Original Article

Comparing Early vs Delayed Mobilization After Coronary Artery Bypass Grafting (CABG) and Its Impact on Functional Recovery

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ABSTRACT

Background: *Delayed functional recovery and postoperative complications remain common challenges following coronary artery bypass grafting (CABG), often prolonging hospitalization and impairing patient independence. Postoperative immobility contributes to muscle deconditioning, pulmonary complications, and reduced exercise tolerance. Early mobilization has been proposed as a strategy to enhance recovery; however, its benefits compared with conventional delayed mobilization remain inconsistently applied in routine cardiac surgical care.* ***Objective:*** *To evaluate whether early postoperative mobilization accelerates functional recovery and reduces complications compared with delayed mobilization in patients undergoing CABG.* ***Methods:*** *A single-center randomized controlled trial was conducted in a tertiary cardiac care setting. Sixty adult patients undergoing elective, first-time isolated CABG were randomly allocated to early mobilization (initiation within 24 hours postoperatively) or delayed mobilization (initiation after 72 hours). Functional recovery was assessed at discharge using the Six-Minute Walk Test, Barthel Index, and Modified Borg Scale. Postoperative complications and length of hospital stay were recorded from clinical records. Between-group comparisons were performed using appropriate parametric statistical tests, with significance set at $p < 0.05$.* ***Results:*** *Patients in the early mobilization group demonstrated significantly greater walking capacity (312.6 ± 48.9 m vs. 248.3 ± 52.1 m, $p < 0.001$) and higher independence in activities of daily living (Barthel Index: 87.4 ± 8.6 vs. 74.9 ± 10.2, $p < 0.001$) compared with the delayed group. Perceived exertion was lower among early mobilized patients ($p = 0.002$). Pulmonary complications, particularly atelectasis, were less frequent in the early mobilization group, and hospital stay was significantly shorter (6.2 ± 1.1 vs. 7.8 ± 1.4 days, $p < 0.001$).* ***Conclusion:*** *Early postoperative mobilization after CABG was associated with improved functional recovery, fewer complications, and reduced hospital stay, supporting its integration into standard postoperative rehabilitation protocols.*

Keywords: *Activities of Daily Living; Coronary Artery Bypass; Early Ambulation; Hospitalization; Postoperative Complications; Rehabilitation; Six-Minute Walk Test*

INTRODUCTION

Coronary artery bypass grafting remained one of the most frequently performed surgical interventions for advanced coronary artery disease and continued to play a central role in improving survival and quality of life among patients with complex ischemic heart conditions (1). Despite advances in surgical techniques, anesthesia, and perioperative care, recovery after CABG was often complicated by reduced functional capacity, pulmonary complications, prolonged hospital stay, and delayed return to independence (2). These postoperative challenges not only affected patient well-being but also imposed a substantial burden on healthcare systems, particularly in settings where hospital resources and rehabilitation services were limited (3).

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Postoperative immobility had long been recognized as a major contributor to adverse outcomes following cardiac surgery. Extended bed rest was associated with muscle deconditioning, impaired pulmonary ventilation, increased risk of atelectasis, venous thromboembolism, and a general decline in physical functioning (4). In response, early mobilization emerged as a key component of enhanced recovery pathways in various surgical disciplines (5). In cardiac surgery, mobilization strategies traditionally followed a cautious approach, often delaying ambulation due to concerns regarding hemodynamic instability, sternal integrity, and patient safety. However, growing evidence suggested that prolonged inactivity might pose greater risks than carefully supervised early movement (6).

Early postoperative mobilization, defined as initiating sitting, standing, and ambulation within the first 24 hours after surgery, had been shown in several clinical contexts to preserve muscle strength, improve cardiopulmonary function, and promote faster functional recovery (7). In patients undergoing CABG, early mobilization was increasingly incorporated into physiotherapy protocols, yet its timing and intensity varied widely across institutions. While some centers adopted early mobilization as routine practice, others continued to rely on delayed approaches, reflecting uncertainty regarding its safety and effectiveness in this patient population. As a result, postoperative care following CABG remained inconsistent, particularly in low- and middle-income regions where standardized rehabilitation protocols were less firmly established (8).

Functional recovery represented a critical outcome after CABG, as it directly influenced patients' ability to perform daily activities, regain independence, and reintegrate into their social and occupational roles. Measures such as walking capacity and activities of daily living provided meaningful indicators of recovery beyond traditional clinical endpoints (9). Furthermore, reducing postoperative complications and shortening hospital stay were increasingly important goals, given rising healthcare costs and growing patient volumes. Interventions that could safely accelerate recovery while minimizing complications were therefore of considerable clinical relevance (10).

Although previous studies had explored early mobilization after cardiac surgery, many were limited by heterogeneous patient populations, small sample sizes, or observational designs. Moreover, evidence from South Asian healthcare settings remained sparse, despite differences in patient demographics, comorbidity profiles, and hospital practices that could influence recovery trajectories (11). This gap in context-specific data limited the generalizability of existing findings and underscored the need for well-designed randomized trials conducted within regional healthcare systems. Clarifying whether early mobilization offered measurable advantages over delayed mobilization in such settings was essential for guiding clinical decision-making and optimizing postoperative care pathways (12).

The present study was undertaken against this background to address a clinically relevant and practical question in postoperative cardiac rehabilitation. By directly comparing early and delayed mobilization strategies following CABG within a randomized controlled framework, the study sought to provide robust evidence on functional and clinical outcomes using validated, patient-centered measures(13). Emphasis was placed on real-world applicability, reflecting routine postoperative care conditions and physiotherapy practices. In doing so, the study aimed to inform clinicians, physiotherapists, and healthcare planners about the potential benefits and feasibility of initiating mobilization earlier in the postoperative course.

The primary objective of the study was to evaluate whether early postoperative mobilization following coronary artery bypass grafting led to superior functional recovery compared with delayed mobilization, as assessed by walking capacity and independence in daily activities

(14). Secondary objectives were to determine whether early mobilization reduced perceived exertion, decreased the incidence of postoperative complications, and shortened the length of hospital stay, thereby supporting a more efficient and patient-centered recovery process.

METHODS

The study was conducted as a single-center, parallel-group randomized controlled trial in the Islamabad–Rawalpindi region, selected because it hosts multiple tertiary-care cardiac surgery centers with established postoperative rehabilitation services and a high volume of coronary artery bypass grafting procedures, allowing feasible recruitment within a limited timeframe. Data were collected over a four-month period, which was considered sufficient to observe early functional recovery and short-term postoperative complications following CABG.

Participants were adult patients who had undergone elective, first-time isolated CABG via median sternotomy. Eligible individuals were aged 40–70 years, hemodynamically stable within 24 hours after surgery, extubated within the first postoperative day, and able to follow verbal commands. Patients were excluded if they had pre-existing neurological deficits, severe chronic obstructive pulmonary disease, left ventricular ejection fraction below 30%, postoperative mechanical complications, prolonged ventilatory support beyond 24 hours, or any musculoskeletal condition limiting ambulation. A total sample size of 60 participants was determined based on feasibility and consistency with previously published trials on early mobilization after cardiac surgery, which commonly enrolled between 40 and 80 patients while demonstrating clinically meaningful differences in functional outcomes. Participants were randomly allocated in a 1:1 ratio to either early mobilization or delayed mobilization groups using a computer-generated random sequence with sealed opaque envelopes.

The early mobilization group initiated supervised sitting, standing, and assisted ambulation within 24 hours postoperatively, progressing to corridor walking twice daily as tolerated. The delayed mobilization group followed conventional care, with mobilization initiated after 72 hours postoperatively. Both groups received standardized physiotherapy, thereafter, differing only in the timing of initiation.

Functional recovery was assessed using validated outcome measures, including the Six-Minute Walk Test for functional capacity, the Barthel Index for activities of daily living, and the Modified Borg Scale for perceived exertion. Postoperative complications such as atelectasis, wound infection, and prolonged hospital stay were recorded from clinical charts using a structured data extraction form.

Data were entered and analyzed using standard statistical software. Continuous variables were assessed for normality using the Shapiro–Wilk test and were expressed as mean ± standard deviation. Between-group comparisons for continuous outcomes were performed using independent sample t-tests, while within-group changes over time were analyzed using paired t-tests. Categorical variables, including complication rates, were compared using the chi-square test. A two-tailed p-value of less than 0.05 was considered statistically significant. This analytical approach was selected to allow transparent comparison of functional recovery trajectories between early and delayed mobilization strategies following CABG.

RESULTS

A total of 68 patients were screened for eligibility during the study period, of whom 60 met the inclusion criteria and consented to participate. All enrolled participants were randomized equally into the early mobilization group (n = 30) and the delayed mobilization group (n = 30). There were no losses to follow-up, protocol deviations, or withdrawals after

randomization, and complete outcome data were available for all participants, yielding a response rate of 100%. Participant flow through the study is illustrated in Figure 1.

The baseline demographic and clinical characteristics of the participants are summarized in Table 1. The overall mean age of the sample was 58.4 ± 7.6 years, with a predominance of male participants (76.7%). Baseline variables, including age, sex distribution, body mass index, smoking status, prevalence of diabetes and hypertension, and preoperative left ventricular ejection fraction, were comparable between the two groups, with no statistically significant differences observed ($p > 0.05$ for all). This indicated adequate randomization and baseline homogeneity.

Functional recovery outcomes demonstrated clear between-group differences favoring early mobilization. At hospital discharge, the mean Six-Minute Walk Test distance was significantly greater in the early mobilization group compared with the delayed mobilization group (312.6 ± 48.9 m vs. 248.3 ± 52.1 m, $p < 0.001$), as shown in Table 2.

Similarly, Barthel Index scores were higher among patients who initiated mobilization within 24 hours, reflecting greater independence in activities of daily living (87.4 ± 8.6 vs. 74.9 ± 10.2, $p < 0.001$). Perceived exertion measured by the Modified Borg Scale was lower in the early mobilization group (3.1 ± 1.0) compared with the delayed group (4.2 ± 1.1, $p = 0.002$), indicating better exercise tolerance.

Postoperative clinical outcomes also differed between groups. The incidence of pulmonary complications was significantly reduced in the early mobilization group, with atelectasis observed in 3 patients (10.0%) compared with 9 patients (30.0%) in the delayed mobilization group ($\chi^2 = 3.75$, $p = 0.048$).

Superficial sternal wound infection occurred in one patient (3.3%) in the early group and three patients (10.0%) in the delayed group, though this difference did not reach statistical significance ($p = 0.30$). Mean postoperative length of hospital stay was shorter in the early mobilization group (6.2 ± 1.1 days) than in the delayed mobilization group (7.8 ± 1.4 days, $p < 0.001$), as detailed in Table 3.

Table 1. Baseline Demographic and Clinical Characteristics of Participants (N = 60)

Variable	Total Sample (N=60)	Early Mobilization (n=30)	Delayed Mobilization (n=30)
Age (years)	58.4 ± 7.6	57.9 ± 7.2	58.9 ± 8.0
Male sex, n (%)	46 (76.7)	23 (76.7)	23 (76.7)
BMI (kg/m²)	27.1 ± 3.4	26.8 ± 3.2	27.4 ± 3.6
Diabetes mellitus, n (%)	28 (46.7)	14 (46.7)	14 (46.7)
Hypertension, n (%)	41 (68.3)	20 (66.7)	21 (70.0)
Smoking history, n (%)	22 (36.7)	11 (36.7)	11 (36.7)
LVEF (%)	48.6 ± 6.2	49.1 ± 6.0	48.0 ± 6.4

Table 2. Functional Recovery Outcomes at Discharge

Outcome Measure	Early Mobilization	Delayed Mobilization	p-value
Six-Minute Walk Test (m)	312.6 ± 48.9	248.3 ± 52.1	<0.001
Barthel Index score	87.4 ± 8.6	74.9 ± 10.2	<0.001
Modified Borg Scale	3.1 ± 1.0	4.2 ± 1.1	0.002

Table 3. Postoperative Clinical Outcomes by Group

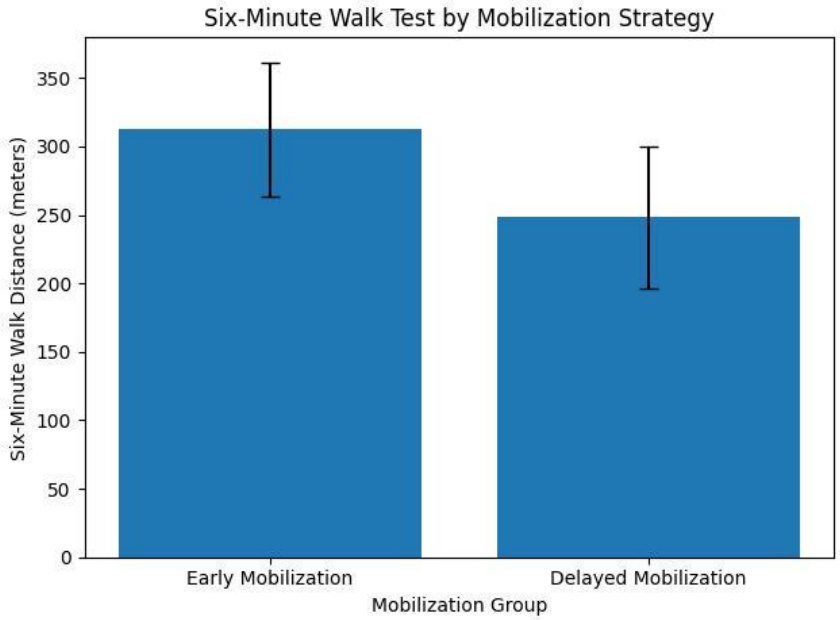
Outcome	Early Mobilization n (%) / Mean ± SD	Delayed Mobilization n (%) / Mean ± SD	p-value
Atelectasis	3 (10.0%)	9 (30.0%)	0.048
Wound infection	1 (3.3%)	3 (10.0%)	0.30
Length of hospital stay (days)	6.2 ± 1.1	7.8 ± 1.4	<0.001

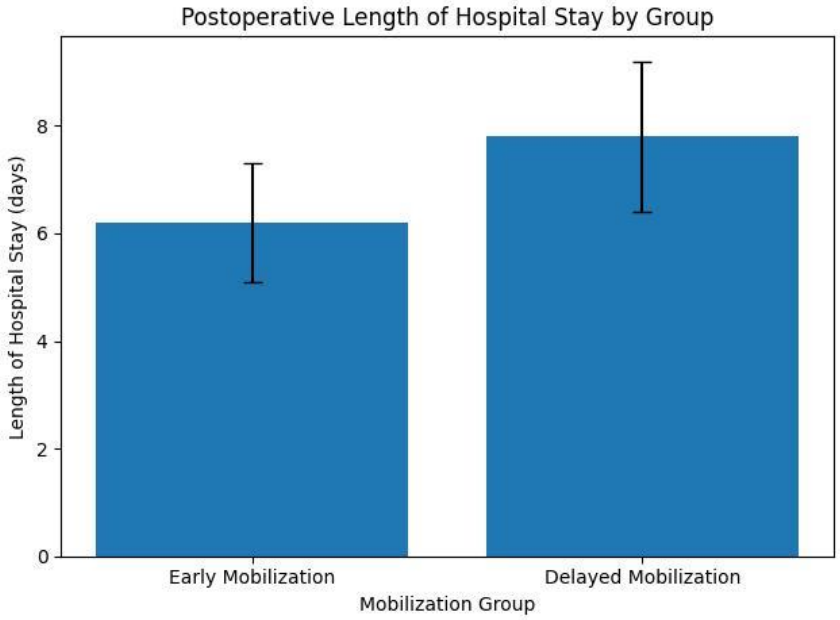
Table 4. Correlation Matrix Between Key Functional Outcomes

Variables	6MWT Distance	Barthel Index	Borg Scale
6MWT Distance	1.00	0.62*	−0.51*
Barthel Index	0.62*	1.00	−0.47*
Borg Scale	−0.51*	−0.47*	1.00

Correlation analysis demonstrated a moderate positive association between early mobilization and functional capacity at discharge, with Six-Minute Walk Test distance showing significant correlations with Barthel Index scores ($r = 0.62$, $p < 0.001$) and an inverse correlation with Borg Scale scores ($r = -0.51$, $p < 0.001$), as presented in Table 4. These findings indicated that improved functional independence was closely linked to enhanced exercise tolerance.

Overall, the results consistently showed that early postoperative mobilization following CABG was associated with superior functional recovery, fewer pulmonary complications, and reduced hospital stay when compared with delayed mobilization.





DISCUSSION

The findings of this randomized controlled trial demonstrated that initiating mobilization within the first 24 hours after coronary artery bypass grafting was associated with significantly better functional recovery and more favorable short-term clinical outcomes compared with a delayed mobilization approach (15). Patients who underwent early mobilization achieved greater walking capacity, higher independence in activities of daily living, and lower perceived exertion at the time of discharge (16). These improvements were accompanied by a reduction in pulmonary complications and a shorter length of hospital stay, collectively suggesting that early mobilization supported a more efficient and patient-centered recovery trajectory after CABG.

The observed improvement in functional capacity, reflected by longer distances achieved on the Six-Minute Walk Test, aligned with the physiological rationale that early ambulation counteracts postoperative muscle deconditioning and enhances cardiopulmonary efficiency (17). Improved Barthel Index scores further indicated that early mobilization translated into meaningful gains in day-to-day functioning rather than isolated performance measures. This distinction was clinically important, as functional independence remained a key determinant of discharge readiness and post-hospital quality of life (18). The lower perceived exertion among patients in the early mobilization group suggested that these individuals not only walked farther but did so with greater tolerance, supporting the notion that early activity facilitated adaptive recovery rather than imposing excessive physiological stress.

The reduction in pulmonary complications observed in the early mobilization group was particularly notable. Atelectasis, a common postoperative issue following cardiac surgery, was substantially less frequent among patients mobilized early (19). This finding supported the concept that upright positioning and ambulation improved lung expansion and secretion clearance, thereby reducing respiratory morbidity (20). Although differences in wound infection rates did not reach statistical significance, the trend toward fewer infections in the early mobilization group suggested that enhanced circulation and reduced immobility might contribute to improved wound healing, a hypothesis warranting further exploration.

The shorter hospital stay associated with early mobilization carried important implications for healthcare systems. Reduced length of stay not only lowered the risk of hospital-acquired complications but also eased resource utilization in high-volume cardiac centers (21). From

a patient perspective, earlier discharge often reflected better functional readiness and psychological well-being, reinforcing the broader benefits of timely rehabilitation. These findings collectively supported the integration of early mobilization into routine postoperative care pathways for CABG patients, provided that appropriate monitoring and multidisciplinary collaboration were maintained.

Several strengths enhanced the credibility of the study. The randomized controlled design minimized selection bias and ensured baseline comparability between groups (22). The use of validated and widely accepted outcome measures strengthened the clinical relevance and interpretability of the findings. Additionally, the study was conducted within a real-world tertiary care setting, increasing the practical applicability of the results to everyday clinical practice. Complete follow-up and absence of attrition further reinforced the internal validity of the outcomes.

Nevertheless, certain limitations should be acknowledged. The relatively small sample size, while adequate to detect meaningful differences in functional outcomes, limited the ability to examine less frequent complications or conduct subgroup analyses (23). The single-center design may have restricted generalizability, as institutional practices, staffing patterns, and patient characteristics could differ across settings. Furthermore, outcomes were assessed only up to the point of hospital discharge, precluding conclusions regarding long-term functional recovery or readmission rates. Variability in individual patient motivation and pain perception, which could influence participation in mobilization, was difficult to quantify and may have affected performance-based outcomes.

Future research could address these limitations by incorporating multicenter designs with larger and more diverse populations. Extended follow-up periods would allow evaluation of sustained functional benefits, quality of life, and long-term morbidity (24). Further investigation into optimal mobilization intensity, frequency, and progression could refine protocols and enhance safety. Exploring patient-reported outcomes and cost-effectiveness analyses would also provide valuable insights for policymakers and clinicians aiming to balance clinical benefits with resource constraints.

In summary, the present study provided evidence that early postoperative mobilization after CABG was both feasible and beneficial, leading to improved functional recovery, fewer pulmonary complications, and reduced hospital stay. While cautious interpretation was warranted given the study's scope, the findings supported a shift toward earlier, structured mobilization as an integral component of postoperative cardiac rehabilitation and highlighted important directions for future investigation.

CONCLUSION

Early postoperative mobilization following coronary artery bypass grafting was associated with faster functional recovery, reduced pulmonary complications, and shorter hospital stay compared with delayed mobilization. These findings highlighted the practical value of initiating structured movement within the first postoperative day as a safe and effective strategy to enhance rehabilitation outcomes. Incorporating early mobilization into routine postoperative care may improve patient independence while supporting more efficient use of healthcare resources.

REFERENCES

1. Esmealy L, Allahbakhshian A, Gholizadeh L, Khalili AF, Sarbakhsh PJANR. Effects of early mobilization on pulmonary parameters and complications post coronary artery bypass graft surgery. 2023;69:151653.

2. Allahbakhshian A, Khalili AF, Gholizadeh L, Esmealy LJAnr. Comparison of early mobilization protocols on postoperative cognitive dysfunction, pain, and length of hospital stay in patients undergoing coronary artery bypass graft surgery: A randomized controlled trial. 2023;73:151731.

3. Da Silva DJG, Martins DO, Egídio KF, Carneiro LCA, da Silva Santana LS, Guimarães ARF, et al. PHYSIOTHERAPEUTIC GUIDANCE ON FUNCTIONAL INDEPENDENCE AND QUALITY OF LIFE AFTER CORONARY ARTERY BYPASS GRAFTING: CLINICAL TRIAL. 2025.

4. Judas MCLd, Fontes RdF, Moura Rd, Santos Ld, Almeida Md, Gomes VJIJoCS. Effectiveness of Early Mobilization in Prevention and Rehabilitation of Functional Impairment After Myocardial Revascularization Surgery: A Systematic Review. 2023;36:e20210166.

5. Yu J, Wei L, Li P, Zhang SJJoPN. Effectiveness of early mobility interventions for the management of cardiac surgery patients: a meta-analysis. 2025.

6. Ma H, Huang S, You M, Yang J, Zong R, Zhang C, editors. Effect of Early Rehabilitation Exercise on Lower Limb Function and Psychological State After Coronary Artery Bypass Grafting: A Randomized Controlled Trial. The Heart Surgery Forum; 2024.

7. Ceylan İ, Mhmood AH, Al-Janabi RQKJIJoMS. Effects of early mobilization in elderly patients undergoing cardiac surgery. 2024;193(6):2733-44.

8. Al-Jaddah HAS. Early Physical Activity and its Effects on Functional Capacity and Quality of Lıfe in Post-Surgery Cardiac Patients: Kirsehir Ahi Evran University (Turkey); 2024.

9. Shawk A, Moffatt F, ALaseem AJIJoT, Rehabilitation. The effectiveness of early mobilisation on physical function in patients after heart valve surgery: a systematic review. 2024;31(10):1-17.

10. Shahraby MA, Sedighi L, Sanaei N, Nasiri MJAoA, Care C. The Effect of Early Mobilization Techniques on Meliorating Fatigue and Physical Activity Tolerance of Patients Admitted to Cardiac Intensive Care Units. 2025.

11. Yumul MB. Preoperative Clinical Practice Guidelines for Patients Undergoing Coronary Artery Bypass Graft Surgery: Walden University; 2025.

12. Xiu M, Yang F, Yang F, Wang C, Zhang M, Zhang WJPp, et al. Implementation of Early Mobilization in Post-CABG Patients: A Constructivist Grounded Theory Study. 2025:2697-709.

13. Jacob P, Surendran PJ, Gupta P, Mahinay M, Sarmiento AL, Abas ASE, et al. Enhancing early functional independence following cardiac surgery: a quality improvement programme. 2023;12(4).

14. Atef H, Marques-Sule E, Moreno-Segura N, Maged A, ELSayed SH, Pengelly J, et al. Impact of early balance training on recovering following coronary artery bypass grafting. A randomized trial. 2025:02692155251407320.

15. Nakamura K, Arai S, Kobayashi K, Nakai S, Sho R, Ishizawa A, et al. Safe and promising outcomes of in-hospital preoperative rehabilitation for coronary artery bypass grafting after an acute coronary syndrome. 2024;24(1):139.

16. Kourek C, Dimopoulos SJWJoC. Cardiac rehabilitation after cardiac surgery: An important underutilized treatment strategy. 2024;16(2):67.

17. Li P, Zhang H-PJWJoC. From surgery to recovery: Measuring success through quality of life and functional improvements after cardiac surgery. 2025;17(2):100213.

18. Alsubaiei ME, Althukair W, Almutairi HJJoM, Life. Functional capacity in smoking patients after coronary artery bypass grafting surgery: a quasi-experimental study. 2023;16(12):1760.

19. Pozzi M, Mariani S, Scanziani M, Passolunghi D, Bruni A, Finazzi A, et al. The frail patient undergoing cardiac surgery: lessons learned and future perspectives. 2023;10:1295108.

20. Ceylan İ, Al-Jaddah HAS, Al-Janabi RQKJJoCMoK. Correlation between functionality and quality of life in patients after cardiac surgery. 2024;21(4):26-32.

21. Nazir AJJoMH. Effectiveness of Active Cycle of Breathing Technique in Improving Physiological and Functional Outcomes Following Coronary Artery Bypass Graft Surgery: A Narrative Review. 2025:5431-9.

22. Subih M, Alhadidi M, Alrahahleh M, Eldien AS, Alfawaeer ZJAP. A Systematic Review of Cardiac Rehabilitation Programs for Patient with Coronary Artery Bypass Grafts Surgery. 2024.

23. Olsen DB, Pedersen PU, Noergaard MWJJes. Prehabilitation before elective coronary artery bypass grafting surgery: a scoping review. 2023;21(6):1190-242.

24. Kristen Desanto M, Jason R. Association of physical function with hospital readmissions among older adults: A systematic review. 2024.

DECLARATIONS

Ethical Approval
Ethical approval was not required because this study was a narrative review of published literature and did not involve human/individual identifiable data.

Informed Consent
NA

Conflict of Interest
The authors declare no conflict of interest.

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Authors' Contributions
Concept: AK, HM, MA, PR, RK, SK; Design: AK, HM, MA, PR, RK, SK; Data Collection: AK, HM, MA, PR, RK, SK; Analysis: AK, HM, MA, PR, RK, SK; Drafting: AK, HM, MA, PR, RK, SK

Data Availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgments
Not applicable.

Study Registration
Not applicable.