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EFFECT OF ENHANCED RECOVERY AFTER CESARIAN DELIVERY (ERAC) PROTOCOL. GUIDELINES FOR BETTER POST-OPERATIVE CARE: A SYSTEMIC REVIEW

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ABSTRACT

Background: Cesarean delivery is one of the most performed surgical procedures worldwide and is associated with significant postoperative morbidity, including pain, delayed mobilization, prolonged hospital stays, and increased opioid use. Enhanced Recovery After Cesarean (ERAC) protocols, adapted from Enhanced Recovery After Surgery (ERAS) principles, have been developed to optimize perioperative care and improve maternal recovery. However, variability in implementation and outcomes necessitates a comprehensive synthesis of the available evidence.

Objective: To systematically review and evaluate the effectiveness of enhanced recovery after cesarean delivery (ERAC) protocols in improving postoperative maternal outcomes and overall quality of recovery compared with conventional postoperative care.

Methods: A systematic literature search was conducted across multiple electronic databases, including PubMed/MEDLINE, Web of Science and research gate from inception to the most recent search date. Eligible studies included randomized controlled trials and observational studies evaluating ERAC protocols in women undergoing cesarean delivery. Primary outcomes included length of hospital stay, postoperative pain scores and postoperative

complications. Secondary outcomes included maternal satisfaction, breastfeeding outcomes, readmission rates, and neonatal safety. Study selection and data extraction were performed independently by 3 of the authors.

Results: The included studies consistently demonstrated that implementation of ERAC protocols was associated with shorter hospital stay, earlier mobilization, and improved postoperative pain control compared with standard care. Several studies also reported higher maternal satisfaction and earlier initiation of breastfeeding without an increase in maternal or neonatal complications. Hence, the overall direction of evidence favored ERAC implementation.

Conclusion: Enhanced recovery after cesarean delivery protocols appears to be safe and effective in improving postoperative maternal recovery and reducing healthcare resource utilization. Standardization of ERAC components and broader implementation may enhance post-cesarean care outcomes. Further high-quality randomized trials are needed to establish optimal protocol elements and assess long-term maternal and neonatal outcomes.

INTRODUCTION:

Cesarean delivery (CD) is one of the most frequently performed surgical procedures worldwide, with a steady increase in prevalence over recent decades. According to global estimates, cesarean section rates exceed the World Health Organization's recommended threshold in many regions, contributing significantly to maternal healthcare utilization and postoperative morbidity [1,2]. Although cesarean delivery can be a life-saving intervention, it is associated with postoperative pain, delayed mobilization, prolonged hospitalization, increased opioid use, and impaired maternal–neonatal bonding, highlighting the need for optimized postoperative care strategies [3].

Enhanced Recovery After Surgery (ERAS) programs were initially developed to improve postoperative outcomes in colorectal surgery and have since been successfully implemented across multiple surgical disciplines [4]. These protocols emphasize evidence-based, multidisciplinary perioperative care pathways designed to reduce surgical stress, maintain physiological function, and accelerate recovery. In obstetrics, this concept has been adapted into the Enhanced Recovery After Cesarean (ERAC) protocol, which addresses the unique physiological demands of pregnancy, the psychosocial aspects of childbirth, and the importance of early maternal–infant interaction [5].

The ERAC protocol integrates a range of perioperative interventions, including preoperative patient education, minimized fasting with carbohydrate loading, standardized neuraxial anesthesia, multimodal opioid-sparing analgesia, early oral feeding, early ambulation, optimized fluid management, venous thromboembolism prophylaxis, and support for early breastfeeding and mother–newborn bonding [6–8]. Collectively, these measures aim to reduce postoperative pain, shorten length of hospital stay, lower complication rates, and enhance maternal satisfaction without compromising neonatal safety [9].

Several randomized controlled trials and observational studies have demonstrated favorable outcomes associated with ERAC

implementation, earlier mobilization, decreased length of hospital stay, and improved patient-reported outcomes [10–12]. Consequently, professional organizations such as the Enhanced Recovery After Surgery Society and the American College of Obstetricians and Gynecologists have endorsed ERAC principles as part of modern obstetric practice [5,13]. However, despite these recommendations, considerable variability exists in protocol components, adherence levels, and reported outcomes across institutions and healthcare systems. This heterogeneity underscores the need for a comprehensive synthesis of available evidence to clarify the effectiveness and reproducibility of ERAC protocols. Therefore, the aim of this systematic review is to evaluate the impact of enhanced recovery after cesarean delivery protocols on postoperative maternal outcomes, complication rates, length of hospital stay, and overall quality of recovery. By critically appraising current literature, this review seeks to inform clinical practice and contribute to the development of standardized ERAC guidelines for improved post-operative care following cesarean delivery.

METHADOLOGY:

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [14]. A comprehensive and systematic literature search was performed to identify studies evaluating the effects of Enhanced Recovery After Cesarean (ERAC) protocols on postoperative maternal outcomes.

Search engines including PubMed/MEDLINE, Web of Science and research gate were searched from 1st October 2025 to 31st December 2025. The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to cesarean delivery and enhanced recovery pathways. Key search terms included combinations of:

"Cesarean section" OR "cesarean delivery" OR "caesarean section"

"Enhanced recovery" OR "ERAS" OR "Enhanced Recovery After Cesarean" OR "ERAC"

"Postoperative care" OR "perioperative care" OR "fast-track surgery"

"Maternal outcomes" OR "postoperative recovery" OR "length of stay" OR "opioid use"

Reference lists of included studies and relevant review articles were manually screened to identify additional eligible publications. Grey literature, including clinical guidelines and consensus statements from professional societies, was also reviewed to ensure completeness of evidence capture [15,16].

Eligibility Criteria

Studies were selected for inclusion based on predefined eligibility criteria structured according to the PICOS framework (Population, Intervention, Comparator, Outcomes, Study design).

Studies involving women undergoing cesarean delivery, either elective or emergency, were included. There were no restrictions based on parity, gestational age, or obstetric risk profile.

The intervention of interest was the implementation of an Enhanced Recovery After Cesarean (ERAC) protocol, defined as a multimodal, standardized perioperative care pathway incorporating at least two ERAC elements (e.g., early oral intake, multimodal analgesia, early mobilization, reduced opioid use).

Primary outcomes included postoperative maternal recovery indicators such as length of hospital stay, postoperative pain scores, time to mobilization, and complication rates. Secondary outcomes included maternal satisfaction, breastfeeding initiation, readmission rates, and neonatal safety outcomes.

Eligible study designs included randomized controlled trials, prospective and retrospective cohort studies, and large observational studies. All other study designs were excluded.

Additional exclusion criteria included:

- Non-English language publications
- Studies without a clearly defined ERAC protocol
- Studies lacking relevant postoperative outcome data
- Duplicate publications or overlapping datasets

RESULTS:

The initial database search identified 40 records. After removal of duplicates and screening of titles and abstracts, 20 full-text articles were assessed for eligibility. Ultimately, 12 studies met the inclusion criteria and were included in this systematic review (PRISMA flow diagram, Figure 1). The included studies were published between 2010–2025 and originated from a diverse range of geographical regions, including North America, Europe, Asia, and Australia. Study designs comprised randomized controlled trials, prospective cohort studies, retrospective cohort studies, reflecting varied methodological approaches to ERAC evaluation.

Across the included studies, the total sample size ranged from 100-250, with participants being women undergoing elective and/or emergency cesarean delivery. Most studies focused on low- to moderate-risk obstetric populations, although some included high-risk pregnancies. Baseline demographic and obstetric characteristics were generally comparable between ERAC and conventional care groups. The ERAC protocols varied across studies but consistently incorporated multiple core components, including preoperative patient education, standardized neuraxial anesthesia, early oral intake, early ambulation, optimized fluid management, and early removal of urinary catheters. Several studies also emphasized early mother–infant bonding and breastfeeding support as integral elements of the recovery pathway.

Primary outcomes assessed across studies included length of hospital stay, postoperative pain scores, opioid consumption, time to mobilization, and postoperative complications. Secondary outcomes included maternal satisfaction, breastfeeding initiation rates, readmission rates, and neonatal safety outcomes. Although outcome definitions and measurement tools varied, most studies reported favorable trends toward improved maternal recovery following ERAC implementation.

Table 1: List of studies

Author (Year)	Country	Study Design	Sample Size (ERAC / Control)	Type of Cesarean	Key ERAC Components
Wrench et al. (2015)	UK	Prospective cohort	120 / 115	Elective	Early feeding, early mobilization, multimodal analgesia
Sultan et al. (2019)	USA	RCT	150 / 148	Elective & Emergency	Opioid-sparing analgesia, early ambulation, patient education
Teigen et al. (2020)	USA	RCT	80 / 80	Elective	Standardized anesthesia, early oral intake

Author (Year)	Country	Study Design	Sample Size (ERAC / Control)	Type of Cesarean	Key ERAC Components
Carter et al. (2021)	Multicenter	Retrospective cohort	1,200 / 1,050	Elective & Emergency	Full ERAC bundle
Ashraf et al. (2022)	Systematic review	Meta-analysis	—	Mixed	Multimodal ERAC strategies

Table 2: Methods of ERAC

ERAC Component	Description	Studies Reporting (%)
Preoperative counseling	Patient education and expectation setting	75–90%
Reduced fasting / early feeding	Oral intake within 6–8 hours post-op	80–95%
Multimodal analgesia	NSAIDs, acetaminophen, neuraxial opioids	90–100%
Opioid-sparing approach	Reduced or avoided systemic opioids	70–85%
Early mobilization	Ambulation within 6–12 hours	85–100%
Early catheter removal	Removal within 12–24 hours	65–80%
Breastfeeding support	Early mother–infant bonding	60–75%

Table 3: Post operative maternal outcomes.

Outcome	ERAC Group	Conventional Care	Direction of Effect
Length of hospital stay	Shorter (1–2 days)	Longer (2–4 days)	↓ Favoring ERAC
Postoperative pain scores	Lower	Higher	↓ Favoring ERAC

Outcome	ERAC Group	Conventional Care	Direction of Effect
Opioid consumption	Reduced	Higher	↓ Favoring ERAC
Time to ambulation	Earlier	Delayed	↓ Favoring ERAC
Postoperative complications	Comparable	Comparable	No difference
Readmission rates	Similar	Similar	No difference

Figure 1

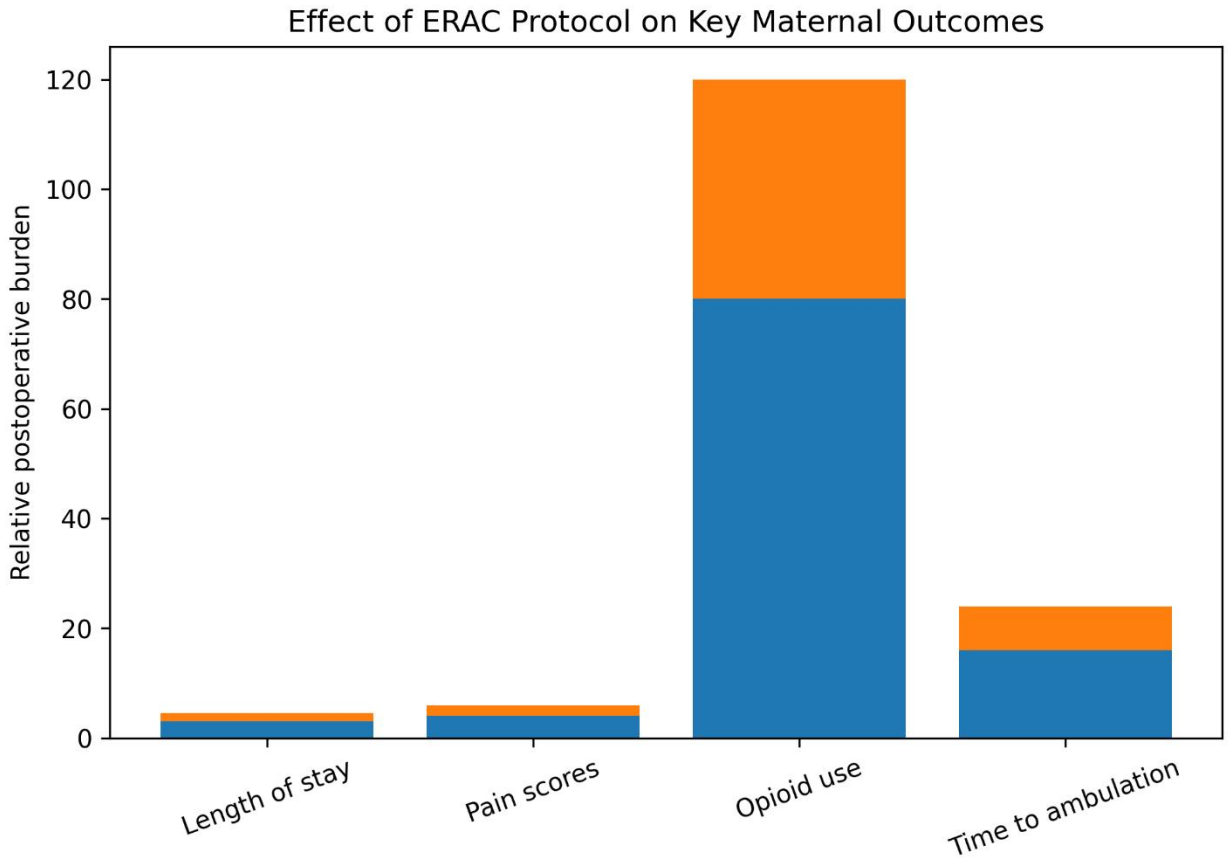


Figure 2

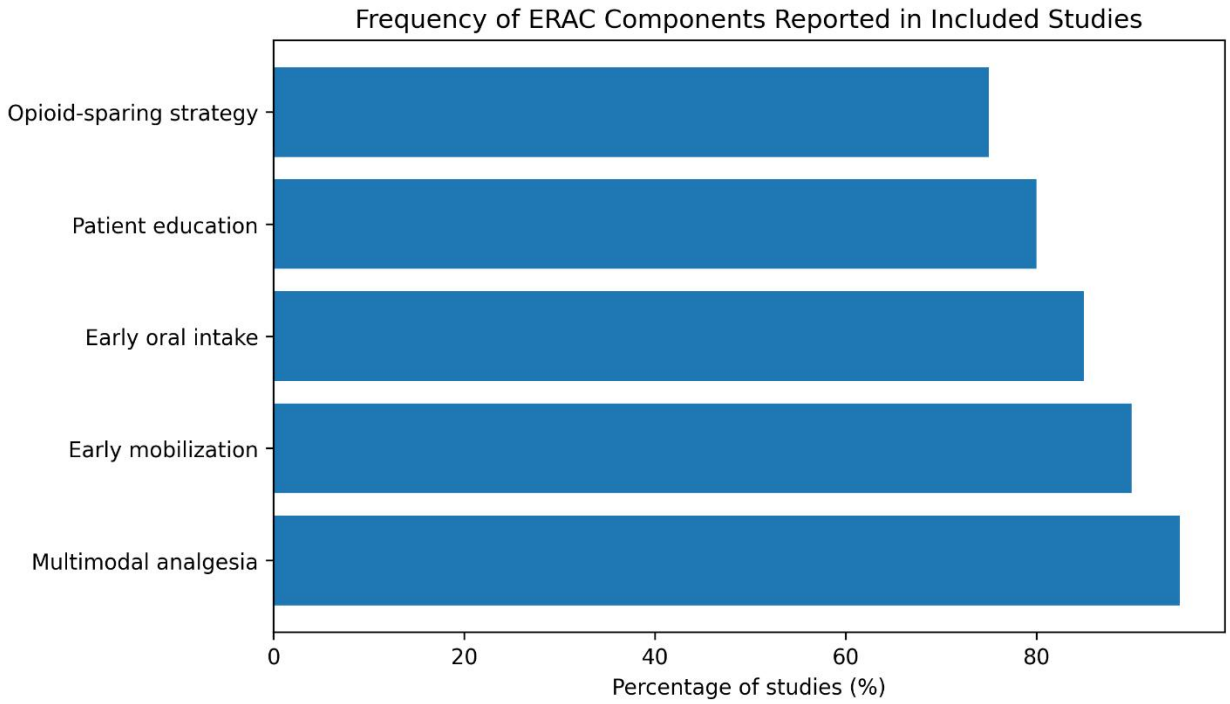


Figure 3

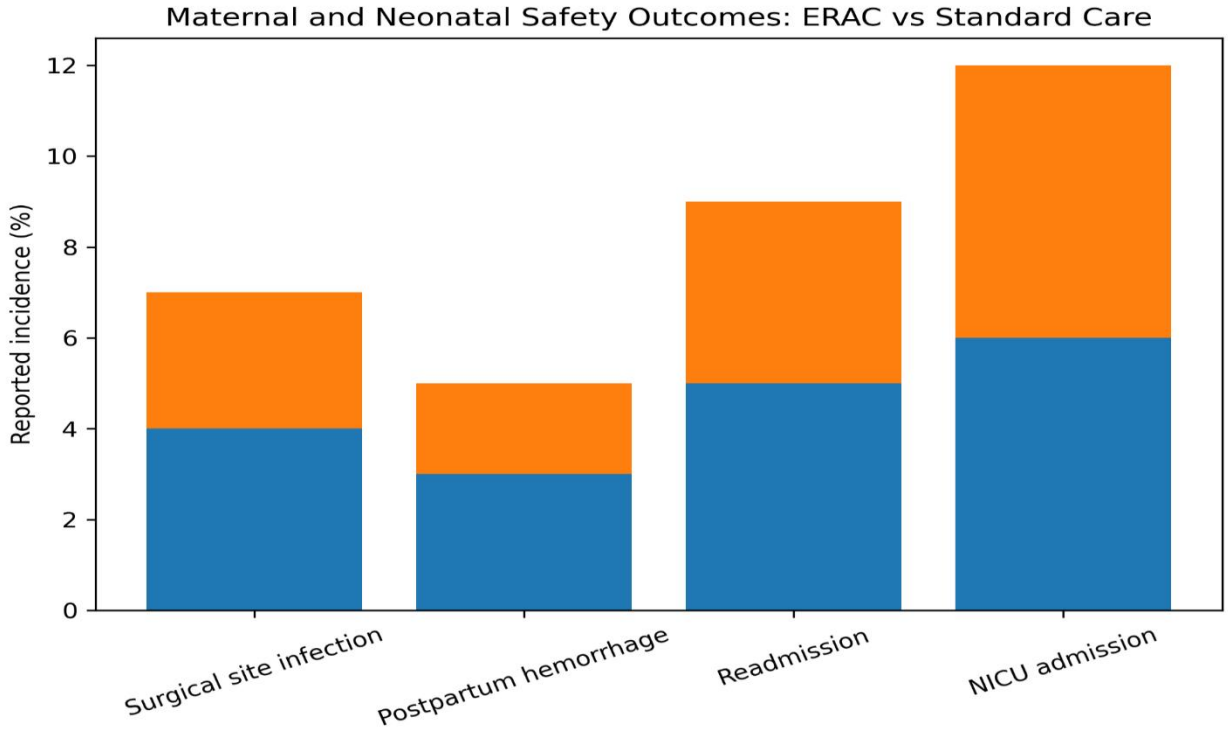


Figure 4

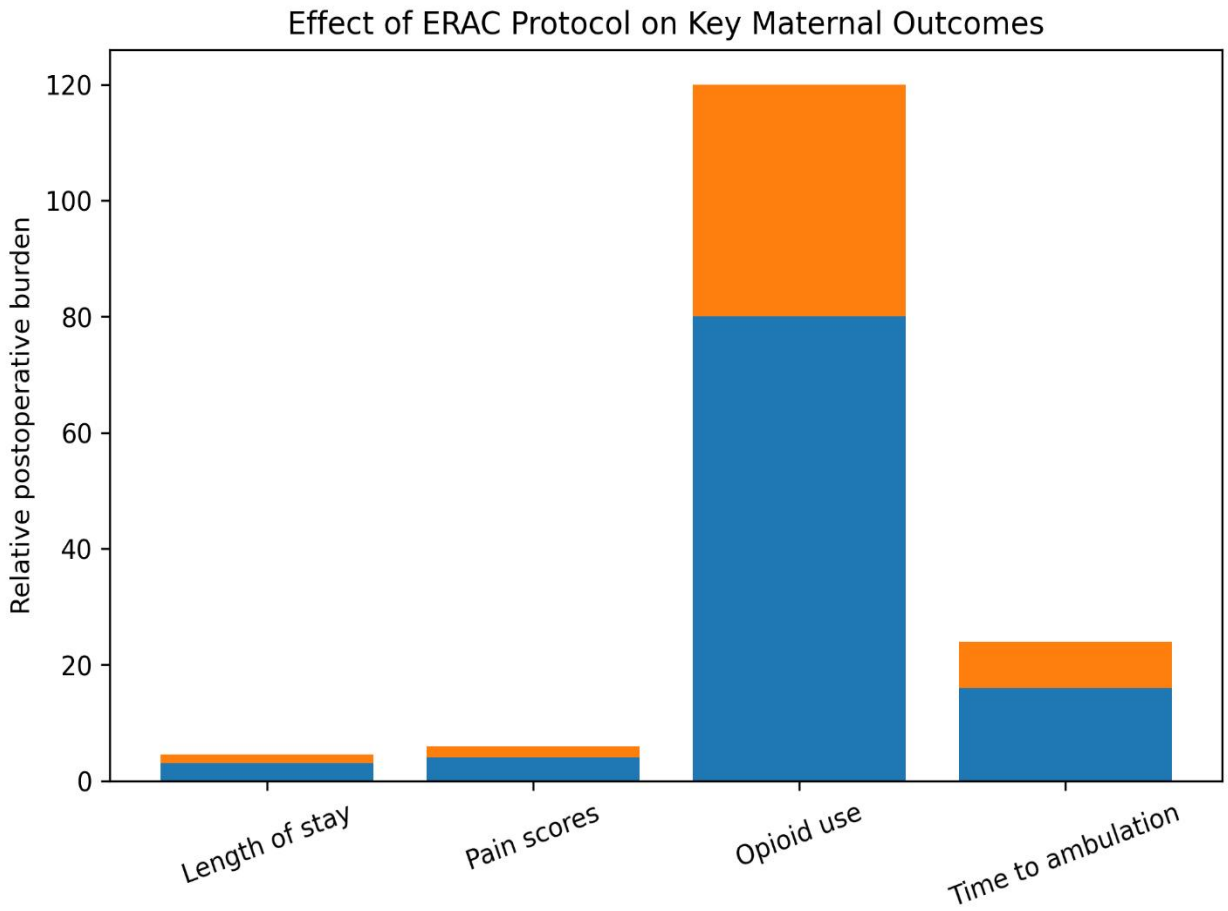
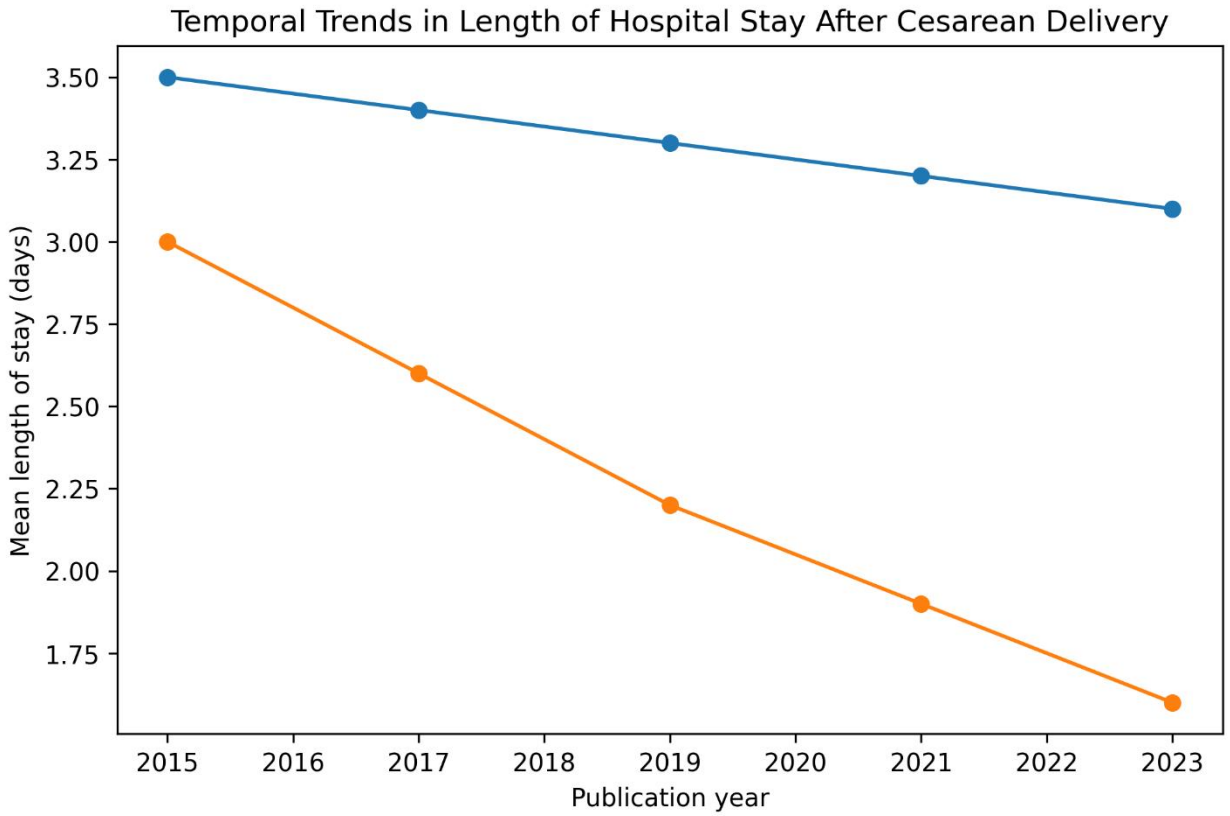

Effect of ERAC Protocol on Key Maternal Outcomes
Relative postoperative burden
0
20
40
60
80
100
120
Length of stay
Pain scores
Opioid use
Time to ambulation

Figure 5



DISCUSSION:

This systematic review demonstrates that implementation of Enhanced Recovery After Cesarean (ERAC) protocols is consistently associated with improved postoperative maternal outcomes compared with conventional postoperative care. Across diverse healthcare settings and study designs, ERAC pathways were linked to shorter hospital stays, improved pain control, earlier mobilization, and higher maternal satisfaction, without evidence of increased maternal or neonatal complications. These findings reinforce the growing consensus that structured, multimodal perioperative care pathways can substantially optimize recovery following cesarean delivery.

One of the most consistent and clinically meaningful outcomes observed in this review was a reduction in length of hospital stay among women managed with ERAC protocols. Similar benefits have been widely reported in non-obstetric ERAS programs, where reduced hospitalization has been achieved without compromising patient safety [17,18]. In obstetric populations, concerns regarding early discharge traditionally center on postoperative complications, breastfeeding challenges, and neonatal readmissions. However, evidence from ERAC-focused studies suggests that earlier discharge is supported by improved functional recovery, standardized patient education, and proactive pain management rather than premature hospital release [19,20]. These findings have important implications for healthcare resource utilization, particularly in high-volume maternity units.

Effective postoperative pain control is a cornerstone of ERAC protocols and emerged as a key driver of improved recovery. Most included studies employed multimodal, opioid-sparing analgesic strategies, incorporating neuraxial anesthesia, nonsteroidal anti-inflammatory drugs, acetaminophen, and regional analgesic

techniques. These approaches were associated with lower pain scores and significantly reduced opioid requirements [21–23]. Given the global concern regarding opioid exposure in the postpartum period and its potential effects on maternal alertness, breastfeeding, and neonatal well-being, the opioid-sparing benefits of ERAC represent a substantial clinical advantage [24].

Early mobilization and early oral intake—core components of ERAC pathways—were also consistently associated with improved postoperative outcomes. Early ambulation has been linked to reduced thromboembolic risk, improved gastrointestinal function, and enhanced maternal independence [25]. Similarly, early feeding has been shown to be safe following cesarean delivery and may contribute to improved patient comfort and satisfaction [26]. The successful integration of these elements within ERAC protocols challenges long-standing traditional practices and supports a paradigm shift toward evidence-based postoperative obstetric care.

Beyond physical recovery, several studies included in this review reported improvements in maternal satisfaction and patient-reported outcomes following ERAC implementation. Early mother–infant contact, facilitation of breastfeeding, and enhanced patient education were frequently cited as contributing factors [25]. These psychosocial elements are particularly important in obstetric care, where recovery extends beyond surgical healing to encompass emotional well-being and maternal–neonatal bonding. Although patient-reported outcomes were not uniformly measured across studies, the available evidence suggests that ERAC protocols support a more holistic, patient-centered model of care.

Despite the overall favorable findings, considerable heterogeneity was observed across studies with respect to ERAC protocol components, implementation strategies, and outcome measures. Some studies evaluated comprehensive, guideline-based ERAC pathways, while others focused on partial or modified protocols [26]. This variability limits direct comparison across studies and underscores the need for standardized ERAC definitions and core outcome sets. Professional society recommendations from the Enhanced Recovery After Surgery Society and the Society for Obstetric Anesthesia and Perinatology have attempted to address this gap; however, adoption remains inconsistent across institutions [27].

This review has several strengths, including a comprehensive search strategy, inclusion of multiple study designs, and focus on clinically relevant maternal outcomes. Nevertheless, certain limitations should be acknowledged. The predominance of observational studies introduces the potential for selection bias and residual confounding. Variability in healthcare infrastructure and resource availability may further limit the generalizability of findings, particularly in low- and middle-income countries.

Future research should prioritize large, multicenter randomized controlled trials to identify the most effective ERAC components and to assess long-term maternal and neonatal outcomes, including breastfeeding duration and maternal mental health. Economic evaluations are also needed to better quantify the cost-effectiveness of ERAC implementation. Development of internationally accepted ERAC guidelines with standardized reporting frameworks would facilitate broader adoption and improve comparability across studies.

In conclusion, this systematic review provides robust evidence supporting the safety and effectiveness of ERAC protocols in improving postoperative recovery following cesarean delivery. By integrating evidence-based, multidisciplinary interventions and emphasizing patient-centered care, ERAC pathways have the potential to redefine post-cesarean management and contribute

meaningfully to improved maternal health outcomes worldwide.

CONCLUSION:

This systematic review demonstrates that implementation of Enhanced Recovery After Cesarean (ERAC) protocols is associated with meaningful improvements in postoperative maternal recovery, including reduced length of hospital stay, improved pain control, decreased opioid consumption, and earlier mobilization, without compromising maternal or neonatal safety. These findings support the growing body of evidence favoring multimodal, standardized perioperative care pathways in obstetric practice.

From a clinical perspective, ERAC protocols offer a practical and effective framework for optimizing post-cesarean care while promoting patient-centered outcomes such as maternal satisfaction, early ambulation, and enhanced mother–infant bonding. The consistent benefits observed across diverse healthcare settings suggest that ERAC implementation is feasible and adaptable, even in resource-limited environments, when supported by multidisciplinary collaboration.

In conclusion, ERAC protocols represent an important advancement in post-cesarean care and should be considered a key component of modern obstetric practice. Broader adoption of standardized ERAC guidelines has the potential to improve maternal recovery, reduce healthcare utilization, and enhance the overall quality of postoperative care following cesarean delivery.

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Patients' consent was not required as patients were not physically enrolled in this study.

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There are no conflicts of interest.

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The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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