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EARLY MOBILIZATION FOR CARDIOVASCULAR FUNCTION RECOVERY IN POST-CABG PATIENTS WITH CARDIOPULMONARY BYPASS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Coronary artery bypass grafting (CABG) surgery is often performed with cardiopulmonary bypass (CPB) to maintain systemic perfusion during the procedure. While improving procedural safety, CPB can trigger a systemic inflammatory response and hemodynamic fluctuations that can potentially delay early recovery. Early mobilization is a crucial component of the postoperative recovery approach because it can prevent deconditioning, improve activity tolerance, and support cardiorespiratory stability. However, evidence regarding the form of early mobilization protocols and their impact on cardiovascular function recovery in post-CABG patients with CPB is scattered and heterogeneous. To synthesize scientific evidence regarding early mobilization in post-CABG patients with CPB. A systematic literature review was conducted following the PRISMA 2020 guidelines. A literature search was conducted in PubMed/MEDLINE, Scopus, and CINAHL databases for articles in English or Indonesian published between 2010 and 2025. A total of 518 articles were identified. After removal of duplicates, title and abstract screening, followed by full-text review, were performed. Eight studies with randomized controlled trial or quasi-experimental designs met the inclusion criteria and were analyzed using a narrative synthesis approach. The synthesis of these findings suggests that progressive early mobilization, including position changes, range-of-motion exercises, sitting, standing, and early ambulation, tends to provide better outcomes than conventional care or less structured mobilization. The most consistent positive impact is seen in increased functional capacity, particularly walking parameters such as the six-minute walk test prior to discharge. Several studies also report improved oxygenation and reduced pulmonary complications, decreased pain intensity, and some protocols, starting very early after extubation, are associated with shorter ICU and hospital stays. In addition to protocol factors, patient characteristics such as smoking status and self-efficacy-based educational support also influence recovery outcomes. Evidence from eight studies suggests that early mobilization after CABG with CPB is generally associated with better recovery outcomes, particularly in functional capacity, oxygenation, pulmonary complications, pain, and length of stay in some studies. These findings underscore the importance of implementing structured, progressive, and safety-based early mobilization, tailored to the patient's clinical condition, to optimize postoperative recovery.

Keywords: cardiopulmonary bypass; cardiovascular function recovery; coronary artery bypass grafting; early mobilization; functional capacity; systematic literature review

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INTRODUCTION

Coronary artery bypass grafting (CABG) surgery remains a primary procedure for patients with coronary heart disease (CHD) with multi-vessel involvement or certain clinical conditions requiring surgical revascularization (Coyan et al., 2021). In many cases, CABG is performed with the assistance of cardiopulmonary bypass (CPB) to maintain systemic perfusion during the procedure (Som et al., 2017). Although CPB improves the technical safety of the operation, the use of an extracorporeal circuit can trigger a systemic inflammatory response and alter vascular regulation, contributing to hemodynamic compromise and postoperative organ dysfunction. The inflammatory response associated with CPB and its impact on postoperative recovery has been widely discussed as a factor prolonging the physiological instability phase after cardiac surgery (Jin et al., 2020).

In the context of post-CABG care, clinical attention focuses not only on acute stabilization but also on accelerating the recovery of cardiovascular function through evidence-based recovery strategies. One widely recommended intervention in the enhanced recovery after surgery (ERAS) approach to cardiac surgery is early mobilization, which involves gradually increasing physical activity early after the patient is clinically stable (Alsubaiei et al., 2023). ERAS in cardiac surgery emphasizes standardized perioperative interventions to reduce the impact of surgical stress, improve clinical outcomes, and shorten length of stay (Thomas et al., 2024). Early mobilization is a key component that needs to be integrated with pain management, ventilation, and patient safety monitoring (Afxonidis et al., 2021).

Conceptually, early mobilization differs from the later phase of cardiac rehabilitation. Early mobilization is generally performed from the ICU phase through early hospitalization, with the goal of maintaining physiological function, preventing deconditioning, and accelerating the return of activity tolerance (Allahbakhshian et al., 2023). Within the framework of cardiovascular rehabilitation, structured physical activity from the early phase is seen as fundamental to optimizing functional capacity recovery and cardiovascular system adaptation after surgical stress, while also serving as a bridge to subsequent rehabilitation programs (Amjadian et al., 2020). Recent scientific statements on the core components of cardiac rehabilitation also emphasize the importance of safe and targeted physical activity interventions as part of the recovery of patients with cardiovascular disease (Weng et al., 2021).

From a physiology and perioperative nursing perspective, early mobilization has the potential to influence cardiovascular function recovery through several mechanisms: increased venous return and peripheral perfusion, improved autonomic responses to position changes, increased ventilation-perfusion efficiency that supports myocardial oxygenation, and prevention of decreased cardiorespiratory capacity due to bed rest (Weng et al., 2021). However, in post-CABG patients with CPB, early mobilization also requires caution because the early phase of recovery can be accompanied by blood pressure fluctuations, changes in vascular tone, sternotomy wound pain, use of vasoactive drugs, and the risk of arrhythmias or activity intolerance (Afxonidis et al., 2021). Therefore, mobilization protocols need to consider hemodynamic stability and safety parameters as primary prerequisites (Bertrand et al., 2021).

Although early mobilization is increasingly recognized as an important practice in postoperative care, its implementation in real-world settings remains challenging. Variations in unit policies, differences in team competencies, resource limitations (e.g., number of nurses/therapists), and concerns about hemodynamic side effects can lead to delayed or inconsistent mobilization (AbuRuz & Al-Dweik, 2022). On the other hand, several intervention studies in post-CABG patients have shown that guided exercise/mobilization programs during the inpatient phase can improve functional capacity at discharge, for example, increased walking distance in the intervention group compared to standard care (Kao et al., 2022). However, intervention components, timing of mobilization initiation, intensity, and measured recovery indicators often differ across publications (Rianda et al., 2022).

As RCTs and quasi-experimental studies on early mobilization after CABG (including in the context of CPB) continue to grow, the available scientific evidence tends to be scattered and heterogeneous both in terms of design, mobilization protocols, and outcomes used (e.g., hemodynamic parameters, activity tolerance, complications, or length of stay) (Auer et al., 2017). This situation makes it difficult for clinicians to formulate consistent recommendations regarding “when to start mobilization,” “how intense,” and “what cardiovascular outcomes are most responsive.” Therefore, this systematic literature review was conducted to synthesize the best evidence regarding the effect of early mobilization on cardiovascular function recovery in post-

CABG patients with CPB. Specifically, this review aims to identify the characteristics of early mobilization interventions used in RCTs/quasi-experimental studies.

METHOD

Study Design

This study used a systematic literature review design to identify and synthesize scientific evidence related to the effect of early mobilization on cardiovascular function recovery in post-coronary artery bypass grafting (CABG) patients with cardiopulmonary bypass (CPB). The systematic literature review reporting process was systematically compiled and reported following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency and rigor in the search, selection, and reporting stages of study results (Page et al., 2021).

Literature Search Strategy

A systematic literature search was conducted in the electronic databases PubMed/MEDLINE, Scopus, and CINAHL. The search was limited to articles published between 2010 and 2025, in English or Indonesian. The search strategy was based on the research question, combining keywords and synonyms representing CABG and CPB procedures, early mobilization interventions, and outcomes related to cardiovascular function recovery.

Keywords used included population- and procedure-related terms, such as “coronary artery bypass graft,” “CABG,” “cardiac surgery,” “cardiopulmonary bypass,” “CPB,” and “on-pump.” Intervention-related terms included “early mobilization,” “early ambulation,” “early activity,” “progressive mobilization,” and “phase I cardiac rehabilitation.” Outcome-related terms included “cardiovascular recovery,” “hemodynamic,” “heart rate,” “blood pressure,” “mean arterial pressure,” “cardiac output,” and functional capacity indicators such as “functional capacity” and “6-minute walk test.” The Boolean operators “AND” and “OR” were used to combine keywords to ensure a broad yet relevant search, tailored to the characteristics of each database. In addition to database searches, additional searches were conducted by examining the bibliographies of articles meeting the criteria to identify other relevant studies.

Inclusion and Exclusion Criteria

Inclusion criteria were established using the PICOS framework. The population included adult post-CABG patients undergoing surgery with cardiopulmonary bypass (CPB) support in the early care phase, either in the ICU or the ward. The interventions studied were early mobilization, which is a gradual physical activity phase initiated early after surgery, including early bed mobilization, sitting, standing, and walking, or a phase I rehabilitation protocol implemented earlier than standard care. Comparison groups could include standard care, later mobilization, or different mobilization protocols that allow for evaluation of the intervention's impact. The outcomes reviewed included recovery of cardiovascular function, particularly relevant hemodynamic and clinical recovery indicators, such as changes in heart rate, blood pressure, hemodynamic stability, activity tolerance, and indicators of functional capacity that reflect the patient's ability to return to activity. Accepted study designs were limited to primary studies with randomized controlled trials (RCTs) or quasi-experimental designs.

Studies were excluded if they did not focus on post-CABG patients or if CABG data could not be separated from other cardiac surgical procedures, if they did not use CPB or if their CPB status could not be ascertained, if they did not assess early mobilization as a primary intervention, or if they did not report outcomes relevant to cardiovascular function recovery. Non-original articles such as systematic literature reviews, literature reviews, editorials, opinion pieces, case reports, protocols, and conference abstracts without full text were also excluded.

Study Selection and Data Extraction
All search results from each database were compiled and duplicates were removed using a reference management tool. The study selection process was conducted in two stages. The first stage involved screening titles and abstracts to assess initial suitability for inclusion criteria, specifically regarding the post-CABG population with CPB, the presence of early mobilization interventions, and the RCT or quasi-experimental study design. The second stage involved a full-text review to ensure comprehensive study suitability, including details of surgical procedures, timing of mobilization, comparator characteristics, and availability of outcome data.

Data from eligible studies were extracted using a standardized data extraction form that included study identification (author, year of publication, country), setting and sample characteristics, study design, details of the early mobilization intervention, type of comparison group, reported cardiovascular function recovery outcome indicators, and a summary of key findings. The extracted data were then systematically organized to facilitate the synthesis process.

Data Synthesis
Data synthesis was conducted descriptively using a narrative synthesis approach, taking into account variations in study design, early mobilization protocols, differences in intervention initiation time, and differences in cardiovascular function recovery indicators used between studies. The review results are presented in the form of a summary of study characteristics and a narrative of key findings that categorizes the evidence based on the type of early mobilization intervention and the type of cardiovascular outcomes evaluated. This approach was used to generate a comprehensive understanding of the pattern of findings, consistency of effects, and implications of early mobilization in supporting cardiovascular recovery in post-CABG patients with CPB.

RESULT
A total of 518 articles were identified through searches of PubMed/MEDLINE, Scopus, and CINAHL databases. After deduplication, 96 articles were excluded, leaving 422 articles for title and abstract screening. At this stage, 374 articles were eliminated because they did not focus on early mobilization in post-CABG patients with cardiopulmonary bypass, did not assess cardiovascular function recovery outcomes, or were not original studies with an interventional design.

After screening titles and abstracts, an additional 38 articles were excluded due to incomplete outcome reporting, unclear timing of mobilization, or intervention contexts that did not meet the definition of early mobilization in this review. Ten articles were then selected for full-text review. Of these, two articles were excluded because they did not meet the inclusion criteria, primarily because the study design was not a RCT or quasi-experimental, the study population did not specifically involve CABG patients with CPB, or the reported outcomes were not directly related to cardiovascular function recovery. Ultimately, eight articles met all inclusion criteria and were included in this systematic literature review. The complete study selection process is presented in the PRISMA flowchart (Figure 1), while the characteristics of the included studies are summarized in Table 1.

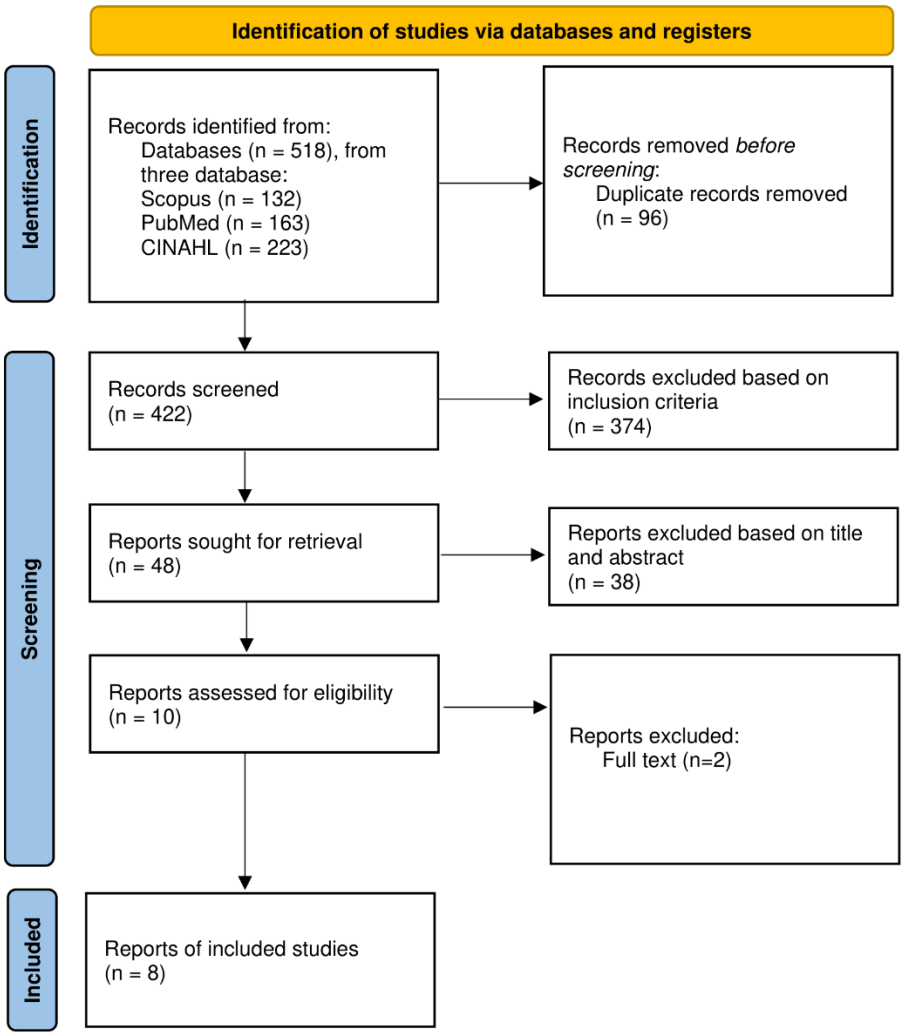

Figure 1. PRISMA Flow Diagram

Table 1.
Data Extraction

No	Authors, Year	Purpose	Country	Sample	Intervention	Key Results
1	(Esmealy et al., 2023)	To compare the effects of four-phase (4-EMP) and three-phase (3-EMP) early mobilization protocols on respiratory parameters and complications.	Iran	120 patients (divided into 3 groups: 4-EMP, 3-EMP, and control).	Duration:Performed twice daily on post-operative days 1 and 2. Activities: - 4-EMP: Passive ROM exercises, head of bed elevation (30°, 45°, up to 90°), sitting on the edge of the bed, and walking up to 20 meters. - 3-EMP: Deep breathing exercises, bottle-blowing, chest physiotherapy (percussion), effective coughing, sitting on the edge of the bed, and static walking.	Both protocols significantly increased oxygen saturation (SpO2), PaO2, and decreased the incidence of pulmonary complications (atelectasis, pneumonia) compared to the control group.
2	(Hirschhorn et al., 2008)	To determine whether a supervised walking program (with or without breathing exercises)	Australia	92 patients.	Duration:Performed twice daily progressively from day 1 until discharge. Activities: - Walking: Starting with walking on the spot (day 1), walking 100m/5 minutes (day 2), up	A supervised moderate-intensity walking program significantly improved the 6-minute walk test

No	Authors, Year	Purpose	Country	Sample	Intervention	Key Results
		improves walking capacity and quality of life.			to 10 minutes and stair climbing (day 4+). - Walking/Breathing Group: Adding the use of an incentive spirometer (20 breaths/session) and shoulder/thoracic ROM exercises.	(6MWA) distance at hospital discharge. Additional breathing exercises provided no additional benefit to walking capacity.
3	(Alsubaiei et al., 2023)	Exploring the effects of early mobilization on functional capacity in patients with different smoking histories.	Saudi Arabia	51 male patients (17 active smokers, 17 former smokers, 17 non-smokers).	Duration:Starting from the first day after extubation until the fifth postoperative day. Activities: Deep breathing exercises, assessment of upper limb ROM, use of an incentive spirometer, and walking with and without assistance.	Smoking status was significantly associated with lower functional capacity (6MWT) and a higher risk of atelectasis compared to non-smokers.
4	(Borges et al., 2016)	Investigating the effects of aerobic exercise using a cycle ergometer performed very early after surgery.	Brazil	34 patients (15 intervention group, 19 control).	Duration:Twice daily in the ICU and once daily on the ward until discharge. Activity: The intervention group performed conventional physiotherapy plus unloaded cycle ergometer exercise for 5 minutes in the ICU (45° Fowler's position) and 10–20 minutes on the ward (seated position in a chair).	Early aerobic exercise successfully maintained functional capacity (6MWT distance did not decrease significantly) compared to the control group which experienced a significant decline.
5	(Noopiam et al., 2025)	Evaluating the effects of a self-efficacy theory-based cardiac rehabilitation program on self-efficacy and physical fitness.	Thailand	40 patients (20 experimental group, 20 control).	Duration:Conducted from the pre-operative period until the 6th post-operative day. Activities: - Pre-op: Education, watching videos of successful patient models, and re-demonstrations. - Post-op: Progression from 60-90° sitting (day 1), arm/leg weight training (day 3), to walking 150m and climbing stairs (day 6).	The experimental group had significantly higher self-efficacy scores, 6-minute walk distance (6MWD), and maximal oxygen consumption (VO2 max) than the control group at discharge.
6	(Zanini et al., 2019)	Comparing the effectiveness of four different inpatient rehabilitation protocols on functional capacity and pulmonary function.	Brazil	40 patients (divided into 4 protocol groups).	Duration:Performed twice daily for at least 6 days. Activities: - G1: Limb exercises, systematic early ambulation, and inspiratory muscle training (IMT). - G2: Limb exercises and early ambulation only. - G3: IMT only. - G4: Control (standard chest physiotherapy).	Protocols combining active physical exercise and early ambulation (G1 & G2) were more effective in restoring functional capacity (6MWD) and increasing VO2 peak at 30 days post-surgery.

No	Authors, Year	Purpose	Country	Sample	Intervention	Key Results
7	(Afxonidis et al., 2021)	To investigate the effect of physical activity and respiratory physiotherapy on post-operative day 0.	Greece	78 patients (39 EEPC group, 39 control/CPC).	Duration:The EEPC group started the intervention on day 0 (a few hours after extubation) with a total of 3 sessions per day for the first 3 days. Activities: Respiratory physiotherapy (deep breathing, spirometry, percussion), sitting on the edge of the bed, standing, and static walking of 10-50 steps (intensity ≤3 METs).	The very early mobilization (EEPC) group had significantly shorter ICU and hospital stays than the conventional group (8.1 vs 8.9 days).
8	(Jalili et al., 2025)	To evaluate the effects of two early mobilization protocols on pain intensity and hemodynamic indicators.	Iran	105 patients (divided into 3 groups: Int1, Int2, Control).	Duration:Performed for 5 consecutive days post-surgery. Activities: - Int1 (Morris): Change of position, limb ROM (5 minutes), sitting in bed, standing, and walking (6 minutes). - Int2 (Breathing Exercise): Similar to Int1 plus intensive breathing exercises (spirometry, deep breathing, effective coughing 8x a day) and sitting in a chair for up to 45 minutes.	The protocol emphasizing breathing exercises (Int2) was more effective in increasing oxygen saturation and significantly reducing pain intensity than the other groups.

Based on the analysis of the eight attached articles, there are several main types of interventions in the rehabilitation of patients after Coronary Artery Bypass Graft (CABG) surgery. The most basic type of intervention is progressive physical mobilization, which is performed in stages, starting with passive and active range of motion (ROM) exercises, changing positions in bed, and progressing to early ambulation, such as sitting, standing, and walking (Esmealy et al., 2023). These mobilization protocols often follow systematic steps, such as the Morris protocol, which guides patients from bed rest to six-minute walking (Jalili et al., 2025). Furthermore, a moderate-intensity walking program directly supervised by a healthcare professional has been shown to be effective in increasing patients' walking distance before they are discharged from the hospital (Hirschhorn et al., 2008). A patient's functional capacity for these mobilizations is also influenced by external factors such as smoking status, with non-smokers generally achieving better functional outcomes than active smokers (Alsubaiei et al., 2023).

The next intervention is respiratory physiotherapy, which aims to optimize lung function and prevent complications such as atelectasis. This activity includes deep breathing exercises, the use of an incentive spirometer, effective coughing techniques, and chest physiotherapy using percussion (Alsubaiei et al., 2023). Some protocols even use specific methods, such as bottle-blowing, to help clear the airway and increase oxygen saturation (Esmealy et al., 2023). In addition to standard techniques, there is also inspiratory muscle training, which uses special weights to strengthen the patient's respiratory muscles in a more structured manner (Zanini et al., 2019).

Furthermore, the use of aerobic exercise equipment such as cycle ergometers or stationary bicycles has been implemented very early, even while patients are still in the intensive care unit (ICU). The addition of stationary bicycle training to conventional physiotherapy protocols has been shown to maintain patients' functional capacity, preventing a drastic decline upon discharge (Borges et al., 2016). In addition to the type of activity, the timing of the intervention is also key, as initiating

mobilization and breathing exercises several hours after extubation on "Day 0" can significantly shorten the length of stay in the ICU (Afxonidis et al., 2021).

Finally, there are interventions that focus on strengthening psychological and educational aspects through self-efficacy theory. This approach integrates pre-operative information, the use of videos featuring examples of patients who have successfully recovered, and persuasive verbal support to build patient confidence in undergoing physical rehabilitation activities (Noopiam et al., 2025). This combination of active physical exercise and mental reinforcement has been found to provide more optimal results for physical fitness levels and maximal oxygen consumption in patients after cardiac surgery (Noopiam et al., 2025).

DISCUSSION

This systematic literature review summarizes eight original studies with both RCT and quasi-experimental designs that evaluated the effect of early mobilization on cardiovascular function recovery and related clinical outcomes in post-CABG patients with cardiopulmonary bypass support. Overall, the findings demonstrate a relatively consistent pattern: early and progressive mobilization tends to be associated with better recovery compared to conventional care or less structured mobilization. The effects seen are not limited to increased activity tolerance, but also include improved oxygenation, reduced pulmonary complications, improved comfort, particularly pain, and, in some studies, shortened ICU and hospital stays (Alsubaiei et al., 2023).

In the context of post-CABG with cardiopulmonary bypass, these results can be understood through the physiological characteristics of the early recovery phase. CPB is often associated with a systemic inflammatory response, changes in capillary permeability, and fluid dynamics, which can trigger hemodynamic fluctuations and delay organ function recovery. In such situations, prolonged bed rest exacerbates cardiorespiratory deconditioning, reduces aerobic capacity, and increases the risk of ventilation-perfusion compromise (Tippinit & Polsook, 2023). Therefore, early mobilization, performed in a gradual and safe manner, has the potential to break the cycle of inactivity, preserve cardiorespiratory function, and accelerate the return to activity tolerance without excessive physiological burden (Tippinit & Polsook, 2023).

The most frequently reported and consistent outcome was functional capacity, specifically walking ability, as patients approached discharge. Hirschhorn et al. demonstrated that a supervised, moderate-intensity walking program progressively initiated early in hospital treatment increased the six-minute walk test distance at hospital discharge (Rianda et al., 2022). This finding aligns with Borges et al.'s report that very early aerobic exercise on a cycle ergometer, combined with conventional physical therapy, maintained functional capacity, with a smaller decrease in the six-minute walk test distance at discharge compared to a control group (Afxonidis et al., 2021). These findings reinforce the argument that early mobilization is not simply an additional activity but rather a protective strategy against the acute decline in fitness that commonly occurs after major cardiac surgery (Zengin & Tasci, 2021).

In addition to functional capacity, several studies in this review highlight the contribution of early mobilization to the recovery of respiratory parameters, which have strong implications for cardiovascular stability (Akbik et al., 2020; Viberg et al., 2021). Esmealy et al. found that a multi-phase, stepwise early mobilization protocol that included range-of-motion exercises, head-of-bed elevation, bedside sitting, and walking improved oxygen saturation and partial oxygen pressure while reducing pulmonary complications such as atelectasis and pneumonia compared to a control group (Roosendaal et al., 2021). Although the primary focus is respiratory outcomes, improved oxygenation has direct relevance to myocardial oxygen supply and cardiac efficiency, thus indirectly supporting the cardiovascular recovery process and patient readiness for increased physical activity (Kato et al., 2019).

The role of combining mobilization with respiratory interventions appears to produce varying findings across studies. In Hirschhorn et al., the addition of breathing exercises did not provide significant additional benefits for improving walking capacity compared to a walking program alone. However, in Jalili et al., a mobilization protocol combined with more intensive breathing exercises demonstrated superiority in increasing oxygen saturation and reducing pain intensity (Alsubaiei et al., 2023). These differences indicate that the additional benefits of respiratory interventions may be more pronounced for specific outcomes such as oxygenation and comfort, and may be influenced by the dose of exercise, timing of administration, and patient characteristics (Allahbakhshian et al., 2023). Therefore, combination interventions should be selected based on prioritized outcome targets at the treatment phase, rather than applied uniformly without considering clinical need .

The timing of intervention initiation also emerged as an important determinant in the results of this review. Afxonidis et al. showed that mobilization initiated on day zero after extubation and delivered several sessions per day for the first three days was associated with shorter ICU and hospital stays compared to conventional care (Kourek et al., 2022). These findings support the notion that the early recovery phase is a critical period for initiating physical activity, as long as clinical stability is established and safety monitoring is effective (González-Rueda et al., 2020). Faster mobilization, in terms of initiation time alone, is not always sufficient, as success is also influenced by protocol structure, frequency of administration, and a clear activity progression so that patients receive an adequate dose of exercise without increasing risk (Nurzhanova et al., 2024).

This review also demonstrated that the response to early mobilization can be influenced by patient characteristics that act as modifying factors. Alsubaiei et al. demonstrated that smoking status was associated with lower functional capacity and a higher risk of atelectasis in current and former smokers compared to nonsmokers (Shan et al., 2022). These findings are important because they emphasize the need for an individualized approach to early mobilization, including strengthening respiratory interventions in at-risk patients, more closely monitoring activity tolerance, and integrating education regarding lifestyle factors that influence recovery (Kao et al., 2022). Therefore, early mobilization protocols should remain standardized, but their implementation should be tailored to the patient's clinical profile (Tippinit & Polsook, 2023).

On the other hand, several studies indicate that a more comprehensive rehabilitation program may provide additional benefits over physical mobilization alone (Anderson et al., 2016; Köhler et al., 2020; Yang et al., 2024). Self-efficacy-based cardiac rehabilitation program initiated preoperatively and continuing through the sixth postoperative day improved self-efficacy, six-minute walk test distance, and maximal oxygen consumption at discharge (Yang et al., 2024). These findings suggest that post-CABG recovery is influenced not only by physical ability but also by the patient's psychological readiness and understanding of how to safely perform activities (Nurzhanova et al., 2024). Improved self-efficacy can improve adherence to exercise, reduce fear of movement, and encourage active participation in the recovery process, resulting in optimal functional outcomes (Shehata et al., 2021).

Although the findings tend to support early mobilization, several limitations should be considered. Mobilization protocols vary considerably across studies, including timing of initiation, intensity, frequency, and supporting components such as breathing exercises and the use of exercise equipment (Kao et al., 2022). The outcomes used are also not entirely uniform, as some studies emphasize oxygenation and pulmonary complications, while more specific cardiovascular indicators such as vasoactive requirements, orthostatic tolerance, or detailed hemodynamic parameters are not always reported consistently (Afxonidis et al., 2021). Differences in settings and relatively diverse sample sizes also potentially impact the generalizability of the results, particularly

as clinical practices in ICUs and wards can vary across institutions and countries (Rianda et al., 2022).

The practical implications of this systematic literature review emphasize the importance of implementing early mobilization after CABG with cardiopulmonary bypass through a clear, stepwise, and safety-oriented protocol (Jin et al., 2020). The most promising approach is progressive mobilization, initiated as early as possible after extubation and clinical stability, accompanied by healthcare provider support and patient response monitoring (Kavita et al., 2020). Respiratory interventions can be considered as an additional component, especially in patients at risk of pulmonary complications or with low activity tolerance, while strengthening education and self-efficacy can help increase patient engagement and lead to a more consistent recovery (Majid et al., 2020).

Future research requires interventional studies that report more standardized mobilization protocols and use more specific and consistent cardiovascular outcomes across studies. Research should also clarify the surgical characteristics and use of cardiopulmonary bypass, and evaluate the impact of early mobilization on at-risk groups such as smokers, elderly patients, and those with high comorbidities. Strengthening the evidence in these areas will help generate more precise, measurable, and easily implemented clinical recommendations for post-CABG care with cardiopulmonary bypass.

CONCLUSION

This systematic literature review shows that early mobilization in post-CABG patients with cardiopulmonary bypass is generally associated with better outcomes in the early recovery phase, particularly related to increased functional capacity, improved oxygenation, reduced pulmonary complications, decreased pain intensity, and in some studies, shortened ICU and hospital stays. Evidence from the eight studies analyzed shows a relatively consistent trend that early and progressive mobilization interventions are more beneficial than conventional care or unstructured mobilization, especially when the program is carried out under the supervision of healthcare professionals and with clear activity stages.

Furthermore, the findings of this study confirm that the effectiveness of early mobilization is determined not only by how quickly the intervention begins, but also by the protocol structure, frequency, activity progression, and supporting components such as breathing exercises and education that enhance patient engagement. However, the variation in protocols between studies and the differences in outcomes indicate that standards for implementing early mobilization after CABG with CPB are still not fully uniform. Therefore, it is recommended that early mobilization be implemented in a planned and safety-based manner, with adjustments to the patient's clinical condition, and supported by further interventional research using more specific cardiovascular indicators and more detailed protocol reporting to ensure more precise and easily implemented clinical recommendations.

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