Pak. J. Chest Med. 2025;31(03)

Original Article

journal homepage: https:/www.pjcm.net/

Pakistan Journal of Chest Medicine

Official journal of Pakistan Chest Society

Comparative Long-Term Outcomes of ICU and Non-ICU COVID-19 Patients: A Six-Month Follow-up study

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Article History:

Received:	Apr 15, 2025
Revised:	Jun 29, 2025
Accepted:	July 26, 2025
Available Online:	Sep 02, 2025

Author Contributions:
AH conceived idea, SS drafted the study, KR collected data, NS did statistical analysis and interpretation of data, AH KR critical reviewed manuscript. All approved final version to be published.

Declaration of conflicting interests:
The authors declare that there is no conflict of interest.

How to cite this article:
Haq A, Shaheen S, Rehman K, Shah N. Comparative Long-Term Outcomes of ICU and Non-ICU COVID-19 Patients: A Six-Month Follow-up study. Pak J Chest Med. 2025;31(03):206-214.

ABSTRACT

Background: COVID-19 survivors often deal with long-term issues related to their lungs, overall function, and quality of life. Patients who needed ICU care during their acute infection may have worse outcomes than those treated outside the ICU. Understanding these differences is crucial for directing care and rehabilitation after discharge.

Objective: To investigate how COVID-19 affects lung structure, lung function, exercise capacity, and quality of life in patients discharged from ICU and medical wards.

Methodology: This study followed 110 adult COVID-19 patients who were discharged from ICU and non-ICU wards at a tertiary care hospital. At a six-month follow-up, all patients underwent high-resolution chest CT scans, pulmonary function tests, six-minute walk tests, and SF-36 quality-of-life assessments. Clinical data were analyzed using SPSS version 26.0. We used appropriate statistical tests to compare groups, setting significance at $p<0.05$.

Results: At six months, ICU patients had a higher rate of ongoing CT abnormalities (67.3% vs. 27.6%) and impaired lung function, especially reduced FVC and PEF values. The median distance walked in six minutes was significantly lower in the ICU group (435 m vs. 472 m), with 50% walking less than 80% of what was predicted. ICU patients also had lower SF-36 scores across most areas, showing a poorer quality of life.

Conclusion: COVID-19 patients who needed ICU care face more severe and lasting long-term issues than those not in the ICU. These issues include abnormal lung structure, reduced lung function, limited physical capacity, and lower quality of life. Early identification and focused rehabilitation are crucial. Ongoing follow-up care should be prioritized to enhance recovery outcomes.

Keywords: Respiratory Issues; COVID-19; ICU; COVID-19 Survivors

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by the new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has greatly affected global health systems, economies, and societies. Since it appeared in late 2019, the virus has infected hundreds of millions of people around the world and led to significant illness and death.[1] While the acute symptoms of COVID-19 vary from no symptoms at all to severe respiratory failure that requires admission to an intensive care unit (ICU), more evidence shows that many patients, especially those with severe illness, continue to experience lasting symptoms and difficulties long after they recover.[2]

During the acute phase, COVID-19 mainly impacts the respiratory system, causing pneumonia, acute respiratory distress syndrome (ARDS), and affecting multiple organs in critical cases.[3] High-resolution computed tomography (HRCT) is widely used to check for lung involvement, with findings like bilateral ground-glass opacities, consolidation, and interstitial abnormalities often observed. Lung issues usually relate to the severity of the disease, and ICU patients often show more severe radiological problems than non-ICU patients.[4]

Emerging literature has focused on the long-term effects of COVID-19, often referred to as "post-acute COVID-19 syndrome" or "long COVID." This condition includes a wide range of physical, psychological, and functional problems that continue after the initial phase.[5] These effects may involve chronic fatigue, shortness of breath, lower exercise capacity, poor lung function, and a decreased quality of life.[6] Several cohort studies have shown that even six to twelve months after being discharged, many survivors, especially those who had severe illness or stayed in the ICU, do not return to their previous health status.[7]

Pulmonary function tests (PFTs), such as spirometry and diffusing capacity for carbon monoxide (DLCO), have shown restrictive ventilatory problems and diffusion issues in a significant number of patients after COVID-19, particularly those who needed mechanical ventilation.[8] At the same time, six-minute walk tests have shown lower functional capacity, which is believed to result from a mix of lung scarring, lack of physical activity, and ongoing inflammation.[9] These challenges greatly reduce health-related quality of life (HRQoL), as measured by tools like the Short Form-36 (SF-36).[10]

The degree and persistence of these long-term complications seem to depend on how severe the illness was at first. ICU patients often face more serious post-COVID problems due to prolonged immobility, higher oxygen needs, and the use of invasive ventilation.[11] In contrast, non-ICU patients may also have lingering symptoms, but less often and with less severity.[12] However, we still do not fully understand the difference in post-COVID complications between ICU and non-ICU patients. This is especially true in low- and middle-income countries, where healthcare services, access to rehabilitation, and follow-up support might be limited.[13]

Persistent radiological abnormalities on chest imaging, including fibrotic changes, reticular opacities, and bronchiectasis, have been found in both ICU and non-ICU patients, although they are more common in the former group. These imaging results often link to lung function problems and may act as important signs for long-term respiratory issues.[14] Despite initial efforts to study these changes, we still do not fully understand the long-term radiological and functional outcomes of COVID-19 survivors, especially when comparing those who were in ICU care versus those who were not.

Given the significant healthcare burden from post-COVID conditions, it is important to identify the recovery patterns and the level of functional and radiological impairment based on different disease severities. This information is crucial for guiding follow-up care and planning rehabilitation. It also plays a key role in how resources are allocated and in policymaking, especially in places with limited resources.

While several studies have looked at the long-term effects of COVID-19, few have directly compared lung imaging, lung function, physical performance, and quality of life between ICU-treated and non-ICU patients. This study aims to address that gap by examining chest CT results, breathing function, exercise ability, and quality of life in both groups six months after they were discharged from the hospital. By making these comparisons, the research hopes to offer insights into recovery patterns after COVID-19, help prioritize long-term healthcare plans, and guide personalized rehabilitation based on how severe the initial disease was.

Objective

To investigated the effect of COVID-19 on lung structure, pulmonary function, exercise capacity, and quality of life in patients discharged from ICU and medical wards.

Methodology

This cohort study took place at Department of Medicine, Ziauddin University Hospital North campus, Karachi, from January to December 2023. The study aimed to compare long-term outcomes related to lung health, imaging, function, and quality of life in patients hospitalized with COVID-19 who required intensive care unit (ICU) admission versus those treated in general medical wards (non-ICU). The Institutional Review Board of Ziauddin University approved the study under approval number (202/ZU/2022). All participants provided written informed consent, and the study followed the Declaration of Helsinki.

To be included, patients had to be 18 years or older, have a confirmed COVID-19 diagnosis through reverse transcription-polymerase chain reaction (RT-PCR), and have been discharged after recovery. Two patient groups were established: one for those who required ICU care and another for those treated solely in the medical ward. Patients were classified in the ICU group if they needed invasive or noninvasive ventilation or received high-flow nasal cannula (HFNC) during hospitalization. The non-ICU group consisted of patients with moderate-to-severe COVID-19 who did not need critical care but received oxygen therapy or medical management in the pulmonary ward. All patients had to complete at least six months of follow-up after discharge to be included in the analysis.

We excluded patients with neurodegenerative diseases, active malignancies, significant physical disabilities that limited their mobility or lung assessment, and those who were readmitted for non-COVID-related reasons during follow-up. We gathered demographic and clinical data from hospital electronic medical records. This included age, sex, body mass index (BMI), smoking history, comorbidities (like hypertension, diabetes, chronic obstructive pulmonary disease), severity of illness at admission, and treatments received while in the hospital (such as antivirals, corticosteroids, antibiotics, and immunomodulatory agents).

At the six-month follow-up visit, each patient had a thorough evaluation. This included high-resolution computed tomography (HRCT) of the chest, pulmonary function tests (PFTs), the six-minute walk test (6MWT), and an assessment of health-related quality of life using the Short Form-36 (SF-36) questionnaire. A qualified physician recorded persistent symptoms like shortness of breath, fatigue, and muscle weakness through a structured interview. A physiotherapist supervised the 6MWT test, following the standards set by the American Thoracic Society. The results were reported in meters walked and as a percentage of the predicted norm based on the patient's age and sex.

We carried out pulmonary function tests using a computerized spirometer per the guidelines from the American Thoracic Society and European Respiratory Society. The measured parameters included forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF), and peak inspiratory flow (PIF). Results were expressed as percentages of predicted norms, defining abnormalities as values below 80% of predicted levels.

HRCT scans were taken at full inspiration with 1 mm slice thickness and reviewed by a radiologist who did not know which group the patient belonged to. We calculated a semi-quantitative CT severity score by evaluating each of the five lung lobes and assigning scores based on the extent of lung involvement: 0 for no involvement, 1 for less than 5%, 2 for 5–25%, 3 for 25–50%, 4 for 50–75%, and 5 for more than 75%. The total CT score ranged from 0 to 25. We recorded imaging findings such as ground-glass opacities, subpleural lines, and fibrotic streaks.

The main outcome of the study was the ratio of patients with ongoing abnormalities in chest CT scans at six months. Secondary outcomes included lung function impairment, reduced six-minute walk distance, persistent symptoms, and quality-of-life scores assessed via SF-36. The self-administered SF-36 questionnaire measured eight areas: physical functioning, role limitations due to physical and emotional problems, social functioning, vitality, mental health, bodily pain, and general health perception. Scores were converted to a 0–100 scale, with higher scores indicating better health.

We performed statistical analysis using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). We tested continuous variables for normality using the Kolmogorov-Smirnov test, presenting them as median with interquartile range (IQR) or mean ± standard deviation, as appropriate. We summarized categorical variables using frequencies and percentages. We made group comparisons using the Mann-Whitney U test for continuous variables and the Chi-square or Fisher's exact test for categorical variables. Logistic regression analysis helped identify independent predictors of persistent radiological abnormalities at follow-up. We considered a p-value of less than 0.05 statistically significant.

Results

A total of 110 patients, who had been hospitalized with confirmed COVID-19 and then discharged, participated in this six-month follow-up study. Among these, 52 patients required admission to the intensive care unit (ICU) during their acute illness, while 58 patients were treated in general medical wards (non-ICU). The median age of the entire group was 57 years (IQR 48 to 65), and 67 patients (61%) were male. Common health issues included hypertension (38%) and diabetes mellitus (30%) (Table 1).

At admission, ICU patients had much higher CT severity scores than non-ICU patients, with a median of 18 compared to 12, $p < 0.001$. At the six-month follow-up, we observed ongoing radiological abnormalities in 35 ICU patients (67.3%) and 16 non-ICU patients (27.6%). These abnormalities included mainly ground-glass opacities (GGO), subpleural bands, and fibrotic streaks. The median follow-up CT scores were 6 (IQR 3–10) in the ICU group and 1 (IQR 0–3) in the non-ICU group, $p < 0.001$ (Table 2).

PFTs were done by 105 patients. Abnormalities in at least one PFT parameter were more common among ICU survivors, especially in forced vital capacity (FVC) and peak expiratory flow (PEF). 14 ICU patients (26.9%) had FVC below 80% of what was expected, compared to 6 non-ICU patients (10.3%) ($p = 0.022$). CT abnormalities at follow-up were linked to lower lung function parameters.

This scatter plot shows the inverse relationship between

Table 1. Baseline Demographic and Clinical Characteristics of ICU vs. Non-ICU Patients

Characteristic	ICU Patients (n=52)	Non-ICU Patients (n=58)	p-value
Age, median (IQR), years	59 (51–66)	54 (45–60)	0.021
Male, n (%)	36 (69.2%)	31 (53.4%)	0.048
Hypertension, n (%)	24 (46.2%)	18 (31.0%)	0.089
Diabetes Mellitus, n (%)	19 (36.5%)	14 (24.1%)	0.117
Charlson Comorbidity Index	2 (1–3)	1 (0–2)	0.035
Length of hospital stay, days	16 (12–24)	9 (7–13)	<0.001

CT severity scores and FVC % predicted among ICU and non-ICU patients six months after being discharged from COVID-19. Patients who needed ICU-level care (shown as red dots) usually had higher CT scores. This means they had more severe lung damage and correspondingly lower FVC% values, indicating worse lung function. In contrast, non-ICU patients (blue dots) often had lower CT scores and higher predicted FVC%, which suggests their lung function was relatively preserved. The negative slope of the regression line further confirms this inverse relationship, highlighting that more radiological damage connects with greater lung issues. This finding shows the long-term effects of severe COVID-19 pneumonia on lung function and emphasizes the importance of ongoing respiratory monitoring for ICU survivors (Figure 1).

The median walking distance in the 6MWT was 435 meters for ICU patients and 472 meters for non-ICU patients (p = 0.031). In total, 26 patients (50%) in the ICU group walked less than 80% of the expected norms based on age and sex, while 17 patients (29.3%) in the non-ICU group fell below this threshold.

This bar chart compares the median six-minute walk distance (6MWD) between ICU and non-ICU COVID-19 survivors six months after discharge. ICU patients showed a lower median distance of 435 meters, while the non-ICU group had a distance of 472 meters. The bars are color-coded, with red for ICU and blue for non-ICU, to underscore the difference in physical performance.

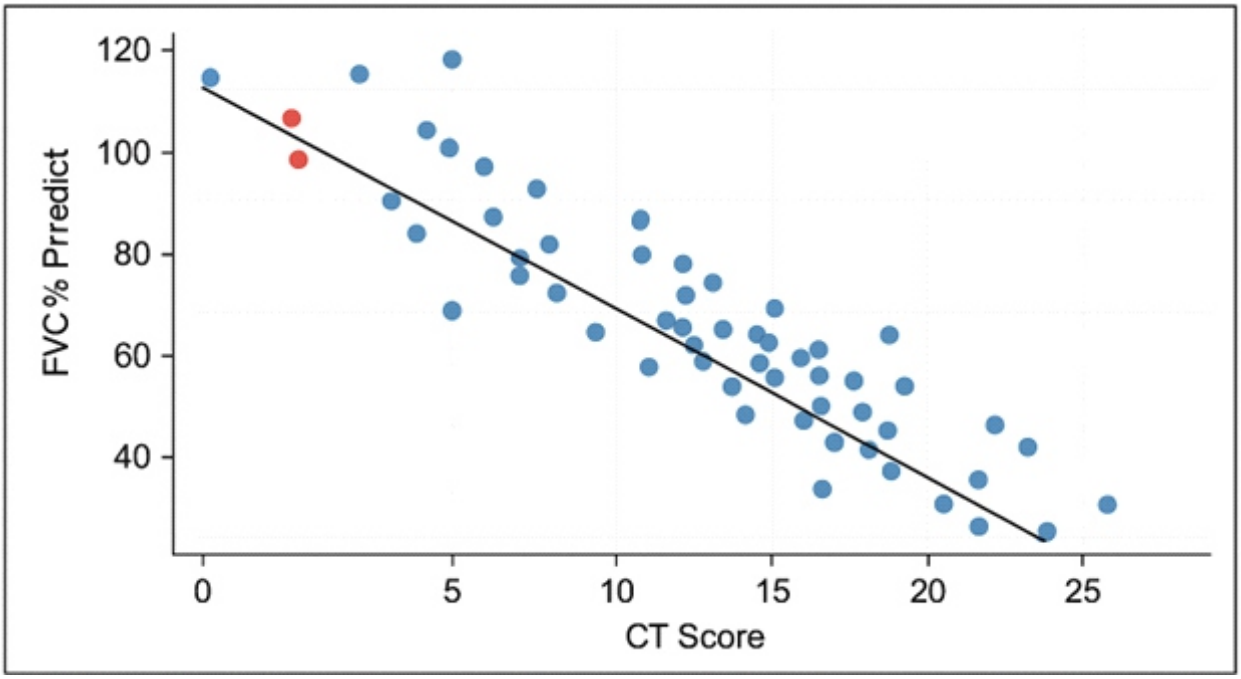

Figure 1. Relationship Between Follow-Up CT Scores and PFT Abnormalities

Table 2. CT Severity Scores and Follow-Up Findings

Parameter	ICU (n=52)	Non-ICU (n=58)	p-value
Admission CT Score (median, IQR)	18 (14–23)	12 (9–15)	<0.001
6-month CT Score	6 (3–10)	1 (0–3)	<0.001
Any CT Abnormality at 6-months	35 (67.3%)	16 (27.6%)	<0.001

Percentage labels above each bar indicate the proportion of patients in each group whose walking distance was less than 80% of the predicted value: 50% in the ICU group and 22% in the non-ICU group. These findings suggest that ICU patients faced greater limitations in their functional ability, likely due to muscle weakness, breathing difficulties, and the overall impact of severe illness. The 6MWD serves as a clear indicator of post-COVID rehabilitation needs and long-term recovery (Figure 2).

Overall, 81% of patients reported at least one ongoing symptom at six months. ICU patients experienced significantly higher rates of symptom persistence, with 90% compared to 72%, p = 0.019. Common symptoms included shortness of breath (65%), fatigue (54%), and muscle weakness (33%). Female patients noted a greater symptom burden.

Using the SF-36 instrument, both groups had lower scores in physical functioning and role limitations due to physical and emotional health. The median physical functioning scores were 70 for ICU patients versus 78 for non-ICU patients, p = 0.089, although this was not statistically significant. Role limitations were notably lower among ICU survivors. Female patients had overall lower SF-36 scores (Table 3).

This radar chart shows the SF-36 quality of life scores for six important health areas in ICU and non-ICU patients, measured six months after they were discharged. Each axis represents a specific area: Physical Functioning, Role Limitations due to Physical Health, Role Limitations due to Emotional Problems, Social Functioning, General Health, and Vitality. ICU survivors, shown in red, scored lower in all areas compared to non-ICU patients, represented in blue. This highlights a greater burden on their health and daily functioning. The biggest differences were in Physical Functioning (45 vs. 62), Role-Physical (40 vs. 58), and Vitality (44 vs. 60). These scores reflect the long-lasting effects of severe illness on daily activities, energy levels, and overall well-being. The radar format clearly illustrates the gap in health-related quality of life.

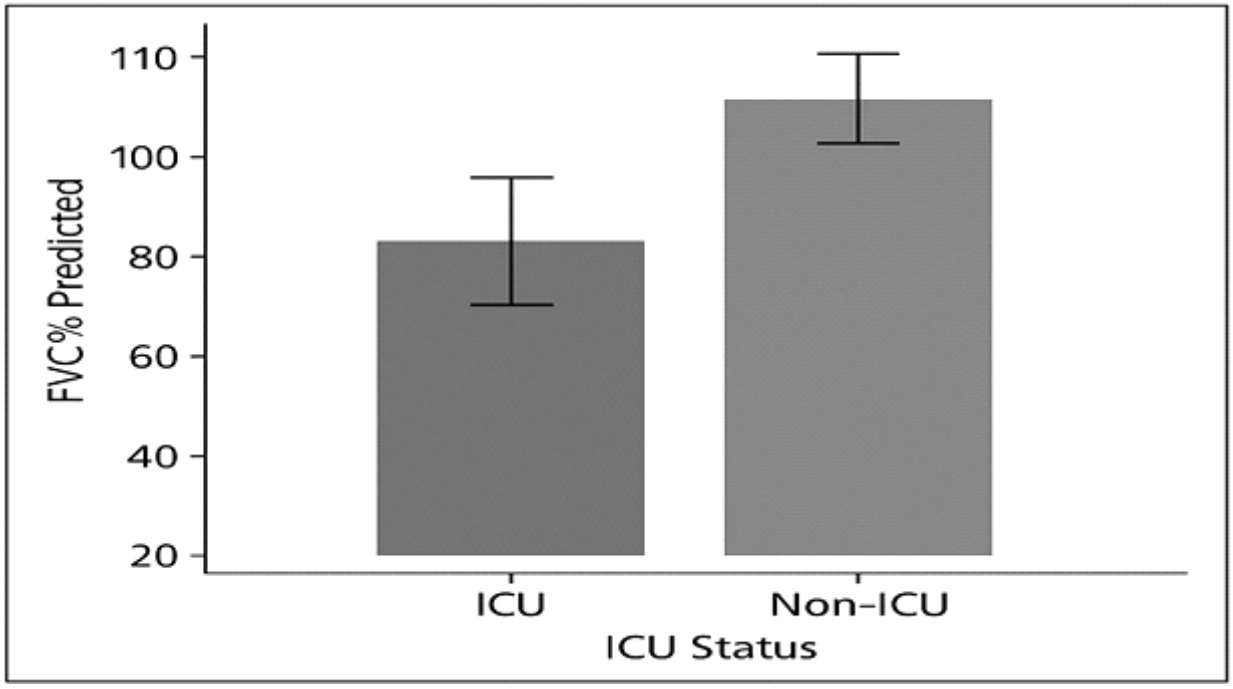

Figure 2 a. 6-Minute Walking Distance in ICU vs. Non-ICU Patients

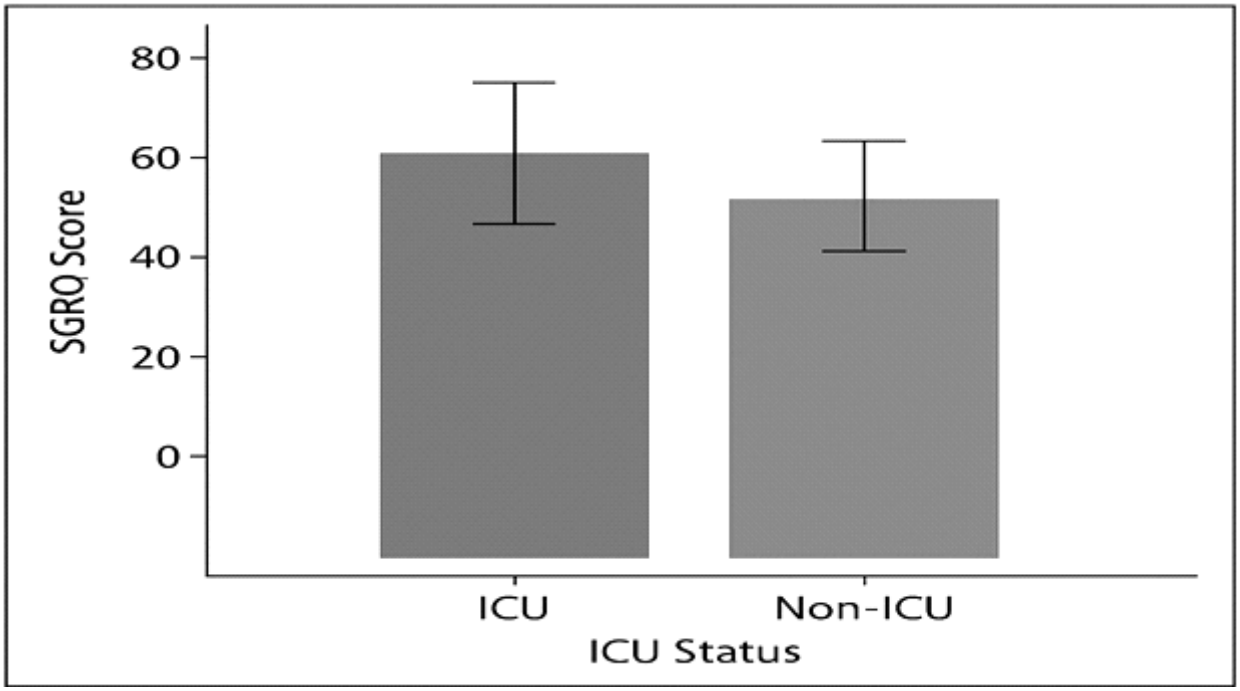

Figure 2 b. 6-Minute Walking Distance in ICU vs. Non-ICU Patients

This reinforces the need for focused psychological and physical rehabilitation, especially for those recovering from ICU stays (Figure 3).

Discussion

The long-term effects of COVID-19 have become an important area of research. Millions of people recover from acute infections but continue to struggle with lingering symptoms and physical issues. This study looked at the six-month outcomes of COVID-19 survivors who either needed intensive care or were treated in non-ICU settings. The results showed clear differences between the two groups in areas like lung imaging, lung function, exercise ability, and quality of life. Survivors from the ICU experienced more severe lung problems, lower physical performance, and worse quality-of-life scores, highlighting the lasting effects of severe COVID-19. These findings not only match global patterns but also stress the importance of follow-up care and rehabilitation plans based on the severity of the initial illness.

This study compares six-month follow-up outcomes in patients who were hospitalized with COVID-19, divided by ICU and non-ICU admission status. The results reveal ongoing issues in imaging, lung function, physical ability, and quality of life, especially for ICU survivors. These findings align with earlier global studies and underline the need for organized post-COVID monitoring and

Table 3. SF-36 Quality of Life Scores at Follow-Up

Domain	ICU (n=52)	Non-ICU (n=58)	p-value
Physical Functioning	70 (55–85)	78 (65–92)	0.089
Role Limitations – Physical	50 (25–75)	65 (50–100)	0.043
Role Limitations – Emotional	45 (20–70)	60 (40–90)	0.058
Social Functioning	62 (40–78)	74 (55–85)	0.045
General Health	60 (45–80)	68 (52–85)	0.072
Vitality	58 (35–74)	63 (48–78)	0.142

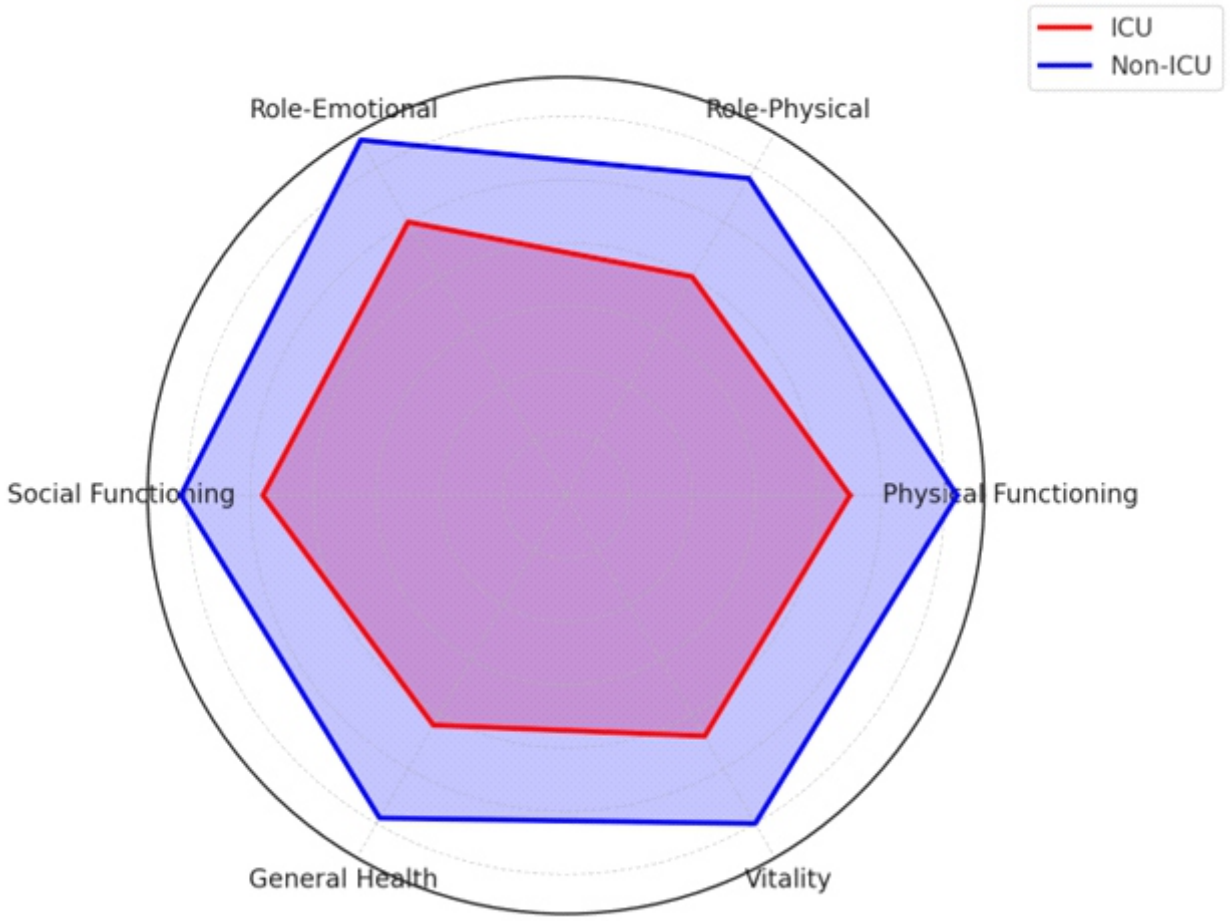

Figure 3. Comparison of SF-36 scores Between ICU and Non-ICU Groups

rehabilitation.

A much higher percentage of ICU patients (67.3%) had abnormal CT findings six months after discharge compared to non-ICU patients (27.6%). The main abnormalities included ground-glass opacities, fibrotic bands, and subpleural lines. This result matches a multicenter cohort study by Han et al. (2021). They reported that 65% of ICU-treated COVID-19 patients showed ongoing radiologic abnormalities at six months, indicating long-term changes in lung tissue.[13] Similarly, Liu et al. (2020) found partial improvement in non-severe cases but noted that fibrotic lesions remained in 59% of critical cases after 90 days.[15] Another study by Caruso et al. (2021) also showed that patients needing ICU support had significantly higher CT scores during follow-up compared to non-ICU patients.[16] These observations indicate that disease severity and treatments such as invasive ventilation might lead to ongoing inflammation. This could cause slower recovery in imaging results or lasting changes in structure.

ICU patients showed a higher rate of poor lung function, especially with lower FVC and PEF values. About 26.9% of ICU patients had FVC below 80% of what is expected. Similar findings were reported by Mo et al. (2020), where 25% of recovered patients had abnormal lung function at discharge, mostly showing restrictive patterns.[7] In a study by Talman et al. (2021),[17] ICU patients had much lower spirometry results than non-ICU patients at three months. Lerum et al. (2021) also confirmed a link between reduced lung function and the initial severity of the disease in their Norwegian group.[18] These issues may stem from post-inflammatory lung scarring, lung damage from mechanical ventilation, and long periods of immobility during the ICU stay.

ICU survivors had significantly lower six-minute walk distances, with 435 m compared to 472 m. Fifty percent of them performed below 80% of the predicted distance. Bellan et al. (2021) reported that 53% of ICU patients had reduced 6MWT performance at four months, which they linked to muscle wasting and heart-lung dysfunction.[19] A Chinese cohort study by Huang et al. (2021) found similar results, with ICU patients achieving only 67% of the predicted walk distance at six months.[5] Another study by Spielmanns et al. (2022) concluded that reduced physical

performance in ICU patients could last even after one year.[20] These reductions may reflect a combination of ventilator-related deconditioning, systemic inflammation, and neuromuscular issues. This highlights the need for structured physical rehabilitation after ICU stays.

Persistent symptoms were more common in ICU patients (90%) than in non-ICU patients (72%). Dyspnea and fatigue were the most frequently reported symptoms. A study by Xiong et al. (2021) found that 76% of hospitalized patients reported at least one symptom at six months, with fatigue and dyspnea being the most common.[21] Similarly, research from Italy by Carfì et al. (2020) showed that 87% of discharged COVID-19 patients experienced persistent symptoms two months after leaving the hospital.[22] Fernández-de-las-Peñas et al. (2021) also documented long-lasting symptoms, particularly in ICU patients.[23] These findings highlight the complex nature of post-COVID syndrome, which includes immune issues, blood vessel problems, and psychological stress.

Most ICU patients reported lower scores in various SF-36 areas, especially in physical functioning, role limitations (both physical and emotional), and social functioning. Tabacof et al. (2022) found that post-COVID patients had significantly lower quality-of-life scores, with ICU survivors facing the worst outcomes.[9] In a German study, Halpin et al. (2021) also observed marked reductions in HRQoL, particularly in energy, physical health, and role limitations.[24] A Canadian study by Herridge et al. (2021) looked into long-term ICU outcomes and further highlighted the ongoing impact of critical illness on mental and social health.[10] These findings show that the effects of severe COVID-19 go far beyond respiratory issues, influencing overall well-being and daily life.

The findings clearly show that the severity of initial COVID-19 illness significantly affects long-term recovery. Patients needing intensive care are more likely to have ongoing physiological, radiological, and functional problems. These issues can lead to lower physical performance and a reduced quality of life related to health. These differences highlight the need for personalized rehabilitation programs and ongoing monitoring, especially for high-risk survivors of serious illness. While our study provides important insights into the range of post-COVID issues, more studies with larger groups and longer follow-ups are needed to improve recovery pathways and guide post-acute care in various healthcare settings.

Conclusion

This study reveals the considerable and lasting burden of post-COVID effects, especially in patients who received ICU-level care during their hospital stay. Six months after leaving the hospital, ICU survivors showed more frequent radiological problems, greater lung function issues, lower exercise capacity, and significantly poorer health-related quality of life scores compared to non-ICU patients. These results emphasize the need to identify high-risk individuals early and to implement customized rehabilitation programs to support full recovery. Adding structured follow-up assessments to regular post-COVID care could lead to better long-term outcomes and lessen the ongoing impact of severe SARS-CoV-2 infection on patients and healthcare systems.

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