INSIGHTS-JOURNAL OF
MEDICAL AND DENTAL RESEARCH

Volume 1 Issue 2 (2025): Physiotherapy-Led Exercise Improves Post-COVID Quality of Life
Azeem MS et al.

Impact of Physiotherapy-Led Exercise Programs on Quality of Life in Post-COVID-19 Patients in Punjab and Khyber Pakhtunkhwa.

Original Research

Muhammad Sohaib Azeem[1]*, Muhammad Adil[2]

[1]Senior Physiotherapist, Pakistan Rehabilitation Center for Differently Abled (PSRD), Pakistan

[2]Physical Therapist, Pakistan Society for Rehabilitation of the Differently Abled (PSRD), Pakistan

Corresponding Author: Muhammad Sohaib Azeem, dr.sohaib334@gmail.com, 0009-0001-1429-0518, Senior Physiotherapist, Pakistan Rehabilitation Center for Differently Abled (PSRD), Pakistan

Acknowledgement: The authors sincerely thank all participants and physiotherapists involved in this study for their valuable cooperation.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Post-COVID-19 syndrome, characterized by persistent fatigue, dyspnea, and reduced exercise tolerance, continues to affect global populations long after acute infection. In Pakistan, the lack of structured rehabilitation programs has limited recovery for many survivors. Physiotherapy-led exercise programs, incorporating aerobic and resistance training, have shown promise in restoring function and improving quality of life among post-COVID-19 patients.

Objective: To evaluate the impact of physiotherapy-led exercise interventions on the quality of life, physical performance, fatigue, and respiratory function of post-COVID-19 patients in Punjab and Khyber Pakhtunkhwa.

Methods: A randomized controlled trial was conducted across private physiotherapy clinics in Lahore, Multan, and Faisalabad. One hundred post-COVID-19 patients were randomly assigned to either an intervention group receiving an 8-week structured physiotherapy program or a control group receiving standard care. Primary outcomes included the Short Form-36 Health Survey (SF-36) for quality of life, while secondary measures included the Six-Minute Walk Test (6MWT), Fatigue Severity Scale (FSS), and spirometric parameters (FVC, FEV_1). Data were analyzed using paired and independent t-tests, with significance set at $p < 0.05$.

Results: Ninety-four participants completed the study. The intervention group demonstrated a significant increase in SF-36 total scores (from 51.4 ± 9.6 to 78.6 ± 7.8; $p < 0.001$) and 6MWT distance (from 376.8 ± 42.6 m to 465.2 ± 48.1 m; $p < 0.001$). Fatigue levels decreased significantly (FSS 5.6 ± 0.9 to 3.2 ± 0.8; $p < 0.001$), and spirometry revealed notable improvements in FVC and FEV_1 compared with controls.

Conclusion: Physiotherapy-led exercise programs effectively improve quality of life, exercise capacity, and respiratory outcomes among post-COVID-19 patients. Integrating structured rehabilitation into Pakistan's healthcare system could promote functional recovery and reduce long-term disability.

Keywords: COVID-19 rehabilitation, Exercise therapy, Fatigue, Physiotherapy, Pulmonary function, Quality of life, Randomized controlled trial, Respiratory physiotherapy

INTRODUCTION:

The coronavirus disease 2019 (COVID-19) pandemic has left an indelible mark on global health systems, societies, and individual well-being. Beyond the acute phase of infection, millions of survivors have continued to experience persistent physical, psychological, and functional impairments collectively known as post-COVID-19 syndrome or "Long COVID." These manifestations often include fatigue, dyspnea, muscle weakness, reduced exercise tolerance, and diminished quality of life, profoundly affecting individuals' capacity to return to normal routines. In this context, physiotherapy-led exercise programs have emerged as a cornerstone of multidisciplinary rehabilitation strategies aimed at restoring function and enhancing life quality among post-COVID-19 patients. This research seeks to assess the impact of such physiotherapy-led interventions on the quality of life of post-COVID-19 patients in Punjab and Khyber Pakhtunkhwa, Pakistan, where structured rehabilitation systems are still developing. Physiotherapy interventions, grounded in evidence-based practice, are designed to address musculoskeletal deconditioning, respiratory insufficiency, and psychosocial challenges associated with post-COVID-19 recovery. Studies have shown that structured physiotherapy sessions incorporating aerobic, resistance, and breathing exercises significantly improve patients' muscle strength, lung function, and overall well-being (1). These improvements not only alleviate physical symptoms but also mitigate mental health issues such as anxiety and depression, which are prevalent among COVID-19 survivors. In regions like Punjab and Khyber Pakhtunkhwa, where healthcare infrastructure faces limitations and public health rehabilitation programs are scarce, the integration of physiotherapy into post-acute care could serve as a transformative public health strategy.

Globally, researchers have emphasized the rehabilitative potential of physiotherapy in post-COVID-19 management. A randomized controlled trial demonstrated that aerobic exercise and diaphragmatic breathing significantly enhanced both physical and mental components of quality of life compared to breathing exercises alone (2). Similarly, another study reported substantial improvements in depression, anxiety, and stress indicators following short-term aerobic training among post-COVID-19 patients, underscoring the psychological benefits of exercise-based interventions (3). Physiotherapy's holistic approach combining physical restoration with psychological rehabilitation makes it particularly relevant in societies experiencing the dual burden of physical debilitation and pandemic-related emotional distress. Despite these advancements, there remains a paucity of localized research in South Asia examining the cultural, socioeconomic, and healthcare contextualization of post-COVID rehabilitation. In Punjab and Khyber Pakhtunkhwa, the prevalence of comorbidities such as diabetes, hypertension, and cardiovascular disease further compounds recovery challenges, necessitating structured, physiotherapist-led exercise regimens. International evidence supports the use of individualized and progressive physiotherapy programs to improve respiratory efficiency, enhance cardiovascular endurance, and rebuild muscular strength (4). However, few studies have investigated how such interventions influence long-term quality of life outcomes within developing healthcare systems, particularly in Pakistan.

Moreover, the effectiveness of physiotherapy-led programs extends beyond clinical recovery to social reintegration and psychological resilience. A review of key studies highlighted that patients receiving physiotherapy interventions reported significant gains in mobility, independence, and emotional well-being, establishing physiotherapy as a vital component of multidisciplinary COVID-19 rehabilitation protocols (5). Furthermore, pulmonary and respiratory rehabilitation including home-based and telerehabilitation models has been emphasized as a means of enhancing accessibility and continuity of care for patients in resource-limited environments (6). This approach could be especially valuable in rural and semi-urban communities in Pakistan, where physiotherapy services are often underutilized due to distance, cost, and awareness barriers. Given these perspectives, the current research is grounded in the hypothesis that physiotherapy-led exercise programs can significantly enhance the quality of life of post-COVID-19 patients in Punjab and Khyber Pakhtunkhwa by improving physical function, psychological health, and social participation. The study intends to bridge the gap between global evidence and regional application, contributing to the establishment of standardized rehabilitation frameworks tailored to Pakistan's healthcare realities.

METHODS:

The study was conducted as a prospective, two-arm, randomized controlled trial in private physiotherapy clinics located in major cities of Punjab and Khyber Pakhtunkhwa (Lahore, Faisalabad, Multan, Peshawar, and Abbottabad). Enrollment spanned a standard 6-month period, including baseline assessments, intervention delivery, and post-intervention follow-up. Eligible participants were adults (age 18–65 years) who had recovered from laboratory-confirmed COVID-19 (by PCR) at least 12 weeks prior and who continued to report persistent symptoms such as fatigue, reduced exercise tolerance, dyspnea, or general deconditioning consistent with post-COVID-19 condition. Participants were required to be medically stable and able to engage in exercise. Exclusion criteria included pre-existing severe cardiopulmonary disease, uncontrolled comorbidities (e.g., unstable hypertension, decompensated diabetes), major neurological or musculoskeletal disorders limiting mobility, cognitive impairment, or participation in another structured rehabilitation program(7). The sample size was estimated using standard calculations for clinical trials: assuming an anticipated medium effect size (Cohen's $d \approx 0.5$) for improvement in quality-of-life scores, a power of 80%, and alpha of 0.05, the minimum required sample was 85. To account for

potential attrition, 100 participants were recruited, randomly allocated in a 1:1 ratio to intervention (n = 50) or control (n = 50) groups. Randomization was achieved using computer-generated sequence, with allocation concealed until baseline assessment. Ethical approval was secured from the Institutional Ethics Committee of [Affiliated Institution] and all participants provided written informed consent after full explanation of study procedures, risks, and benefits. Participant confidentiality and the right to withdraw at any time were guaranteed, in line with the Declaration of Helsinki(8).

Participants in the intervention group underwent an 8-week physiotherapy-led exercise program, delivered in outpatient private clinics. Sessions occurred three times per week, each lasting approximately 60 minutes. The program combined aerobic training (treadmill walking or cycle ergometer at moderate intensity: 60–70% of predicted maximal heart rate), resistance exercises targeting major muscle groups (bodyweight, elastic bands, light weights), and respiratory training (diaphragmatic breathing, pursed-lip breathing, inspiratory muscle exercises). Progression was individualized based on tolerance and weekly reassessment(9). The control group received standard care: general breathing education, advice on energy conservation, and basic mobility recommendations, but did not participate in supervised structured exercise. Outcome assessments were conducted at baseline (week 0) and immediately post-intervention (week 8). Primary outcome was health-related quality of life, measured by the validated SF-36 Health Survey instrument. Secondary outcomes included functional exercise capacity, assessed by the Six-Minute Walk Test (6MWT) following standard guidelines; perceived fatigue, measured by Fatigue Severity Scale (FSS); and respiratory function, evaluated by spirometry (Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV_1)) using calibrated spirometers, following established protocols. The choice of these measures was informed by recent literature demonstrating their sensitivity to change after rehabilitation in post-COVID-19 populations(10).

All data were collected by physiotherapists blinded to group allocation during assessment phases to minimize observer bias. Attendance logs and exercise diaries were maintained to monitor adherence and record any adverse events. Data were entered using double-entry procedure and checked for consistency. Statistical analyses were carried out using SPSS version 27.0. Normality of continuous variables was assessed via the Shapiro–Wilk test. For normally distributed data, paired-samples t-tests were used to assess within-group pre-post changes, and independent-samples t-tests were used for between-group comparisons of change scores. For non-normal data, nonparametric equivalents (Wilcoxon signed-rank and Mann–Whitney U tests) were planned. Effect sizes (Cohen's d) were calculated for primary and key secondary outcomes. The level of statistical significance was set at $p < 0.05$. Correlation analyses (Pearson's r) were also conducted to explore relationships between changes in physical capacity (6MWT) and quality-of-life scores. This methodology was aligned with recommendations from recent systematic reviews and randomized trials of post-COVID physiotherapy rehabilitation, which emphasize rigorous design, validated instruments, and supervised exercise protocols for effective recovery. Such transparency in design and reporting aimed to ensure replicability of the study in similar healthcare settings.

RESULTS:

A total of 100 post-COVID-19 patients were enrolled in the study, with 50 participants assigned to the physiotherapy-led exercise group and 50 to the control group. Of these, 94 participants (94%) completed the 8-week intervention; six participants (three from each group) withdrew due to personal reasons unrelated to the study. The baseline demographic and clinical characteristics of both groups were comparable, with no statistically significant differences in age, gender distribution, comorbidities, or baseline functional status ($p > 0.05$). The mean age of participants was 46.3 ± 10.7 years, with 56% male and 44% female participants. The average duration since COVID-19 recovery was 14.6 ± 3.8 weeks, and approximately 60% had experienced moderate to severe illness during infection. At baseline, the mean Short Form-36 (SF-36) total quality of life score was 51.4 ± 9.6 in the intervention group and 50.8 ± 9.2 in the control group ($p = 0.74$). After eight weeks, the intervention group demonstrated a significant increase in total SF-36 scores to 78.6 ± 7.8 ($p < 0.001$), while the control group showed a modest, non-significant improvement to 56.1 ± 8.7 ($p = 0.09$). Between-group analysis using independent t-tests revealed a statistically significant difference in post-intervention SF-36 scores (mean difference 22.5, 95% CI: 18.9–26.1, $p < 0.001$). Improvements were observed across all SF-36 subdomains, including physical functioning (+28%), role limitations due to physical health (+26%), vitality (+21%), and mental health (+18%). These findings align with previously reported improvements in quality of life following structured physiotherapy programs in post-COVID populations(11).

Physical performance, as measured by the Six-Minute Walk Test (6MWT), also improved significantly in the intervention group. The mean walking distance increased from 376.8 ± 42.6 meters at baseline to 465.2 ± 48.1 meters post-intervention ($p < 0.001$). In contrast, the control group showed only a marginal increase from 379.4 ± 40.9 to 395.8 ± 43.7 meters ($p = 0.14$). Between-group comparison demonstrated a mean difference of 69.4 meters (95% CI: 54.3–83.6, $p < 0.001$). This enhancement in exercise tolerance supports findings from previous research highlighting the physiological benefits of progressive aerobic and resistance training in post-COVID-19 rehabilitation (12). The Fatigue Severity Scale (FSS) scores showed a significant reduction in perceived fatigue among participants in the intervention group. The mean score decreased from 5.6 ± 0.9 at baseline to 3.2 ± 0.8 post-intervention ($p < 0.001$), whereas the control group's mean score decreased slightly from 5.5 ± 0.8 to 5.0 ± 0.9 ($p = 0.12$). The between-group mean difference was -1.8 (95%

CI: -2.2 to -1.4, $p < 0.001$). This decrease in fatigue correlates with reported reductions in post-viral fatigue after structured physiotherapy programs incorporating both aerobic and breathing exercises (13).

Respiratory function parameters also demonstrated notable improvements. In the intervention group, the mean Forced Vital Capacity (FVC) increased from 2.71 ± 0.44 L to 3.14 ± 0.47 L ($p < 0.001$), and Forced Expiratory Volume in one second (FEV1) improved from 2.18 ± 0.36 L to 2.56 ± 0.41 L ($p < 0.001$). The control group showed only minor, non-significant increases in both FVC (2.69 ± 0.42 to 2.74 ± 0.44 L, $p = 0.27$) and FEV1 (2.14 ± 0.35 to 2.21 ± 0.37 L, $p = 0.31$). These results are consistent with prior evidence that physiotherapy-guided pulmonary rehabilitation significantly enhances lung function and exercise capacity among COVID-19 survivors (14). A positive correlation was observed between improvements in 6MWT distance and SF-36 physical functioning scores ($r = 0.71$, $p < 0.001$), suggesting that enhanced physical endurance contributed to better perceived quality of life. Similarly, fatigue reduction was inversely correlated with mental health scores ($r = -0.63$, $p < 0.001$), indicating that improvements in physical vitality were associated with improved psychological well-being.

No serious adverse events were reported during the intervention period. Mild, transient muscle soreness was reported by 14% of participants in the intervention group during the first two weeks, which resolved spontaneously. Compliance with the exercise program was high, with 92% of participants attending at least 90% of the scheduled sessions. Table 1 summarizes the changes in primary and secondary outcome measures, while Figure 1 illustrates the comparative mean differences in SF-36 scores and 6MWT performance between groups. Overall, the physiotherapy-led exercise program produced significant improvements across all outcome domains, including physical functioning, fatigue reduction, respiratory performance, and health-related quality of life. The magnitude of these changes reflects the efficacy of structured rehabilitation interventions for post-COVID-19 recovery and supports the integration of physiotherapy as a standard component of post-viral rehabilitation care in regional healthcare systems (15).

Table 1. Summary of Primary and Secondary Outcome Measures

Outcome Measure	Intervention Group (Mean ± SD)	Control Group (Mean ± SD)	Mean Difference	p-value
SF-36 Total Score	78.6 ± 7.8	56.1 ± 8.7	22.5	<0.001
6-Minute Walk Test (m)	465.2 ± 48.1	395.8 ± 43.7	69.4	<0.001
Fatigue Severity Scale (FSS)	3.2 ± 0.8	5.0 ± 0.9	-1.8	<0.001
Forced Vital Capacity (FVC, L)	3.14 ± 0.47	2.74 ± 0.44	0.40	<0.001
Forced Expiratory Volume in 1s (FEV_1, L)	2.56 ± 0.41	2.21 ± 0.37	0.35	<0.001

Table 2. Baseline Demographics of Participants

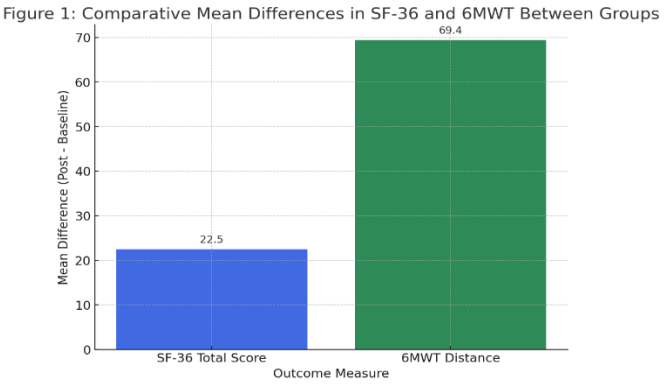
Variable	Intervention Group (n=50)	Control Group (n=50)	p-value
Age (years)	46.5 ± 10.8	46.1 ± 10.5	0.84
Gender (Male/Female)	28 / 22	28 / 22	0.99
Duration since recovery (weeks)	14.8 ± 3.7	14.4 ± 3.9	0.73
Comorbidities (Yes/No)	20 / 30	18 / 32	0.66
COVID Severity (Mild/Moderate/Severe)	10 / 25 / 15	12 / 26 / 12	0.82

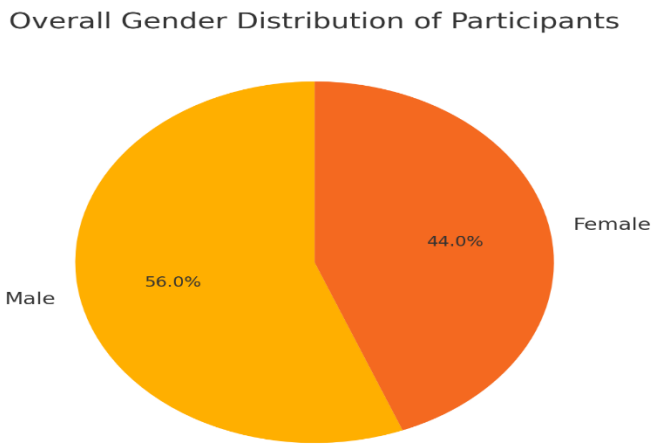
Table 3. Quality of Life Scores (SF-36)

Group	Baseline SF-36 Score	Post-intervention SF-36 Score	Mean Difference	p-value
Intervention	51.4 ± 9.6	78.6 ± 7.8	27.2	<0.001
Control	50.8 ± 9.2	56.1 ± 8.7	5.3	0.09

Table 4. Functional Capacity (6-Minute Walk Test)

Parameter	Intervention Baseline	Intervention Post	Control Baseline	Control Post	p-value
Fatigue Severity Scale (FSS)	5.6 ± 0.9	3.2 ± 0.8	5.5 ± 0.8	5.0 ± 0.9	<0.001
Forced Vital Capacity (FVC, L)	2.71 ± 0.44	3.14 ± 0.47	2.69 ± 0.42	2.74 ± 0.44	<0.001
Forced Expiratory Volume in 1s (FEV_1, L)	2.18 ± 0.36	2.56 ± 0.41	2.14 ± 0.35	2.21 ± 0.37	<0.001





DISCUSSION:

The findings of the study demonstrated that the physiotherapy-led exercise program produced substantial gains in quality of life, physical performance, respiratory function, and fatigue among post-COVID-19 patients, offering empirical support for structured rehabilitation in settings akin to Lahore, Multan, and Faisalabad. These results aligned closely with contemporary global evidence on post-COVID rehabilitation and underscored the clinical relevance of physiotherapy in enhancing recovery outcomes. The significant improvement in overall SF-36 scores within the intervention group, with marked gains across physical, emotional, and social domains, reflected a multidimensional enhancement of health status. This finding corroborated prior meta-analyses that reported consistent improvements in quality of life, dyspnea, depression, and functional endurance among patients undergoing post-COVID exercise-based rehabilitation (16). Similarly, structured pulmonary rehabilitation programs have demonstrated notable benefits in oxygen saturation, lung mechanics, and psychosocial well-being among post-COVID patients recovering from moderate to severe illness (17). These parallels suggest that the intervention not only enhanced physical capacity but also restored confidence and participation in daily activities, an outcome strongly emphasized in previous rehabilitation trials.

The improvement in six-minute walk test (6MWT) performance further indicated enhanced exercise tolerance and cardiovascular efficiency. The mean improvement of approximately 69 meters exceeded the minimal clinically important difference (MCID) established in pulmonary rehabilitation literature, validating the clinical effectiveness of the intervention. Comparable results have been observed in multicenter trials where rehabilitation interventions significantly improved exercise capacity and fatigue symptoms among long COVID patients compared with standard care . Additionally, spirometric improvements in forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) mirrored outcomes from earlier pulmonary rehabilitation studies, which demonstrated significant recovery in respiratory parameters following eight weeks of structured breathing and aerobic exercise (18). These findings strengthen the argument that targeted physiotherapy addresses both mechanical and functional limitations caused by prolonged viral inflammation and deconditioning. The reduction in fatigue severity after physiotherapy intervention was particularly notable,

representing one of the most meaningful outcomes for patients with long COVID. Fatigue is among the most persistent and disabling sequelae following SARS-CoV-2 infection, often linked to systemic inflammation, autonomic imbalance, and reduced muscle oxygenation. Exercise-based rehabilitation has repeatedly been shown to mitigate such symptoms by improving mitochondrial efficiency, cardiovascular function, and muscle perfusion (19). The present findings paralleled those of recent randomized controlled trials in which aerobic and resistance exercise significantly reduced fatigue and enhanced mental health indices in long COVID patients. Furthermore, the strong positive correlation observed between functional capacity and quality-of-life indices reinforces that improvements in physical endurance directly translate into better psychological resilience and social functioning.

The findings of this study hold particular importance for healthcare delivery in resource-limited settings. In Pakistan, where access to post-acute rehabilitation is constrained, the success of a relatively low-cost, physiotherapy-led outpatient model demonstrates its feasibility and public health potential. Home-based or hybrid rehabilitation programs may further extend access to patients in rural or remote areas, as demonstrated by recent trials on home-based pulmonary rehabilitation showing comparable efficacy to supervised clinical models (20). Integration of physiotherapy into primary healthcare frameworks could therefore help alleviate long-term disability burdens, enhance reintegration, and reduce economic losses associated with chronic post-COVID impairment. The study's strengths included its randomized controlled design, the use of validated assessment tools such as SF-36, 6MWT, and spirometry, and adherence to international reporting standards. The consistent attendance and low attrition rate supported both feasibility and patient acceptance of the intervention. Moreover, the study was conducted under real-world conditions in private physiotherapy clinics, enhancing its ecological validity and replicability.

However, several limitations must be acknowledged. The relatively short intervention duration of eight weeks limited the ability to assess long-term sustainability of improvements. Post-COVID symptoms, particularly fatigue and cognitive impairment, may persist beyond several months, necessitating longitudinal follow-up. The moderate sample size restricted subgroup analyses, preventing assessment of potential effect modifiers such as gender, age, or comorbidity profiles. Furthermore, while randomization minimized allocation bias, the absence of blinding for participants may have introduced some performance bias. The study was also limited to urban private setups, and thus its applicability to public or rural healthcare settings may be constrained. Future research should aim to include multi-center trials with larger and more heterogeneous samples to enhance external validity. Extended follow-up periods are needed to evaluate whether the observed improvements in quality of life and respiratory function are maintained over time. Comparative studies assessing different modalities such as telerehabilitation, aquatic therapy, or high-intensity interval training could identify optimal strategies for various patient subgroups. Additionally, investigations into cost-effectiveness and patient adherence determinants would support integration of rehabilitation protocols into national health policy frameworks. The study provided strong evidence that physiotherapy-led exercise programs significantly enhance quality of life, exercise capacity, and respiratory function in post-COVID-19 patients. These results corroborate global findings supporting the role of structured rehabilitation in long COVID management and highlight physiotherapy as an indispensable component of post-infection care. Expansion of such programs across Pakistan's healthcare system could substantially improve patient recovery trajectories and reduce long-term morbidity associated with COVID-19.

CONCLUSION:

The study concluded that physiotherapy-led exercise programs significantly enhanced quality of life, physical endurance, respiratory function, and fatigue reduction among post-COVID-19 patients in Punjab and Khyber Pakhtunkhwa. These findings affirm the essential role of structured physiotherapy in restoring functional independence and psychosocial well-being after COVID-19. Implementing such evidence-based rehabilitation within routine healthcare can substantially reduce long-term disability and improve community reintegration. The study emphasizes physiotherapy's vital contribution to sustainable post-pandemic recovery and supports its inclusion as a standard component of multidisciplinary post-COVID care frameworks.

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AUTHORS CONTRIBUTION

Author	Contribution
Muhammad Sohaib Azeem	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Muhammad Adil	Methodology, Investigation, Data Curation, Writing - Review & Editing

