

MULTIMODAL PREHABILITATION ASSOCIATED WITH THE ENHANCED RECOVERY AFTER SURGERY PROTOCOL IN COLORECTAL SURGERY: IMPACT ON POSTOPERATIVE OUTCOMES

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ABSTRACT

Recovery after colorectal surgery remains a significant challenge, particularly in patients with low functional capacity and a higher risk of complications. In this context, the combination of multimodal prehabilitation with the Enhanced Recovery After Surgery protocol has been proposed as a strategy to better prepare patients for surgical stress and enhance postoperative recovery. This review analyzed studies published between 2019 and 2026 to evaluate the impact of this approach on postoperative outcomes. The findings demonstrated consistent improvements in functional capacity, reflected by better performance in the Six-minute Walk Test, as well as evidence of faster recovery and greater adherence to Enhanced Recovery After Surgery components. Although the effects on postoperative complications and length of hospital stay were variable, the benefits were more pronounced in patients with lower physiological reserve. Therefore, multimodal prehabilitation stands out as a promising tool to optimize perioperative care, reinforcing the importance of an individualized approach focused on the patient's overall recovery.

Keywords: Colorectal surgery, Enhanced postoperative recovery, Postoperative complications, Preoperative exercise, Rehabilitation.

INTRODUCTION

Colorectal surgery is one of the most complex procedures in the elective surgical setting and is associated with relevant rates of postoperative morbidity, functional decline, and prolonged hospital stay.¹ Patients undergoing this type of surgery frequently present with comorbidities, malnutrition, and low aerobic capacity, factors that increase the risk of complications and delay recovery.^{2,3} The Enhanced Recovery After Surgery (ERAS) protocol represents the main paradigm shift in the perioperative management of this population, incorporating evidence-based multimodal interventions aimed at reducing surgical stress, accelerating

recovery, and decreasing postoperative complications.³ The ERAS® Society guidelines for elective colorectal surgery consolidate graded recommendations for perioperative optimization, ranging from nutritional preparation and anemia management to early mobilization and multimodal analgesia.³

Despite the advances achieved with the ERAS protocol, a significant proportion of patients still present insufficient physiological reserve in the preoperative period, limiting the potential benefits that can be achieved.⁴ In this context, multimodal prehabilitation—defined as a set of interventions performed between diagnosis and surgery, integrating structured physical exercise, nutritional support, and psychological support—emerges as a complementary strategy to increase functional capacity and patient resilience to surgical stress.^{4,5} Recent evidence indicates that prehabilitation programs may reduce postoperative complications, shorten hospital stay, and improve functional recovery, with potentially greater benefit in patients with lower baseline physical fitness.^{5,6} The association between multimodal prehabilitation and the ERAS protocol therefore represents a promising and complementary perioperative approach, although results in the literature remain heterogeneous, justifying the present integrative review.⁶

OBJECTIVES

The objective of this study is to conduct an integrative literature review to evaluate the impact of multimodal prehabilitation associated with the Enhanced Recovery After Surgery (ERAS) protocol on postoperative outcomes in patients undergoing elective colorectal surgery, based on evidence published between 2019 and 2026. The study seeks to identify the components of prehabilitation most frequently associated with improved clinical outcomes, as well as to analyze their effects on postoperative complications, length of hospital stay, mortality, and patients' functional recovery. In addition, it aims to discuss the clinical applicability of combining multimodal prehabilitation with the ERAS protocol in the perioperative setting of colorectal surgery.

METHODS

This is an integrative literature review conducted with the aim of synthesizing the available evidence on the effects of multimodal prehabilitation integrated with the Enhanced Recovery After Surgery (ERAS) protocol on postoperative outcomes in patients undergoing colorectal surgery. The process of study identification, screening, and selection was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.⁷

The literature search was performed in two electronic databases: MEDLINE/PubMed and Embase. Searches were conducted in [month/year], with no language restrictions and with publication dates limited to the period between 2019 and 2026. In PubMed, the following structured search strategy using Boolean operators was applied: ("prehabilitation" OR "multimodal prehabilitation") AND ("ERAS" OR "Enhanced Recovery After Surgery" OR "fast-track surgery") AND ("colorectal surgery" OR "colorectal cancer" OR "colectomy") AND ("postoperative outcomes" OR "postoperative complications" OR "length of stay" OR "functional recovery" OR "mortality"). In Embase, an equivalent search strategy was used, adapted to the database's controlled vocabulary (Emtree), with the same descriptors and logical operators.

Studies published between January 2019 and May 2026, with full text available free of charge, were included if they had one of the following designs: clinical trial, randomized clinical trial, observational study, systematic review, or meta-analysis. Studies were considered eligible if they specifically addressed multimodal prehabilitation in patients undergoing colorectal surgery and reported at least one postoperative outcome of

interest, including complications, length of hospital stay, functional recovery, or mortality. Duplicate studies identified in more than one database, studies addressing exclusively unimodal prehabilitation, as well as case reports, case series, letters to the editor, editorials, and conference abstracts without a direct relationship to the ERAS protocol or colorectal surgery were excluded.

Screening was conducted in three sequential stages: title assessment, abstract assessment, and full-text review. In PubMed, the search identified 10 records; after exclusion by title ($n = 2$) and abstract ($n = 1$), 7 articles were included. In Embase, the search identified 52 records; after exclusion by title ($n = 39$) and abstract ($n = 9$), 4 articles underwent full-text review, of which 3 were excluded as duplicates already identified in the PubMed search, resulting in the inclusion of 1 article unique to this database. At the end of the selection process, a total of 8 articles were included. The study selection flow is presented in the PRISMA diagram (Figure 1).

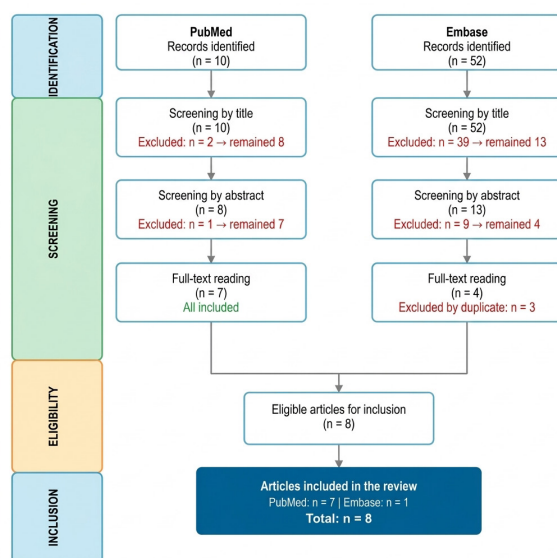


Figure 1: Flowchart of Article Selection
Source: Prepared by the authors (2026).

Data were extracted in a standardized manner, including authors, year of publication, country, study design, population, characteristics of the multimodal prehabilitation intervention, components of the ERAS protocol adopted, and outcomes assessed. The synthesis was conducted narratively due to the heterogeneity among the included studies regarding the type of intervention, population, and measured outcomes.

RESULTS AND DISCUSSIONS

Functional capacity, assessed using the 6-Minute Walk Test (6MWT), showed statistically significant improvements in the preoperative period. Of the 8 articles included in this review, 6 provided quantitative data eligible for comparison of functional performance between the analyzed groups, as summarized in Table 1. Overall evidence shows that multimodal prehabilitation increases the

distance walked before surgery by an average of 24.91 meters compared with the control group.^{1,table1} In a study conducted in China, the intervention group showed better performance both on the day before surgery (400.40 meters vs. 383.25 meters) and at 30 days postoperatively (375.40 meters vs. 336.85 meters).^{8,table1} These findings were also observed in recent meta-analyses, which identified a mean gain of 50.83 meters eight weeks after surgery, suggesting faster functional recovery.^{6,table1} In older adults, there was also a significant improvement of 18.38 meters in the 6MWT, although the impact on other clinical outcomes was less evident in this group.^{5,table1} In addition, some studies associated functional improvement with increased cardiorespiratory fitness and physiological reserve during the perioperative period.^{2,4}

Table 1: Comparison of Functional Performance Between the Multimodal Prehabilitation and Control.

Study (Ref.)	Population Evaluated	Time of Assessment	Functional Outcome (6MWT)	Prehabilitation Group	Control Group	Statistical Result
Molenaar et al. ¹	Patients undergoing abdominal surgery	Preoperative	Mean difference in distance walked (m)	+24.91 m	—	p < 0.001
Carli et al. ²	Patients undergoing abdominal surgery	4 weeks postoperatively	Distance walked (m)	336.40 m	286.10 m	p = 0.34
Gillis et al. ⁴	Patients in an ERAS protocol	6 weeks postoperatively	Distance walked (m)	554.00 m	537.00 m	p = 0.01
Srinivasan et al. ⁵	Older adults undergoing colorectal surgery	Postoperative	Change in distance walked (m)	+18.38 m	—	p = 0.04
Widanage et al. ⁶	Patients undergoing multimodal prehabilitation	8 weeks postoperatively	Mean gain in 6MWT (m)	+50.83 m	—	p < 0.001
Tai et al. ⁸	Patients with colorectal cancer	30 days postoperatively	Distance walked (m)	375.40 m	336.85 m	p = 0.03

Source: Prepared by the author (2026) based on the articles included in the review.

Regarding postoperative complications, the studies present divergent results, demonstrating the complexity of the clinical application of multimodal prehabilitation. Some analyses reported a significant reduction in the risk of overall postoperative morbidity, with an odds ratio of 0.60⁶. In addition, an international clinical trial showed a decrease in major complications from 29.7% to 17.1%, as well as a reduction in medical complications from 27.3% to 15.4%.^{1,6} On the other hand, studies conducted in centers with well-established Enhanced Recovery After Surgery (ERAS) protocols and greater use of minimally invasive surgery did not identify statistically significant differences in the severity of complications assessed by the Comprehensive Complication Index (CCI).^{2,9} In these settings, the additional benefits of prehabilitation on morbidity were considered

limited, possibly due to the already high quality of established perioperative care.^{1,2} Although improvement in functional capacity was consistent across the studies, this improvement did not always translate into a proportional reduction in postoperative complications, demonstrating that functional gain alone may not be sufficient to modify all clinical outcomes.^{2,6,9}

Regarding hospital efficiency, some studies observed a reduction in length of stay (LOS), particularly in supervised hospital-based programs.⁷ In these cases, an approximate reduction of 1.15 days in hospital stay was reported.⁷ However, most of the evidence, including meta-analyses involving older patients and studies conducted in routine clinical practice, did not demonstrate a significant reduction in total length of stay.^{2,4,5,9} Nevertheless, multimodal prehabilitation was found to contribute to greater readiness for hospital discharge and better adherence to essential components of the ERAS protocol, such as early ambulation and adequate postoperative oral intake.⁴ The studies also highlighted that higher adherence rates to the programs were associated with better functional outcomes and faster postoperative recovery.^{4,8}

Multimodal prehabilitation aims to increase the patient's physiological reserve in order to reduce the impact of surgical stress.³ One of the main points discussed in the literature is the effectiveness of this strategy in settings where ERAS protocols are already well established. Some authors suggest the existence of a "ceiling effect," in which the high quality of perioperative care, including multimodal analgesia and early mobilization, would reduce the additional benefits of prehabilitation.^{2,9} In this context, the strategy may have a greater impact on high-risk patients or those with low functional reserve, whereas the benefits may be more modest in highly specialized centers². Patients with sarcopenia, pre-existing functional limitations, and lower physical fitness appear to have greater potential for clinical benefit from the intervention.^{1,5}

The combination of physical exercise, nutritional support, and psychological support is considered fundamental to the observed outcomes. Adequate nutritional support plays an important role in increasing strength and muscle mass, since protein deficiency may limit the effects of exercise.⁴ In addition, inspiratory muscle training helps strengthen the diaphragm and reduce respiratory complications, acting as a complement to nutritional support.⁸ Psychological support also contributes to reducing anxiety related to the diagnosis and surgical procedure, favoring greater adherence to the program and better functional recovery, particularly in older adults.^{4,7} The integration of these components demonstrates that the benefits of prehabilitation depend not only on physical training alone, but also on the overall optimization of the patient's clinical and emotional condition during the preoperative period.^{1,4}

The included studies showed important differences regarding the duration, intensity, and degree of supervision of prehabilitation programs, involving variable combinations of aerobic exercise, resistance training, nutritional support, and psychological support.^{1,4,8} This methodological heterogeneity may directly influence the differences observed among the study results.^{1,5}

Despite the positive results, important limitations remain regarding the universal application of multimodal prehabilitation.^{1,5} The wide variety of protocols used makes comparisons between studies and standardization of the strategy difficult. In addition, short intervention periods may not be sufficient to reverse more advanced sarcopenia, which may require longer programs.² Another issue discussed is the risk of bias in non-blinded studies, as well as the possibility that patients in the control group may begin exercising on their own, which may interfere with the results.¹ The methodological heterogeneity observed among the studies, including differences in exercise intensity, duration of interventions, and criteria used for functional assessment, also limits direct comparison of the available findings.^{1,3,5} Thus, future studies are likely to direct prehabilitation

toward more individualized models, combined with the use of remote monitoring technologies to improve adherence and expand the application of this strategy within healthcare services.^{4,8} Overall, the findings suggest that multimodal prehabilitation has a greater clinical impact in patients with lower baseline functional reserve and higher surgical risk, particularly when combined with well-structured perioperative strategies.^{1,2,5}

CONCLUSION

Multimodal prehabilitation associated with the ERAS protocol proved to be a promising strategy for optimizing recovery in patients undergoing elective colorectal surgery, particularly by improving functional capacity during the perioperative period. The analyzed findings indicate that interventions combining structured physical exercise, nutritional support, psychological support, and, in some cases, inspiratory muscle training may increase patients' physiological reserve and promote faster postoperative recovery.

However, the effects on postoperative complications, length of hospital stay, and mortality remain inconsistent across studies. In centers with well-established ERAS protocols and extensive use of minimally invasive techniques, the additional benefit of prehabilitation appears to be more modest, possibly because of the quality of the perioperative care already in place. On the other hand, patients with higher surgical risk, low functional capacity, sarcopenia, advanced age, or multiple comorbidities appear to constitute the group with the greatest potential for clinical benefit.

The main limitations observed in the literature involve the heterogeneity of prehabilitation protocols, differences in the duration and intensity of interventions, variability in the outcomes assessed, and the difficulty of making direct comparisons between studies. Therefore, although the findings support the incorporation of multimodal prehabilitation as a complement to ERAS, further prospective, multicenter studies using more standardized protocols are still needed to determine which components are most effective, the optimal duration of the intervention, and which patient profiles should be prioritized.

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