Multi-DisciplinaryJournal
ISSN No- 2581-9879 (Online), 0076-2571 (Print)
www.mahratta.org,editor@mahratta.org

Evaluation And Comparison of Physiological Cost Index, And Functional Status In Post Covid-19 Patients: An Observational Study

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Abstract:

Introduction: The global COVID-19 virus pandemic continues to claim victims. One of the most frequent presentations remains, upper respiratory tract, conducting airways and migrate into lower respiratory tract infection and other complications like decreased Physical activity In this context, evaluation of chronotropic response and therefore tolerance to sub maximal exercise can be assessed using the Physiological Cost index (PCI), a reliable tool calculated after 6-Minute Walk Test (6MWT). The aim of this study was to assess the impact of COVID-19 on PCI and functional status on post COVID patients.

Methods: 60 subjects participated in this study.30 each group .Subjects were explained about the study and study procedure. Participant's information sheet and an informed consent forms were given. Their demographic data were recorded in terms of age, gender, occupation, height, weight BMI, date of diagnosis of COVID -19, and persistent symptoms.

Results: Data were analysed using SPSS software. For all the statistical test, significance level was fixed at 5%, i.e., the results were considered statistically significant when $P < 0.05$.

In our study, we concluded that the Physiological cost of index was significantly increased in post COVID patients than in healthy controls. Physiological cost of index and Post COVID functional status scale showed positive correlation in post COVID patients

Key words: COVID-19,Physiological cost Index, Questionnaire

Introduction:

The pandemic created by novel coronavirus disease 2019 (COVID-19) can potentially involve the, upper respiratory tract, conducting airways and migrate into lower respiratory tract infection. Novel coronavirus (SARS-CoV-2) outbreak which is responsible for coronavirus disease (COVID-19), was first reported in Hubei province, China in 2019.[1' 2]Many separate cytokines and inflammatory markers are produced by virus-laden pneumocytes.[3'2] Neutrophils, T cells are drawn by this 'cytokine

storm' are tend to get sequestered in the lung tissue. These cells fight against the virus, which is responsible for the resulting infection and lung damage. The host cell undergoes apoptosis with the release of new viral particles, which then infect the adjacent type 2 alveolar epithelial cells. Due to persistent injury, there is loss of pneumocytes leads to diffuse alveolar damage with resulting acute respiratory distress syndrome

Long-term pulmonary sequelae and its relation to reduction in functional ability have been raised in people suffering from COVID-19.“Post-COVID Syndrome” referred as persistent symptoms that could be related to residual inflammation , organ damage, non-specific effects from the hospitalization or prolonged ventilation, social isolation or impact on pre-existing health conditions.[4] There is actually no widely agreed time frame on when the post-acute period starts.[5]Greenhalgh propose that Post COVID is defined as extending beyond three weeks from onset of symptoms.[3] Dyspnoea, exercise intolerance, fatigue and lung fibrosis are the most common clinical manifestations of this condition, as they directly affect health related quality of life.[3,7]

Notably, acute respiratory distress syndrome (ARDS), the most worrisome consequence of SARS-CoV-2 infection, seems to develop mainly in older adults with multimorbidity.6ARDS involves bilateral pulmonary infiltration limiting haematosis and reducing oxygen supply for mitochondrial bioenergetics. Patients with ARDS are transferred to intensive care unit (ICU) to receive adequate oxygen supplementation through non-invasive or mechanical ventilation. The combination of ARDS and ICU-related procedures may cause a major insult to muscle by increasing protein break down and reducing protein synthesis, there by establishing a catabolic environment leading to severe muscle atrophy. Muscle wasting is experienced by 50% of ICU patients involving diaphragmatic and lower limb muscle, causing serious respiratory and physical complications that may remain for years after hospital discharge. Observational studies have shown that ARDS survivors have substantially lower performance on mobility and physical function relative to healthy age- and sex-matched people.[13]

Following COVID-19 Sequelae of Severe Acute Respiratory Syndrome (SARS) and rehabilitation from SARS may serve as a useful starting point for planning for optimal recovery from COVID-19. At about one month post-discharge, one-third of patients with SARS had dyspnoea on exertion, general malaise and moderate to severe impairment of work or household tasks. Whether these extended effects of COVID in post recovery affects the Physiological cost of index is unknown. Therefore, this study aims at determining the Physiological cost of index and its correlation with fatigue severity and functional status of patients in post COVID-19 Physical Impairment and Dysfunction

Need of the study:

An accurate measurement of physical activity and energy consumption is therefore important for both epidemiological studies and clinical context. Walking is one of the most basic human movements. Field experiments or non-exercise approaches may provide knowledge about VO2max using prediction equations where certain laboratory methods are not feasible. The 6-minute walk test is sub-maximal, easy to administer and reflects the functional exercise level for daily physical activities. Whether these extended effects of COVID in post recovery affects the Physiological cost of index is unknown. Therefore, this study needs to determine the Physiological cost of index and its correlation with functional status of patients in post COVID-19

Aim

To asses and study the Physiological cost of index, functional status in post COVID-19 patients

Objectives

- To evaluate Physiological cost of index in post COVID-19 patients and age-gender matched normal individuals
- To assess functional status in post COVID-19 patients using post COVID functional status scale.
- To determine correlation between Physiological cost of index and post COVID-19 functional status in post COVID-19 patients.

Methodology

Study Type: Observational

Study Design: Cross Sectional

Study Set Up: Hospitals in and around Pune

Sample Size: 60

Sample type: SimpleRandom sampling method

Study Duration: 6 months

INCLUSION CRITERIA:

Study group: (Post COVID patients)

1. Post COVID-19 patients(>3weeks from symptom onset)

2. Subjects in the age group (18 years and above)

3. Subjects willing to participate

Control group:

(Age matched healthy Individuals)

1. Healthy individuals Age matched control group

EXCLUSION CRITERIA

1. Presence of any musculoskeletal, neuromuscular and cardiovascular problems which significantly decrease walking performance.
2. Patient with respiratory problems such as COPD, asthma etc.
3. Any other co-morbidities affecting the results like Smoking, Addict to alcohol etc.

Materials Used

1. Measuring tape
2. Chair
3. Stopwatch
4. Marking cone
5. Stethoscope
6. Sphygmomanometer
7. Pulse Oximeter
8. Post COVID functional scale
9. Modified Borg RPE scale

Procedure

60 subjects participated in this study. Subjects were explained about the study and study procedure. Participant's information sheet and an informed consent forms were given. Their demographic data were recorded in terms of age, gender, occupation, height, weight BMI, date of diagnosis of COVID - 19, and persistent symptoms.

Physiological cost of Index was estimated using 6-minute walk test. 6-minute walk test was performed as per American Thoracic Society (ATS) guidelines. Rate, blood pressure, oxygen saturation and rate of perceived exertion using modified BORG scale was noted at rest. Patient was explained that 6 minutes is long time to walk and they are allowed to take rest and resume as soon they are able.

PCI (beats/meter) = Walking Heart Rate – Resting Heart Rate

Walking speed

They were also assessed with functional status using post COVID functional status scale. Post-COVID-19 Functional Status (PCFS) is a self-report scale. PCFS scale used to assess recovery after the SARS-CoV-2 infection, this PCFS scale covers the entire range of functional limitations, including changes in lifestyle, sports and social activities. PCFS Scale grade concerns the average situation of the past week. PCFS Scale considered as a main outcome in many clinical trials

Outcome Measures – Post-COVID-19 Functional Status (PCFS),Physical activity scale

Results

In this study, 60 participants were taken. Among them, 30 were post COVID patients and 30 normal healthy individuals. All 60 subjects participated in the study completed the procedure except one due to unable to join the protocol. All the participants performed 6-MWT at a comfortable speed and completed International Physical Activity Questionnaire, Post COVID functional status scale. Data were analysed using SPSS software. For all the statistical test, significance level was fixed at 5%, i.e., the results were considered statistically significant when $P < 0.05$.

Table 1 shows that 91.4% were inactive in post covid group whereas 80.1% in healthy control group. No significant association was seen in IPAQ when compared between post COVID and healthy control group.

Table 1. Descriptive analysis of IPAQ in post COVID and healthy control group

	Post Covid Group		**Control Group**	
	Count	**%**	**Count**	**%**
Inactive	32	91.4	28	80.0
Minimally active	03	8.6	06	17.1
HEPA active	0	0	01	2.9

Graph 1:

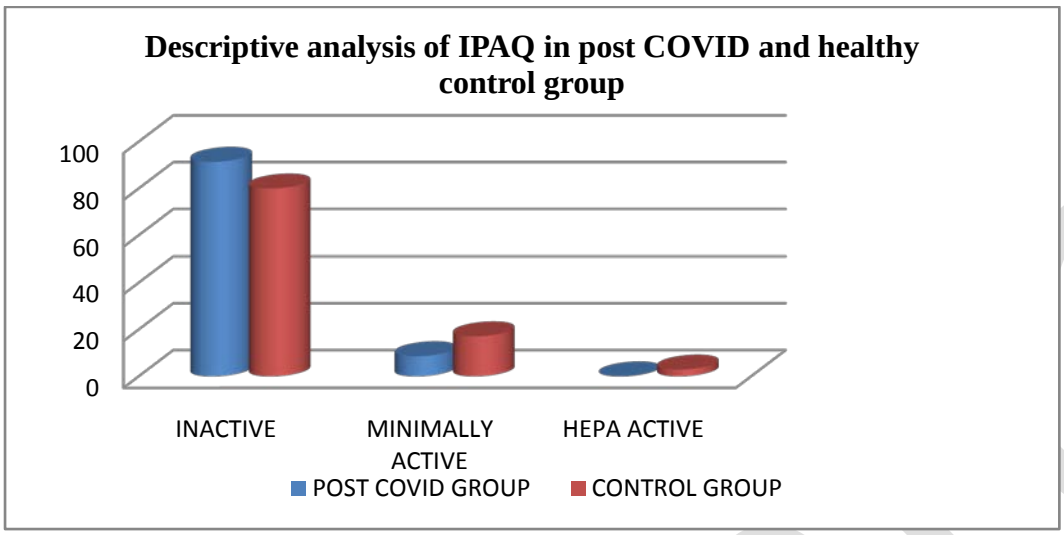


Table 2: Descriptive statistics of 6MWT distance in post COVIDand control group.

	Post COVID group		Control Group	
	Mean	**SD**	**Mean**	**SD**
Total Distance covered	401.19	81.84	481.75	43.36
Predicted Distance	536.72	35.82	545.30	31.72

Graph 2: Descriptive statistics of 6MWT distance in post COVIDand control group.

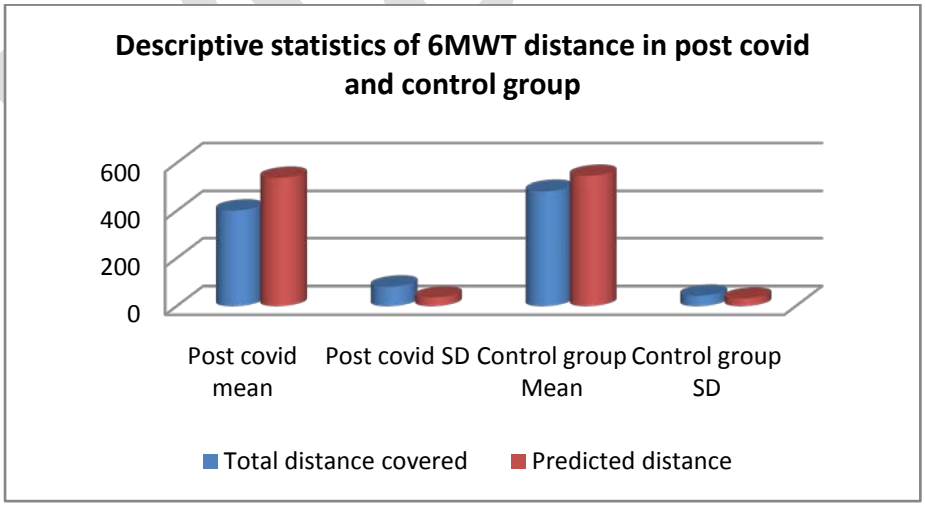


Table 3: Descriptive analysis of 6-minute walk test pre-post parameters in post COVID and control group

	Group			
	Post COVID Group		Control group	
Pre HR	86.60	11.91	84.51	10.42
Post HR	117.26	13.16	111.00	15.12
Pre RR	20.80	3.68	19.89	2.35
Post RR	32.60	5.44	30.14	3.96
Pre syst	122.80	9.90	121.54	10.76
Pre Diast	82.11	7.08	81.20	7.03
Post syst.	141.51	11.41	136.00	11.11
Post Diast	92.86	8.63	89.34	8.21
Pre SPO2	98.14	1.70	97.37	2.00
Post SPO2	94.46	2.90	97.77	2.04
Pre RPE	.17	.24	.16	.24
Post RPE	3.31	.93	2.71	79
Def.HR	3.66	6.01	26.49	10.14

Graph 3:Descriptive analysis of 6-minute walk test pre-post parameters in post COVID and control group

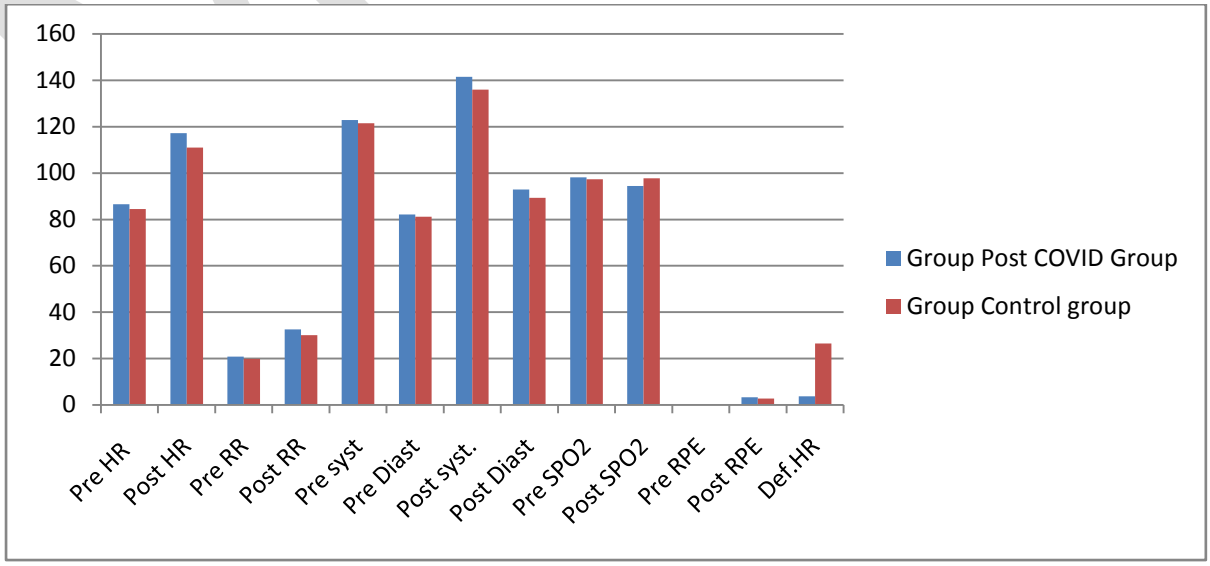


Table 4: comparison between total distances covered and predicted distance between post COVID and control group.

	t-Value	DF	P Value
Total Distance Covered	**-5.172**	**68**	**0.00**
Predicted Distance	**-1.061**	**68**	**.292**

Table 5:

Pre HR compared between post COVID and control group was non-significant. (p value 0.063). Difference in HR was also statistically insignificant (p value 0.107) when compared between two groups.

Pre HR: t-test	**DF**	**P Value**
1.891	68	.063

Graph 5:Comparison of HR between post COVID & control group

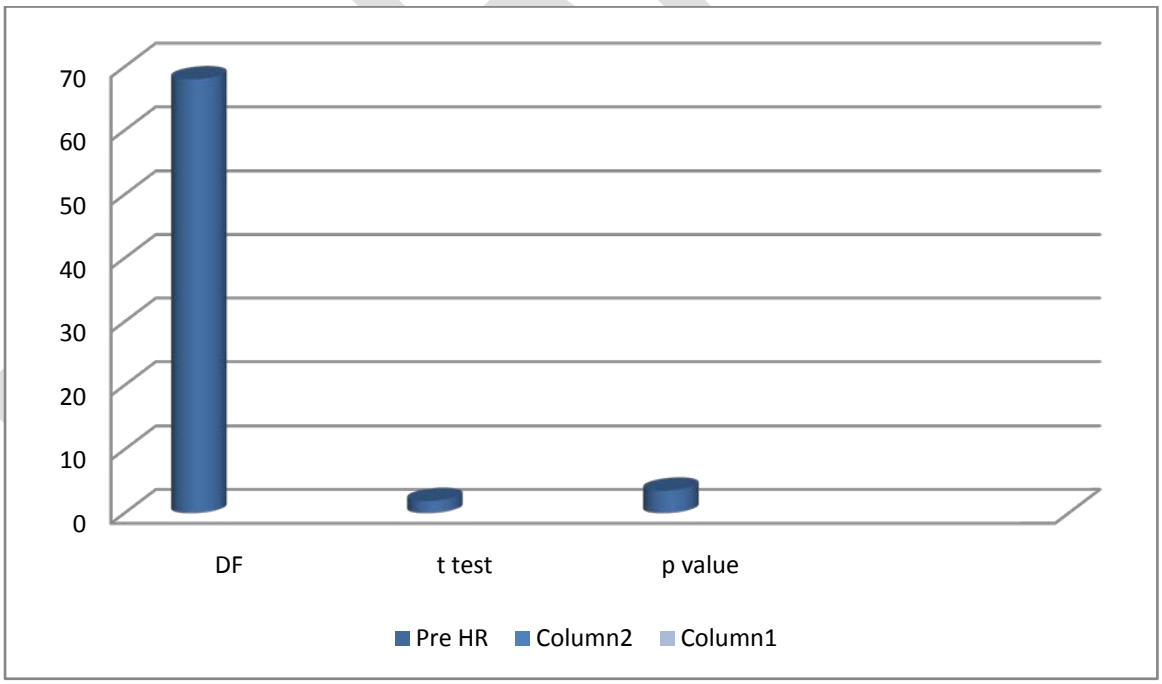


Table 6: Descriptive statistics of walking speed in post COVID and control group

	Groups			
	Post COVID		Control group	
Walking speed	**Mean**	**SD**	**Mean**	**SD**
	66.38	13.52	80.28	7.06

Graph 6: Descriptive statistics of walking speed in post COVID and control group

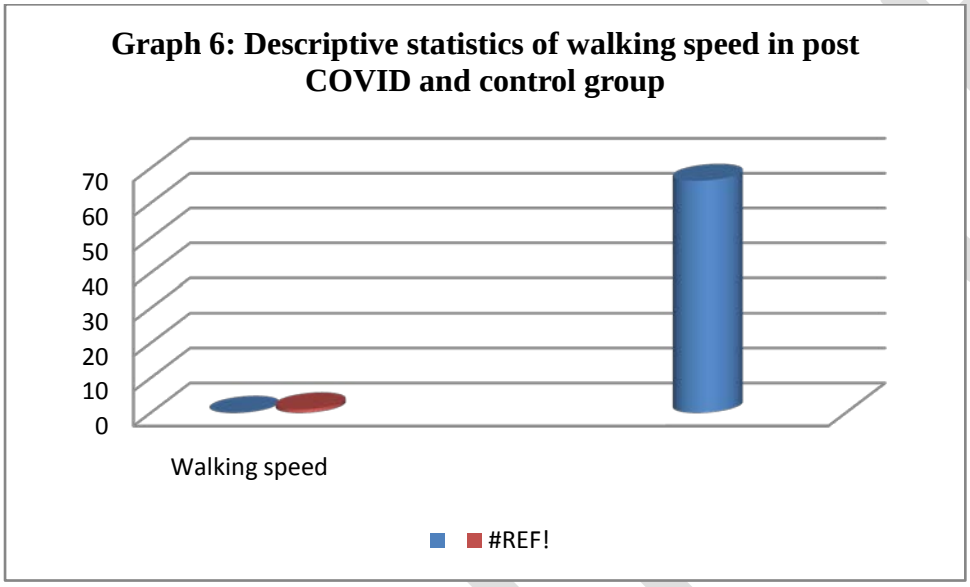
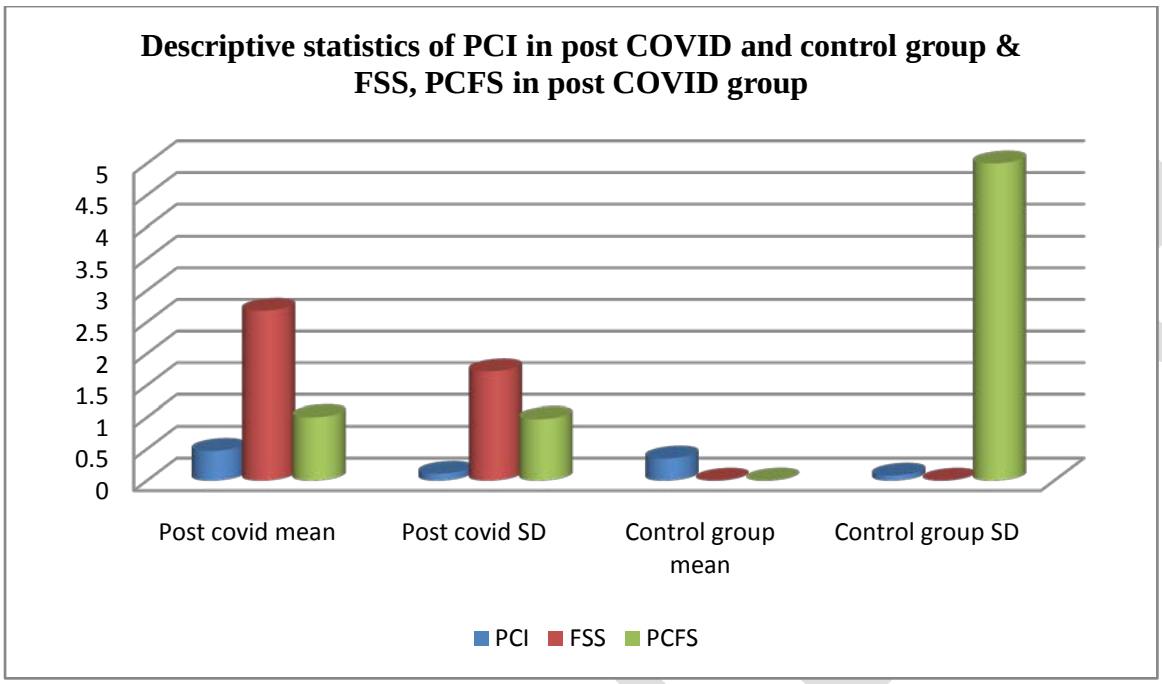


Table 7: Shows PCI was significantly different in both the groups. It showed that PCI was higher in post COVID group than of control group. (p value 0.000).Also it shows that mean score of FSS was 2.68 ± 1.72 and PCFS was 1.00 ± 0.97. Mean PCI score of post COVID group and control group was 0.47 ± 0.11 and 0.35 ± 0.08 respectively.

Table 7: Descriptive statistics of PCI in post covid and control group & FSS, PCFS in post COVID group.

	Group			
	Post COVID Group		Control group	
	Mean	**SD**	**Mean**	**SD**
PCI	.47	.11	.35	.08
FSS	2.68	1.72	.00	.00
PCFS	1.00	.97	.00	.00

Graph 7: Descriptive statistics of PCI in post COVID and control group & FSS, PCFS in post COVID group.



Discussion:

Present study was to compare Physiological cost of index in post COVID group and healthy control group. 30 post COVID patients were participated in this study and an age matched healthy adults accepted as the control group. 6-Minute walk test was used to evaluate physiological cost of index in both the groups. All the study subjects in control group could complete 6-minute walk test successfully. In COVID group except two subjects could not completed the 6-minute walk test.

Physiological cost index measures energy cost of walking. Physiological cost index is determined as, PCI (beats/meter) = [Walking Heart Rate (WHR) – Resting Heart Rate (RHR)] /Walking speed. Estimation of PCI can be used for various purposes such as determining impact and severity of a disease, effectiveness of management, etc. There are many studies have established normal values of Physiological Cost of Index (PCI) for healthy adults. It was found to lie in the range of 0.23 beats/meter – 0.42 beats/meter. So, values of PCI lower than the mentioned range indicate lower or efficient energy expenditure, whereas higher values indicate high or inefficient energy expenditure. Higher values of PCI have been documented in subjects affected with chronic obstructive pulmonary disease, various interstitial lung diseases, lower limb amputees, children with cerebral palsy etc. Increased values have frequently been attributed to increased ventilatory demands, respiratory and

peripheral muscle dysfunction contributing to impaired exercise tolerance. In the current study it was seen that the mean PCI in post COVID patients and control groups were found to be 0.47 ± 0.11 beats/meter and 0.35 ± 0.08 beats/meter respectively.

It is evident that though the mean value of PCI achieved by the control group was comparable to normal values. It could also be noted that physiological cost of index of walking of the post COVID group was higher as compared to the control group, with the difference being statistically significant ($p<0.05$).

When walking speed was analysed, it was noted that the walking speed of post COVID patients was significantly lower as compared to the healthy controls. The mean walking speed of post COVID subjects was found to be 1.11 ± 0.22 m/s and that of control group was 1.33 ± 0.11 m/s. The difference in walking speed was highly significant ($p < 0.05$). It was seen that walking speed of control group was well within the normal range estimated in the literature, whereas mean walking speed of post COVID group was found fall below the range. So, the current findings signify that reduction in the walking speed was the prime contributor to the increase in PCI in the post COVID subjects when we go through various literature search and various published articles have also the same finings like reduction in walking speed and therefore the physiological cost index.

Perry J et al reported in his study that the walking speed correlates with the functional ability. This was found true with the findings of the present study too. In the present study functional ability was evaluated using Post COVID Functional Status scale (PCFS). The results of PCFS evaluation showed that functional status of post COVID patients ranged from 0 being no functional limitation to 3 being moderate functional limitation. In current study, 5.7% reported grade 3 limitation which signifying “I suffer from moderate limitation in everyday life as I’m not able to perform all activities due to symptoms, pain, depression or anxiety. However, I’m able to take care of myself without any assistance.” 28.5% reported grade 2 signifying “I suffer from slight limitation in everyday as I have to avoid or reduce usual activities or need to spread over time due to symptoms, pain, depression or anxiety. However, I’m able to perform activities without any assistance.” Whereas 37.1% of the post COVID study samples reported grade - 1 limitation signifying “I have negligible limitation in everyday life as I can perform all usual duties/activities, although I still have persistent symptoms, pain, depression or anxiety.” and 28.5% of post COVID study samples reported grade 0 limitation signifying “I have no limitation in everyday life and no symptoms, pain, depression or anxiety related to infection.” It was also noted there was a moderate negative correlation between the walking speed and the PCFS scores. This meant that the subjects with more score on PCFS (poor functional status) walked slower than the ones with lower score (better functional status). Consequently, a moderate

positive correlation was found between the PCI and the scores of PCFS scale ($r = 0.509$ $p<0.05$), indicating higher PCI scores in subjects with higher difficulties in functional abilities. Physiological cost index of walking was found to be increased in post COVID patients, therefore screening of individuals affected with COVID 19 for evaluation of limitations in exercise capacity and functional capacity is highly recommended. So, results of this study point towards requirement of at discharge and follow up assessment of the individuals Therefore screening of individuals affected with COVID 19 for evaluation of limitations in exercise capacity and functional capacity is highly recommended.

Conclusion

In our study, we concluded that the Physiological cost of index was significantly increased in post COVID patients than in healthy controls. Physiological cost of index and Post COVID functional status scale showed positive correlation in post COVID patients

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