# " EFFECT ON VITAL SIGNS IN COVID 19 RECOVERED PATIENT AFTER 6-MINUTES WALK TEST "

A dissertation

Submitted

In Partial fulfilment of the requirements

for the Degree of

**MASTERS OF PHYSIOTHERAPY**

In

Cardiopulmonary

Submitted by

**Kiran Bhawan Nangarwal**

Under the Supervision of

**Dr. Ammar Faisal Khan (PT)**

Department of Physiotherapy

Faculty of Health & Medical Sciences

**INTEGRAL UNIVERSITY, LUCKNOW, INDIA**

May 2022

# CERTIFICATE

This is to certify that **Mrs. Kiran Bhawan Nangarwal** (Enroll. No.- 2000100398) has carried out the research work presented in the dissertation titled **"**Effect on vital signs in COVID 19 recovered patient after 6-minutes walk test **"** submitted for partial fulfilment for the award of the **Degree of Master of Physiotherapy in Cardiopulmonary** from **Integral University,**
**Lucknow** under my supervision.
It is also certified that:

1. This dissertation embodies the original work of the candidate and has not been earlier submitted elsewhere for the award of any degree/diploma/certificate.
2. The candidate has worked under my supervision for the prescribed period.
3. The dissertation fulfils the requirements of the norms and standards prescribed by the University Grants Commission and Integral University, Lucknow, India.
4. No published work (figure, data, table etc) has been reproduced in the dissertation without express permission of the copyright owner(s).

Therefore, I deem this work fit and recommend for submission for the award of the aforesaid degree.

Signature of Supervisor

Full Name: Dr Ammar Faisal Khan (PT)

Designation: Assistant Professor

Address: Department of Physiotherapy

Integral University, Lucknow

Date:

Place:

## CERTIFICATE (HEAD OF DEPARTMENT)

I hereby recommend that the project prepared under my supervision by Kiran Bhawan Nangarwal entitled "**Effect on vital signs in COVID 19 recovered patient after 6-minutes walk test** "is an original work done by her and be accepted in partial fulfilment for the degree of Master of Physiotherapy (Cardiopulmonary).

_____

Prof. (Dr.) Abdur Raheem Khan

M.P.T. (Musculoskeletal), Ph.D.

Head of Department of Physiotherapy,

Integral University, Lucknow

# CERTIFICATE OF CO SUPERVISOR

I hereby recommend that the dissertation prepared under my supervision by Kiran Bhawan Nangarwal entitled " Effect on vital signs in COVID 19 recovered patient after 6-minutes walk test " is a final work done by her and be accepted in partial fulfilment of the requirement for the degree Master of Physiotherapy (Cardiopulmonary).

Signature of Co supervisor

Full Name: Dr Neeraj Maurya (PT)

Designation: Assistant Professor

Address: Department of Physiotherapy
Integral University, Lucknow

Date:

Place:

# CERTIFICATE (EXTERNAL EXAMINER)

I hereby recommend that the dissertation prepared by Kiran Bhawan Nangarwal entitled " Effect on vital signs in COVID 19 recovered patient after 6-minutes walk test " is an original work done by her and be accepted and approved by me for the partial fulfilment of the requirement for the degree of Master of Physiotherapy.

Signature of external examiner

Full Name:

Designation:

Address:

Date:

Place:

# DECLARATION

I hereby declare that the dissertation titled “Effect on vital signs in COVID 19 recovered patient after 6-minutes walk test” is an authentic record of the research work carried out by me under the supervision of Dr. Ammar Faisal Khan (PT), Department of Cardiopulmonary, for the period from 2020 to 2022 at Integral University, Lucknow. No part of this dissertation has been presented elsewhere for any other degree or diploma earlier.

I declare that I have faithfully acknowledged and referred to the works of other researchers wherever their published works have been cited in the dissertation. I further certify that I have not wilfully taken other's work, para, text, data, results, tables, figures etc. reported in the journals, books, magazines, reports, dissertations, theses, etc., or available at web-sites without their permission, and have not included those in this M.P.T. dissertation citing as my own work.

Date: Signature

# COPYRIGHT TRANSFER CERTIFICATE

Title of the Dissertation: Effect on vital signs in COVID 19 recovered patient after 6-minutes walk test

Candidate Name: Kiran Bhawan Nangarwal

The undersigned hereby assigns to Integral University all rights under copyright that may exist in and for the above dissertation, authored by the undersigned and submitted to the University for the Award of the M.P.T. degree.

The Candidate may reproduce or authorize others to reproduce material extracted verbatim from the dissertation or derivative of the dissertation for personal and/or publication purpose(s) provided that the source and the University's copyright notices are indicated.

Signature of Candidate

Name- Kiran Bhawan Nangarwal

Enroll. No. 2000100398

## ACKNOWLEDGEMENT

I have reserved the right to acknowledge the people who have been influential in this onerous task of bringing this study to completion.

I certainly owe all my gratitude to GOD for His guidance and mercy.

I express my sincere gratitude to Prof. (Dr.) Ashfaque Khan, Director, IIAHSR, Integral University, Lucknow, for allowing me to utilize their facilities of their esteemed institution for this dissertation.

I would like to express my indebtedness to my teacher Prof. (Dr.) Abdur Raheem Khan, Head Physiotherapy, IIAHSR, Integral University, Lucknow, for his able guidance & valuable suggestions & encouragement in shaping of this dissertation.

A student without a guide is like a ship without a sailor that has no direction & can never reach its ultimate goal. So, for being my constant support I would like to express my most humble gratitude to my guide Dr. Ammar Faisal Khan, Assistant Professor, Department of Physiotherapy, Integral University, Lucknow, for his timely guidance, patience, advice & encouragement.

I immensely thank Dr. Neeraj Kumar Maurya, Dr. Mohd Javed Iqbal, Dr. A.M.H. Inam, Dr. Shoaim Sir, Dr. Namrata Suri, Dr. Aafreen and Dr. Sadiya Begum, for their kind understanding and support during the course of my study.

With great respect, I extend my special thanks to all the Teaching and Non-Teaching Staff for their help and contributions rendered to me during my study period.

It would be unfair of me if I fail to thank all the Participants in this study without whom this study would have been impossible. I am grateful to all my Classmates and Friends for extending their kind help when required.

I certainly owe my gratitude to my PARENTS, & my BROTHER, for their never-ending love and support and being there as a strong and unshakable force now and forever this work is dedicated to them.

Date:

Place: Lucknow

Kiran Bhawan Nangarwal

## TABLE OF CONTENTS

## ABBREVIATIONS USED

| | | |
|---|---|---|
| SBP | : | Systolic blood pressure |
| DBP | : | Diastolic blood pressure |
| RR | : | Respiratory Rate |
| $SPO_2$ | : | Peripheral capillary oxygen saturation |
| HR | : | Heart Rate |
| BMI | : | Body Mass Index |
| MAP | : | Mean Arterial Pressure |

## ABSTRACT

**Purpose**: Almost all organs are affected by this virus so cardiorespiratory system even persists as late effect. There are multiple direct or indirect factors involved for this damage. There are several studies have been done so far but no study till date has been done regarding impact on vital signs in Covid 19 recovered patients after 6- minutes walk test.

**Methodology:** Total 30 patients and 30 normal individuals were selected for the study on the basis inclusion & exclusion criteria. These 30 covid patients were further categorises to mild, moderate and severe covid. All these patients were RTPCR tested covid positive patients. Effect of 6- minutes walk test was calculated in form of change in vitals and compared with normal subjects.

**Result:** Demographic data showed the personal characteristics of the study subjects. In our study we had 60 respondents in which 58.3 % are male and 41.7 % are female. Covid patients were categorized into mild (8 in number), moderate (10 in number) and severe (12 in number) and further analysed into each variables. There was significant difference in SPO2 after doing 6-minutes walk test with a P value of 0.047. Similar results were found in heart rate, systolic, diastolic blood pressure and mean arterial pressure.

**Conclusion:** In covid recovered patients as there are still post covid effects because of which they show more change in vitals after 6- minutes walk test as compared to normal subjects.

# CHAPTER-1

# INTRODUCTION

# INTRODUCTION

Since December 2019, the global pandemic had started due to COVID 19 infection caused by virus (SARS-CoV-2). Almost all organs are affected by this virus so cardiorespiratory system even persists as late effect. There are multiple direct or indirect factors involved for this damage[1]. Lungs can be involved from mild pneumonitis to severe ARDS[2].

COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS- CoV-2), which is a member of the genus Betacoronavirus like the two other coronaviruses that have caused pandemic diseases (severe acute respiratory syndrome coronavirus (SARS- CoV) and Middle East respiratory syndrome coronavirus (MERS- CoV))[6-9]. As with SARS- CoV and MERS- CoV, SARS- CoV-2 causes a respiratory infection, which leads to viral pneumonia and acute respiratory distress syndrome (ARDS) in some patients1. However, in addition to respiratory symptoms, uncontrolled SARS- CoV-2 infection can trigger a cytokine storm, whereby pro- inflammatory cytokines, and chemokines such as tumour necrosis factor- α, IL-1β and IL-6 are overproduced by the immune system, resulting in multiorgan damage[10].

The first human CoV (HCoV)was identified in the mid-1960s in human embryonic tracheal organ cultures, and until 2003, only 2 HCoV species, HCoV-229E and HCoV-OC43, were recognized. Currently, 7 different CoV strains are known to infect humans, including HCoV-229E, HCoV-NL63, HCoV-OC43, and HCoV-HKU1, which generally cause self-resolving infection. There are also severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East Respiratory Syndrome coronavirus (MERS-CoV), and newly identified SARS-CoV-2, which can cause lethal respiratory infections in humans[11, 12].

It has been clinically reported that the well-known primary target area of this virus is the lungs, but several other tissues, organs, and organs system were also recorded to be

severely injured by viral replication. Based on the clinical reports this virus mainly invades the respiratory system, the second major area of infection were recently recorded to be the cardiovascular system and blood coagulation mechanism. Other target areas include the gastrointestinal tract, kidney, and organs representing endothelial cell with ACE2 surface marker[13]. The severity of these viral infections involves various factors including age groups, gender specificity, comorbid such as diabetes, hypertension, cardiovascular disease, suppressed immune system etc[14].

**Cardiovascular conditions Manifested with SARS-CoV-2 Infection**

SARS-CoV-2 acts as a risk factor for developing the following cardiac abnormalities clinically reported until 2020 which includes Myocarditis, pericarditis, myocardial injury [MI], arrhythmias, and abnormal coagulation mechanism and these conditions were manifested asymptomatically in few cases[16]. The death rate due to cardiac abnormalities was reported to be high in patients especially with myocardial injury indicated with an escalated level of troponin exhibiting a short life span.

**Respiratory conditions Manifested with SARS-CoV-2 Infection**

Viral pneumonia is the most frequent serious clinical manifestation of COVID-19, prominently featuring fever, cough, dyspnoea, hypoxemia, and bilateral infiltrates on chest radiography[17- 19]. Dry cough is more common than a productive cough. Dyspnoea appears after a median time of 5 to 8 days[20, 21]. Severe hypoxemic respiratory failure consistent with the Berlin definition of the acute respiratory distress syndrome (ARDS) occurs in a significant proportion of patients with COVID-19 pneumonia[22, 23]. Patients who require mechanical ventilation have a high risk of death.

Radiographic studies of the respiratory system of patients with COVID-19 variably reveal normal lung parenchyma, ground-glass opacities, focal consolidations, and abnormalities of pulmonary vascular perfusion[17]. Ground glass opacities in bilateral, peripheral, and lower lobe distribution appear to be the most common pattern on computed tomography (CT) scanning, although systematic reviews suggest that there is no pathognomonic CT pattern[18-20]. Comparison of CT scans of COVID-19–associated pneumonia to CT scans of other viral pneumonias suggests that the peripheral distribution of opacities, a ground-glass appearance, fine reticular appearance, and vascular thickening are more prominent in COVID-19 [21]. Pathology studies have established insights into the lung pathology caused by SARS-CoV-2 infection. Autopsy studies of patients with COVID-19 have found congested lungs with a patchy distribution of abnormalities on gross examination. Microscopic findings included diffuse alveolar damage (DAD) with hyaline membrane formation, pneumocyte activation, microvascular thrombi, lymphocytic inflammation, and proteinaceous edema[22- 23]. Other autopsy series report vascular remodelling via intussusceptive angiogenesis in the presence of microvascular thrombi. Other reports note that lung histopathologic findings in COVID-19 are varied and reflect the wide range of abnormalities demonstrated in ARDS from other causes [24]. A core needle biopsy-based study described areas of fibrosis, chronic inflammation, and loose fibrous plugs associated with organizing pneumonia in addition to ARDS [25]. A small series of autopsies reported lymphocytic viral pneumonia in patients who died early in the course of the disease and acute fibrinous and organizing pneumonia among patients who died later in the course [26].

**6min walk test**

Six min walk test (6MWT) is an exercise test that evaluates the functional status which is relevant to daily activities of patients with cardiopulmonary disease. The walking distance is

closely related to gender, age, and height, conventionally need a hierarchical analysis according to the above parameters. However, the sample size of our study was small which was not suitable for stratified analysis based on age, gender, and height. So, we estimated the walking distance of healthy people of the same gender, age and height according to reference equations for the 6MWT in healthy adults[15]. Then we calculated the ratio of measured value of the patients to the predicted value of the healthy person in fair condition. By comparing the ratio of two groups we could see whether there was difference in 6MWT between non severe and severe COVID-19 patients.

Statement of question

Whether there is any change in vitals after 6 weeks of recovery from COVID 19 infection.

Purpose of Study

To see any changes in vitals after 6 weeks of recovery from COVID 19 infection after 6-minutes walk test.

## Hypothesis

**Null hypothesis**

- There is no difference in blood pressure, heart rate and respiratory rate after recovery from COVID 19 infection

**Alternate hypothesis**

- There is change in blood pressure, heart rate and respiratory rate even after recovery from COVID 19 infection

# CHAPTER-2

# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

1. Paul Aveyard, *Min Gao, Nicola Lindson, & et.al. (2021)

   Association between pre-existing respiratory disease and its treatment, and severe COVID-19: a population cohort study

2. Huang, Cuiyan Tan, Jian Wu& et.al (2020)

   Impact of coronavirus disease 2019 on pulmonary function in early convalescence Phase

3. Masataka Nishiga , Dao Wen Wang, Yaling Han, & et.al. (2020)

   COVID-19 and cardiovascular disease: from basic mechanisms to clinical Perspective. Pre-existing cardiovascular disease seems to be linked with worse outcomes and increased risk of death in patients with COVID-19, whereas COVID-19 itself can also induce myocardial injury, arrhythmia, acute coronary syndrome and venous thromboembolism. Potential drug–disease interactions affecting patients with COVID-19 and comorbid cardiovascular diseases are also becoming a serious concern.

4. Somasundaram Raghavan, R. Gayathri, Sudhakar Kancharla, & et.al. (2021) Cardiovascular Impacts on COVID-19 Infected Patients.

   Recent reports of cardiovascular complications due to COVID 19 was clinically reported on a wide scale. Infection to SARS-CoV-2 has become a risk factor for cardiac disorders lately. Compared to adults, aged persons were prone to more complications and severity of cardiac conditions due to COVID-19 infection. Symptomatic and Supportive treatment was clinically administered for COVID-19 infected patients. Phase I and II clinical trials are currently in progress in many countries. The vaccine under clinical trials exhibits only short immunogenic effects

which lead to administration of booster dose after 72–150 days to increase its efficacy up to 90%. To avoid infection preventive measures including usage of face mask, sanitiser, social distancing has to be followed until the discovery of a vaccine with prolonged immunogenic effects.

5. Shari B. Brosnahan, Annemijn H. Jonkman, Matthias C. Kugler, et.al. (2020) COVID-19 and Respiratory System Disorders. Current Knowledge, Future Clinical and Translational Research Questions

   COVID-19 affects all components of the respiratory system, including the neuromuscular breathing apparatus, the conducting airways, the respiratory airways and alveoli, the pulmonary vascular endothelium, and pulmonary blood flow. As of this writing, after fewer than 6 months of clinical experience and research into the disease, many publications have described gross and histological pathology, radiographic changes, and clinical manifestations of the disease. Few data, however, convincingly combine these observations into a more complete mechanistic model of the disease that permits researchers and clinicians to identify cause-and-effect relationships that can be targeted safely and effectively to improve clinical outcomes. Nevertheless, the accumulated data to this point identify several tantalizing avenues for investigation that may successfully lead to a fuller understanding of disease pathogenesis and identification of viable therapeutic targets. Although COVID-19 of the respiratory system appears to be a complex disease that may resist finding a single silver bullet intervention, these observations provide promising avenues to pursue.

# CHAPTER-3
# METHODOLOGY

# METHODOLOGY

This chapter deals with the methodology implemented to conduct the study. This section provides information on the type of study design sample, technique, and procedure of data collection.

**Sampling:**

### No. of Subjects

Total 30 patients and 30 normal individuals were selected for the study on the basis inclusion & exclusion criteria.

### Space & Location

A Sample of convenience was taken from SGPGI, Lucknow and normal individuals were residents of Lucknow.

### Selection Criteria:

1. Patients recovered from covid
2. All covid categories included
3. Normal subjects were also included
4. Controlled comorbidities were taken
5. Patients of 18- 60 years age group
6. Both male and female
7. Patients with mild, moderate, and severe covid with hospital stay of less than 1 month
8. Willingness of patient to participate in the study

### Exclusion criteria:

1. Patients with uncontrolled DM, HTN and asthma
2. Patients with history of coronary artery disease
3. Patients with history of stroke.
4. Patients with peripheral vascular disease

5. Patient not able to walk
6. Recent thoracic & abdominal surgery
7. Any associated restrictive lung disease

**Study Design**

It is a cross sectional observational study.

## Variables

**Dependent Variables:**

1. Heart Rate
2. Respiratory Rate
3. Blood Pressure
4. $O_2$ Saturation
5. Mild, moderate, and severe COVID 19

**Independent Variables:**

- 6-minutes walk test

**Equipment Required**

1. Stethoscope
2. Sphygmomanometer
3. Pulse Oximetry
4. Inch tape
5. Weighing scale

# PROCEDURE

All the selected subjects were informed in detail about the type and nature of the study. The patient was requested to sign the consent form. A complete cardiopulmonary physiotherapy assessment was done for each patient. Patient meeting inclusion and exclusion criteria was selected for the study who were further randomly assigned into experimental (group A- Mild, B- Moderate and C-Severe) and control group. Control group was normal individuals with comparable age group and of similar gender. Random distribution was done according to random number tables.

**Methods:**

- Blood pressure, heart rate and respiratory rate will be measured before and after 6-minutes walk test in COVID 19 recovered patient
- Similar findings will be noted in comparable normal group
- In each group 30- 30 patients will be allotted
- Further patients will be categorized in mild, moderate, and severe covid
- Comparison of both groups will be done if there is any change.

Pre & Post intervention data for determining the following parameters like heart rate respiratory rate, blood pressure, O2 Saturation will be recorded by the using of the following methods. The device use for the study includes in which stethoscope is use for measuring heart rate and respiratory rate is sphygmomanometer is use for measuring blood pressure, pulse oximetry is use for measuring the O2 saturation level in blood, inch tape is use for measuring height in meter & weighing machine use for measuring weight in KG for the BMI.

**Operational Definitions:**

**Heart Rate**

Heart rate is the number of times heartbeat in one minutes. Normal value: 72 beats per minutes.

**Respiratory Rate**

Inhalation and Exhalation of environmental air in per unit time. Normal Value: 12 breaths per minutes.

**Blood Pressure**

Force exerted by the blood against any unit area of the vessel wall. Normal value: 120/80 mmHg.

**Basal Metabolic Index (BMI):**

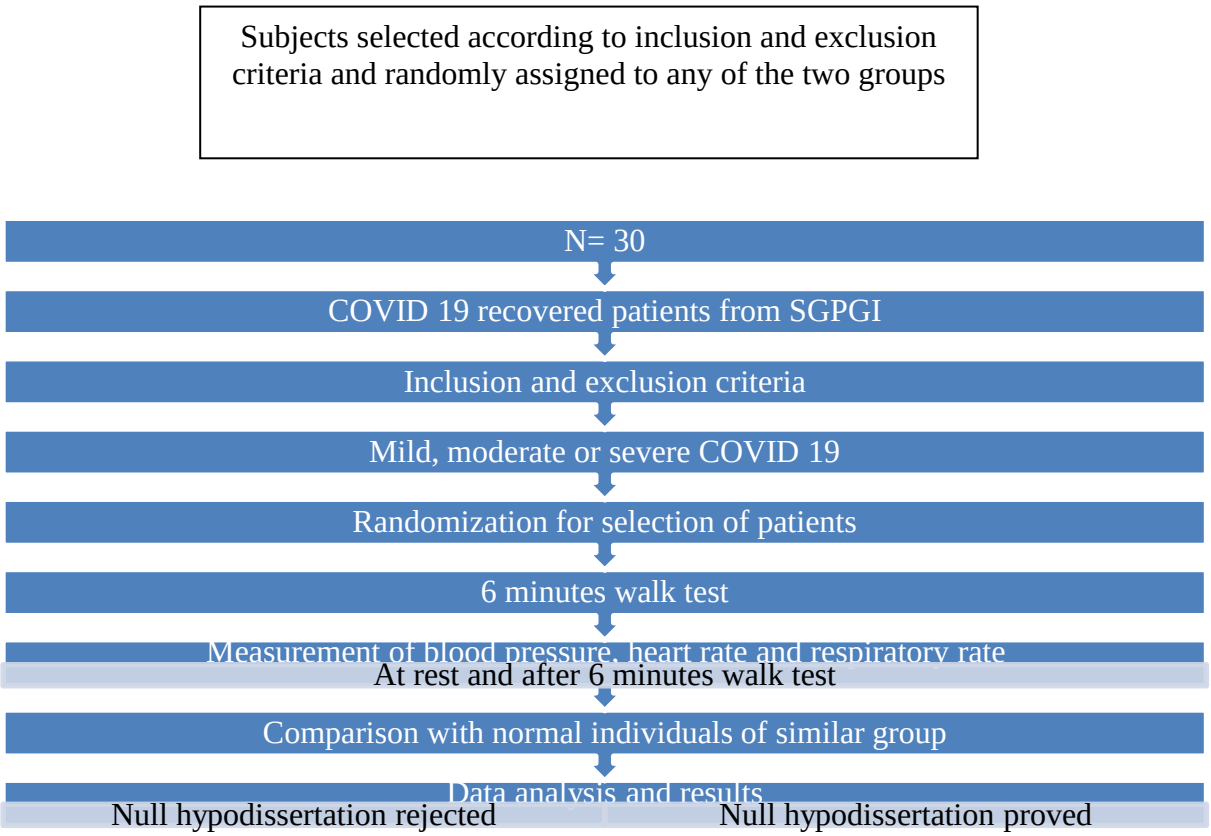
Weight in kg divided by the height in meters squared. Normal value- Adults: 18-25.

**Oxygen Saturation**

To indicate the amount of hemoglobin capable of transporting O2 and "fractional O2HB" to represent the fraction of hemoglobin that is oxygenated.

## PROTOCOL

On the basis of the criteria mentioned above the subjects will be randomly assign to any of the two groups.




| | | |
|---|---|---|
| **Group A- Mild disease** | | Symptomatic patients meeting the case definition for COVID-19 without evidence of viral pneumonia or hypoxia. See the WHO website for most up-to-date case definitions[24]. |
| **Group B- Moderate disease** | **Pneumonia** | **Adolescent or adult** with clinical signs of pneumonia (fever, cough, dyspnoea, fast breathing) but no signs of severe pneumonia, including SpO2 ≥ 90% on room |

| | | |
|---|---|---|
| | | air[25].<br><br>**Child** with clinical signs of non-severe pneumonia (cough or difficulty breathing + fast breathing and/or chest indrawing) and no signs of severe pneumonia. Fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40 [26]. While the diagnosis can be made on clinical grounds; chest imaging (radiograph, CT scan, ultrasound) may assist in diagnosis and identify or exclude pulmonary complications.<br><br>**Caution:** The oxygen saturation threshold of 90% to define severe COVID-19 was arbitrary and should be interpreted cautiously. For example, clinicians must use their judgment to determine whether a low oxygen saturation is a sign of severity or is normal for a given patient with chronic lung disease. Similarly, a saturation >90-94% on room air is abnormal (in patient with normal lungs) and can be an early sign of severe disease if patient is on a downward trend. Generally, if there is any doubt, the panel suggested erring on the side of considering the illness as severe. |

| | | |
|---|---|---|
| **Group C- Severe disease** | **Severe pneumonia** | **Adolescent or adult** with clinical signs of pneumonia (fever, cough, dyspnoea) plus one of the following: respiratory rate > 30 breaths/min; severe respiratory distress; or SpO2 < 90% on room air [27, 28]. **Child** with clinical signs of pneumonia (cough or difficulty in breathing + fast breathing or chest wall indrawing) + at least one of the following:<br>• SpO2 < 90%;<br>• Very severe chest wall indrawing, grunting, central cyanosis, or presence of any other general danger sign (inability to breastfeed or drink, lethargy or unconsciousness, or convulsions)[29].<br>While the diagnosis can be made on clinical grounds; chest imaging (radiograph, CT scan, ultrasound) may assist in diagnosis and identify or exclude pulmonary complications. |

Subjects meeting inclusion criteria were selected for the study. Participants were randomly distributed into the three groups. All subjects were evaluated for the outcome measures before the commencement of pre and post 6-minutes walk test. Each subject was evaluated individually and tested following standard Protocol. 30 subjects of COVID recovered and 30 were normal individuals.

# CHAPTER-4

# DATA ANALYSIS

# DATA ANALYSIS

Statistical analysis was performed using Statistical Package for Social Science (SPSS) Version 20.0. Measurement data was expressed as mean ± standard deviation. Continuous variables were compared using independent sample t test, whereas the rank sum test was used for nonparametric data. Comparison of proportion was evaluated by Chi-square test. Spearman correlation test was used to detect the correlations between lung function and lung total severity score. All statistical tests were two tailed. Statistical significance was taken as $p<0.05$.

# CHAPTER-5

# RESULT

# RESULT

This chapter deals with the data analysis of three groups mild, moderate, severe covid group, and normal individuals on outcome measures HR, RR, SPO2, BP (SBP, DBP) and MAP both pre and post 6-minutes walk test.

**Demographic data:**

Demographic data showed the personal characteristics of the study subjects. In our study we had 60 respondents in which 58.3 % are male and 41.7 % are female. The male to female ratio was 1.4: 1. The total number of subjects were 60 which were equally distributed in two groups; Normal and Covid 19 recovered. The subject's demographic data is given below:

**Table No. 1: Distribution of gender of the study subjects in different groups**

| Variable | Normal | Covid | p-value |
|---|---|---|---|
| Male | 18 | 17 | 0.500 |
| Female | 12 | 13 | |

Table 1 shows the distribution of gender of the study subjects in different groups. Statistical analysis shows that the distribution of male and female is different in each group with p value - 0.500)

**Table No. 2: Distribution of covid category**

| | Frequency | Percent |
|---|---|---|
| Normal | 30 | 50.0 |
| Mild | 8 | 13.3 |
| Moderate | 10 | 16.7 |
| Severe | 12 | 20.0 |

| | | |
|---|---|---|
| Total | 60 | 100.0 |

Covid patients were categorized into mild (8 in number), moderate (10 in number) and severe (12 in number) and further analyzed into each variables.

The mean age of study subjects in normal group was 43.76 years with SD 10.813, in covid group was 45.07 years with SD 11.166.

**Table No. 3: Mean age of covid category**

This table shows age group of all covid category and normal subjects.

| covid category | Mean | N | Std. Deviation | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|
| Normal | 43.67 | 30 | 10.813 | 17 | 60 | |
| Mild | 53.75 | 8 | 4.496 | 45 | 59 | |
| Moderate | 41.30 | 10 | 10.688 | 23 | 62 | 0.061 |
| Severe | 42.42 | 12 | 12.124 | 24 | 60 | |
| Total | 44.37 | 60 | 10.920 | 17 | 62 | |

On applying ANNOVA test, it was found that there was no statistical difference in age group distribution for covid as far as severity is concerned (p value- 0.061)

**Table No. 4: Mean BMI (kg/m2) in covid and normal patients**

This table shows the how covid affects the obese patients and severity of covid in these patients.

| covid category | Mean | N | Std. Deviation | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|
| Normal | 26.203 | 30 | 6.7968 | 16.8 | 45.3 | |
| Mild | 33.600 | 8 | 5.3020 | 22.0 | 39.5 | 0.034 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Moderate | 25.520 | 10 | 5.4536 | 19.7 | 34.7 | |
| Severe | 27.008 | 12 | 6.8541 | 16.8 | 39.8 | |
| Total | 27.237 | 60 | 6.7736 | 16.8 | 45.3 | |

It was found that there was statistically significant difference with p value of 0.034 in BMI. It means BMI affects the Covid severity in patients.

However, on comparing the normal to covid patient, there was no statistically significant difference in covid occurrence according to BMI (p value- 0.241).

**Table 4.1: Comparison of covid and normal with BMI**

| COIVD OR NORMAL | Mean | N | Std. Deviation | P value |
|---|---|---|---|---|
| Normal | 26.203 | 30 | 6.7968 | 0.241 |
| Covid | 28.270 | 30 | 6.7036 | |
| Total | 27.237 | 60 | 6.7736 | |

**Effect on vitals after 6- minutes walk test:**

Both groups, covid and normal subjects were made to do 6- minutes walk test and all vitals including SPO2, heart rate, systolic and diastolic blood pressure including mean arterial pressure was measured and compared to check whether there is effect on vitals after doing exercise testing and their significant difference.

**Table No. 5: Comparison of SPO2 before and after exercise testing**

| Covid Category | | Pre Spo2 | Post Spo2 | P value |
|---|---|---|---|---|
| Normal | Mean | 98.37 | 97.20 | |

| | | | | |
|---|---|---|---|---|
| | N | 30 | 30 | |
| | Std. Deviation | 1.033 | 1.448 | |
| | Minimum | 96 | 93 | |
| | Maximum | 100 | 99 | |
| | Mean | 97.88 | 96.38 | |
| | N | 8 | 8 | |
| Mild | Std. Deviation | 1.356 | 1.598 | |
| | Minimum | 96 | 94 | 0. 047 |
| | Maximum | 99 | 99 | |
| | Mean | 97.90 | 91.50 | |
| | N | 10 | 10 | |
| Moderate | Std. Deviation | .738 | .972 | |
| | Minimum | 97 | 90 | |
| | Maximum | 99 | 93 | |
| | Mean | 97.25 | 88.58 | |
| | N | 12 | 12 | |
| Severe | Std. Deviation | 1.485 | 1.929 | |
| | Minimum | 94 | 84 | |
| | Maximum | 99 | 91 | |
| | Mean | 98.00 | 94.42 | |
| Total | N | 60 | 60 | |
| | Std. Deviation | 1.193 | 3.872 | |

| | | | |
|---|---|---|---|
| Minimum | 94 | 84 | |
| Maximum | 100 | 99 | |

Table 5 shows that there was significant difference in SPO2 after doing 6-minutes walk test with a P value of 0.047.

The change in SPO2 was further analyzed between these groups and shown in table 5.1

**Table 5.1: Change in SPO2 after 6-minutes walk test**

Change in SPO2

| Covid category | Mean | N | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Normal | 1.57 | 30 | 1.278 | 0 | 6 |
| Mild | 2.00 | 8 | 1.069 | 1 | 4 |
| Moderate | 6.40 | 10 | 1.174 | 5 | 8 |
| Severe | 8.67 | 12 | 1.614 | 5 | 11 |
| Total | 3.85 | 60 | 3.251 | 0 | 11 |

This table shows that there was a change of 1.57± 1.278 in normal subjects while there is little more drop in SPO2 in covid recovered patients with a maximum drop occurred in severe patients of 8.67± 1.614. This difference was statistically significant with a P value of 0.047

**Table No. 5: Comparison of heart rate before and after exercise testing**

| Covid category | | Pre HR | Post HR | P value |
|---|---|---|---|---|
| Normal | Mean | 76.20 | 99.23 | 0.000 |
| | N | 30 | 30 | |
| | Std. Deviation | 5.542 | 9.874 | |
| | Minimum | 64 | 79 | |
| | Maximum | 84 | 118 | |
| Mild | Mean | 79.25 | 107.25 | |
| | N | 8 | 8 | |
| | Std. Deviation | 6.628 | 9.130 | |
| | Minimum | 68 | 94 | |
| | Maximum | 88 | 121 | |
| Moderate | Mean | 84.30 | 130.70 | |
| | N | 10 | 10 | |
| | Std. Deviation | 3.802 | 6.019 | |
| | Minimum | 81 | 121 | |
| | Maximum | 94 | 139 | |
| Severe | Mean | 92.58 | 136.50 | |
| | N | 12 | 12 | |
| | Std. Deviation | 3.801 | 6.667 | |
| | Minimum | 85 | 120 | |
| | Maximum | 98 | 142 | |
| Total | Mean | 81.23 | 113.00 | |

| | | | |
|---|---|---|---|
| N | 60 | 60 | |
| Std. Deviation | 8.150 | 18.382 | |
| Minimum | 64 | 79 | |
| Maximum | 98 | 142 | |

This table shows that there was change in heart rate after 6- minutes walk test with significant p-value.

The difference between heart rate pre and post walk test was also analyzed as shown in table 5.1

**Table 5.1: difference of heart rate after 6- minutes walk test**

Difference in HR

| Covid category | Mean | N | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Normal | 23.03 | 30 | 8.430 | 8 | 39 |
| Mild | 28.00 | 8 | 11.427 | 19 | 46 |
| Moderate | 46.40 | 10 | 5.232 | 40 | 57 |
| Severe | 43.08 | 12 | 5.823 | 31 | 49 |
| Total | 31.60 | 60 | 12.804 | 8 | 57 |

This shows that there was more change in moderate and severe covid recovered patients in heart rate after 6- minutes walk test which is statistically significant on applying ANNOVA test.

**Table No. 6: Comparison of respiratory rate before and after exercise testing**

Difference in RR

| Covid category | Mean | N | Std. Deviation | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|
| Normal | 8.37 | 30 | 3.011 | 2 | 13 | |
| Mild | 9.38 | 8 | 1.408 | 7 | 11 | |
| Moderate | 15.00 | 10 | 3.859 | 10 | 22 | 0.000 |
| Severe | 19.08 | 12 | 2.746 | 14 | 23 | |
| Total | 11.75 | 60 | 5.261 | 2 | 23 | |

This table no. 6 shows that there was increase in respiratory rate in every subject but there was more increase in covid patients and that too is changing with severity of disease.

**Table No. 7: Comparison of systolic blood pressure before and after exercise testing**

| Covid category | | Pre SBP | Post SBP | P value |
|---|---|---|---|---|
| Normal | Mean | 123.33 | 141.27 | |
| | N | 30 | 30 | |
| | Std. Deviation | 6.133 | 7.781 | |
| | Minimum | 117 | 128 | |
| | Maximum | 141 | 163 | |
| Mild | Mean | 121.63 | 141.63 | |
| | N | 8 | 8 | |

| | | | | |
|---|---|---|---|---|
| | Std. Deviation | 3.777 | 2.875 | |
| | Minimum | 117 | 138 | |
| | Maximum | 129 | 147 | 0.015 |
| | Mean | 126.40 | 152.00 | |
| | N | 10 | 10 | |
| Moderate | Std. Deviation | 8.168 | 5.292 | |
| | Minimum | 117 | 143 | |
| | Maximum | 138 | 161 | |
| | Mean | 129.92 | 154.58 | |
| | N | 12 | 12 | |
| Severe | Std. Deviation | 7.342 | 7.077 | |
| | Minimum | 117 | 147 | |
| | Maximum | 140 | 166 | |
| | Mean | 124.93 | 145.77 | |
| | N | 60 | 60 | |
| Total | Std. Deviation | 6.972 | 8.909 | |
| | Minimum | 117 | 128 | |
| | Maximum | 141 | 166 | |

This table shows that there was a change in systolic blood pressure of all subjects. But more change was noted in covid recovered patients as compared to normal group and this change was statistically significant with a P- value of 0.015

**Table 7.1: Difference of SBP pre and post 6- minutes walk test**

Difference in SBP

| Covid category | Mean | N | Std. Deviation | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|
| Normal | 17.93 | 30 | 4.856 | 8 | 25 | |
| Mild | 20.00 | 8 | 2.673 | 18 | 25 | 0.000 |
| Moderate | 25.60 | 10 | 4.835 | 16 | 32 | |
| Severe | 24.67 | 12 | 5.087 | 19 | 34 | |
| Total | 20.83 | 60 | 5.660 | 8 | 34 | |

**Table No. 8: Comparison of diastolic blood pressure before and after exercise testing**

| Covid category | | Pre DBP | Post DBP | P value |
|---|---|---|---|---|
| | Mean | 80.63 | 89.77 | |
| | N | 30 | 30 | |
| Normal | Std. Deviation | 5.183 | 4.819 | |
| | Minimum | 70 | 82 | |
| | Maximum | 94 | 98 | |
| Mild | Mean | 80.38 | 93.25 | |

| | | | | |
|---|---|---|---|---|
| | N | 8 | 8 | |
| | Std. Deviation | 2.615 | 3.151 | |
| | Minimum | 76 | 89 | |
| | Maximum | 84 | 99 | |
| | Mean | 83.30 | 94.30 | |
| | N | 10 | 10 | 0.004 |
| Moderate | Std. Deviation | 5.034 | 5.376 | |
| | Minimum | 78 | 88 | |
| | Maximum | 92 | 103 | |
| | Mean | 86.75 | 99.00 | |
| | N | 12 | 12 | |
| Severe | Std. Deviation | 5.396 | 3.568 | |
| | Minimum | 79 | 93 | |
| | Maximum | 92 | 104 | |
| | Mean | 82.27 | 92.83 | |
| | N | 60 | 60 | |
| Total | Std. Deviation | 5.424 | 5.681 | |
| | Minimum | 70 | 82 | |
| | Maximum | 94 | 104 | |

his table shows that there was a change in diastolic blood pressure of all subjects. But more change was noted in covid recovered patients as compared to normal group and this change was statistically significant with a P- value of 0.004

**Table 8.1: Difference of DBP pre and post 6- minutes walk test**

Difference in DBP

| Covid category | Mean | N | Std. Deviation | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|
| Normal | 9.17 | 30 | 3.405 | 4 | 17 | |
| Mild | 12.88 | 8 | 2.232 | 10 | 17 | 0.005 |
| Moderate | 11.00 | 10 | 2.000 | 9 | 14 | |
| Severe | 12.25 | 12 | 3.361 | 7 | 18 | |
| Total | 10.58 | 60 | 3.366 | 4 | 18 | |

The above result shows that there was more change in diastolic blood pressure in covid patients as compared to normal individuals with a p value of 0.005

**Table 8.1: Difference of Mean arterial pressure pre and post 6- minutes walk test**

Difference in MAP

| Covid category | Mean | N | Std. Deviation | Minimum | Maximum | P value |
|---|---|---|---|---|---|---|
| Normal | 12.00 | 30 | 3.582 | 5 | 18 | |
| Mild | 15.13 | 8 | 1.959 | 12 | 17 | |
| Moderate | 16.00 | 10 | 1.826 | 12 | 18 | 0.000 |
| Severe | 16.25 | 12 | 3.769 | 12 | 23 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total | 13.93 | 60 | 3.718 | 5 | 23 | |

The above results showed that there was increase in mean arterial pressure in all subjects but more increase in covid recovered patients and this result was statistically significant.

# CHAPTER-6

# DISCUSSION

# DISCUSSION

While a number of studies describe the clinical features of patients with COVID-19, few have directly compared the clinical presentation and outcomes of COVID-19 to other respiratory illnesses[29, 30]. Without a control group, and in settings of restricted COVID-19 test availability, we cannot ascertain whether COVID-19 presents differently from other forms of respiratory illnesses. Patients diagnosed with COVID-19 had a longer duration of symptoms prior to presentation and were more likely than control patients to report fever, fatigue and myalgias. It is notable, however, that 44% of COVID-19 negative patients reported fevers and systemic symptoms were common[4, 6, 7]. There are very limited studies which have shown the late impact of covid on vitals and their relation to the exercise testing.

## Demographics

In our study we had 60 respondents in which 58.3 % are male and 41.7 % are female. The male to female ratio was 1.4: 1. The mean age of study subjects in normal group was 43.76 years with SD 10.813, in covid group was 45.07 years with SD 11.166.

Chen Q et al[31] studied Cardiovascular manifestations in severe and critical patients with COVID-19. The average age in their study population was 57.6 ± 12.7 years old and aged people older than 65 years accounted for one-third. Nearly two-third of the patients were male in whether severe or critical cases. The age and gender distribution in their study were consistent with the data recently published in Lancet[32], suggesting that old adult male patients are more likely to develop critical conditions and deserve more attention. We suspected that fewer females in severe and critical cases may partly owe to the protection of X chromosome and oestrogens in female patients.

In our study, it was found that obesity having impact on severity of disease. In our study, overall mean BMI of patients was 27.237 ± 6.7736 kg/m2. The difference was statistically significant with a P value of 0.034.

There have been several reports indicating obesity to be a strong factor for becoming seriously ill with COVID- 19[33-35]. A retrospective study from Lille, France analysed the relationship between body mass index BMI and requirement for invasive mechanical ventilation (IMV) in 124 consecutive patients admitted in intensive care for SARS-COV-2. Out of 124 patients, 84 (75.8%) were obese (BMI > 30 kg/m2), indicating a high incidence of obesity among patients admitted to intensive care for SARS-COV-2 [36].

**Effect on vitals:**

**Oxygen saturation (SPO2)**

SpO2, also known as oxygen saturation, is a measure of the amount of oxygen-carrying haemoglobin in the blood relative to the amount of haemoglobin not carrying oxygen.

In our study, there was significant difference in SPO2 after doing 6 minutes walk test with a P value of 0.047. The overall mean change in SPO2 after 6 minutes walk test was 3.85± 3.251. the decrease in SPO2 after walk test was less in normal individuals 1.57± 1.278 while higher in covid patients and maximum decrease in SPO2 found in severely affected covid patients 8.67± 1.614.

Ray et al in their study found that the most common cause for prolonged hospitalisation in these patients was need for oxygen therapy to maintain a saturation of ≥95%, seen in 93 (59.6%) patients which constituted our study group. Of the 30/156 patients who were ≥70 years of age, 29 (96.6%) required oxygen at the time of transfer to the isolation ward [37].

## Heart rate

There is always an increase in heart rate following 6-minutes walk test in both normal and patients. In our study, mean increase in heart rate in normal subjects was 23.03 ± 8.430 per minutes. While in covid patients it was much higher than normal subjects. In covid patients, there is almost two- fold increase in heart rate following 6- minutes walk test, e.g. In severe covid recovered patient, there was mean increase in heart rate of 43.08 ± 5.823 per minutes. This change was statistically significant.

The study done by Jared Kaltwasser found patients who were positive for the infection took longer to return to their pre-infection resting heart rate, sleep duration, and step counts, compared to those who tested negative for the virus, though resting heart rate took the longest to recover. On average, it took patients 79 days after symptom onset for their resting heart rate to return to normal, versus 32 and 24 days for step count and sleep quality, respectively. In addition, the investigators found a small subset of patients, about 13.7%, took more than 133 days to return to normal [38].

## Respiratory rate

In our study, there was increase in respiratory rate in every subject but there was more increase in covid patients and that too is changing with severity of disease. The overall increase was 11.75 ± 5.261 breaths per minutes. In normal subjects, there was increase of 8.37± 3.01 breaths per minutes while there was greater increase in respiratory rate following 6- minutes walk test. In addition to that there was higher increment in relation to severity of covid. The mild covid recovered patients had lesser increase in respiratory rate (9.38 ± 1.408) as compared to severely affected covid recovered patients (19.08 ±. 2.746) was found statistically significant.

A 1-year follow-up study on 97 recovering SARS patients in Hong Kong showed that 27.8% of survivors presented with decreased lung function and signs of pulmonary fibrosis compared to a normal population, which was confirmed by another follow-up study 39. Moreover, the phylogenetically related Middle East respiratory syndrome (MERS) coronavirus (CoV) was shown to induce pulmonary fibrosis in up to 33% of patients [40]. As SARS-CoV-2 shares high homology with SARS-CoV-1, and to a lesser extent with MERS-CoV, it is thus conceivable that survivors of COVID-19 may also develop pulmonary fibrosis [41]. With worldwide >74 million confirmed cases at the time of writing, and an average 20% of patients with a moderate-to-severe course of infection often needing hospitalisation, the development of fibrosing lung disease after clearance of infection could become an enormous health concern.

**Blood pressure**

In our study, there was a change in systolic blood pressure of all subjects. But more change was noted in covid recovered patients as compared to normal group and this change was statistically significant with a P- value of 0.015. SBP increases more in covid patients.

Our study showed that there was a change in diastolic blood pressure of all subjects. But more change was noted in covid recovered patients as compared to normal group and this change was statistically significant with a P- value of 0.004. The increase in DBP was higher in covid recovered patients as compared to normal subjects.

In our study, there was increase in mean arterial pressure in all subjects but more increase in covid recovered patients and this result was statistically significant. The mean change in MAP in normal subject was $12 \pm 3.58$ mm of Hg while in covid recovered subjects, there was greater increase in MAP after 6-minutes walk test.

This concludes that although there is increase in SBP, DBP and MAP but there is little increase in MAP and DBP and more increase in SBP in our study.

In this retrospective study done by Jinjun Ran et al[42] of 803 COVID-19 patients with coexisting hypertension, we found that high average SBP and high SBP/DBP variability during hospitalization were independently associated with in-hospital mortality, ICU admission, and heart failure. The findings suggest that low and stable BP are optimal to achieve a favorable prognosis for COVID-19 patients with coexisting hypertension. Another finding with clinical implications is that ARB drugs did not cause higher risks of adverse outcomes in hypertensive patients, and even a benefit in regard to heart failure was observed. The researchers estimated the risks and excess burden of cardiovascular outcomes per 1000 persons 12 months after COVID-19 using electronic medical record data from 3 large cohorts:

- 153 760 patients who used VHA services in 2019 and had a positive SARS-CoV-2 test result between March 1, 2020, and January 15, 2021

- 5 637 647 patients with no evidence of SARS-CoV-2 infection who used VHA services in 2019—the contemporary control group

- 5 859 411 prepandemic patients who used VHA services in 2017—the historical control group

At the 12-month mark, compared with the contemporary control group, for every 1000 people, COVID-19 was associated with an extra:

- 45.29 incidents of any prespecified cardiovascular outcome

- 23.48 incidents of major adverse cardiovascular events (MACEs), including myocardial infarction, stroke, and all-cause mortality

- 19.86 incidents of dysrhythmias, including 10.74 incidents of atrial fibrillation

- 12.72 incidents of other cardiovascular disorders including 11.61 incidents of heart failure and 3.56 incidents of nonischaemic cardiomyopathy

- 9.88 incidents of thromboembolic disorders, including 5.47 incidents of pulmonary embolism and 4.18 incidents of deep vein thrombosis

- 7.28 incidents of ischemic heart disease including 5.35 incidents of acute coronary disease, 2.91 incidents of myocardial infarction, and 2.5 incidents of angina

- 5.48 incidents of cerebrovascular disorders, including 4.03 incidents of stroke

- 1.23 incidents of inflammatory disease of the heart or pericardium, including 0.98 incidents of pericarditis and 0.31 incidents of myocarditis

Patients with more severe disease—determined by whether they recuperated at home, were hospitalized, or were admitted to the intensive care unit—had higher risks. But the risks were evident even among those who were not hospitalized with COVID-19. Other subgroup analysis found increased risks regardless of age, race, sex, obesity, smoking, hypertension, diabetes, chronic kidney disease, hyperlipidaemia, and pre-existing cardiovascular disease.

## Limitations of study

- The study is limited by small sample size.
- The study is limited by time because short time of duration was used in study.

Scope for future research

- Future research can be carried out but taking larger sample size.
- Long duration of time can be included for future studies.
- Other parameters can also be included in further study

# CHAPTER-7

# CONCLUSION

# CONCLUSION

- There have been lots of studies done related to covid symptoms, treatment and outcome including post effects of covid.
- Overall burden of post covid symptoms has been increasing. Still there are various studies are going on as covid situation has not been eradicated yet because of multiple new strains are coming up after every wave.
- Almost all organs are affected by this virus so cardiorespiratory system even persists as late effect. There are multiple direct or indirect factors involved for this damage.
- All individuals have change in vitals (heart rate, respiratory rate, and blood pressure).
- Covid recovered patients have more change in vitals after 6- minutes walk test due to post covid symptoms.
- The severity of covid also responsible for greater change in vitals in patients.

# CHAPTER-8
# REFERENCES

## REFERENCES


1. Groß S, Jahn C, Cushman S, Bär C, Thum T. SARS-CoV-2 receptor ACE2-dependent implications on the cardiovascular system: from basic science to clinical implications. J Mol Cell Cardiol. 2020; 144:47–53.
2. Zou, L.; Ruan, F.; Huang, M.; Liang, L.; Huang, H.; Hong, Z.; Yu, J.; Kang, M.; Song, Y.; Xia, J.; et al. SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. N. Engl. J. Med. 2020, 382, 1177–1179.
3. Puntmann VO, Carerj ML, Wieters I, et al. Outcomes of cardiovascular magnetic resonance imaging in patients recently recovered from coronavirus disease 2019 (COVID-19). JAMA Cardiol. Published online July 27, 2020. doi:10.1001/jamacardio.2020.3557
4. Huang Y, Tan C, Wu J, et al. Impact of coronavirus disease 2019 on pulmonary function in early convalescence phase. Respir Res. 2020;21(1):163. doi:10.1186/s12931-020-01429-6
5. Zhao YM, Shang YM, Song WB, et al. Follow-up study of the pulmonary function and related physiological characteristics of COVID-19 survivors three months after recovery. EClinicalMedicine. 2020; 25:100463. doi:10.1016/j.eclinm.2020.100463
6. Zhou, P. et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature 579, 270–273 (2020).
7. Wu, F. et al. A new coronavirus associated with human respiratory disease in China. Nature 579, 265–269 (2020).
8. Lu, R. et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 395, 565–574 (2020).
9. Hoffmann, M. et al. SARS- CoV-2 cell entry depends on ACE2 and TMPRSS2 and is blocked by a clinically proven protease inhibitor. Cell 181, 271–280 (2020).
10. Tay, M. Z., Poh, C. M., Renia, L., MacAry, P. A. & Ng, L. F. P. The trinity of COVID-19: immunity, inflammation, and intervention. Nat. Rev. Immunol. 20, 363–374 (2020).

11. LiW, Hulswit RJG, Kenney SP, et al. Broad receptor engagement of an emerging global coronavirus may potentiate its diverse cross-species transmissibility. Proc Natl Acad Sci USA. 2018;115(22): E5135-E5143. doi:10.1073/pnas.1802879115
12. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia inWuhan, China: a descriptive study. Lancet. 2020;395(10223):507-513. doi:10.1016/S0140-6736(20)30211-7
13. Zadow EK, Wundersitz DWT, Hughes DL, Adams MJ, Kingsley MIC, Blacklock HA, et al. Coronavirus (COVID-19), coagulation, and exercise: interactions that may influence health outcomes. Semin Thromb Hemost. (2020) 46:807–14. doi: 10.1055/s-0040-1715094
14. Golemi MI, Golemi L, Tafur, Pursnani AA. The novel coronavirus disease (COVID-19) and its impact on cardiovascular disease. Card Rev. (2020) 28:163–76.
15. SHERRILL PLEA. Reference equations for the six-minutes walk in healthy adults. Am J Respir Crit Care Med. 1998; 158:1384–7.
16. Kwenandar F, Japar KV, Damay V, Hariyanto TI, Tanaka M, Lugito NPH, et al. Coronavirus disease 2019 and cardiovascular system: a narrative review. IJC Heart Vascul. (2020) 29:100557. doi: 10.1016/j.ijcha.2020100557
17. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y,Wei Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020; 395:507–513. doi: 10.1016/S0140-6736(20)30211-7
18. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DSC, et al; China Medical Treatment Expert Group for Covid-19. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med. 2020; 382:1708–1720. doi: 10.1056/NEJMoa2002032
19. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020; 395:497–506. doi: 10.1016/S0140- 6736(20)30183-5
20. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-

infected pneumonia in Wuhan, China. JAMA. 2020; 323:1061–1069. doi: 10.1001/jama.2020.1585

21. Ranieri VM, Rubenfeld GD, Thompson BT, Ferguson ND, Caldwell E, Fan E, Camporota L, Slutsky AS; ARDS Definition Task Force. Acute respiratory distress syndrome: the Berlin Definition. JAMA. 2012; 307:2526–2533. doi: 10.1001/jama.2012.5669
22. Wu C, Chen X, Cai Y, Xia J, Zhou X, Xu S, Huang H, Zhang L, Zhou X, Du C, et al. Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA Intern Med. 2020; 180:934–943.
23. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, Wu Y, Zhang L, Yu Z, Fang M, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med. 2020; 8:475–481. doi: 10.1016/S2213- 2600(20)30079-5
24. World Health Organization: Country & technical guidance – coronavirus disease (COVID-19). 2020.
25. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al.: Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The lancet 2020;395(10229):1054-1062
26. World Health Organization: IMAI District Clinician Manual. Hospital care for adolescents and adults. 2020.
27. World Health Organization: Pocket book of hospital care for children: Guidelines for the management of common childhood illnesses: Second edition. 2020.
28. Russell FM, Reyburn R, Chan J, Tuivaga E, Lim R, Lai J, et al.: Impact of the change in WHO's severe pneumonia case definition on hospitalized pneumonia epidemiology: case studies from six countries. Bulletin of the World Health Organization 2019;97(6):386-393.
29. Kim D, Quinn J, Pinsky B, Shah NH, Brown I. Rates of Co-infection Between SARS-CoV-2 and Other Respiratory Pathogens. JAMA. April 2020. doi: 10.1001/jama.2020.6266 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

30. 39. Sun Y, Koh V, Marimuthu K, et al. Epidemiological and Clinical Predictors of COVID-19. :7. [PMC free article] [PubMed] [Google Scholar
31. Chen Q, Xu L, Dai Y, et al. Cardiovascular manifestations in severe and critical patients with COVID-19. Clin Cardiol. 2020;43:796–802. https://doi. org/10.1002/clc.23384
32. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395:507-513.
33. Palaiodimos L, Kokkinidis DG, Li W, Karamanis D, Ognibene J, Arora S, et al. Severe obesity is associated with higher in-hospital mortality in a cohort of patients with COVID-19 in the Bronx. New York. Metabolism. 2020;108:154262.
34. Gao F, Zheng KI, Wang XB, Sun QF, Pan KH, Wang TY, et al. Obesity is a risk factor for greater COVID-19 severity. Diabetes Care. 2020;43(7):e72–4.
35. Chiappetta S, Sharma AM, Bottino V, Stier C. COVID-19 and the role of chronic inflammation in patients with obesity. Int J Obes. 2020;44(8):1790–2.
36. Simonnet A, Chetboun M, Poissy J, Raverdy V, Noulette J, Duhamel A, et al. High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) requiring invasive mechanical ventilation. Obesity (Silver Spring). 2020;28(7):1195–9.
37. Ray, A., Chaudhry, R., Rai, S., Mitra, S., Pradhan, S., Sunder, A., & Nag, D. S. (2021). Prolonged Oxygen Therapy Post COVID-19 Infection: Factors Leading to the Risk of Poor Outcome. Cureus, 13(2), e13357. https://doi.org/10.7759/cureus.13357
38. Jared Kaltwasser. Heart Rate, Sleep Patterns Can Remain Off for Weeks After COVID-19 Infection. July 29, 2021
39. Hui DS, Wong KT, Ko FW, et al. The 1-year impact of severe acute respiratory syndrome on pulmonary function, exercise capacity, and quality of life in a cohort of survivors. Chest 2005; **128**: 2247–2261. doi:10.1378/chest.128.4.2247
40. Ngai JC, Ko FW, Ng SS, et al. The long-term impact of severe acute respiratory syndrome on pulmonary function, exercise capacity and health status. Respirology2010; **15**: 543–550. doi:10.1111/j.1440-1843.2010.01720
41. Das KM, Lee EY, Singh R, et al. Follow-up chest radiographic findings in patients with MERS-CoV after recovery. Indian J Radiol Imaging 2017; **27**: 342–349. doi:10.4103/ijri.IJRI_469_16

42. Ran, J., Song, Y., Zhuang, Z. et al. Blood pressure control and adverse outcomes of COVID-19 infection in patients with concomitant hypertension in Wuhan, China. Hypertens Res **43,** 1267–1276 (2020). https://doi.org/10.1038/s41440-020-00541-w
43. Abbasi J. The COVID Heart—One Year After SARS-CoV-2 Infection, Patients Have an Array of Increased Cardiovascular Risks. JAMA. 2022;327(12):1113–1114. doi:10.1001/jama.2022.2411