

# Comorbidities and Vaccination Significantly Influence on Post-Coronavirus Disease 19 Functional and Health Status: A Single-Center Experience from South India

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## Abstract

**Background:** Health-care specialists and clinical researchers worldwide have been concentrating more on the acute and intense phase of the coronavirus disease 19 (COVID-19) infection, but there is an exigency toward the incessant monitoring in the postdischarge period to foresee the long-lasting effects of the disease. The main objective of this study is to evaluate the post-COVID-19 health and functional status (PCFS) and the long-term health implications of severe acute respiratory syndrome coronavirus-2 infection among COVID-19 recovered patients. **Materials and Methods:** An observational, cross-sectional, and hospital-based study was conducted among the COVID-19 recovered patients. The PCFS scale was used as a study tool to assess the functional status. Data were entered into Excel spreadsheets 2019, and statistical analysis was performed using the SPSS version 24.0. Descriptive statistics were used, and the Chi-square test was used to determine the role of sociodemographic characteristics on questions. The statistical significance level was set at  $P < 0.05$  (two-sided). **Results:** A total of 80 patients were included in the study and the mean age was  $37.03 \pm 15.15$  years. More than half of the participants (52.5%) showed functional limitations. Fatigue (30%), anxiety (23.75%), and cough (6.25%) were noted to be persistent symptoms reported post-COVID-19 recovery. The majority (88.75%) of the study participants experienced at least one symptom post-COVID-19 and 52.5% have experienced at least one functional limitation. The presence of comorbidities ( $r = 0.664$ ; likelihood ratio [LR] = 0.968), and vaccination ( $r = 0.700$ ; LR = 0.611) considerably influenced the PCFS. **Conclusion:** Our study revealed that there is a significant limitation of PCFS among recovered patients. The presence of comorbidities and vaccination significantly correlated with the PCFS. Standard identification tools, extensive screening, and wide education of consequences related to post-COVID-19 along multicentric and global studies are the need of the hour.

**Keywords:** Coronavirus disease 19, functional status, health status, infection, post-COVID-19, severe acute respiratory syndrome coronavirus-2

## INTRODUCTION

Coronavirus Disease-19 (COVID-19) caused by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has been declared a pandemic by the World Health Organization. This novel virus has been significantly impacting public health institutions, people, and the global economy. The COVID-19 pandemic is continuing to be a cause of the death of millions of people worldwide and had resulted in severe morbidity, especially among older people and people with comorbidities. Although the introduction of vaccination minimized the

effect of the virus, the cause of concern is the evolution of new variants of concern. This is responsible for the cause of vaccine ineffectiveness along with the already existing vaccine

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hesitancy, and inequity problems/issues. However, the number of recovered patients displaying persistent symptoms and unexpected sequelae is increasing progressively.<sup>[1]</sup> Earlier viral outbreaks which were caused by the Influenza virus (Spanish flu), SARS-CoV-1, Middle East Respiratory Syndrome CoV, and Ebola viruses have exhibited an extraordinary ability to cause long-term sequelae among the survivors of infections.<sup>[2,3]</sup> Hence, research is required to determine the long-term effects and post-COVID-19 health status of the survivors. Postacute care of patients with COVID-19 will become particularly relevant after having addressed the surge of infections in the acute care settings during the current pandemic. It is anticipated that infection with SARS-CoV-2 may have a major impact on physical, cognitive, mental, and social health status, involving even patients who suffered mild disease. Due to the preestablished heterogeneity of COVID-19 in terms of radiological and clinical presentations, it is crucial to have a simple tool to monitor the course of symptoms and, more importantly, the impact of these symptoms on the functional and health status of patients.<sup>[4,5]</sup> Elder adults who survived the critical illness resulting from COVID-19 have limitations in their daily activities that include dressing, walking, and eating, among others. Disability in daily activities is associated with escalated risk of hospitalizations, raised health-care spending, and higher rates of morbidity and mortality. Moreover, the after-critical illness survivors of COVID-19 manifest cognitive deterioration and other mental issues such as anxiety, psychological stress, and depression which make the recovery phase life cumbersome.<sup>[6,7]</sup> There is a need for a valid and reliable tool or a scale to assess the consequences of the disease in quantifiable terms, beyond the primary outcomes of morbidity and mortality.<sup>[8]</sup> Keeping the massive number of COVID-19 survivors in mind who require effective follow-up, an easy, invariable, and reproducible instrument is required to guide physicians and public health officials for judicious use of medical resources and potentiating better recovery. Such a tool will help to identify and facilitate the patients as well, especially those who are undergoing a delayed recovery.<sup>[9,10]</sup> At least one or the other form of limitation of the normal functions of the COVID-19 survivors should be anticipated and expected. This assumes significance considering the lessons learned from the previous pandemics that enabled scientists to predict the worst scenarios of deliberate complications after the survival. Health-care specialists and clinical researchers worldwide have been concentrating more on the acute and intense phase of the COVID-19 infection, but there is an exigency towards the incessant monitoring in the postdischarge period to foresee the long-lasting effects of the disease.

The main objective of our study is to evaluate the post-COVID-19 health status and the long-term health implications of SARS-CoV-2 infection among COVID-19 recovered patients. This is a novel study done in the Indian setting, focusing on post-COVID outcomes, and functional and health status.

## MATERIALS AND METHODS

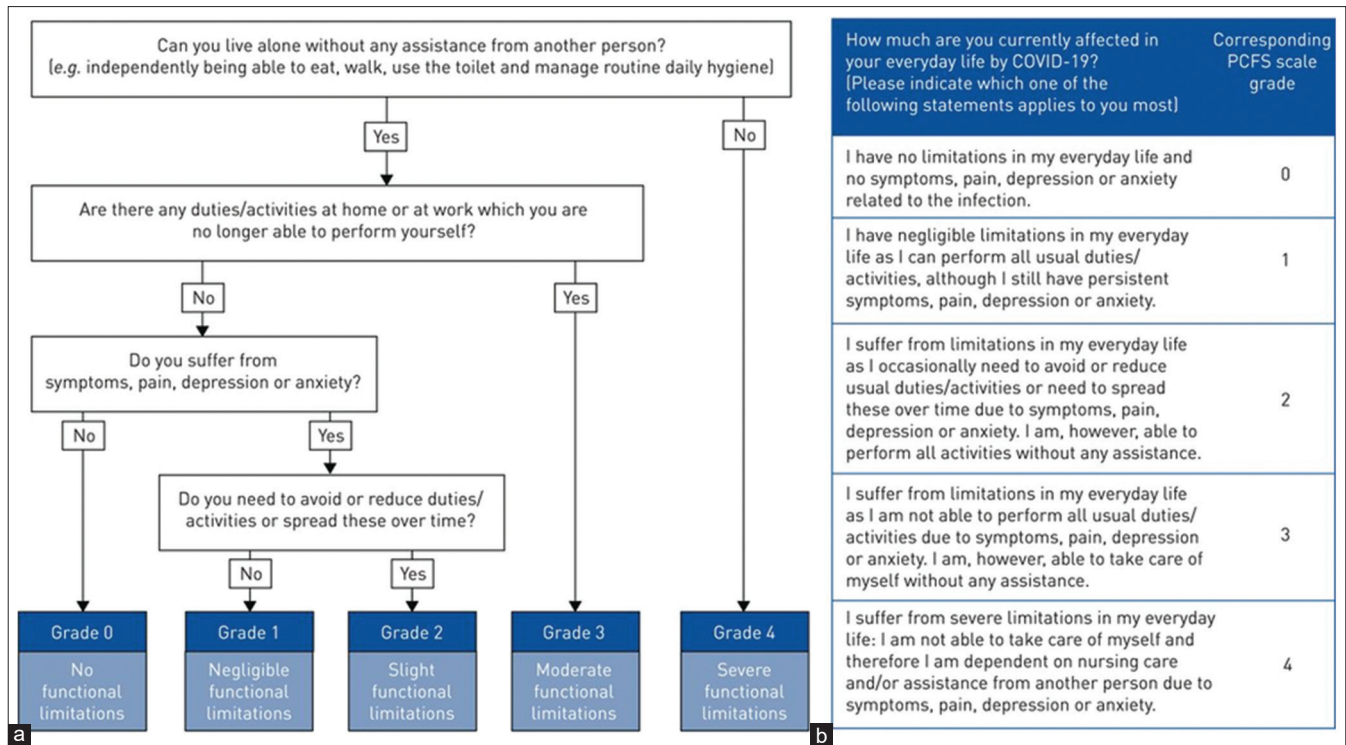
An observational, cross-sectional, and the hospital-based study was conducted among the COVID-19 recovered patients between June 2021 and July 2021 (2 months). A random sampling method was used, and 80 participants were taken into the study. The inclusion criteria were all adults (aged above 18 years) who recovered from COVID-19 and were voluntarily willing to participate in the study. The exclusion criteria included people with current COVID-19 infection, non-COVID-19 patients, and COVID-19 recovered patients who were not willing to participate in the study. Patients with existing functional disabilities and illnesses which can progress, and limit functional ability were also excluded from the study.

The study tool applied was the post-COVID-19 health and functional status (PCFS) scale, which was developed and validated by Klok *et al.* in 2020.<sup>[11]</sup> The patient questionnaire included questions that were used to assess the functional status of COVID-19 recovered patients [Figure 1].

The PCFS scale is designed to estimate a broad range of functional limitations that included lifestyle changes, sports, and social activities, among others. A PCFS scale grade is assigned to the study participants based on the present functional status in comparison to the situation on the day of discharge. The symptoms observed in the study participants included assessment for dyspnea, pain, fatigue, muscle weakness, memory loss, depression, and anxiety. When the interviewer finds that a study participant could fit into two grades, the highest grade was chosen based on the scale developer's recommendations.<sup>[11]</sup> Along with the PCFS scale, a few other questions on post-COVID-19 health status were asked while interviewing the participants. Informed consent was taken from all study participants and a face-to-face interview was undertaken on all the study participants following proper COVID-19 protocols and guidelines. The interviews were conducted by a qualified physician which also included interns. Before the interview, the design, purpose of the study, and action taken by the researchers to protect confidentiality were explained to the study participants. All interviews began with background information, (age, gender, state, educational status, occupation) followed by questions regarding PCFS. The study was approved by the institutional ethics committee of the Prathima Institute of Medical Sciences (Ref no-IEC/PIMS/2021/004).

### Statistical analysis

Data were entered into Excel spreadsheets 2019, and the statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 24.0 (SPSS, Inc., Chicago, IL, USA). The results were presented using mean, standard deviation, frequency, and percentage. Descriptive statistics were used along with Pearson's correlation ( $r$ ), and likelihood ratio to evaluate statistical significance/relevance.



**Figure 1:** Post-COVID-19 health and functional status (PCFS) scale

## RESULTS

A total of 80 COVID-19 recovered patients were included in the study. The mean age was  $37.03 \pm 15.15$  years. Thirty-four (42.5%) were female and 46 (57.5%) were male. The most common comorbidities among study participants were diabetes (12.5%), hypertension (12.5%), and 8.75% have both diabetes and hypertension. The majority (95%) of the study participants were nonsmokers. The sociodemographic and clinical profile of study participants are described in Table 1.

Only 18.75% (15) of study participants required hospitalization during the COVID-19 and the mean hospitalization time among hospitalized patients was 13.6 days. 33.75% (27) have participated in this study during 16–30 days after testing negative/recovered from COVID-19. Post-COVID-19 profile and PCFS grades of study participants are described in Table 2.

Of the study participants most (47.5%) showed a PCFS Grade of “0” indicating no functional limitations after recovering from COVID-19. A majority (52.5%) of the study participants have at least one functional limitation after recovering from COVID-19. Almost a quarter (23.75%) of the study group has revealed PCFS Grade 1 functional limitation. Many (88.75%) study participants experienced at least one post-COVID-19 sequelae and 26.25% had revealed no symptoms after recovery from COVID-19. The most common and persistent symptoms after recovery from COVID-19 were fatigue (30%), anxiety (23.75%), cough (6.25%), headache (6.25%), shortness of breath (5%), and fever (5%).

## DISCUSSION

The COVID-19 caused by the novel SARS-CoV-2 is responsible for the continuing pandemic that is severely affecting the global health, social, cultural, and economic situation.<sup>[12,13]</sup> The initial responses to the pandemic involved controlling the spread of the infection and increased diagnostic testing, which gradually shifted to improve patient management and reduce mortality.<sup>[14-16]</sup> However, the scientific community was completely unaware of the post-COVID-19 health implications.<sup>[17]</sup> From the experiences of the previous pandemics, it was evident that the patients who recovered from the COVID-19 may be predisposed to health implications that may potentially affect the quality of life.<sup>[18]</sup> Therefore, it has been suggested that a tool to assess the PCFS of the recovered patients is required to improve the understanding of the long-term health implications of COVID-19.<sup>[2,11]</sup>

To the authors’ knowledge, the present research study was one of the foremost ones that are being conducted on post-COVID-19 health status in India. Our study revealed that most COVID-19 recovered patients were suffering from post-COVID-19 symptoms and have limitations in functional status. This is evident from the current study wherein 88.75% of the study participants experienced at least one post-COVID-19 symptom and 52.5% have experienced functional limitation. An important finding in this study is the potential implications of the comorbidities in the development and progression of long-term health implications. Furthermore, it was observed that there is an association between vaccination and the PCFS. Although this association does not necessarily rule out poor

**Table 1: The sociodemographic and clinical profile of study participants (n=80)**

|                                | Number of individuals<br>(n=80), n (%) |
|--------------------------------|--|
| Gender                         |  |
| Male                           | 46 (57.5)                              |
| Female                         | 34 (42.5)                              |
| Age                            |  |
| 18-30                          | 38 (47.5)                              |
| 31-50                          | 25 (31.25)                             |
| ≥51                            | 17 (21.25)                             |
| Occupation                     |  |
| Government employee            | 13 (16.25)                             |
| Healthcare worker              | 8 (10)                                 |
| Private employee               | 9 (11.25)                              |
| Self-employed                  | 13 (16.25)                             |
| Students                       | 27 (33.75)                             |
| Unemployed                     | 11 (13.75)                             |
| Smoking status                 |  |
| Nonsmoker                      | 76 (95)                                |
| Smoker currently               | 2 (2.5)                                |
| Quit smoking after COVID-19    | 2 (2.5)                                |
| Comorbidities                  |  |
| Diabetes                       | 10 (12.5)                              |
| Hypertension                   | 10 (12.5)                              |
| Both diabetes and hypertension | 7 (8.75)                               |
| Thyroid disorder               | 7 (8.75)                               |
| Asthma                         | 3 (3.75)                               |
| None                           | 43 (53.75)                             |
| Vaccination                    |  |
| Vaccinated before COVID-19     | 20 (24.09)                             |
| Vaccinated after COVID-19      | 22 (26.5)                              |
| Not vaccinated                 | 41 (49.4)                              |

PCFS among the vaccinated population, it does suggest that the vaccinated people may have lower chances of developing long-term health issues related to COVID-19.

In a study by Pant *et al.*, conducted in Nepal, they evaluated the post-COVID-19 health status using the PCFS scale.<sup>[5]</sup> One hundred and six study participants were evaluated, and more than half of the patients (56.6%) reported having no functional limitation (Grade 0) which is more than in our study (47.5%). The prevalence of the degree of functional limitation was observed in 46 (43.4%) patients (Grade 1-4) which was less than in our study. The most common persistent symptoms in their study were fever, cough, and fatigue, whereas in our study fatigue, anxiety, and cough. In a study by Mohamed Hussein *et al.*, conducted in Egypt, post-COVID-19 health status was evaluated using the PCFS scale.<sup>[19]</sup> In all, 444 study participants were evaluated and only 20% revealed no functional limitation which was very less when compared to our study. About 80% of the study participants had at least one functional limitation which was higher than our study. In a study by Taboada *et al.* conducted in Spain, a decreased functional status measured with the PCFS scale was reported in 87 (47.5%)

patients.<sup>[20]</sup> The long-term consequences of COVID-19 may vary extensively among patients. Given the massive number of COVID-19 survivors who require long-term follow-up, a simple, easy, reproducible, and cost-effective tool would be vital for proper utilization of resources in postacute care for COVID-19 patients and guide rehabilitative measures.<sup>[17]</sup>

Immediate rehabilitation protocols to manage post-COVID-19 functional disabilities were previously suggested by Italian studies.<sup>[21,22]</sup> Here, the patients included had a higher mean age ( $72.6 \pm 10.9$  years) as compared to the present study ( $37.03 \pm 15.15$  years). The functional disabilities included pulmonary insufficiencies such as dyspnea and shortness of breath along with fatigue after a 6-min walk test. However, such an assessment may not effectively confirm the functional status as evident by the observations of patients who recovered from critical illnesses.<sup>[23,24]</sup> It may further be noted that more effective, and specific evaluation methods are needed to find out the PCFS accurately.

The Innovative Support for Patients with SARS-COV-2 Infections Registry in the United States of America took an initiative to register SARS-CoV-2-infected patients voluntarily. All enrolled patients were followed up for the next 18 months and their self-reported health status along with hospital records was recorded to assess the PCFS.<sup>[25]</sup> This study aimed to understand the factors responsible for sequelae, and potential risk factors that are more specific to COVID-19. The invasive mechanical ventilation while the patient management was increasingly associated with PCFS as to those who received noninvasive ventilation.<sup>[26]</sup> Old age could potentially predispose COVID-19 recovered patients to deteriorating PCFS involving physical, mental, and psychological domains.<sup>[27]</sup>

The PCFS not only involves the lungs as evident by the results of recent studies which surveyed the COVID-19 recovered patients for speech, swallowing, and hearing issues. It was that patients who were treated in the intensive care units, and those who required long hospital stays could potentially suffer symptoms of the aerodigestive and laryngeal system and require rehabilitation programs for improved management.<sup>[28,29]</sup> Physical activity was noted to play a significant role in the severity of COVID-19, contribute to increased vaccine efficacy, and may potentially improve PCFS.<sup>[30]</sup>

Further studies have been attempted to find clinical interventions that can help patients to minimize the effects of PCFS. The inhalation of molecular hydrogen for 14 days after recovery from COVID-19 was found beneficial in counteracting the sequelae and improving the PCFS.<sup>[31]</sup>

### Study limitations

The limitations of our study were low sample size and only patients from a single hospital were included. The study subjects were not assessed for functional status and quality of life before COVID-19 infection. The patients were not followed up over a long period (for more than 6 months) and the association of COVID-19 with PCFS and quality of life

**Table 2: Post-COVID-19 profile and post-COVID-19 functional status grades of study participants (n=80)**

|   | Number of individuals<br>(n=80), n (%) |
|---|--|
| Outcomes of COVID-19 infection                                      |  |
| Hospitalized  | 15 (18.75)                             |
| Recovered with home quarantine                                      | 65 (81.25)                             |
| Number of days completed after testing negative/postrecovery (days) |  |
| <15   | 21 (26.25)                             |
| 16-30   | 27 (33.75)                             |
| 31-45   | 16 (20)                                |
| 46-60   | 7 (8.75)                               |
| 61-75   | 1 (1.25)                               |
| >90   | 11 (13.75)                             |
| PCFS grade  |  |
| Grade 0   | 38 (47.5)                              |
| Grade 1   | 19 (23.75)                             |
| Grade 2   | 14 (17.5)                              |
| Grade 3   | 5 (6.25)                               |
| Grade 4   | 4 (5)                                  |
| Most common persistent symptoms present still now                   |  |
| Fatigue   | 24 (30)                                |
| Anxiety   | 19 (23.75)                             |
| Cough   | 5 (6.25)                               |
| Headache  | 5 (6.25)                               |
| Fever   | 4 (5)                                  |
| Shortness of breath   | 4 (5)                                  |
| Loss of smell   | 4 (5)                                  |
| Loss of taste   | 4 (5)                                  |
| Chest pain  | 1 (1.25)                               |
| Sore throat   | 1 (1.25)                               |

PCFS: Post-COVID-19 functional status

was not evaluated. This study was conducted at the peak of the second wave of COVID-19 in India, and the patients were not clinically evaluated for functional disabilities. The PCFS was not correlated with the severity of illness and the type of intervention required for patient management (intubation, on-invasive, etc.).

## CONCLUSION

The study results demonstrate that there is a significant limitation in the PCFS among recovered patients. The presence of comorbidities and vaccination may have a significant role in the development or minimization of long-term health implications after recovering from COVID-19. Further studies are required to assess the potential beneficial effects of vaccination on the long-term sequelae associated with COVID-19. Increased understanding of post-COVID-19 health effects contributes to improved patient management and better quality of life. Age of the patients, vaccination status, comorbidities, the severity of the clinical illness, and other factors could influence the PCFS. Therefore, standard tools, massive screening, widespread education of consequences

related to post-COVID-19 along with multicentric and global studies are the need of the hour to further the understanding of post-COVID-19 health effects and potential contributing factors.

## Ethics approval

This study was approved by the Prathima Institute of Medical Sciences (Ref no-IEC/PIMS/2021/004).

## Consent to participate

Informed consent was obtained from the study participants.

## Consent for publication

Informed consent was obtained from the study participants.

## Availability of data and material (data transparency)

Yes, data were transparent. Data were available and will be provided on request if needed.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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