were all significantly decreased in COVID-19 subjects compared with controls. This finding agrees with Yuan and coworkers [26], who found that severe and critically ill patients had significantly decreased RBC and Hb and with another study reporting a rapid decline of Hb and RBC among COVID-19 patients [27].

Additionally, a study by Mei et al. [28] found that the red blood cell parameters (RBC, Hb, and HCT) were significantly reduced in patients where COVID-19 was severe. The exact mechanism of how COVID-19 causes anemia is not fully understood but suggested to be via inhibition of erythropoiesis in the bone marrow. On the contrary, Usul et al. [22] stated that Hb levels in COVID-19-positive

patients were found to be significantly higher than those in COVID-19-negative patients. This discrepancy from our results could be attributed to differences in study population characteristics such as the presence of underlying chronic diseases and cigarette smoking, which could directly affect the RBC profile. Those factors were not the exclusion criteria as mentioned by the authors [22, 29]. Fan and his colleagues [30] revealed that on admission to the hospital, most COVID-19 patients had a normal CBC (normal Hb, WBC, and platelet count).

In this study, the median values of RDW show a statistically significant increase among COVID-19 subjects against the control group. This finding is consistent with that of Lee and coworkers [31] that nearly half (49.7%) of the patients hospitalized for COVID-19 were found to have elevated RDW values at presentation and with Wang et al., who found that the morphological parameters (RDW-CV and RDW-SD) were significantly higher in the severe COVID-19 group [32].

The current study found no significant difference in Total White Blood Cell count, lymphocyte count, and basophil count median values between the two groups. However, several studies reported lymphocytopenia as the most common finding among the COVID-19 cases. Meanwhile, other studies observed neutrophilia [30, 33–35]. A decrease in lymphocyte count is strongly associated with the severity of the disease. This may explain the conflict in results between the current study and the mentioned reports, as most of them collected the data from severely ill or Intensive Care Unit (ICU) cases, reflecting poor prognosis of the disease. The present study found a significant decrease in the eosinophil count and platelet count median values among COVID-19 patients compared with controls. This finding is in agreement with previous reports [25, 33–36]. Thrombocytopenia is common among COVID-19 patients through inhibition of thrombopoiesis, immunological destruction of platelets, and consumption due to lung injury [37].

#### 5. Conclusion

COVID-19 patients may have complications of anemia such as hypoxia and coronary and pulmonary insufficiency because of low Hb concentration. Bleeding disorders may also occur among COVID-19 patients because of thrombocytopenia. Therefore, transfusion of packed RBCs and platelets may assist in alleviating and avoiding complications like anemia and bleeding, in turn reducing the mortality rate from COVID-19 infection.

## Data Availability

The data used to support the findings of this study are included in the article. Should further data or information be required, these are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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