



ASSESSMENT OF CARDIORESPIRATORY FITNESS IN POST COVID PATIENTS USING YMCA 3 MINUTE STEP TEST

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ABSTRACT

Aim: To assess cardiorespiratory fitness in post covid patients using YMCA 3 min step test.

Background: -Coronavirus disease 2019 (COVID-19) is caused by a novel beta-coronavirus known as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Infection caused by SARS-CoV-2 virus may range from a asymptomatic to a broad variety of symptoms, ranging from mild upper respiratory tract infection to life-threatening sepsis. Even though Covid-19 is a respiratory disease, but it causes a great damage to various other organs of the body including the heart. Thus, there's a need to study the Cardiorespiratory functioning (CRF) in post covid patients and thus the study is undertaken.

Methodology -This study was a cross sectional observational study where 56 post-covid patients were selected using convenient sampling.

Post Covid patients (1-3 months) between age group of 30-45 years including both hospitalized and patients who were under isolation were included in the study. YMCA 3 min step test was performed. Pre-test and post-test vitals were recorded. The post test heart rates were then compared with the YMCA rating scale.

Result - Out of the 40 subjects, 9 subjects had an average score, while 16 of them were below average and the remaining 15 subjects had poor cardiorespiratory functioning.

Conclusion -The cardio respiratory fitness as measured through Pulse rate, Pulse recovery time and SpO2 levels using YMCA-TMST was poor in post Covid Patients irrespective of the fact that they were hospitalized or were under isolation.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) is caused by a novel beta-coronavirus known as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).

Infection caused by SARS-CoV-2 virus may range from a asymptomatic to a broad variety of symptoms, ranging from mild upper respiratory tract infection to life-threatening sepsis. COVID-19 first emerged in December 2019, when a cluster of patients with pneumonia of unknown cause was recognized in Wuhan, China.^[1]

As of September, 2021, SARS-CoV-2 has affected more than 200 countries, resulting in more than 234 million identified cases with 4.8 million confirmed deaths Covid 19 has created a havoc globally affecting majority of the sectors in the world especially the health care sector. The sudden rise in the cases with rampant spread of the virus and with a limited information about the virus, it has become difficult to treat the patients infected with the virus while simultaneously curbing the spread of the virus. With the necessity to halt the rapid

spread of the pandemic, various countries across the world including have come up with the vaccines in order for prevention or rather minimizing the severity of the disease.

Clinical presentation

As stated by WHO, COVID-19 is a now a pandemic and affects different people in different ways. The common presentation seen is mild to moderate illness and recover without hospitalization where the most common symptoms are found to be fever, cough, tiredness, loss of taste or smell.

While the less common symptoms: sore throat, headache, aches and pains, diarrhoea, a rash on skin, or discoloration of fingers or toes, red or irritated eyes. At times patient also present with serious symptoms which includes difficulty breathing or shortness of breath, loss of speech or mobility, or confusion, chest pain.

Approximately half of the infected patients have comorbidities, 60% to 90% of hospitalized infected patients have comorbidities. The most common comorbidities in hospitalized patients include hypertension, diabetes, cardiovascular disease, chronic pulmonary disease, chronic kidney disease, malignancy, and chronic liver disease. Anosmia or ageusia

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may be the sole presenting symptom in some of the patients. COVID -19 comes along with a variety of complications with impaired functioning seen in many other vital organs viz heart, brain, lung, liver, kidney and the circulatory system having problems with the coagulation. The disease can also lead to myocarditis, cardiomyopathy, ventricular arrhythmias, and hemodynamic instability.^[1]

Significant cardiovascular damage has been observed in severe COVID-19 cases. Cardiac biomarkers cardiac troponin and Brain natriuretic peptides indicative of cardiac injury and failure are significantly raised according to several studies done earlier. Also, a strong correlation is seen in the rising cardiac troponin levels and other inflammatory markers like CRP, Interlukin-6 and ferritin. Thus, suggests of inflammatory damage to the heart. Notwithstanding, it's important to notice that a couple of studies have described cases presenting with primary cardiac symptoms, suggesting myocarditis and stress-related cardiomyopathy thanks to respiratory failure and hypoxemia. Right now, there is lacking validation to support direct virus infection of cardiomyocytes, although SARS-CoV-2 genomes are effectively detected in endomyocardial postmortem examinations, predominantly involving endangered cell infiltrates. In addition to the above mechanism, cytokine release is known to directly affect cardiomyocytes and also causes endothelial cell reprogramming and dysfunction, rebuilding their crucial role in COVID-19 cardiovascular manifestations^[2]

As seen earlier the literatures have suggested the devastating cardiorespiratory signs and symptoms in these covid patients. The assessment of exercise capacity is an important clinical measure of the functional status in people with pulmonary disease. Thus, there is a need to study on the cardiorespiratory fitness in these patients in their post covid phase. Moreover, there are many articles and researches done over the cardiorespiratory functioning of the various pulmonary conditions like COPD, asthma, bronchiectasis, and restrictive lung conditions, but there's lack of research done on CRF in Post Covid patients. This deadly disease thus demands for this research.

Cardiorespiratory fitness (CRF) is a health-related component of physical fitness defined as the ability of the circulatory, respiratory, and muscular systems to supply oxygen during sustained physical activity.^[3] The gold standard tests used for its assessment are the cardiopulmonary exercise testing, on a treadmill or a cyclo-ergometer, and the one-repetition maximum. Even the field walking tests are considered valid options viz. the six-minute walk test and the incremental or endurance shuttle walk test.^[4,5]

The disadvantages in these mentioned tests are that they require a large amount of space, the equipments are necessary for cardiopulmonary exercise testing, thus becomes a drawback in the application in the new pulmonary rehabilitation protocols.^[5]

At the time of this COVID-19 pandemic it is very important to bridge the gap between the hospitalization to community/home and, for that, the search for tests with minimal space requirements for exercise testing is necessary.

YMCA Step Test

Step tests are an effective way, as it serves the purpose of less space requirement, easily available equipment, and the major

benefit or advantage is that it is analogous to the daily activities like the stair climbing. There are many step tests that are described which generally have different equipments like the stepper but with various objectives and parameters to be looked upon. These parameters may vary like the pace of the test which may be self-decided or may be on a metronome with a fixed frequency.^[6]

Step tests have an upper hand over other submaximal tests with few advantages. We have a wide number of step test protocols with varying step duration, stages and frequency serving the main moto of Assessing CRF. One popular example is the YMCA 3MST for assessing the CRF, but doesn't calculate the VO_{2max} .^[7]

MATERIALS AND METHODS

This study was a cross sectional observational study where 56 post-covid patients were selected using convenient sampling. Inclusion criteria: Post Covid patients (1-3 months) willing to participate, the subjects in this study were both males and females, the age group of 30-45 years including both hospitalized and patients who were under isolation.

Exclusion criteria: Subjects having any recent musculoskeletal injuries or any recent trauma to the lower extremity or having any neurological problems or any previously diagnosed severe cardiorespiratory pathology were excluded from the study.

Procedure

The post covid patients were screened and included in the study according to the inclusion criteria. The subjects were carefully explained about the procedure and a written informed consent was taken. The subjects were advised not to have any heavy meals before the test.

Demographic data was recorded. Anthropometric values like Height and weight were noted and BMI was calculated.

METHOD

A total of 60 participants were screened for the study, 16 of them did not meet up the inclusion criteria, 44 subjects who matched the inclusion criteria who gave consent for the study were included. Out of which 4 subjects couldn't complete the test. 3 of them couldn't maintain the speed of the metronome and rest got tired and 1 discontinued the test.

40 subjects completed the test successfully. Participants were advised not to have any kind of heavy meals prior to the test. Anthropometric measurements noted. Weight(kg) and height(m) were noted and BMI was calculated.

YMCA 3 MIN STEP TEST was demonstrated and shown to the subjects.

According to the step test protocol the participants stepped on and off of the stepper 24 times per minute for 3 minutes with help of metronome. Pulse rate was checked before and after the test. Pre-test resting heart rate was recorded.

The metronome was set up to 96 beats per minute with such a volume that is audible to the subject. The subject stood in front of the stepper. When the subject was ready, the timer started and the subject had to step on and off the stepper to the metronome beat following a cadence of up, up, down, down. This was continued for 3 mins. After 3 minutes, the test was ended and the subject was made to sit. Pulse rate was recorded

after 1 minute immediately using a pulse oximeter. The scores were then compared from the YMCA rating scale. The subjects were instructed to sit still, breathe normally, throughout the test and were instructed not to have conversation during recovery period. The Rate of perceived exertion was also noted using Modified Borg’s Scale post the test.

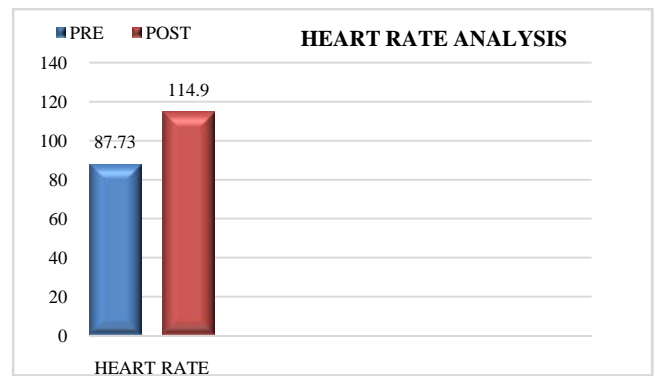


RESULTS

Collected data was entered in Microsoft Excel and was used for the data analysis. The statistical significance of difference for the majority is tested using Graphpad Prism. The Shapiro–Wilk test was applied to check the normality of continuous variables. Paired t-test was used to analyse data pre and post in-between group. In the entire study, the p-values less than 0.005 are considered to be statistically significant.

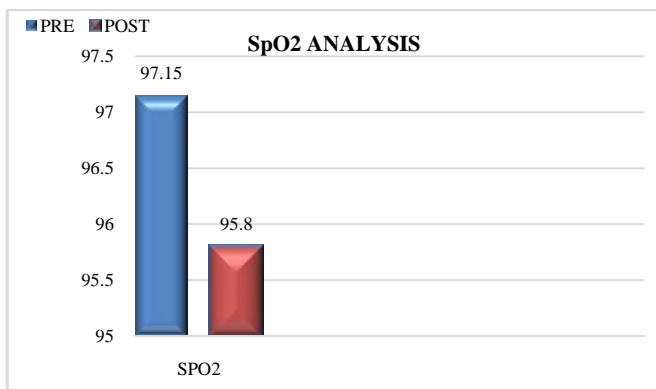
Out of the 40 samples who participated and completed the test, 55% of participants underwent isolation while 45% had been hospitalised. The number of male and female participants in the study, out of which 62.5% were males and 32.5% females. Paired t test was used to analyze the heart rate, SpO₂ pre and post the test, which showed a highly significant p value (p <0.0001).

22.5% subjects had an average score, while 40% of the subjects were below average and the remaining 37.5% subjects had poor cardiorespiratory functioning.



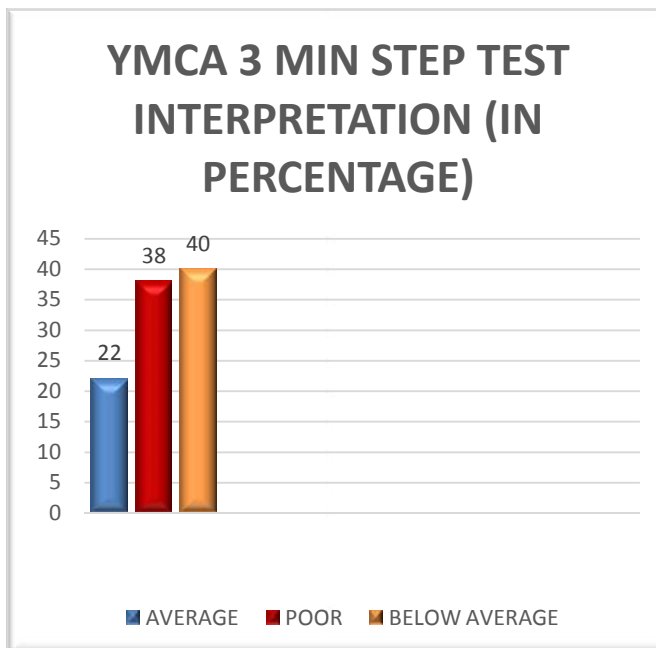
Graph 1 Heart Rate Analysis

VARIABLES	PRE	POST
MEAN	87.73	114.9
SD	5.679	5.876
P value	<0.0001	



Graph 2 SpO₂ Analysis

VARIABLES	PRE	POST
MEAN	97.15	95.80
SD	0.8336	0.7232
P VALUE	<0.0001	



Graph 3 YMCA 3 Min Step Test Interpretation

DISCUSSION

The study undertaken enlightens on the COVID-19 virus and its wide-ranging complications that has affected Cardiorespiratory functioning (CRF) in adults. Until now, there is no study assessing CRF using YMCA 3 MIN Step Test a well-known cardiorespiratory fitness indicator, and also focusing over other possible detrimental effects in relation to the same. A total of 56 post covid patients were taken the study which included both: hospitalized and isolated patients across the age group 30-50 years.

The number of patients with the 2019 novel coronavirus disease (COVID-19) continues to rise, with > 234 million cases confirmed cases worldwide.

Cardiac injury, as seen earlier is now a very common feature seen in about 20% to 30% of hospitalized patients accounting for 40% of deaths. Three phases are known to be seen during the disease progression viz:

The early infection phase which is completely dominated by viral infiltration and replication. Lymphocytopenia is an important marker at this stage. The disease progresses into the pulmonary phase, where respiratory compromise and abnormal chest imaging is the main finding. This stage is followed by the hyperinflammation phase which is explanatory by the name characterized by an exaggerated inflammatory response mediated by the host immunity. Inflammatory markers shoot up in this stage, and secondary organ damage becomes apparent which includes the heart.^[8,9]

Heart Rate Response

In our study it was seen that there was a very significant reduction in the cardiorespiratory functioning of these subjects assessed by the step test where the subjects' CRF were either Average, Below Average or Poor. None of the subjects had their CRF falling in the "above Average". "GOOD" or "excellent".

There were no significant differences seen between the patients who were admitted and the ones isolated with respect to their cardiorespiratory functioning, both these subjects had demonstrated a poor cardiorespiratory functional status.

Two mechanisms are proposed for the Cardiac injury viz. direct or indirect mechanisms. The direct mechanism suggests that there is viral infiltration into myocardial tissue, followed by cardiomyocyte death and inflammation. While the indirect mechanisms include cardiac stress due to respiratory failure and hypoxemia. Also, cardiac inflammation is seen secondary to severe systemic hyperinflammation as seen in the third phase of the disease.^[9]

The possible reason behind this may be acute myocardial injury caused by SARS-CoV-2 infection related to ACE2 receptors. Being widely expressed in both the lungs and cardiovascular system, ACE2-related signaling pathways might also have a role in cardiac injury. Other possible cause is generally thought to be a cytokine storm triggered due to an imbalanced response by type 1 and type 2 T helper cells, while the respiratory dysfunction and hypoxaemia caused by the disease, followed by damage to myocardial cells.^[8]

While the above mechanisms are due to the Covid-19 disease and its effects the other possible cause which may have a role is heart functioning impairment is due to the adverse effects of antiviral drugs and thus demands for monitoring of cardiac

toxicity. Adverse effects of these antiviral drugs are cardiac insufficiency, arrhythmias and other cardiovascular disorders.^[8]

BMI and Its Relation to CRF

In this study it was seen that the average BMI of all these patients pointed towards overweight and obesity class 1 which also might play a factor for affection in the cardiorespiratory functioning. Obesity is one of the major factors that affects the cardiorespiratory functioning.

The possible factors or mechanisms may be increased free fatty acid synthesis from fat cells that result in increased insulin resistance, increased secretion of prothrombin activator inhibitor-1 from fat cells plays a role in procoagulant and alters the endothelial function directly proportional to risk of cardiovascular diseases/disorders and shortened life expectancy. Also, reduction in type I muscle fibers and increase in the type II fibers is also noted. VO₂ max is also found to be reduced which is suggestive of the cardiorespiratory function deconditioning.^[10] Watanabe K *et al* reported that obesity accentuates exercise intolerance and lowers aerobic capacity.^[11]

Recovery Time and SPO₂

The average recovery time seen for these patients to return to their baseline vitals was around 4 mins where the heart rate started to rapidly decrease to the baseline after a minute and took around 5-6 mins to reach the baseline, while the spo₂ values didn't show a great decline following the step test where the SPO₂ values had an average of 95 percent.

Heart rate recovery post exercise is completely dependent upon the autonomic functioning of the person. Thus, being a marker for cardiac autonomous functioning and a predictor of mortality. So, the mechanism behind the increase in heart rate that accompanies exercise is due to slight reduction in vagal tone. While post exercise the recovery of the heart rate immediately is because of vagal reactivation.^[12] Thus the post exercise heart rate recovery also becomes a prognostic marker as it directly tells us about the vagal tone reduction and reactivation. Hence delay in the post exercise recovery might indicate reduction in the vagal tone or its failure/impairment in reactivation.

CONCLUSION

The cardio respiratory fitness as measured through Pulse rate, Pulse recovery time using YMCA-TMST was POOR in post Covid Patients irrespective of the fact that they were hospitalized or were under isolation.

Limitations

Assessment of maximum oxygen uptake (VO₂max) has not been calculated in our study because of absence of a valid predictive formula to calculate the same.

Suggestions

The sample size taken in the study is small as it was done on a small scale, the data distribution might vary with a larger population taken for the and thus might hinder with the results. In the current study covid patients with post infection duration less than 3 months are included. Thus, further studies can be done taking the above criteria in consideration.

Clinical Implication

A major attention needs to be given over aerobic and cardiorespiratory endurance training post covid infection. Along with the pulmonary rehabilitation cardiovascular endurance is also of a great importance in post covid patients because the virus harasses the Cardiovascular system too along with the lungs and pulmonary parameters.

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