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**INVESTIGATION OF $\text{HCO}_3^- / \text{CO}_2$ AS AN EVALUATION
METHOD FOR RESPIRATORY SYSTEM FUNCTIONS IN
PATIENTS RECOVERED FROM COVID-19**

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RESPIRATORY SYSTEM FUNCTIONS IN PATIENTS RECOVERED FROM
COVID-19

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November 2023

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ABSTRACT

INVESTIGATION OF $\text{HCO}_3^-/\text{CO}_2$ AS AN EVALUATION METHOD FOR RESPIRATORY SYSTEM FUNCTIONS IN PATIENTS RECOVERED FROM COVID-19

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The outbreak of the novel coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is seeing a rapid increase in the number of infected patients worldwide. The aim of this study was to assess lung function by calculating HCO_3^- ions, which reflect the shares of carbon dioxide in the body in people who have recovered from COVID-19 and comparing this share to healthy people. The difference between the shares of infected and healthy subjects can be used to assess respiratory function. The study took 130 patients with respiratory problems confirmed with Covid-19 by PCR and/or positive serology (Igg or Igm) compared to another 70 non-Covid-19 patients with PCR and/or serology in Baquba Teaching Hospital in Diyala Governorate, Republic of Iraq. Age had a clear importance, as the study proved that the older the age, the higher the infection rate, and the higher the death rate from COVID-19. There were no differences between the study groups regarding weight and body mass index. Where these results indicate that weight is not a factor for increasing the infection of COVID-19. The results of HCO_3^- indicated a clear importance and changes towards the increase in relation to the second group, and this indicates that the percentage of infection with HCO_3^- increases at the onset of infection with Covid_19. With regard to CO_2 levels changed in both groups, which indicates that the effect remains continuous and the percentage of CO_2 increases and the lack of oxygen leads to death. Sodium results indicate its decrease at the beginning and during infection with COVID-19. The concentrations of IL-6 and hsC-RP changed clearly and

significantly, which indicates an increase in immunological changes when infected with COVID-19. These tests are considered diagnostic tests for COVID-19. D-Dimer concentrations changed dramatically towards an increase, and this increases the blood clotting rate and thus increases the death rates of COVID-19. These tests are considered diagnostic tests for COVID-19. The study found that the levels of white blood cells were affected at the onset of infection with COVID-19.

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Keywords: HCO_3 , COVID-19, CO_2 , Respiratory system



ÖZET

COVID-19'DAN İYİLEŞEN HASTALARDA SOLUNUM SİSTEMİ FONKSİYONLARI İÇİN BİR DEĞERLENDİRME YÖNTEMİ OLARAK HCO₃/CO₂'NİN ARAŞTIRILMASI

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Şiddetli akut solunum sendromu koronavirüs 2'nin (SARS-CoV-2) neden olduğu yeni koronavirüs hastalığı (COVID-19) salgını, dünya çapında enfekte hasta sayısında hızlı bir artış görüyor. Bu çalışmanın amacı, COVID-19'dan iyileşen kişilerde vücuttaki karbondioksit paylarını yansıtan HCO₃ iyonlarını hesaplayarak ve bu payı sağlıklı insanlarla karşılaştırarak akciğer fonksiyonunu değerlendirmektir. Enfekte ve sağlıklı deneklerin payları arasındaki fark, solunum fonksiyonunu değerlendirmek için kullanılabilir. Çalışma, Diyala Valiliği'ndeki Bakuba Eğitim Hastanesinde PCR ve/veya pozitif seroloji (Igg veya Igm) ile solunum sorunları olan 130 hastayı PCR ve/veya serolojisi olan diğer 70 covid19 hastası ile karşılaştırmalı olarak aldı. Irakta. Bulgular: Çalışma, yaş arttıkça enfeksiyon oranının ve COVID-19'dan ölüm oranının da arttığını kanıtladığından, yaşın açık bir önemi vardı. Ağırlık ve vücut kitle indeksi açısından çalışma grupları arasında fark yoktu. Bu sonuçlar kilonun COVID-19 enfeksiyonunu artıran bir faktör olmadığını gösteriyor. HCO₃ sonuçları ikinci gruba göre artış yönünde net bir önem ve değişime işaret etmekte olup bu da COVID-19 enfeksiyonu başlangıcında HCO₃ ile enfeksiyon yüzdesinin arttığına işaret etmektedir. CO₂ seviyeleri açısından her iki grupta da değişim bu da etkinin devam ettiğini ve CO₂ yüzdesinin arttığını ve oksijen eksikliğinin ölüme yol açtığını gösterir. Sodyum sonuçları, başlangıçta ve COVID-19 enfeksiyonu sırasında azaldığını gösteriyor. IL-6 ve hsC-RP konsantrasyonları net ve önemli ölçüde değişti, bu da COVID-19 ile enfekte olduğunda immünolojik değişikliklerde bir artışa işaret ediyor. Bu testler COVID-19

için tanı testleri olarak kabul edilir. D-Dimer konsantrasyonları dramatik bir şekilde artış yönünde deęiřti ve bu da kanın pıhtılařma hızını ve dolayısıyla COVID-19'un ölüm oranlarını artırıyor. Bu testler COVID-19 için tanı testleri olarak kabul edilir. Çalıřma, beyaz kan hücrelerinin seviyelerinin COVID-19 enfeksiyonunun bařlangıcında etkilendiđini buldu.

2023, 51 sayfa

Anahtar Kelimeler: HCO₃, COVID-19, CO₂, Solunum sistemi



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LIST OF SYMBOLS

dL	Deciliter
/	Divide
=	Equal
g	Gram
gm	Gram
≥	Greater or equal to
<	Greater than
≤	Less or equal to
>	Less than
L	Liter
Mg	Magnesium
μL	Micro liter
mcg	Microgram
mg	Microgram
mmol	Milli mole
mIU	Milli-international units
mL	Milliliter
-	Minus
min	Minute
mol	Mole
ng	Nanogram
nm	Nanometer
NS	Non-significant
%	Percent
+	Plus
±	Plus – minus
rpm	Revolutions per minute
**	Significant
m ²	Square meter

LIST OF ABBREVIATIONS

ARDS	Acute respiratory distress syndrome
CPR	Cardiopulmonary resuscitation
CPAP	Continuous positive airway pressure
COVID-19	Coronavirus-2019
CRP	C-reactive protein
IL-6	Interleukin-6
PCO ₂	Plasma carbon dioxide tension
SARS-CoV-2	Severe acute respiratory syndrome -2
SID	Strong ion difference



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1. INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) can cause a variety of serious medical conditions, including but not limited to sepsis, sepsis with multiorgan failure, acute respiratory failure, acute heart failure, acute kidney injury, coagulopathy, extensive microvascular thrombosis, and dysregulated inflammatory response. This is brought on by the virus's great affinity for the respiratory tract, gut, heart, kidney, and nervous systems. Patients with COVID-19 were shown to have a prevalence of 29% for ARDS, 13% for acute renal damage, and 12% for cardiac failure (Yu *et al.* 2020, Middeldorp *et al.* 2020, Huang *et al.* 2020).

Depending on the severity of their condition, around 81% of patients with acute respiratory failure needed oxygen assistance, and the majority of these patients also needed respiratory support (i.e., the degree of hypoxemia and dyspnea). High-flow oxygen therapy, continuous positive airway pressure (CPAP), non-invasive ventilation (NIV), and invasive mechanical ventilation were the most common respiratory supports. From 62% in China to 20% in the USA and 11% in Italy, many patients were given non-invasive respiratory support (Yang *et al.* 2020, Zanella *et al.* 2021).

Depending on the severity of the underlying disease, the patient's acid-base balance may shift due to the existence of altered organ function (lung, heart, and kidney). The acid-base parameters of COVID-19 patients at first hospital admission are not well understood. The pH shift upon admission was significantly related to death in over a thousand severely sick patients. Researchers discovered that metabolic and pulmonary alkalosis were the most prevalent acid-base abnormalities in the 80% of COVID-19 patients on oxygen treatment. Patients with pulmonary alkalosis were more likely to die than those without the disease and had a greater prevalence of underlying disorders (Jung *et al.* 2011, Alfano *et al.* 2022, Zhou *et al.* 2020).

To determine whether alkalemia or acidemia results from a respiratory or metabolic disorder, doctors have traditionally used the Henderson-Hasselbalch equation, which

considers the plasma bicarbonate concentration ($[\text{HCO}_3^-]$), the plasma carbon dioxide tension (PCO_2), and the negative logarithm of the apparent dissociation constant (pK'_1) for carbonic acid (H_2CO_3) in plasma. Despite its widespread use, this approach to diagnosing acid-base imbalance is mostly descriptive rather than mechanistic, and it usually misses the mark when used to critically sick patients. In the late 1970s, Peter Stewart developed a mathematical model based on physicochemical principles that allowed him to define shifts in acid-base balance with respect to three distinct factors: the strong ion difference (SID), carbon dioxide, and weak acids. Stewart's method demonstrated, in comparison to the conventional evaluation, a higher diagnosis of acid-base abnormalities in critically ill non-COVID-19 patients (Berend *et al.* 2014, Stewart *et al.* 1983, Fencl *et al.* 2000, Dubin *et al.* 2007).

Capnography is the measurement of partial CO_2 pressure (PETCO_2) in the respiratory gases of mechanically ventilated patients. It is frequently used to check the position of the endotracheal tube, evaluate the efficacy of cardiopulmonary resuscitation (CPR), check the patient's ventilation during interventional sedation and analgesia, check the patient's ventilation when they are unconscious, and evaluate respiratory conditions. At the time of exhalation, carbon dioxide is at its highest partial pressure, or PETCO_2 . As a result, the patient's ventilation status can be determined using the PETCO_2 measurement that is taken shortly after intubation (Krauss and Hess 2007, Shah *et al.* 2022).

COVID-19 is caused by the encapsulated, ribonucleic acid-containing virus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). More than 80% of individuals with the illness arrive with a mild temperature, but 14%-17% of those patients develop acute respiratory distress syndrome (ARDS), which causes significant respiratory distress. Additionally, 2-3% of patients need tracheal intubation, and 5% of patients have multiple organ dysfunction syndrome (MODS) and septic shock. Critical patients have a mortality rate that ranges from 16.7 to 61.5%. More than 175,000,000 confirmed cases of COVID-19, which the World Health Organization (WHO) has classified as a pandemic, have been documented, including 3,792,777 fatalities (Karaali *et al.* 2022).

A significant amount more than problems in pulmonary mechanics, arterial hypoxemia is the most prominent respiratory characteristic of Coronavirus Disease 2019 (COVID-19). In order to diagnose respiratory, metabolic acidosis, and alkalosis, arterial blood gas (ABG) analysis is used (Mondal *et al.* 2021). Infections with coronaviruses have emerged as a leading global killer in recent years. The COVID-19 coronavirus pandemic is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), also known as novel coronavirus 2019 (nCoV-2019). Infected patients typically experience a specific pattern of metabolic and clinical alterations as a result of this illness. In the predominant form of COVID-19, leukocytopenia, lymphopenia, and increased C-reactive protein (CRP) have been reported. Leukocyte, creatine kinase, and creatinine levels may also rise as the condition progresses (Doaei *et al.* 2021).

1.1 The Aim of Study

Evaluation the function of the lung through the calculation of HCO_3 ions, which is reflect the ration of carbon dioxide in the body in persons whom recovered from COVID-19 and compared this ration with healthy people. The different between the infected and healthy people's ration can used to evaluate the respiratory system function.

2. LITERATURE REVIEW

2.1 Respiratory System

The organs and tissues that make breathing possible make up the respiratory system. The lungs, bronchi, and capillaries make up this system. The respiratory system also includes the muscles that contract and expand the lungs. Together, they help the body get rid of waste and bring in fresh oxygen. The functions of the respiratory system are wide ranging. It does more than only help you breathe in and out by also allowing you to: communicate and smell. Increases humidity and temperature until surrounding air is at a comfortable level for the human body. Delivers oxygen to tissues and organs. Lets out stale air, including carbon dioxide, from within the body. Protects the lungs from harmful chemicals and irritants (Figure 2.1) (Rajadevi *et al.* 2022, Giesbrecht 1995). Multiple impacts on the respiratory system are brought on by either acute or persistent cold exposure. Pulmonary mechanics are impacted by a number of factors, including bronchospasm, airway obstruction, secretions, and impaired mucociliary clearance. These reactions, which are present in cold- or exercise-induced asthma, may be to blame for lowered immune response and reduced defenses against airborne contaminants. Cold air's main effect on ventilation is a reduction in baseline ventilation and respiratory chemosensitivity. Although many animals benefit significantly from these responses in terms of protection against heat loss, humans hardly notice any difference. Additionally, exposure to cold causes a rise in pulmonary vascular resistance. This stimulus interacts with hypoxia and may be the cause of pulmonary hypertension and altitude-related edema. Mucous gland and goblet cell enlargement, hypertrophy of the airway's muscular fascicles, and thicker muscle layers in the terminal arteries and arterioles are only some of the morphological changes that occur with prolonged exposure to cold environments. High altitude may exacerbate preexisting conditions such right heart hypertrophy, chronic obstructive pulmonary disease, and bronchitis (D'Amato *et al.* 2018, Giesbrecht 1995).

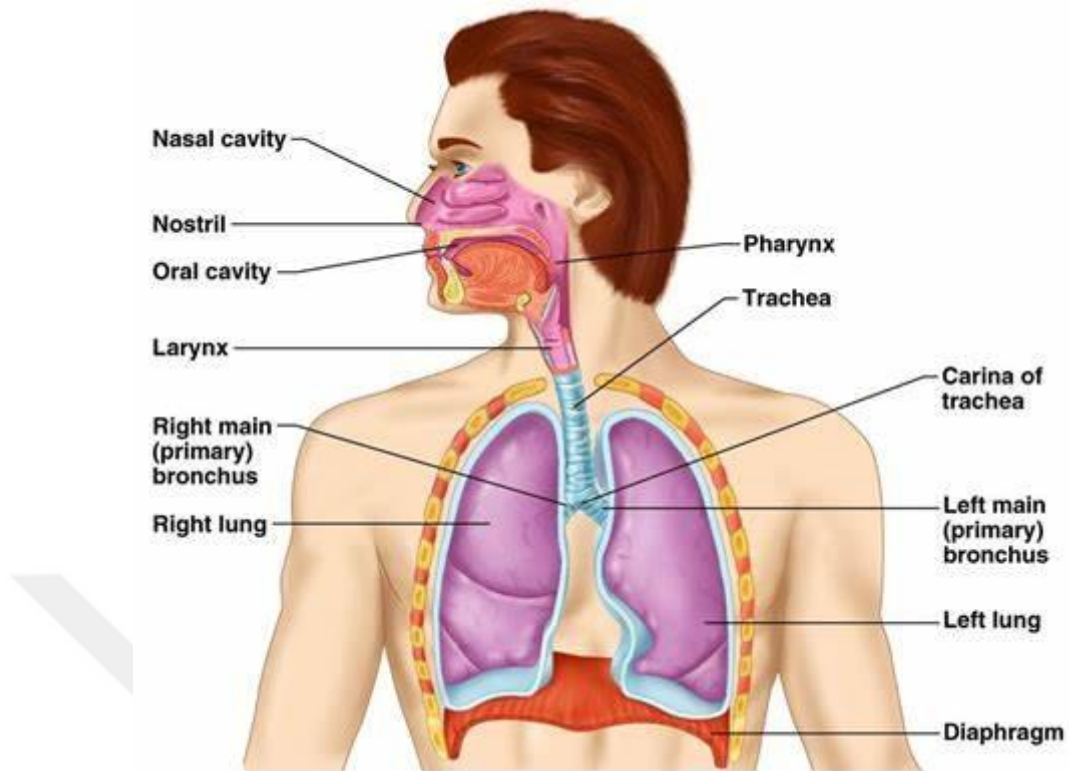


Figure 2.1 Respiratory system (Rajadevi *et al.* 2022)

2.1.1 The parts of the respiratory system

Breathing is made possible by a complex network of organs and tissues (Figure 2.2). Each group of components consists of several separate elements. The airways transport air to the lungs. The airways are a complicated system that includes the mouth and nose, the only two access points to the respiratory system from the outside world. Holes in the skull called sinuses help regulate the relative humidity and temperature of the air we breathe. The pharynx is a tube in the throat that transports air from the oropharynx and nares to the trachea.

The tube connecting the trachea to the bronchi. The bronchial tubes are the windpipe-like passageways that branch off to each lung. Lungs are a pair of organs that draw oxygen from the air and deposit it into the circulatory system. Through the bloodstream, the lungs provide oxygen to all of the body's organs and tissues. Muscles and bones work together to inhale and exhale air. Some of the skeletal and muscular components

of the respiratory system include: The diaphragm is a lung muscle that helps in both inhaling and exhaling. Ribs are the bones that surround and protect the lungs and heart. When we exhale, carbon dioxide and other waste products are carried away by the blood (Bernardini and Natalini 2009, Landing and Dixon 1979). The pulmonary circulation and the coronary arteries are also affected by: The alveoli are tiny air sacs in the lungs that serve as gas exchange sites for carbon dioxide and oxygen. Bronchioles are the small bronchial tube branches that lead to the alveoli. Capillaries may be found in the alveolar wall and are responsible for delivering carbon dioxide and oxygen. Lung lobes are pulmonary divisions. The right lung has three lobes, whereas the left lung only has two. A thin sac called pleura separates the lungs from the chest wall and wraps around each lung lobe. Some more components of the respiratory system are as follows: Cilia are tiny hairs that move in a wavelike fashion to sweep dust and other irritants out of the lungs. The epiglottis is a flap of tissue at the beginning of the trachea that shuts as you swallow to prevent food and liquids from entering the airway (Weibel *et al.* 2005, Kallet and Katz 2003).

2.1.2 The design of the respiratory system

The bony and muscular thoracic cage surrounds the thorax, shielding the lung's delicate gas-exchanging tissues. The lung's primary function is to continually provide oxygen to the body's tissues and to expel carbon dioxide (a gaseous waste product) from the blood. Atmospheric air is forced in and out of the body at regular intervals via a system of tubes called conducting airways that link the gas-exchange zone with the outside world. The airways may be divided into an upper and lower airway system. Near the top of the larynx lies the point of separation between the respiratory and digestive systems (Figure 2.2).

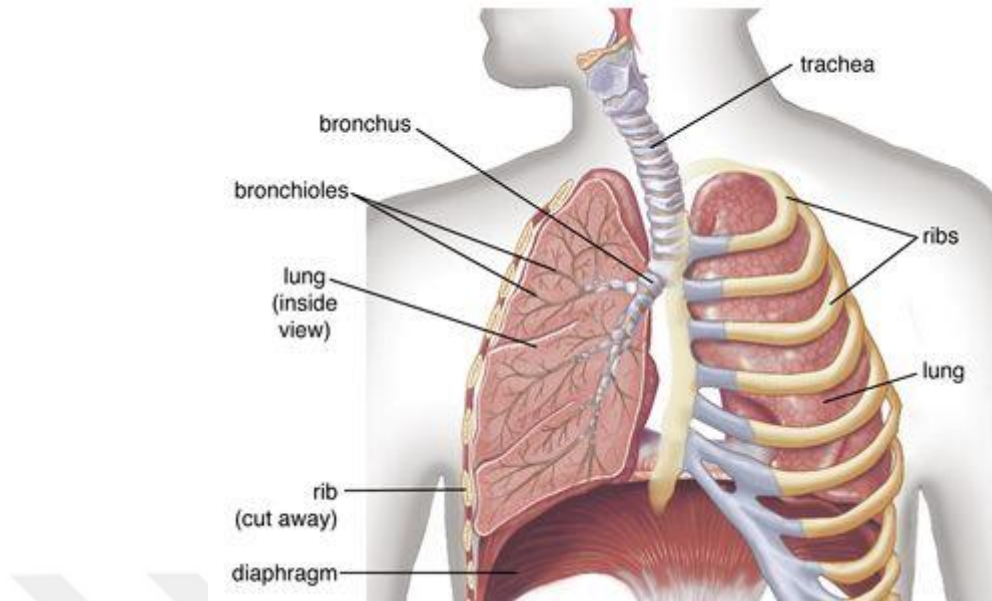


Figure 2.2 Human lungs

The upper airway system consists of the nasal cavity, the paranasal cavities (or sinuses), the pharynx (or throat), and to a lesser degree, the oral cavity. The lower airway system consists of the larynx, trachea, stem bronchi, and all the airways that profoundly ramify inside the lungs, such as the intrapulmonary bronchi, the bronchioles, and the alveolar ducts. It's evident that many different organs and systems coordinate to allow for breathing. The major respiratory muscle, the diaphragm, and the intercostal muscles of the chest wall work together to force air into the lungs under the supervision of the central nervous system. Muscles dilate and constrict the thoracic cavity, which is formed by the ribs and the thoracic vertebrae. The lungs and the chest wall (the ribs and the muscles) are discussed as they pertain to breathing mechanically. The heart and blood arteries, along with the blood itself, are essential components of a well-functioning respiratory system because they carry the gases necessary for breathing (Taylor *et al.* 1999).

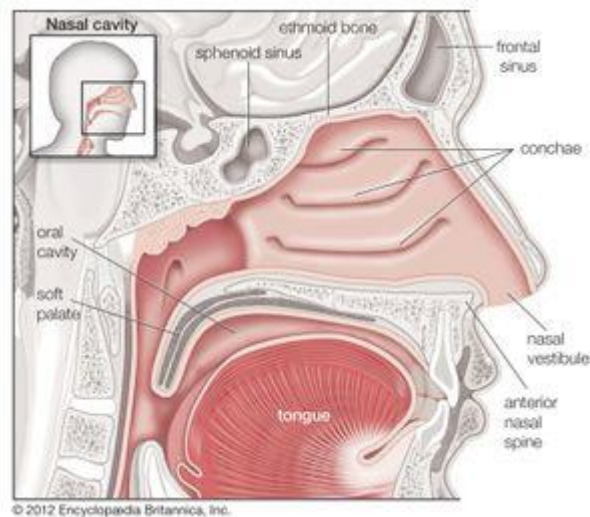


Figure 2.3 The human nasal cavity

2.1.3 The conditions affect the respiratory system

A broad variety of disorders may affect the respiratory system's tissues and organs. Some symptoms appear because of airborne irritants like viruses and bacteria (Zhang *et al.* 2020). Some are inevitable consequences of being old or sick. The following conditions may cause edema, irritation, and discomfort in the respiratory system or other impacts on the respiratory system: Some individuals are allergic to dust, mold, and pollen because of the proteins they contain. The inflammation of the airways may be caused by these proteins. Inflammation of the airways, caused by asthma, may make breathing difficult. Asthma is a chronic (long-lasting) disorder. Bronchitis and pneumonia, inflammations of the bronchial tubes and lungs, are both infectious diseases. Common respiratory illnesses include the common cold and influenza. Chronic obstructive pulmonary disease (COPD) and lung cancer are examples of diseases affecting the lungs. As a result, the body's ability to expel harmful gasses and transport necessary oxygen is hampered. The capacity of the human lungs decreases with aging. Damage to the respiratory system may lead to breathing difficulties (D'Amato *et al.* 2015, *et al.* 2010).

2.2 The COVID-19

A common cold is caused by a virus that enters the body via the nose and spreads to the rest of the upper respiratory system. Fever, headache, sore throat, runny nose, and sneezing are just some of the symptoms that may occur if the throat, larynx, or sinuses are afflicted (Zhou *et al.* 2020). The signs of COVID-19, a new coronavirus, can, however, be confused with those of the flu, colds, and allergies. The virus initially colonized the nose, as it does with typical colds. The coronaviruses are a category of viruses that may cause anything from a mild cold to severe acute respiratory syndrome and other life-threatening disorders. COVID-19 mostly affects the lungs and manifests with fever, a dry cough, and shortness of breath in contrast to the common cold and the flu. In December 2019, a highly infectious sickness with symptoms remarkably similar to those of pneumonia was spread in Wuhan, China. This illness was caused by a novel coronavirus and came to be known as new coronavirus pneumonia (NCP). The pandemic has been labeled a "global public health emergency" by the World Health Organization (WHO) (Seah and Agrawal 2020).

2.2.1 Coronavirus family

There is just one strand of RNA in a coronavirus, and it reads in the right direction. Under an electron microscope, they have a spherical or plumorphic appearance. The genome of a coronavirus typically ranges in size from 26 to 32 kilobase pairs, making it one of the biggest RNA viruses. There is a methylene cap 5 and a polyadenylated tail 3 on the coronavirus RNA genome. The replicase gene encodes a protein that is essential for coronavirus RNA synthesis. The gene, which codes for the polyproteins pp1a and pp1ab, has a length of almost 20,000 nucleotides and is broken down by viral proteases. There are four different varieties of coronaviruses based on their serological and phenotypic characteristics: alpha, beta, gamma, and delta. About three different coronavirus types can be found in humans, animals, and birds. There are two varieties of alpha and beta that cause human coronaviruses. The first open reading frame (ORF) encodes 16 non-structural proteins (NPS), which account for roughly 67% of the genome. The remaining frames code for additional structural proteins. Coronaviruses

have four different proteins: the spike (S) protein, the envelope (E) protein, the membrane (M) protein, and the nucleocapsid (N) protein. Attachment to and entrance into the host cell are not possible without the S protein, which is part of the viral membrane. The various human coronaviruses include the following: human coronavirus 229E (HCoV-229E); human coronavirus OC43 (HCoV-OC43); Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV); human coronavirus NL63 (HCoV-NL63); human coronavirus HKU16; Middle East Respiratory Syndrome Coronavirus, formerly known as novel human coronavirus-2012 or HCoV Children and adults who are exposed to the HCoV-229E, -NL63, -OC43, and -HKU1 viruses frequently develop respiratory illnesses. SARS-CoV-2 is a member of the beta-coronavirus family. After SARS and MERS illness, which both belong to the beta coronavirus family, COVID-19 is the third recognized coronavirus disease of animal origin.

2.3 The bicarbonate and carbon dioxide (CO₂)

Increased carbon dioxide (CO₂) retention to preserve acid-base balance may result from compensatory hypoventilation caused by elevated plasma bicarbonate concentration. Increased plasma bicarbonate concentration, as suggested by the Henderson-Hasselbalch relationship, dampens the CO₂ response by reducing the shift in the concentration of hydrogen ions (pH) in response to a given shift in PaCO₂. The effect of plasma bicarbonate concentration on the CO₂ reaction is controversial, however. Some studies with a small number of healthy participants or stable patients with chronic hypercapnia have found that plasma bicarbonate concentrations influence the ventilator response to CO₂, while others have found no such relationship (Heuer and Grosell 2014, Long 1991).

The effect of plasma bicarbonate concentration on the CO₂ response during mechanical ventilation has only been studied in people with obesity-hypoventilation syndrome. If a correlation between plasma bicarbonate concentration and the CO₂ response can be confirmed in a large group of critically ill patients, normalizing high bicarbonate levels may be an effective method for reducing the time needed to wean from mechanical ventilation. It has not yet been established if the same phenomenon occurs in abruptly

induced increased plasma bicarbonate and continuously raised plasma bicarbonate levels, such as those reported in persons with chronic obstructive pulmonary disease (COPD). The purpose of this research was to compare COPD patients and healthy controls during weaning from mechanical ventilation, specifically focusing on the effect that patients' plasma bicarbonate content had on their CO₂ response (Rialp *et al.* 2014).

2.4 Carbon Dioxide Concentrations in Respiratory Medicine

Globally, rising carbon-based combustible consumption and ongoing deforestation are causing the concentration of atmospheric carbon dioxide (CO₂) to rise. According to WDCGG 2021 and Lafferty (2009), an increase in atmospheric CO₂ concentrations is thought to have a warming effect on the atmosphere. High atmospheric CO₂ levels can hasten the onset of health issues in people such tinnitus, headaches, and increased tiredness. Short-term inhalation of 0.1% CO₂ has been shown to significantly alter cerebral electrical activity, the circulatory system, and the respiratory system (Shakun *et al.* 2012, Jeong *et al.* 2019). Continuous monitoring of air CO₂ concentrations have lately been considered useful for assessing the ventilation conditions in buildings or rooms and have been used as guideline to prevent the spread of severe acute respiratory syndrome. SARS-CoV-2, a coronavirus. The coronavirus disease 2019 (COVID-19), which has become a significant issue in respiratory clinical practice, can be caused by SARS-CoV-2 (Zhu *et al.* 2020, Joost Wiersinga *et al.* 2020).

The arterial blood gas analysis (ABGA) method, on the other hand, is widely used in the everyday clinical practice of pulmonary medicine. Any sort of respiratory disease is frequently assessed for arterial partial pressure of CO₂ (PaCO₂) (Umeda *et al.* 2021, Malley *et al.* 2005). In patients with chronic obstructive pulmonary disease (COPD) or other disorders, PaCO₂ is helpful for the identification of hypo- or hyperventilation as well as to assess the possibility of respiratory drive depression and CO₂ narcosis. pH and PaCO₂ values can be used to assess acid-base imbalance in the setting of respiratory acidosis. Transcutaneous partial pressure of CO₂ (PtcCO₂) and end-tidal partial pressure of exhaled gas (PetCO₂), two non-invasive alternatives, have been created, and Bland-

Altman analysis has been used to assess their accuracy and utility (Xue *et al.* 2010, Bland and Altman 1986).

Evaluation of CO₂ production is a further application for CO₂ concentration measurements in exhaled air. CO₂ production (V_{CO_2}) and oxygen consumption (V_{O_2}) data can be used to compute the respiratory quotient (RQ). Following that, it is possible to determine the partial pressure of oxygen (PO₂) difference between mean alveolar gas and arterial blood (Umeda *et al.* 202). This method has been used to assess the impairment of gas exchange in a variety of lung illnesses. Using CO₂ production data and oxygen consumption data, energy expenditure can also be assessed. Obese individuals with OSAS may find this to be of particular interest (Diaz *et al.* 1997, Tachikawa *et al.* 2016).

3. MATERIALS AND METHODS

The study takes 130 patient had respiratory problems confirmed to be infected with COVID-19 by positive PCR and/or serology (IgG or IgM) compared to another 70 persons without covid19 had negative PCR and/or serology in Baqubah teaching hospital of Diyala governorate in Iraq from whom blood sample taken by a 13eparinized capillary tube or syringe analyses by blood gas machine.

Group IgG: 65 patient had respiratory problems infected with COVID-19 IgG.

Group IgM: 65 patient had respiratory problems infected with COVID-19 IgM

Group HG: 70 people without respiratory problems without infected COVID-19.

3.1 Sample Collection

5 ml was collected from the target patients, as well as from the control group. After collecting the samples, the serum was separated using a centrifuge. After that, the samples were kept in the refrigerator for preserving the models until laboratory tests were performed on them.

3.2 The Blood Electrolyte Analyzers

The ABL800 FLEX blood gas analyzers which designed for measurements of adult and fetal hemoglobin with normal spectrum characteristics gives complete information and data about blood gases measuring many blood parameters pH, pO₂, pCO₂, K, Na, Ca, cCl⁻, cGlu, cLac, cCrea, ctBil, and co-oximetry parameters.

In our study two parameters related to the carbon dioxide (CO₂) content of blood plasma partial pressure of carbon dioxide (pCO₂), and plasma bicarbonate (HCO₃), these blood gas parameters pco₂ and bicarbonate used to evaluate the respiratory function and outcome during stay in intensive care for both covid positive and negative

patients including length of stay, need for assisted ventilation, chronic lung treatment and oxygen requirements on discharge.

3.3 Instruments

The equipment below was used following the manufacturer's instructions, and each item is prefaced by its country of origin:

ELISA Reader.

ELISA Washer.

Centrifuge.

Electrolytes

All of the below-described tests were conducted in line with the protocol (kit user manual) recommended by the manufacturer. The tests used in our study were followed: HCO₃, CO₂, K, Na, CL, IL-6, COVID-19, CR-P, D-dimer, Hb, WBC and Platelet.

3.4 COVID-19 Testing and Information about it

Nasal and oral swabs are tested for the presence of the SARS-CoV-2 virus, the causative agent of COVID-19. Nucleic acid amplification tests (NAATs) and antigen tests are the two most used diagnostic methods for viruses. One kind of testing may be suggested when another is not appropriate. The guidelines set out by the FDA must be adhered to during all testing.

Laboratory testing is the standard for NAATs like polymerase chain reaction (PCR) assays. They are the gold standard for diagnosing a patient with or without symptoms. Viruses may hide in a person's cells for up to 90 days after a positive test, and these diagnostics can find them. Therefore, a should not utilize an NAAT if have tested positive in the past 90 days.

Rapid antigen tests* may give you findings in as little as 15-30 minutes. For symptom-free individuals, they are far less reliable than NAATs. Infection cannot be ruled out by a single negative antigen test. Repeating a negative antigen test at least 48 hours apart (a technique known as serial testing) is recommended for optimal infection detection. A second NAAT may be required to validate the results of an initial antigen test.

*Self-tests, often known as at-home tests, are typically antigen tests that may be done without traveling to a clinical lab. You should test as often as the manufacturer and the Food and Drug Administration recommend. The likelihood that you are not infected with the COVID-19 virus rises when you have several negative test results. According to the packaging of approved OTC antigen tests: All negative findings should be considered hypothesized at this point. Negative findings should not be utilized as the only basis for treatment or patient care choices, including infection control decisions, since they do not rule out SARS-CoV-2 infection.

3.5 Electrolytes Test (HCO₃, CO₂, K⁺, Na⁺ and CL⁻)

Blood contains a number of salts and minerals called electrolytes, including sodium, potassium, chloride, and bicarbonate. They serve as an electrical conductor in the human body. The screening may be performed during a regular physical examination or as part of a battery of tests. If you use diuretics or angiotensin-converting enzyme (ACE) inhibitors, two common drugs used to treat high blood pressure, your electrolyte level may be monitored. An electrolyte panel is a set of blood tests performed to determine whether or not there is an acid-base imbalance (the typical range for arterial blood pH is 7.35 to 7.45).

Treatment progress for an imbalance that has an impact on organ function may also be tracked with an electrolyte test. The findings of the electrolyte test are used to determine a value, known as an anion gap. The gap is used to determine whether there is an unsafe range of difference between the electrolytes' electrical charges. Treatment for an electrolyte imbalance will depend on which electrolyte is out of balance and by how much. If you have a sodium imbalance, for instance, your doctor may recommend that

you cut down on salt (if your sodium levels are too high) or water (if your sodium levels are too low).

3.6 Statistical Analysis

There are numerical and percentage representations of the categories at hand. In our research, the statistical software allows us to describe continuous variables as mean standard deviation and to list the highest and lowest values. Differences between groups were compared with one ANOVA test. Patients without COVID-19 disease were grouped according to the type of infection, i.e., according to the baseline level of plasma IgG and IgM,

4. RESULTS AND DISCUSSION

The world has been profoundly impacted by the corona virus in a variety of ways. By the time this is published (written in mid-April 2020), we'll presumably have a better understanding of its overall effect. The primary tragedy of the COVID-19 pandemic is the lives it has taken. Wars, genocides, massive tyranny, and numerous pandemics have all caused massive loss for humanity throughout history, but none have affected such a large percentage of the world's population at once. Even though many individuals have died away, there are still many more who are seriously sick. The weakening of national economies and social institutions throughout the world has paved the way for increasingly authoritarian governments in many parts of the world.

In this study, we assessed lung function by calculating HCO_3 ions, which reflect the shares of carbon dioxide in the body in people who recovered from COVID-19 and compared this share with healthy people. For more clarity about the results of the research to assess the efficiency of the lungs, we have three important metrics: CO_2 , HCO_3 and hemoglobin. The difference between the shares of infected and healthy subjects can be used to assess respiratory function. The study groups were divided into two groups, each group containing 70 persons. The results of the study were as follows:

4.1 The Age Study

The averages of age results in the study indicated that people infected with COVID-19 group IgG positive (44,33333 and) and in the group positive for COVID-19 group IgM group (42,38462), and the mean of standard deviation was (11,578454 and 13,444568 re, and the results of minimum (13,000, 28,000 and 18,000 respectively) and maximum (67,000, 62,000 and 64,000 respectively) indicated that there were statistically significant differences when comparing the results of the two groups with the control group (29,58824) as in Table 4.1 and Figure 4.1. This indicates that infection with COVID-19 increases in the elderly. Age had a clear importance, as the study shows that the older the age, the higher the infection rate, and the higher the death rate from COVID-19.

School-aged children, children and their parents, and middle-aged adults and the elderly witnessed the largest densities of encounters among persons of comparable ages during the early stages of the pandemic, before extensive deployment of treatments. However, the emergence of non-pharmaceutical therapy caused substantial changes to these interaction patterns. By mid-August 2020, the resurgence in the United States was predominantly driven by adults between the ages of 20 and 49, despite the fact that schools reopening facilitated transmission. Therefore, working adults who need to care for themselves and their families have been fueling the resurging epidemics in the United States (Monod *et al.* 2021).

In the entire country, the COVID-19 cases' median age dropped from 46 years in May to 37 years in July and 38 years in August. In all U.S. Census regions, similar trends were observed for ED visits associated to COVID-19-like illnesses and positive SARS-CoV-2 RT-PCR test results. The COVID-19 incidence was highest in people 20 to 29 years old during the months of June to August, accounting for more than 20% of all confirmed cases. Regional COVID-19 outbreaks occurred in the southern United States in June. According to these regions, rises in the percentage of persons aged 20 to 39 who tested positive for SARS-CoV-2 preceded those in adults over 60 by an average of 8.7 days (range = 4 to 15 days), indicating that younger adults most likely played a role in the community transmission of COVID-19. A strict adherence to community mitigation strategies and personal preventive behaviors by younger adults is required to help lower their risk for infection and subsequent transmission of SARS-CoV-2 to people at higher risk for severe illness, given the role of asymptomatic and PR symptomatic transmission (Boehmer *et al.* 2020).

Table 4.1 Descriptive of age result

Variables	Group HG	Group IgG	Group IgM	Total
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N		70	65	65	200
Mean		29,58824	44,33333	42,38462	37,76190
Std. Deviation		14,396435	11,578454	13,444568	14,726465
Std. Error		3,491648	3,342412	3,728852	2,272343
95% CIM	LB	22,18627	36,97673	34,26014	33,17282
	UB	36,99020	51,68993	50,50909	42,35099
Minimum		13,000	28,000	18,000	13,000
Maximum		67,000	62,000	64,000	67,000
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

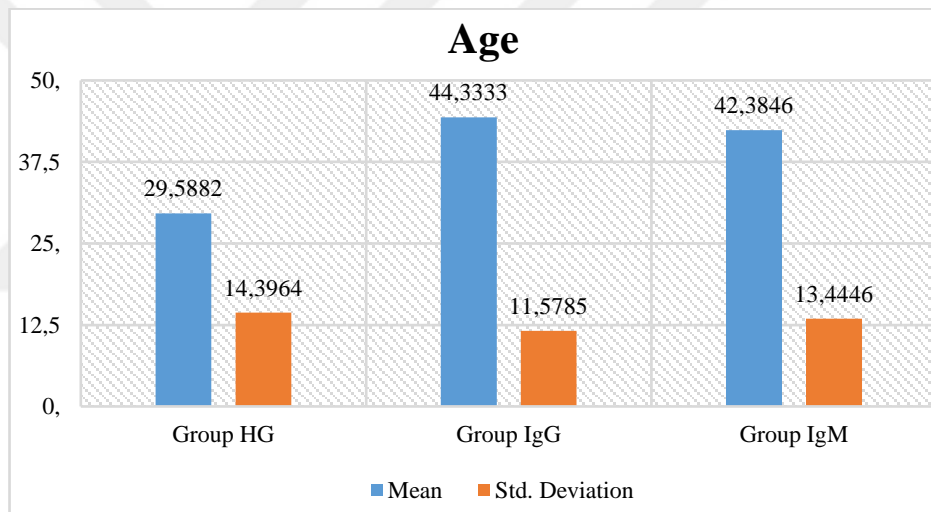


Figure 4.1 Comparison of age ranges

4.2 The Weight Study

The results of the weight averages in the study indicated that people infected with COVID-19 group IgG positive (79.41667) and in the group positive for COVID-19 group IgM group (85.61538), and the mean of standard deviation was (8.292449, 12.206245 and 7.217322) statistic significant when compared to study control (79.47059), and the results of minimum (63, 58 and 67 respectively) and maximum (92, 103 and 95 respectively) as in (Table 4.2 and Figure 4.2). There were no differences

between the study groups regarding weight. Where these results indicate that weight is not a factor for increasing the infection of COVID-19.

Self-reported body weight among individuals who gained weight after COVID-19 self-quarantine has risen between .5 and 1.8 kg (2.8 kg) after just two months of isolation. The following behaviors have been linked to weight gain during COVID-19 self-quarantine: increased sedentary behavior, decreased physical activity, increased snacking frequency (especially after dinner), increased alcohol consumption, decreased water intake, emotional eating, poor sleep, and being overweight or obese (Zeigler 2021).

Table 4.2 Descriptive of weight result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		79,47059	79,41667	85,61538	81,35714
Std. Deviation		8,292449	12,206245	7,217322	9,50692
Std. Error		2,011214	3,52364	2,001725	1,46695
95% CIM	LB	75,207	71,66119	81,254	78,39458
	UB	83,73417	87,17214	89,97677	84,31971
Minimum		63	58	67	58
Maximum		92	103	95	103
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

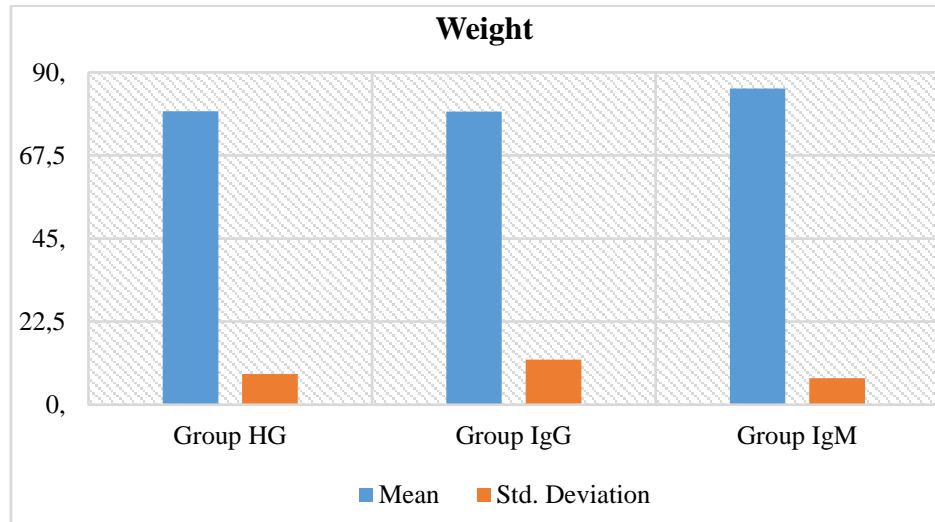


Figure 4.2 Comparison of weight ranges

4.3 The BMI Study

In able 4.3 and Figure 4.3 the results of body mass index (BMI) averages of the study indicated that people infected with COVID-19 group IgG positive (22.58617) and in the group positive for COVID-19 group IgM group (23.82392), and the mean of standard deviation was (3.218692 and 1.675816 respectively), and the results of minimum and maximum (18.854, 19.657 and 20.876 respectively) indicated that there were no statistically significant differences when comparing the results of the two groups with the control group (22.51035). There were no differences between the study groups regarding body mass index. Where these results indicate that weight is not a factor for increasing the infection of COVID-19.

Table 4.3 Descriptive of BMI result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		22,51035	22,58617	23,82392	22,9386
Std. Deviation		2,167995	3,218692	1,675816	2,407614
Std. Error		0,525816	0,929156	0,464788	0,371503
95% CIM	LB	21,39567	20,54111	22,81124	22,18833
	UB	23,62503	24,63123	24,83661	23,68886
Minimum		18,854	19,657	20,876	18,854
Maximum		25,857	29,757	26,75	29,757
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

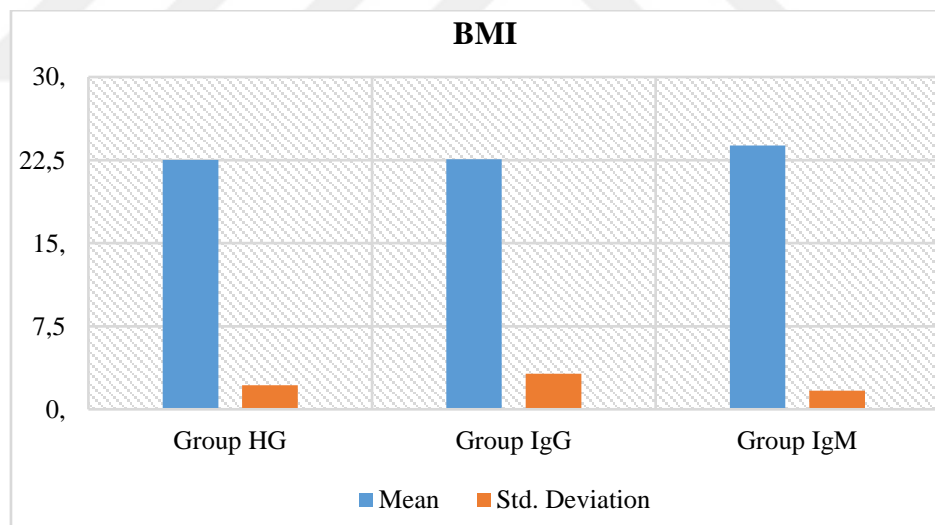


Figure 4.3 The BMI result descriptions

4.4 The HCO₃ Study

The results of HCO₃ mean in the study indicated that people infected with COVID-19 group IgG positive (27.00) and in the group positive for COVID-19 group IgM group

(25.1538), and the mean of standard deviation was (3.4641 and 3.105), and the results of minimum (20.56, 21.58 and 21.49 respectively) and maximum (26.77, 33 and 31) indicated that there were statistically significant differences between controls group with group IgG positive and no statistically significant differences between group IgM positive with controls group (24.1845), as in the (Table 4.4 and Figure 4.4). The results of HCO_3 indicated a clear importance and changes towards the increase in relation to the second group, and this indicates that the percentage of infection with HCO_3 increases at the onset of infection with COVID-19.

The spike protein of the virus is thought to be neutralized in the respiratory tract and lungs by intermittent use of an oxygen ionizer that produces negative oxygen ion clusters $[\text{O}_2(\text{H}_2\text{O})_n]$ and a sodium bicarbonate nebulizer that produces HCO_3 when connected to an oxygen concentrator or ventilator inlet, thereby improving blood oxygen levels. These structural adjustments may substantially reduce viral load, allowing the patient to recover from the illness more quickly (Badhe and Nipate 2021).

A significant amount more than problems in pulmonary mechanics, arterial hypoxaemia is the most prominent respiratory characteristic of Coronavirus Disease 2019 (COVID-19). Finding respiratory, metabolic acidosis, and alkalosis is made possible by arterial blood gas (ABG) analysis. Data of ABG assay, including pH, PaO_2 , PaCO_2 , and bicarbonate (HCO_3), were acquired from ICU records for 314 adult COVID-19 positive cases (MONDAL *et al.* 2021).

Table 4.4 Descriptive of HCO₃ result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		24.1845	27.00	25,1538	25,289
Std. Deviation		1,90647	3,4641	3,105	2,97122
Std. Error		0,46239	1	0,86117	0,45847
95% CIM	LB	23,2043	24,799	23,2775	24,3631
	UB	25,1647	29,201	27,0302	26,2148
Minimum		20,56	21.58	21.49	20,56
Maximum		26,77	33	31	33
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound HCO ₃ x IgG Min=89.24% \ HCO ₃ x IgG Max =136.47%					

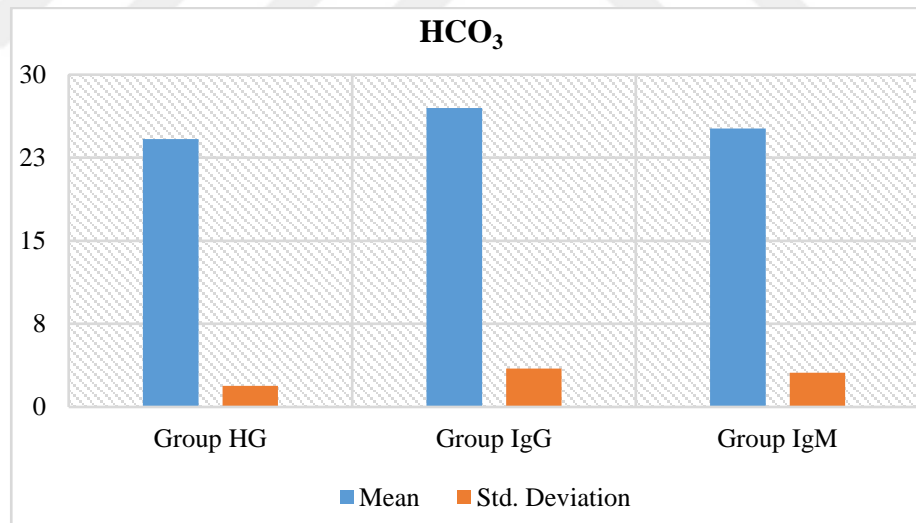


Figure 4.4 The HCO₃ result descriptions

4.5 The CO₂ Study

The results of CO₂ in Table 4.5 and Figure 4.5 indicated that people infected with COVID-19 group IgG positive (27.91667) and in the group positive for COVID-19

group IgM group (28.48792), and the mean of standard deviation is (4.077841 and 4.510027 respectively), and the results of Minimum (22.47, 22.00 and 22.85 respectively) and Maximum (28.568, 36 and 38 respectively) indicated that there are no statistically significant differences when comparing the results of the two groups with the control group (25.40165). With regard to CO₂ levels changed in both groups, which indicates that the effect remains continuous and the percentage of CO₂ increases and the lack of oxygen leads to death.

Human activities, including energy use and carbon dioxide (CO₂) emissions, are impacted by the CCOVID-19 pandemic. Based on almost real-time activity data, we present daily estimates of national CO₂ emissions for various sectors in this article. Patients with COVID-19 frequently experienced breathing difficulties as a result of oxygen deficiency (Liu *et al.* 202).

The growth of worldwide CO₂ emissions has slowed down and decreased in oxygen five years after the Paris Climate Agreement was adopted. The COVID-19 pandemic's widespread disruptions have significantly changed the direction of the world's CO₂ emissions. To maintain a decrease in global emissions in the post-COVID-19 era, new policy decisions must be made to handle the conflicting effects of investments made after COVID-19 in fossil fuel-based infrastructure and the recent strengthening of climate targets (Le Quéré *et al.* 2021).

Table 4.5 Descriptive of CO₂ result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		25,40165	27,91667	28,48792	27,0755
Std. Deviation		1,955524	4,077841	4,510027	3,729387
Std. Error		0,474284	1,177171	1,250857	0,575457
95% CIM	LB	24,39621	25,32573	25,76254	25,91334
	UB	26,40708	30,5076	31,21331	28,23766
Minimum		22,47	22	22,85	22
Maximum		28,568	36	38	38
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound HGxIgG min=86.6% \ HGxIgG max=141.7%					

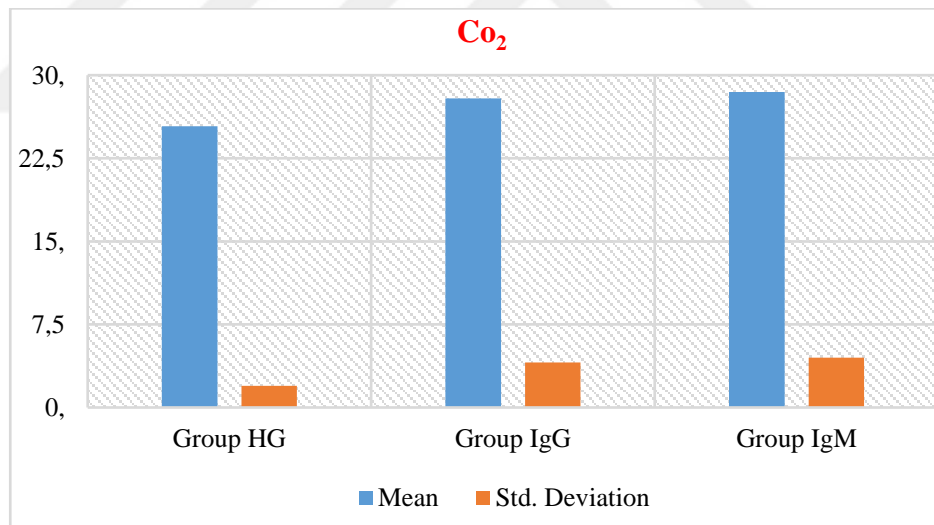


Figure 4.5 The CO₂ result descriptions

4.6 The Potassium Ions Study

The results of potassium ions mean in the study indicated that people infected with COVID-19 group IgG positive (3.76267) they have statistically significant in their results when compared to control group, and in the group positive for COVID-19 group

IgM group (4.29838), and the mean of standard deviation was (0.960064 and 0.873568 respectively), and the results of minimum (2.658, 2.583 and 2758 respectively) and Maximum (5.757, 5.859 and 5743 respectively) indicated that there were no statistically significant differences when comparing the results of the two groups with the control group (4.16356) as in (Table 4.6 and Figure 4.6).

A common issue in COVID-19 participants was hypokalemia. Low serum potassium ions levels have been linked to female gender and using diuretics. In this patient group, hypokalemia was unrelated to death and ICU transfers (Alfano *et al.* 2021).

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the cause of the present global health crisis, coronavirus disease (COVID-19). White blood cell count, D-dimer, C-reactive protein, albumin, lactate dehydrogenase, creatinine, and electrolytes test findings, as well as demographic variables, have all been linked to a bad prognosis for this illness. Electrolyte difficulties, notably low potassium levels, are common in COVID-19 patients. We found that 24.3% of COVID-19 patients had hypokalemia and 4.15 % had hyperkalemia, based on our combined data. The likelihood of adverse consequences, including mortality, may increase if the potassium level deviates from the usual range. Determining how hypokalemia and hyperkalemia can worsen cardiac outcomes and the prognosis of COVID-19 for infected individuals, this paper studied the epidemiology of potassium problems. The article concludes by outlining some crucial factors to take into account when treating these individuals' hypokalemia and hyperkalemia (Kolahi and Safiri 2022).

Table 4.6 Descriptive of K⁺ result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		4,16356	3,76267	4,29838	4,09075
Std. Deviation		0,972532	0,960064	0,873568	0,941868
Std. Error		0,235874	0,277147	0,242284	0,145333
95% CIM	LB	3,66353	3,15267	3,77049	3,79725
	UB	4,66359	4,37266	4,82628	4,38426
Minimum		2.658	2.583	2758	2,,583
Maximum		5.757	5.859	5743	5,,859
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

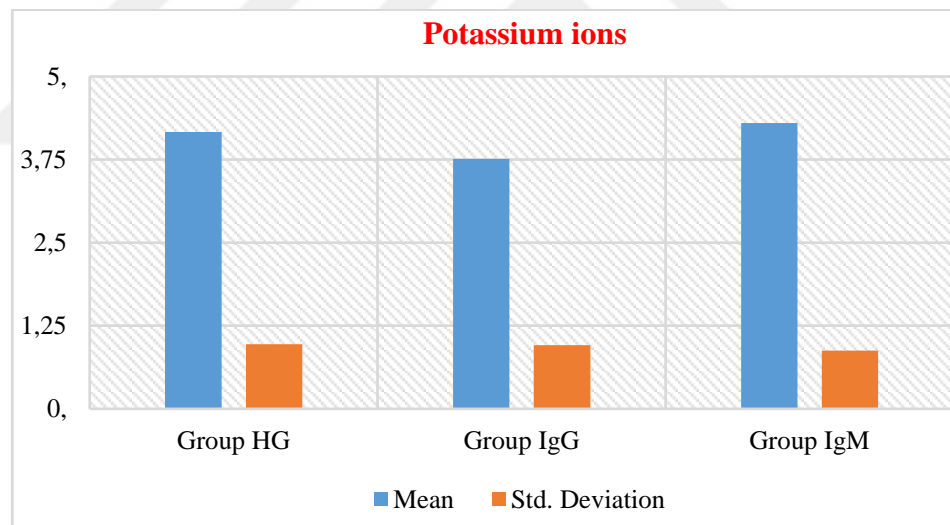


Figure 4.6 The K result descriptions

4.7 The Sodium Ions Study

In the Table 4.7 and Figure 4.7 the results of sodium ions in the study indicated that people infected with COVID-19 group IgG positive (133) and in the group positive for COVID-19 group IgM group (133.38462), and the mean of standard deviation was (2.628515 and 3.731364 respectively), and the results of minimum (136, 128 and 128

respectively) and maximum (145.986, 137 and 142 respectively) indicated that there was statistically significant differences when comparing the results of the two groups with the control group (139.60812). Sodium ions results indicate its decrease at the beginning and during infection with COVID-19.

In Hubei, China, hospitalized COVID-19 patients frequently have sodium balance disorders, especially hyponatremia, which is linked to a higher risk of life-threatening disease and higher in-hospital mortality (Hu *et al.* 2021).

Table 4.7 Descriptive of Na⁺ result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		139,60812	133	133,38462	135.79376
Std. Deviation		2,658523	2,628515	3,731364	4.340991
Std. Error		0,644787	0,758787	1,034894	0,669829
95% CIM	LB	138,24123	131,32992	131,12977	134,44101
	UB	140,975	134,67008	135,63946	137,14651
Minimum		136	128	128	128
Maximum		145.986	137	142	145,986
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

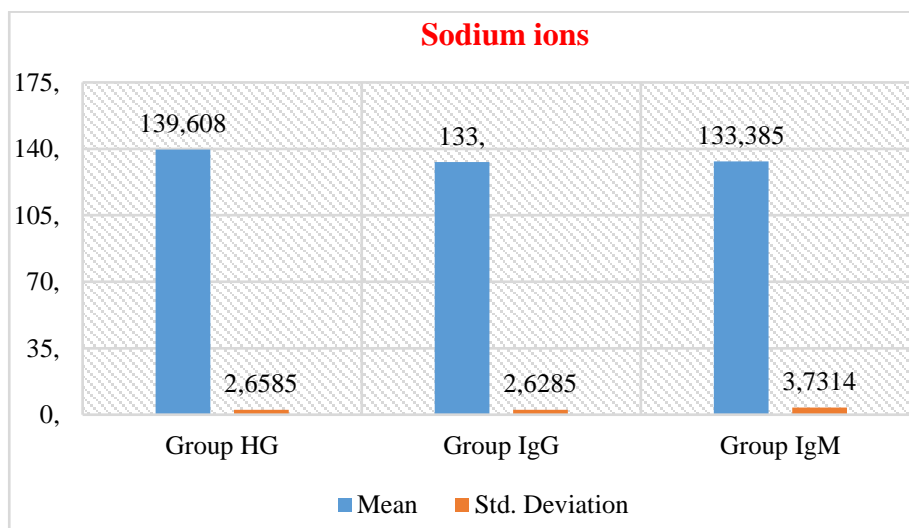


Figure 4.7 The Na⁺ result descriptions

4.8 The Cl⁻ Study

The results of Cl⁻ mean in the study indicated that people infected with COVID-19 group IgG positive (99.75) and in the group positive for COVID-19 group IgM group (98.07692), and the mean of standard deviation was (4.218541, 3.720337 and 6.800264 respectively), and the results of minimum (89.765, 93 and 80 respectively) and maximum (107.76, 105 and 108 respectively) indicated that there were no statistically significant differences when comparing the results of the two groups with the control group (99.74052), as in (Table 4.8 and Figure 4.8).

Table 4.8 Descriptive of cl⁻ result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		99,74052	99,75	98,07692	99,2283
Std. Deviation		4,218541	3,720337	6,800264	4,980133
Std. Error		1,023147	1,073969	1,886054	0,768451
95% CIM	LB	97,57154	97,38621	93,96756	97,67639
	UB	101,90949	102,11379	102,18628	100,78022
Minimum		89.765	93	80	80
Maximum		107.76	105	108	108
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

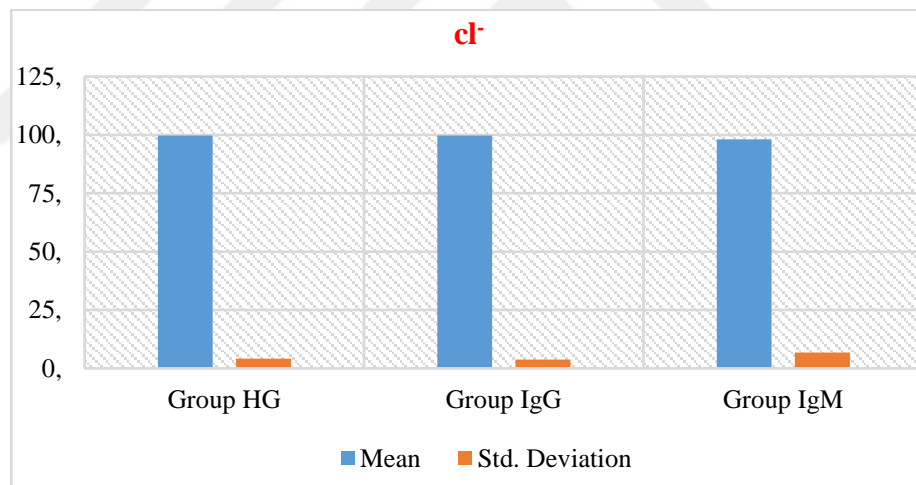


Figure 4.8 The CL result descriptions

4.9 The IL-6 Study

The results of IL-6 indicated that people infected with COVID-19 group IgG positive (19.75257) and in the group positive for COVID-19 group IgM group (23.51585), and the mean of standard deviation was (0.83678, 1.7207483 and 2.6043465 respectively), and the results of Minimum (0.368, 1.583 and 0.368 respectively) and Maximum (3.965

, 68.59 and 39.65 respectively) indicated that there were statistically significant differences when comparing the results of the two groups with the control group (4.10929), as in the (Table 4.9 and Figure 4.9). IL-6 concentrations changed clearly and significantly, which indicates an increase in immunological changes when infected with COVID-19. This test is considered a diagnostic test for COVID-19.

In corona virus disease 2019 (COVID-19), cytokine release syndrome (CRS) contributes to life-threatening multiple organ failure and may be a target for treatment. Designing new immunotherapies is made possible by the mechanistic understanding of CRS. Targeting important inflammatory cytokine molecules, such as interleukin-6 (IL-6), is a unique approach for treating COVID-19-induced CRS and merits more research (Liu *et al.* 2020).

Table 4.9 Descriptive of IL-6 result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		4,10929	19,75257	23,51585	51.01416
Std. Deviation		0,83678	1,7207483	2,6043465	2.429432
Std. Error		0.255798	4,967372	7,223158	37,486952
95% CIM	LB	13.16018	291.37877	103.16018	291.37877
	UB	8.81945	30,68568	8.81945	30,68568
Minimum		0.368	1.583	0.368	1583
Maximum		3.965	68.59	39.65	68,59
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

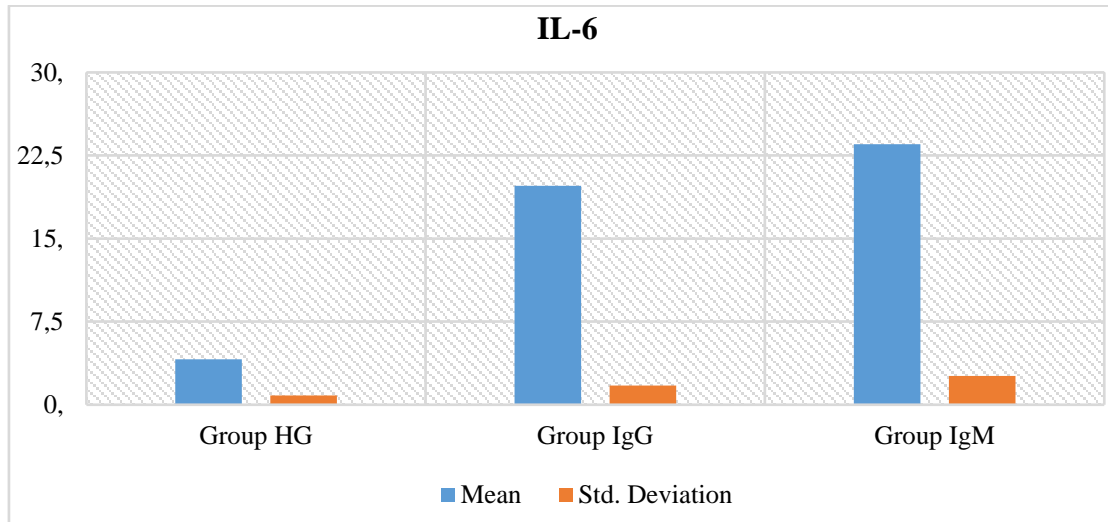


Figure 4.9 The IL-6 result descriptions

4.10 The hsCRP Study

The results of hsCRP in Table 4.10 and Figure 4.10 in our study indicated that people infected with COVID-19 group IgG positive (11.41667) and in the group positive for COVID-19 group IgM group (14.92308), and the mean of standard deviation was (1.561864 and 3.438467 respectively), and the results of minimum (0.636, 6.748 and 0.703 respectively) and maximum (4, 19 and 4 respectively) indicated that there were statistically significant differences when comparing the results of the two groups with the control group (2.93367). The concentrations of hsC-RP changed clearly and significantly, which indicates an increase in immunological changes when infected with COVID-19. These tests are considered diagnostic tests for COVID-19.

It's possible that this illness has no symptoms or affects many organs. However, little research has been done on the role of molecules like C-reactive protein (CRP) as a factor capable of causing an inflammatory status that may be involved in the severe evolution of the disease. Damage caused by the virus is related to immune system dysfunction. Patients with severe COVID-19 evolution, which affected many organ systems, and patients who passed away had high levels of CRP. When added to the inflammatory state brought on by the illness, CRP's effects on apoptosis, complement activation, and the production of pro-inflammatory cytokines may be devastating.

Several drugs have been shown to reduce CRP levels or block its effects, suggesting that they may be useful in the treatment of COVID-19. This data suggests that CRP may have a role in the severe advancement of COVID-19, and that randomized controlled clinical trials should be conducted to evaluate the efficacy of drugs that lower CRP levels or inhibit its activity (Mosquera-Sulbaran *et al.* 2021).

Table 4.10 Descriptive of hsC-RP result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		2,93367	11,41667	14,92308	9.06839
Std. Deviation		0,935774	1,561864	3,438467	6.617355
Std. Error		0.469494	1.316897	1.508359	1.02108
95% CIM	LB	1.93839	3.92895	1.93839	3.92895
	UB	8.5182	14.31514	8.5182	14,31514
Minimum		0.636	6.748	0.703	6.748
Maximum		4	19	4	19
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

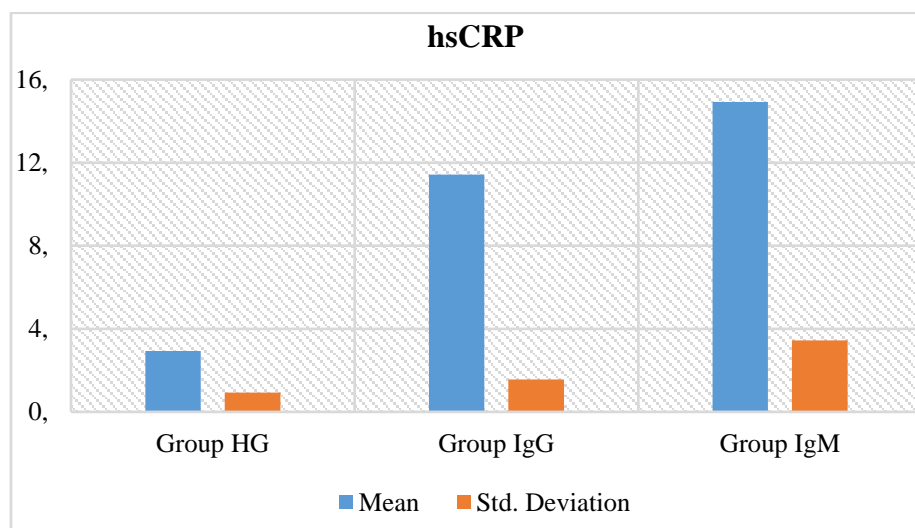


Figure 4.10 The hsC-RP result descriptions

4.11 The D-Dimer Study

The results of D-Dimer in the study indicated that people infected with COVID-19 group IgG positive (386.75) and in the group positive for COVID-19 group IgM group (327.84615), and the mean of standard deviation was (27.718405 and 65.40436 respectively), and the results of minimum (0.357, 27 and 33 respectively) and maximum (1.858, 853 and 857 respectively) indicated that there were high statistically significant differences when comparing the results of the two groups with the control group (0.75776), as in the (Table 4.11 and Figure 4.11). D-Dimer concentrations changed dramatically towards an increase, and this increases the blood clotting rate and thus increases the death rates of COVID-19. These tests are considered diagnostic tests for COVID-19.

The D-dimer level is one of the tests given to patients to check for thrombosis. Research shows that D-dimer and fibrinogen concentrations rise early in COVID-19 illness. D-dimer levels that increase by 3 or 4 fold are correlated with a poor prognosis. D-dimer levels may also grow in patients with COVID-19 who have other risk factors, such as diabetes, cancer, stroke, and pregnancy. Measuring D-dimer and coagulation markers at an early stage of COVID-19 illness may aid in treatment and management of the condition (Rostami *et al.* 2020).

A fibrin breakdown product termed D-dimer, which includes many cross-linked D and/or E domains from the original fibrinogen molecule, may only possibly arise when the fibrinolysis and hemostasis pathways are concurrently active. D-dimer elevations are more common in COVID-19 patients with post-discharge clinical sequelae, and recent study reveals that D-dimer elevations are common in SARS-CoV-2 patients (particularly those with thrombosis). Anticoagulant escalation based on D-dimer levels may be associated with a reduced risk of mortality in patients with severe SARS-CoV-2 infection, and a rise in D-dimer levels after vaccination against COVID-19 mimics an increased risk of developing vaccine-induced thrombocytopenia and thrombosis (VITT) (Lippi *et al.* 2023).

Table 4.11 Descriptive of D-Dimer result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		0,75776	386,75	327,84615	212.2829
Std. Deviation		0,19228	27,718405	65,40436	270.746479
Std. Error		0.095142	80.747748	73.609925	41.777089
95% CIM	LB	0.55607	209.0254	167.4639	127.91236
	UB	095946	564.4746	488.2284	296.65345
Minimum		0.357	27	33	0.357
Maximum		1.858	853	857	857
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

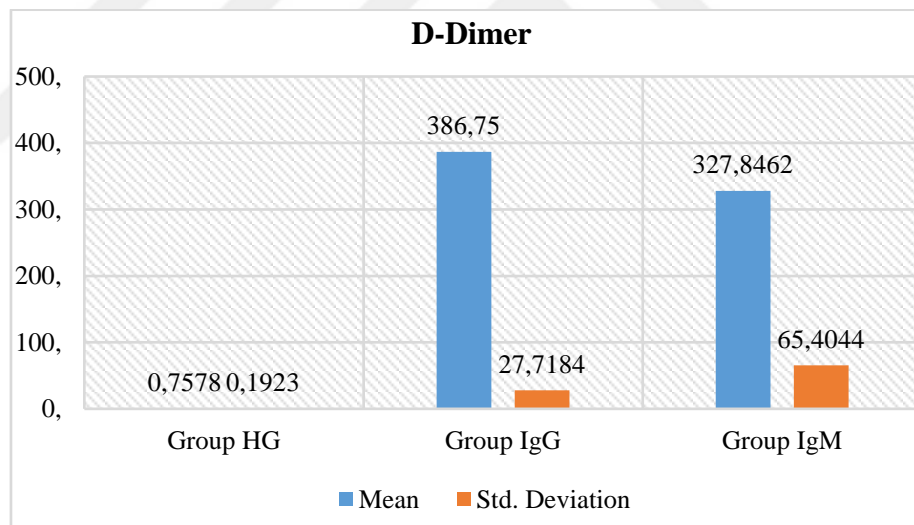


Figure 4.11 The D-Dimer result descriptions

4.12 The Hemoglobin Study

In the Table 4.12 and Figure 4.12, the results of hemoglobin mean in the our study indicated that people infected with COVID-19 group IgG positive (11.60125) and in the group positive for COVID-19 group IgM group (11.00938), and the mean of standard deviation was (1.510823 and 1.80328 respectively), and the results of minimum

(10.955, 15.754 and 11.482 respectively) and maximum (8.579, 13.853 and 9.482 respectively) indicated that there were no statistically significant differences when comparing the results of the two groups with the control group (13.43024).

Table 4.12 Descriptive of Hb result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		13,43024	11,60125	11,00938	12.15836
Std. Deviation		1,461761	1,510823	1,80328	1.891604
Std. Error		0.354529	0.436137	0.50014	0.291881
95% CIM	LB	12.67867	10.64132	9.91967	11.56889
	UB	14.1818	12.56118	12.0991	12.74782
Minimum		10.955	15.754	11.482	15.754
Maximum		8.579	13.853	9.482	13.853
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound HbxIgG Min=117.56% \ HbxIgG Max 103.1%					

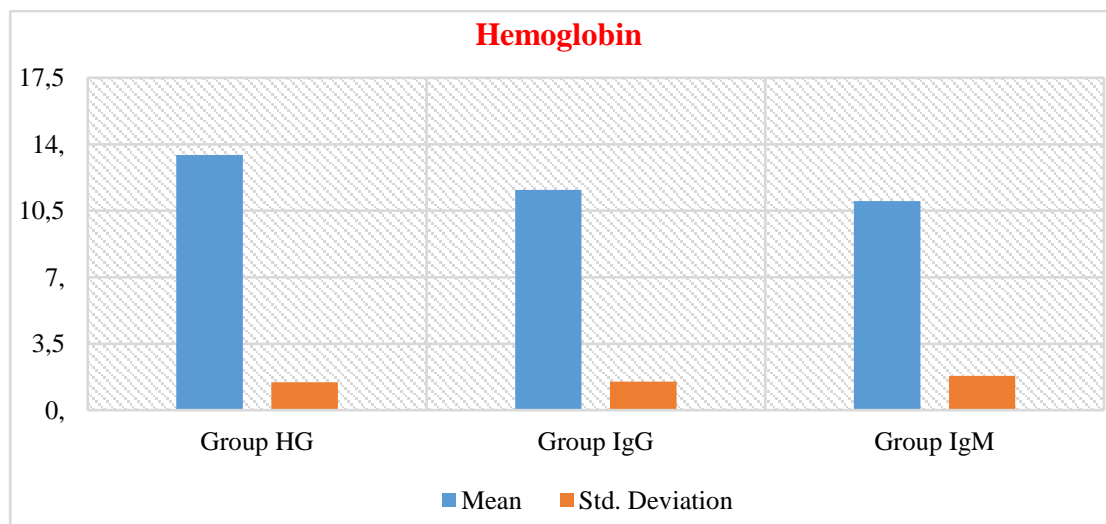


Figure 4.12 The Hb result descriptions

4.13 The White Blood Cells Study

The results of white blood cells in the study indicated that people infected with COVID-19 group IgG positive (1077.35) statistically significant with control group, and in the group positive for COVID-19 group IgM group (6765.69), and the mean of standard deviation was (304.182270 and 173.673 respectively), and the results of minimum (3754, 4635 and 3562 respectively) and maximum (11658, 15367 and 9467 respectively) indicated that there were no statistically significant differences when comparing the results of the two groups with the control group (7306.764), as in the (Table 4.13 and Figure 4.13). The study found that the levels of white blood cells were affected at the onset of infection with COVID-19.

Table 4.13 Descriptive of WBC result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		7306,764	10773,5	6765,69	8129.785
Std. Deviation		219,5688	304,182270	173,673	285.7112
Std. Error		53.2362	87.8098	48.1683	44.0862
95% CIM	LB	6177,84587	8840,81806	5716,1952	7239,44669
	UB	8435,68354	12706,18194	7815,18942	9020,12474
Minimum		3754	4635	3562	3562
Maximum		11658	15367	9467	15367
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

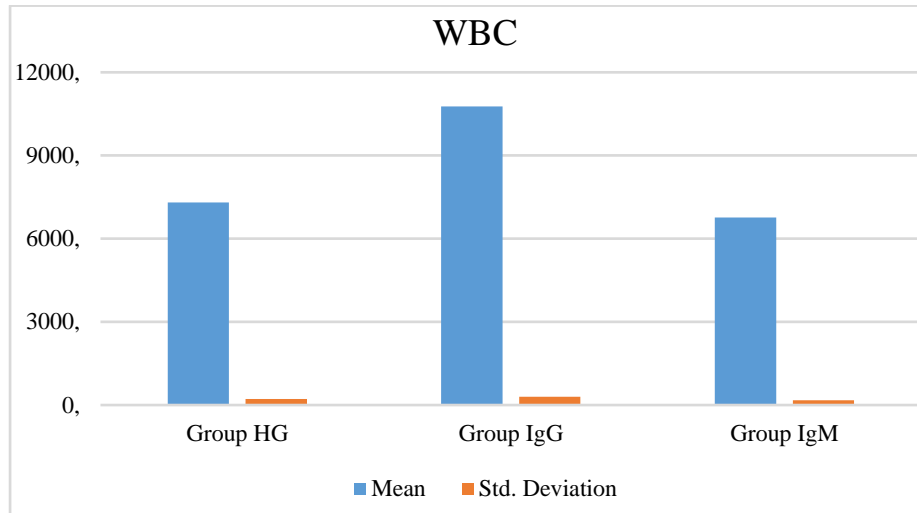


Figure 4.13 The WBC result descriptions

4.14 The Platelets Study

The results of platelet in (Table 4.14 and Figure 4.14) the study indicated that people infected with COVID-19 group IgG positive (268.08333) and in the group positive for COVID-19 group IgM group (291.23077), and the mean of standard deviation was (28.328635 and 33.875046 respectively), and the results of minimum (209, 209 and 132 respectively) and maximum (472, 373 and 574 respectively) indicated that there were no statistically significant differences when comparing the results of the two groups with the control group (299.35294).

Table 4.14 Descriptive of platelet result

Variables		Group HG	Group IgG	Group IgM	Total
N		70	65	65	200
Mean		299,35294	268,08333	291,23077	287.90476
Std. Deviation		31,272313	28,328635	33,875046	31.7654
Std. Error		17.286075	14.817301	29.919155	12.216295
95% CI M	LB	262.7081	235.47067	226.04253	263.23345
	UB	335.99778	300.69599	356.41901	312.57607
Minimum		209	209	132	132
Maximum		472	373	574	574
95% CIM = 95% Confidence Interval for Mean LB= Lower Bound UB= Upper Bound					

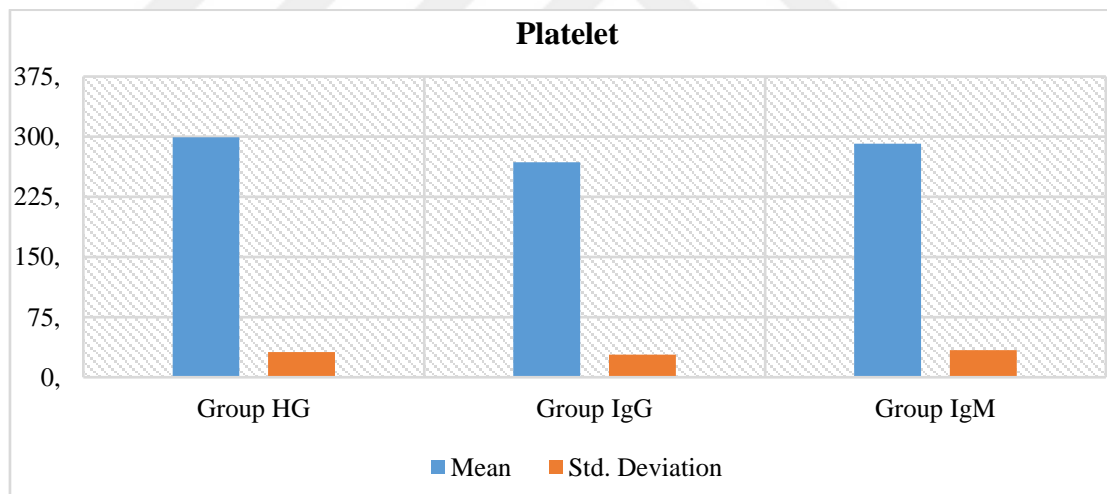


Figure 4.14 The platelet result descriptions

4.15 The Correlation Between HCO₃ and CO₂ with Study Parameters

In order to understand and know the relationship between the variables of the study, the Bison test was conducted to identify these associations. The results indicated a strong association between HCO₃ with D-Dimer D test, WBC. The associations between CO₂

with Hb, potassium, sodium, hsCRP were high correlation. While there was no association with the rest of the variables, or it was a weak association, as in Table 4.15.



Table 4.15 The relationship between HCO₃ and CO₂ with study variables for correlations

Correlations																
	Age	weight	BMI	HCO ₃	CO ₂	K	Na	CL	IL6	hsCRP	DDimer	Hb	WBC	Platelet		
Age	Pearson Correlation		1	,193	-,008	,171	,243	-,112	- ,333*	,058	,325*	,351*	1	-,259	,124	,296
	Significance(2-tailed)			,222	,962	,279	,121	,482	,031	,715	,036	,023	,053	,098	,433	,057
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
weight	Pearson Correlation	,193	1	,643**	-,141	-,048	-,027	-,121	-,105	-,140	,284	,076	-,191	,028	-,021	
	Significance(2-tailed)	,222		,000	,375	,764	,864	,445	,507	,377	,069	,631	,225	,861	,893	
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
BMI	Pearson Correlation	-,008	,643**	1	-,199	,161	-,106	-,142	-,101	-,193	,304	,111	-,043	-,032	-,106	
	Significance(2-tailed)	,962	,000		,206	,308	,502	,371	,526	,221	,050	,482	,789	,841	,503	
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
HCO ₃	Pearson Correlation	,171	-,141	-,199	1	-,020	,000	-,276	-,055	,038	,050	,394**	-,201	,407**	-,037	
	Significance(2-tailed)	,279	,375	,206		,901	1,000	,077	,731	,810	,754	,010	,203	,007	,814	
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
CO ₂	Pearson Correlation	,243	-,048	,161	-,020	1	,411**	- ,318*	,137	,056	,373*	,181	- ,435**	,116	-,289	
	Significance(2-tailed)	,121	,764	,308	,901		,007	,040	,385	,725	,015	,252	,004	,463	,064	
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
K	Pearson Correlation	-,112	-,027	-,106	,000	,411**	1	,060	-,035	,112	,086	-,105	-,093	-,053	- ,311*	
	Significance(2-tailed)	,482	,864	,502	1,000	,007		,705	,827	,481	,588	,507	,558	,739	,045	
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Na	Pearson Correlation	- ,333*	-,121	-,142	-,276	-,318*	,060	1	,063	,142	- ,488**	-,224	,630**	-,129	,117	
	Significance(2-tailed)	,031	,445	,371	,077	,040	,705		,692	,371	,001	,154	,000	,417	,460	

Table 4.15 The relationship between HCO₃ and CO₂ with study variables for correlations (Continued)

CL	Pearson Correlation	,058	-,105	-,101	-,055	,137	-,035	,063	1	,122	-,018	-,038	-,214	,072	,029
	Significance(2-tailed)	,715	,507	,526	,731	,385	,827	,692		,440	,910	,812	,173	,651	,855
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200
IL6	Pearson Correlation	,325*	-,140	-,193	,038	,056	,112	,142	,122	1	-,156	-,102	-,008	-,004	,361*
	Significance(2-tailed)	,036	,377	,221	,810	,725	,481	,371	,440		,325	,519	,962	,980	,019
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200
hsCRP	Pearson Correlation	,351*	,284	,304	,050	,373*	,086	-,488**	-,018	-,156	1	,46*	-	,140	-,161
	Significance(2-tailed)	,023	,069	,050	,754	,015	,588	,001	,910	,325		,002	,000	,377	,307
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200
DDimer	Pearson Correlation	,301	,076	,111	,394**	,181	-,105	-,224	-,038	-,102	,462**	1	-,226	,237	-,061
	Significance(2-tailed)	,053	,631	,482	,010	,252	,507	,154	,812	,519	,002		,150	,130	,701
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Hb	Pearson Correlation	-,259	-,191	-,043	-,201	-	-,093	,630**	-,214	-,008	-	-,226	1	-,076	-,023
	Significance(2-tailed)	,098	,225	,789	,203	,435**	,558	,000	,173	,962	,000	,150		,632	,883
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200
WBC	Pearson Correlation	,124	,028	-,032	,407**	,116	-,053	-,129	,072	-,004	,140	,237	-,076	1	-,220
	Significance(2-tailed)	,433	,861	,841	,007	,463	,739	,417	,651	,980	,377	,130	,632		,161
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Platelet	Pearson Correlation	,296	-,021	-,106	-,037	-,289	-,31*	,117	,029	,361*	-,161	-,061	-,023	-,220	1
	Significance(2-tailed)	,057	,893	,503	,814	,064	,045	,460	,855	,019	,307	,701	,883	,161	
	N	200	200	200	200	200	200	200	200	200	200	200	200	200	200

5. CONCLUSIONS AND RECOMMENDATION

- Age had a clear importance, as the study showed that the older the age, the higher the infection rate, and the higher the death rate from COVID-19.
- There were no differences between the study groups regarding weight and body mass index. Where these results indicate that weight is not a factor for increasing the infection of COVID-19.
- The results of HCO_3 indicated a clear importance and changes towards the increase in relation to the second group, and this indicates that the percentage of infection with HCO_3 increases at the onset of infection with COVID-19.
- With regard to CO_2 levels changed in both groups, which indicates that the effect remains continuous and the percentage of CO_2 increases and the lack of oxygen leads to death.
- Sodium results indicate its decrease at the beginning and during infection with COVID-19.
- The concentrations of IL-6 and hsC-RP changed clearly and significantly, which indicates an increase in immunological changes when infected with COVID-19. These tests are considered diagnostic tests for COVID-19.
- D-Dimer concentrations changed dramatically towards an increase, and this increases the blood clotting rate and thus increases the death rates of COVID-19. These tests are considered diagnostic tests for COVID-19.
- The study found that the levels of white blood cells were affected at the onset of infection with COVID-19.

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