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Original Article

Association Between Rehabilitation Access Barriers, Treatment Adherence, and Functional Status Among Patients with COPD in Lahore, Pakistan: An Analytical Cross-Sectional Study

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ABSTRACT

Background: Hospitalization for pneumonia is associated with reduced mobility, physical performance, and independence in daily activities. Objective: To compare longitudinal functional and respiratory outcomes between two cohorts of hospitalized adults with pneumonia classified by exposure to structured breathing exercises and early mobilization. Methods: A comparative longitudinal cohort was specified over a six-month study period at Gulab Devi Institute of Physiotherapy, Lahore, Pakistan, using purposive sampling and informed consent. The analyzed dataset comprised 46 records (23 in each coded cohort), with assessments at admission, discharge, and 30 days after discharge. Outcomes included Barthel Index, Short Physical Performance Battery (SPPB), Borg dyspnea rating, oxygen saturation, respiratory rate, six-minute walk distance (6MWD), and 30-day readmission. Calculations used between-cohort change contrasts, 95% confidence intervals (CIs), and Fisher's exact test. Results: In the analyzed records, 30-day Barthel improvements were 27.17 ± 6.71 versus 19.78 ± 4.12 points in groups 1 and 0 (difference 7.39, 95% CI 4.06–10.72). SPPB improvements were 4.13 ± 0.76 versus 3.04 ± 0.56 points (difference 1.09, 95% CI 0.69–1.48). Readmission was coded for 1/23 versus 9/23 participants (Fisher p=0.0098). Conclusion: The results showed more favorable functional trajectories in coded group 1, although cohort assignment, selection and disease severity may confound associations; the future-dated follow-up entries require source verification. Keywords: pneumonia; early mobilization; breathing exercises; prospective assessment; longitudinal cohort; Barthel Index; physical performance; rehabilitation.

INTRODUCTION

Community-acquired pneumonia and other acute pneumonic illnesses impose a major burden on adult health services and frequently require hospital-based antimicrobial, oxygen, and supportive management. Clinical assessments prioritize infection severity, physiologic stability, and discharge safety; however, pneumonia-related disability can persist after acute respiratory symptoms improve. The American Thoracic Society and Infectious Diseases Society of America guideline provides the clinical framework for pneumonia management, while observational data show that impairments in basic activities of daily living (ADL) at admission are associated with adverse outcomes during and after hospitalization (1,2).

Loss of functional independence is especially consequential in older adults with acute lower respiratory tract infections. In a prospective study, Weng and colleagues identified functional decline at discharge in approximately one-fifth of older hospital survivors and related decline to frailty and cognitive impairment (3). Woo and colleagues demonstrated an association between early walking time and ADL recovery during admission for community-acquired pneumonia (4). These observations suggest that recovery requires assessment beyond respiratory measurements alone, including mobility, balance, and everyday self-care.

Low physical activity during and following pneumonia admission has been associated with readmission and mortality, providing a rationale for examining structured activity exposure during acute care (5). Large observational analyses have reported associations between early rehabilitation and outcomes in frail patients with pneumonia, including a Japanese nationwide cohort and a US multicentre hospital cohort (6,7). Nevertheless, a separate multicentre analysis using propensity-based adjustment found limited evidence that routine rehabilitation prevented functional deterioration, emphasizing residual confounding and variability in rehabilitation delivery (8).

Interventional evidence is also heterogeneous. A pneumonia-specific systematic review assessed early mobility and clinical outcomes, while a Cochrane review of exercise among acutely hospitalized older medical patients identified uncertainty regarding effects across diverse programmes and populations (9,10). Pneumonia rehabilitation trials have examined inpatient exercise, adjunct neuromuscular electrical stimulation, and improvements in capacity or independence (11,12). More recent studies have evaluated supervised exercise during community-acquired pneumonia admission and different respiratory physiotherapy approaches in bilateral pneumonia, underscoring the ongoing need to distinguish exercise exposure, disease severity, and assessment timing (13,14).

Broader systematic reviews support the feasibility of mobility-promoting strategies in hospitalized older patients but show considerable variation in intervention intensity, implementation, and outcome selection (15–18). Short-term readmission remains a clinically important outcome after pneumonia admission, with patient-level severity and other factors contributing to early rehospitalization risk (19,20). Local longitudinal comparisons that jointly capture ADL independence, lower-limb performance, dyspnea, gas exchange, walking capacity, and rehospitalization may therefore offer clinically useful descriptions, even where nonrandomized allocation precludes causal interpretation.

The objective of this comparative longitudinal cohort study was to examine changes from admission through discharge and 30-day follow-up in functional performance and respiratory status among hospitalized adults with pneumonia, comparing coded higher- and lower-exposure groups for structured breathing exercises and early mobilization. The study further examined the frequency of 30-day readmission between these cohorts.

MATERIALS AND METHODS

A six-month, single-setting, comparative longitudinal cohort study was specified at Gulab Devi Institute of Physiotherapy, Lahore, Pakistan. Participants receiving care for pneumonia were enrolled using purposive sampling. The analytical cohort comprised 46 participant records, divided equally into exposure group 1 (n=23) and comparison group 0 (n=23). The database contained admission and discharge dates and a 30-day post-discharge assessment date, permitting three repeated measurements for the main functional and respiratory variables. The observational reporting framework was informed by STROBE recommendations for cohort studies (21).

The source database recorded age, coded gender, height, weight, body mass index (BMI), coded pneumonia type, chronic obstructive pulmonary disease (COPD), asthma, diabetes mellitus, cardiovascular disease, oxygen requirement, CURB-65 severity score, hospital length of stay, oxygen days, and programme exposure. The exposure variables comprised coded group membership, the number of breathing exercise sessions completed, the number of mobility sessions completed, and the highest mobility category achieved. Group membership was retained exactly as coded in the source data because an authenticated allocation and intervention codebook was not analyzed. Observed programme-session totals were analyzed as descriptive exposure measures rather than assumed randomized treatment assignments.

Functional independence was assessed using the Barthel Index (0–100 points, with higher scores reflecting greater independence), a measure with reported psychometric utility in hospital populations (22). Lower-extremity physical performance was assessed using the SPPB (0–12 points, with higher scores reflecting better performance), supported by systematic psychometric evidence (23). Dyspnea was quantified with a recorded Borg rating; peripheral oxygen saturation (SpO_2) and respiratory rate were recorded as physiological indicators. Functional exercise capacity was represented by six-minute walk distance in metres, with interpretation informed by established field-walking technical standards and clinical guidance (24,25). Outcomes were recorded at admission, at hospital discharge, and 30 days after discharge where available. Readmission within 30 days was recorded as a binary outcome. Hospital length of stay was obtained from the date interval between admission and discharge.

Data were designated for analysis using IBM SPSS Statistics version 26.0. Continuous variables were summarized by mean and standard deviation (SD), and categorical variables by frequency and percentage. The primary descriptive contrast was within-participant change from admission to the recorded 30-day follow-up, compared between cohorts using the Welch two-sample method with 95% confidence intervals. Additional discharge changes were examined. As a limited sensitivity analysis, 30-day Barthel scores were modeled against cohort code, admission Barthel score, and age, with heteroskedasticity-robust standard errors. Readmission proportions were compared using Fisher's exact test, and an unadjusted risk ratio with a 95% confidence interval was calculated. Complete-case analysis was applied for six-minute walk change because baseline and discharge distances were absent for some records. Two-sided $p<0.05$ was used descriptively without representing secondary analyses as multiplicity-adjusted confirmatory tests. The study

received ethical approval from Gulab Devi Institute of Physiotherapy, Lahore, Pakistan, and informed consent was obtained.

RESULTS

The analyzed matrix contained 46 participant records, 23 in each coded cohort. Age averaged 71.65 ± 5.84 years in group 1 and 73.78 ± 6.92 years in group 0; baseline Barthel Index and SPPB means were broadly similar, although other recorded clinical characteristics differed. Group 1 contained a substantially higher number of breathing and mobilization sessions, consistent with its descriptive characterization as the higher-exposure cohort (Table 1). Group 1 completed 10.13 ± 1.10 breathing sessions and 9.48 ± 0.99 mobilization sessions compared with 0.91 ± 0.73 and 1.87 ± 0.69 sessions, respectively, in group 0.

Table 1. Baseline characteristics and recorded programme

Characteristic	Group 1 (n=23)	Group 0 (n=23)
Age, years	71.65 ± 5.84	73.78 ± 6.92
BMI, kg/m²	25.56 ± 1.11	24.79 ± 1.53
Gender code 1, n (%)	15 (65.2)	11 (47.8)
Gender code 2, n (%)	8 (34.8)	11 (47.8)
Gender code 3, n (%)	0 (0.0)	1 (4.3)
COPD, n (%)	12 (52.2)	8 (34.8)
Asthma, n (%)	4 (17.4)	2 (8.7)
Diabetes, n (%)	14 (60.9)	13 (56.5)
Cardiovascular disease, n (%)	10 (43.5)	12 (52.2)
Oxygen required, n (%)	14 (60.9)	13 (56.5)
CURB-65 score	1.90 ± 0.83 (n=21)	2.33 ± 1.06 (n=21)
Barthel Index at admission	61.96 ± 15.28	58.91 ± 18.09
SPPB at admission	5.83 ± 2.06	5.30 ± 2.55
Hospital stay, days	8.13 ± 1.74	8.70 ± 1.92
Breathing sessions completed	10.13 ± 1.10	0.91 ± 0.73
Mobility sessions completed	9.48 ± 0.99	1.87 ± 0.69

Functional independence increased from admission through discharge and the recorded 30-day visit in both groups. The analyzed group 1 Barthel means were 61.96, 78.48, and 89.13 points across the three assessments; corresponding group 0 means were 58.91, 67.17, and 78.70. Group 1 had a mean 30-day change of 27.17 ± 6.71 points compared with 19.78 ± 4.12 in group 0, yielding an unadjusted between-group change difference of 7.39 points (95% CI 4.06–10.72; p<0.001). In a limited admission-score- and age-adjusted sensitivity analysis, the group 1 coefficient for 30-day Barthel Index was 7.97 points (95% CI 5.42–10.53; p<0.001). SPPB improvement from admission to day 30 averaged 4.13 ± 0.76 points in group 1 and 3.04 ± 0.56 in group 0, a between-cohort difference of 1.09 points (95% CI 0.69–1.48; p<0.001). Borg dyspnea rating declined by 3.61 ± 0.66 versus 2.43 ± 0.66 points, corresponding to a change contrast of −1.17 points (95% CI −1.57 to −0.78; p<0.001). Oxygen saturation improved in both groups, with a difference in mean change of 0.96 percentage points (95% CI 0.08–1.83; p=0.033). Respiratory rate also declined in both cohorts; the between-group change contrast was −0.87 breaths/minute (95% CI −1.76 to 0.02; p=0.056).

Table 2. Admission, discharge, and recorded 30-day outcomes by cohort

Outcome/time	Group 1 (n=23)	Group 0 (n=23)
Barthel Index, admission	61.96 ± 15.28	58.91 ± 18.09
Barthel Index, discharge	78.48 ± 13.93	67.17 ± 17.31
Barthel Index, day 30	89.13 ± 11.55	78.70 ± 15.46
SPPB, admission	5.83 ± 2.06	5.30 ± 2.55
SPPB, discharge	8.30 ± 2.08	6.35 ± 2.53
SPPB, day 30	9.96 ± 1.74	8.35 ± 2.48
Borg rating, admission	5.78 ± 1.35	5.65 ± 1.75
Borg rating, discharge	3.52 ± 1.20	4.57 ± 1.70
Borg rating, day 30	2.17 ± 1.07	3.22 ± 1.35
SpO_2, admission (%)	89.65 ± 2.74	89.22 ± 3.18
SpO_2, discharge (%)	94.26 ± 2.09	92.65 ± 2.89
SpO_2, day 30 (%)	96.22 ± 1.44	94.83 ± 2.29
Respiratory rate, admission (breaths/min)	27.39 ± 3.31	28.30 ± 4.00
Respiratory rate, discharge (breaths/min)	20.78 ± 2.91	23.17 ± 3.64
Respiratory rate, day 30 (breaths/min)	18.04 ± 2.14	19.83 ± 3.04
Six-minute walk distance, admission (m)	255.75 ± 67.03 (n=20)	275.67 ± 66.36 (n=15)
Six-minute walk distance, discharge (m)	321.00 ± 68.18 (n=20)	304.33 ± 64.67 (n=15)
Six-minute walk distance, day 30 (m)	364.57 ± 75.24	301.30 ± 97.62

Values are mean ± SD; six-minute walk measurement availability differs between assessments.

Six-minute walk distance had complete baseline-to-follow-up paired data for 20 group 1 records and 15 group 0 records. In these complete cases, mean improvement was 124.75 ± 10.45 m versus 79.00 ± 9.49 m, with a between-group difference of 45.75 m (95% CI 38.85–52.65; p<0.001

Table 3. Comparison of admission-to-day-30 change scores and readmission

Outcome	Group 1 change, mean ± SD	Group 0 change, mean ± SD	Between-group difference (95% CI)	p value
Barthel Index, points	27.17 ± 6.71	19.78 ± 4.12	7.39 (4.06 to 10.72)	<0.001
SPPB, points	4.13 ± 0.76	3.04 ± 0.56	1.09 (0.69 to 1.48)	<0.001
Borg rating, points	−3.61 ± 0.66	−2.43 ± 0.66	−1.17 (−1.57 to −0.78)	<0.001
SpO_2, percentage points	6.57 ± 1.73	5.61 ± 1.16	0.96 (0.08 to 1.83)	0.033
Respiratory rate, breaths/min	−9.35 ± 1.56	−8.48 ± 1.44	−0.87 (−1.76 to 0.02)	0.056
Six-minute walk distance, m	124.75 ± 10.45 (n=20)	79.00 ± 9.49 (n=15)	45.75 (38.85 to 52.65)	<0.001

Between-group differences represent mean group 1 change minus mean group 0 change; confidence intervals and p values use Welch's method.

Readmission by day 30 was coded in 1 of 23 participants (4.3%) in group 1 and 9 of 23 (39.1%) in group 0. Fisher's exact test gave p=0.0098. The unadjusted risk ratio for group 1 compared with group 0 was 0.11 (95% CI 0.02–0.81).

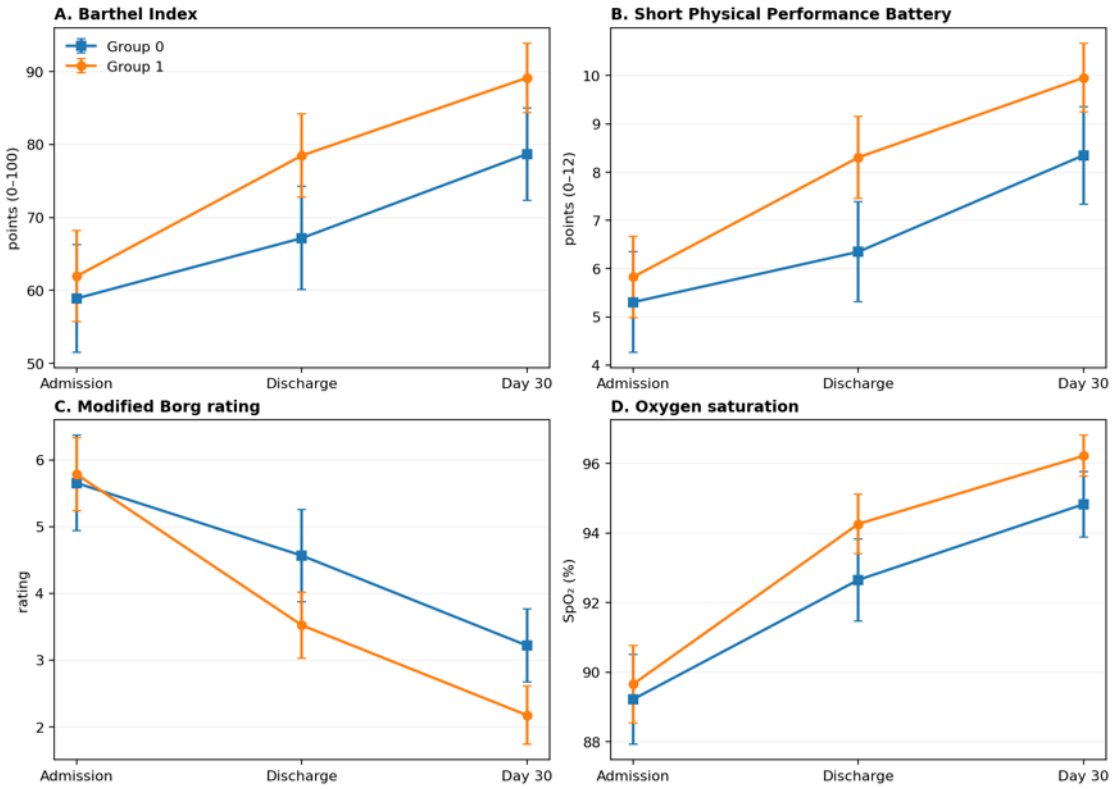


Figure 1. Mean Barthel Index, SPPB, Borg rating, and oxygen saturation at admission, discharge, and coded day-30 follow-up by group; error bars

Figure 1 illustrates longitudinal changes in functional recovery, physical performance, perceived exertion, and oxygen saturation among participants in Groups 0 and 1 at admission, discharge, and 30-day follow-up. Both groups demonstrated progressive improvements across all measured outcomes, with consistently greater improvements observed in Group 1. Barthel Index scores increased from approximately 62 to 89 in Group 1 compared with 59 to 79 in Group 0, indicating greater recovery in functional independence. Similarly, Short Physical Performance Battery scores improved from 5.8 to 9.9 in Group 1 versus 5.3 to 8.3 in Group 0, reflecting enhanced physical performance. Modified Borg ratings declined from approximately 5.8 to 2.2 in Group 1 compared with 5.7 to 3.2 in Group 0, suggesting greater reductions in perceived exertion. Oxygen saturation also improved more prominently in Group 1, increasing from approximately 89.7% to 96.2%, compared with 89.2% to 94.8% in Group 0. Overall, the observed trajectories indicate more favorable functional and respiratory recovery in Group 1 throughout the follow-up period, although statistical significance cannot be established from the figure alone.

DISCUSSION

The data demonstrate a consistent pattern of larger improvements in activities of daily living, lower-extremity physical performance, dyspnea, and functional exercise capacity in the cohort receiving substantially more breathing and mobilization sessions. Improvement was also documented in the lower-exposure cohort, reflecting the expected coexistence of illness recovery, medical treatment, supportive care, and increasing mobility during convalescence. The unadjusted and limited baseline- and age-adjusted Barthel results were directionally concordant, but a nonrandomized, small sample cannot establish that the additional sessions caused these differences.

The importance of functional independence in pneumonia has been demonstrated in prior prospective and retrospective analyses. Ryrsø and colleagues associated low admission Barthel Index with intensive care admission, prolonged length of stay, readmission, and mortality (2). Weng and colleagues highlighted frailty-related vulnerability to post-hospital functional decline (3), and Woo and colleagues linked early walking behavior with recovery of ADL in older inpatients (4). The present dataset's longitudinal functional measurements are therefore aligned with a clinically meaningful outcome domain that is distinct from resolution of infection or normalization of oxygenation.

The observed between-cohort pattern resembles associations reported in the nationwide Japanese analysis of early rehabilitation among frail patients with community-acquired pneumonia and in a US hospital-based analysis of rehabilitation exposure and 30-day outcomes (6,7). Yet Chen and colleagues reported a limited effect after propensity-based adjustment (8). This difference in published findings is important: referral to rehabilitation, the timing and intensity of prescribed exercises, illness severity, baseline disability, comorbidities, and local staffing may all influence both exposure and outcomes. Accordingly, the contrast between ten breathing sessions in one cohort and fewer than one on average in the other should be interpreted as exposure separation, not proof of an isolated therapeutic effect.

Experimental and review literature provides further context. Individual trials have reported functional benefits of inpatient rehabilitation or combined interventions (11,12), whereas the 2026 randomized exercise study found a modest improvement in Barthel Index after supervised in-bed cycling without consistent differences across other measures (13). Respiratory physiotherapy interventions for bilateral pneumonia have also been evaluated in a trial setting, but different interventions and intensive-care populations limit direct comparison (14). Systematic reviews in hospitalized older adults likewise indicate that programme design, intensity, baseline capacity, and adherence should be considered when interpreting functional outcomes (9,10,15–18). The present data do not isolate the breathing component from mobilization or establish a dose-response relationship. The SPPB provides a complementary assessment of standing balance, gait speed, and chair-rise capacity, rather than simply duplicating the self-care domains represented by the Barthel Index. The systematic psychometric review by Kameniar and colleagues (23) and a later meta-analysis by Eusepi and colleagues (26) support its role as a reproducible physical performance measure in older clinical populations. Improvements in dyspnea, SpO_2, and respiratory rate may indicate respiratory recovery alongside functional improvement, but these variables may be affected by prescribed medical treatment, supplementary oxygen, and disease evolution independently of rehabilitation exposure.

Readmission was less frequent in the coded higher-exposure group, and the unadjusted relative risk was substantially below unity. Published pneumonia studies demonstrate that post-discharge rehospitalization is associated with multiple clinical and service factors (19,20). Furthermore, contemporary work on rehabilitation interventions in hospitalized pneumonia patients has emphasized the importance of carefully distinguishing intervention allocation from illness severity, usual care, and longer-term follow-up (27). Research on potentially avoidable pneumonia readmissions also cautions against assuming that all readmissions represent failures of inpatient rehabilitation (28). The small number of readmission events in this dataset does not support a reliable multivariable risk model; the crude estimate is consequently hypothesis-generating.

Several methodological features constrain interpretation. Cohort membership was not randomized, and the source file did not provide a definitive allocation-code dictionary, programme content, session duration, exercise intensity, exclusion criteria, adherence thresholds, or standardized treatment co-interventions. There were no records of premorbid functional status or direct frailty measures, and case mix cannot be fully controlled by baseline Barthel score and age alone. Missing baseline and discharge 6MWD observations disproportionately affected the lower-exposure group, potentially introducing measurement-selection bias. A sample of 46 limits precision for binary readmission and more complex adjusted modeling. The consistent direction of individual improvements also warrants source-data checks. Finally, the recorded follow-up dates extend beyond the manuscript preparation date and must be validated before any analysis can be interpreted as completed clinical follow-up.

The study's practical contribution is the integrated tracking of daily-function, performance, respiratory, and hospital-utilization domains over three intended assessment points. Future verification should prioritize contemporaneous clinical source records, an authenticated cohort-codebook and protocol, complete exposure description, and prespecified covariate adjustment. Once follow-up is complete and records are authenticated, these data could help inform locally relevant evaluation of structured respiratory and mobility rehabilitation among adults recovering from pneumonia.

CONCLUSION

In the analyzed comparative cohort dataset, the higher-exposure group showed greater improvements in Barthel Index, SPPB, dyspnea, and measured walking capacity and fewer coded 30-day readmissions than the lower-exposure group. These patterns represent unverified observational associations and cannot establish programme effectiveness; genuine completion and validation of the dated follow-up records are necessary before the findings can support publication or clinical conclusions.

DECLARATIONS

Authors' Contributions:	Concept: OA; Design: HMA; Data Collection: HZ; Analysis: SR; Drafting: OA, HMA, HZ, SR.
Ethical Approval:	The institution responsible for ethical review was Gulab Devi Institute of Physiotherapy, Lahore, Pakistan
Informed Consent:	Written informed consent was obtained from all participants before enrolment.
Conflict of Interest:	The authors declare no conflict of interest.
Funding:	No external funding was received for this study.
Data Availability:	De-identified data may be available from the corresponding author on request, subject to participant consent and institutional confidentiality requirements.
Acknowledgments:	None.
AI Declaration:	Generative AI tools were used solely for language and grammatical refinement. The authors verified the final manuscript and remain fully responsible for its accuracy, integrity, and scientific content.

REFERENCES

1. Metlay JP, Waterer GW, Long AC, et al. Diagnosis and treatment of adults with community-acquired pneumonia: an official clinical practice guideline of the American Thoracic Society and Infectious Diseases Society of America. Am J Respir Crit Care Med. 2019. doi:10.1164/rccm.201908-1581ST.

2. Ryrsø CK, Hegelund MH, Dungu A, et al. Association between Barthel Index, grip strength, and physical activity level at admission and prognosis in community-acquired pneumonia: a prospective cohort study. J Clin Med. 2022. doi:10.3390/jcm11216326.

3. Weng B, Jin J, Huang LX, et al. Risk factors associated with functional decline in older hospital survivors with acute lower respiratory tract infections: a prospective cohort study. BMC Geriatr. 2024. doi:10.1186/s12877-024-04838-0.

4. Woo H, Aoki H, Kataoka H, et al. Early walking time is associated with recovery of activities of daily living during hospitalization in older patients with community-acquired pneumonia: a single-center prospective study. Geriatr Gerontol Int. 2021. doi:10.1111/ggi.14300.

5. Ryrsø C, Dungu A, Hegelund MH, et al. Physical inactivity and sedentarism during and after admission with community-acquired pneumonia and the risk of readmission and mortality: a prospective cohort study. J Clin Med. 2022. doi:10.3390/jcm11195923.

6. Shimizu A, Maeda K, Inoue T, Mori N, Momosaki R. Early physical rehabilitation effectiveness in frail older patients hospitalized for community-acquired pneumonia: analysis of a nationwide database in Japan. Aging Clin Exp Res. 2022. doi:10.1007/s40520-022-02302-w.

7. Freburger JK, Chou A, Euloth T, Matcho B. Variation in acute care rehabilitation and 30-day hospital readmission or mortality in adult patients with pneumonia. JAMA Netw Open. 2020. doi:10.1001/jamanetworkopen.2020.12979.

8. Chen H, Hara Y, Horita N, Saigusa Y, Hirai Y, Kaneko T. Is rehabilitation effective in preventing decreased functional status after community-acquired pneumonia in elderly patients? Results from a multicentre, retrospective observational study. BMJ Open. 2022. doi:10.1136/bmjopen-2021-051307.

9. Larsen T, Lee A, Brooks D, Michieli S, Robson M, et al. Effect of early mobility as a physiotherapy treatment for pneumonia: a systematic review and meta-analysis. Physiother Can. 2019. doi:10.3138/PTC.2017-51.EP.

10. Hartley P, Keating JL, Jeffs K, Raymond MJ, Smith T, et al. Exercise for acutely hospitalised older medical patients. Cochrane Database Syst Rev. 2022. doi:10.1002/14651858.CD005955.pub3.

11. José A, Dal Corso S. Inpatient rehabilitation improves functional capacity, peripheral muscle strength and quality of life in patients with community-acquired pneumonia: a randomised trial. J Physiother. 2016. doi:10.1016/j.jphys.2016.02.014.

12. López-López L, Torres-Sánchez I, Rodríguez-Torres J, et al. Does adding an integrated physical therapy and neuromuscular electrical stimulation therapy to standard rehabilitation improve functional outcome in elderly patients with pneumonia? A randomised controlled trial. Clin Rehabil. 2019. doi:10.1177/0269215519859930.

13. Ryrsø C, Faurholt-Jepsen D, Ritz C, et al. Exercise training during hospitalization in community-acquired pneumonia: effects on functional ability, body composition, and physical activity level. Aging Clin Exp Res. 2026. doi:10.1007/s40520-026-03480-7.

14. Rutkauskienė L, Kubilius R, Tamošuitis T. Early mobilization, breathing exercises and chest wall oscillation in patients with bilateral pneumonia disease in the intensive care unit: a randomized clinical trial. BMC Pulm Med. 2025. doi:10.1186/s12890-025-04028-7.

15. Valenzuela PL, Morales JS, Castillo-García A, et al. Effects of exercise interventions on the functional status of acutely hospitalised older adults: a systematic review and meta-analysis. Ageing Res Rev. 2020. doi:10.1016/j.arr.2020.101076.

16. Baldwin C, Lynch EA, Munn Z, Bail K, Dolan B, et al. Incorporating "moving more and sitting less" into daily activities of hospitalised older medical patients: a stakeholder-directed systematic review with meta-analysis of complex interventions. Disabil Rehabil. 2025. doi:10.1080/09638288.2025.2584961.

17. Reynolds C, Brazier KV, Burgess EAA, Golla J, Le J, et al. Effects of unstructured mobility programs in older hospitalized general medicine patients: a systematic review and meta-analysis. J Am Med Dir Assoc. 2021. doi:10.1016/j.jamda.2020.12.008.

18. Caba L, Goldin D, Marenus M. Promoting nurse-led mobility protocols for hospitalized older adults: a systematic review. J Gerontol Nurs. 2022. doi:10.3928/00989134-20220606-04.

19. Chakrabarti B, Lane S, Jenks T, Higgins J, Kanwar E, et al. Predictors of 30-day readmission following hospitalisation with community-acquired pneumonia. BMJ Open Respir Res. 2021. doi:10.1136/bmjresp-2021-000883.

20. Reichel F, Tesch F, Berger S, Seifert M, Koschel D, et al. Burden and risk factors for 30-day readmission and mortality after CAP hospitalization: a population-based cohort study. Eur J Intern Med. 2025. doi:10.1016/j.ejim.2025.04.025.

21. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019. doi:10.4103/sja.SJA_543_18.

22. Fritzen dos Reis N, Figueiredo F, Biscaro RRM, Lunardelli ECB, Maurici R. Psychometric properties of the Barthel Index used at intensive care unit discharge. Am J Crit Care. 2022. doi:10.4037/ajcc2022732.

23. Kameniar K, Mackintosh S, van Kessel G, Kumar S. The psychometric properties of the Short Physical Performance Battery to assess physical performance in older adults: a systematic review. J Geriatr Phys Ther. 2022. doi:10.1519/JPT.0000000000000337.

24. Holland AE, Spruit MA, Troosters T, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J. 2014. doi:10.1183/09031936.00150314.

25. Agarwala P, Salzman SH. Six-minute walk test: clinical role, technique, coding and reimbursement. Chest. 2020. doi:10.1016/j.chest.2019.10.014.

26. Eusepi D, Pellicciari L, Ugolini A, et al. Reliability of the Short Physical Performance Battery (SPPB): a systematic review with meta-analysis. Eur Geriatr Med. 2025. doi:10.1007/s41999-025-01277-x.

27. Ryrsø C, Faurholt-Jepsen D, Ritz C, et al. The impact of physical training on length of hospital stay and physical function in patients hospitalized with community-acquired pneumonia: protocol for a randomized controlled trial. Trials. 2021. doi:10.1186/s13063-021-05503-2.

28. Mounayar A, François P, Pavese P, et al. Development of a risk prediction model of potentially avoidable readmission for patients hospitalised with community-acquired pneumonia: study protocol and population. BMJ Open. 2020. doi:10.1136/bmjopen-2020-040573.