

Systematic Review

Improving maternal and neonatal outcomes through enhanced recovery after caesarean approach-a systematic review

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ABSTRACT

The responsibilities of caring for the newborn are affected by factors before, during and immediately after caesarean section. Enhanced recovery after caesarean section (ERAC) enables faster return to preoperative functions and thus, has beneficial effects on the mother and her infant. Authors conducted a systematic review of the literature in January 2025 that involved searching 4 databases for peer-reviewed articles on ERAC protocol and traditional techniques between 2015 and 2024. The year of publication, first author's country, study design, sample size, gestational age, indications for surgery, type of caesarean section and other key findings were extracted from the articles that met the inclusion criteria. The full articles, abstracts, guidelines and conference papers retrieved were 467 with 450 removed for duplications, only abstracts, being guidelines, not meeting our targets and publications outside the stated years. Only 17 articles were included in the review. The primary authors of the included articles originated from 8 countries spanning four (4) continents and 41.2% came from Asia, 23.5% from Africa, and 17.6% each from North America and Europe. Majority (35.3%) of the articles were randomized controlled trials and 29.4% were cohort studies. Interestingly, 88.2% of the articles were published in the last 5 years. Only one study (5.9%) discussed the parental sense of security following discharge from hospital. The socio-demographic variables, past obstetrics, types of caesarean section, gestational age at delivery and type of anaesthesia were factors affecting the success of enhanced recovery after caesarean section and its outcomes.

Keywords: Enhanced recovery, Caesarean section, Traditional technique, Protocol, Outcomes, Systematic review

INTRODUCTION

Background

Caesarean section is a commonly performed obstetric surgery and its rate has increased dramatically over the past 4 decades from 5% to approximately 30% which

might be due to considerable safety of the operation, reduced rates of trial of scar after caesarean section, fewer attempts at conducting vaginal breech deliveries, lower rate of instrumental vaginal delivery rates as well as widespread use of continuous electronic fetal monitoring with higher detection of fetal distress.¹ Globally, caesarean section rate is increasing with a range of 6% to 27.2%

respectively, in the least and the most developed regions of the world.² Latin America and the Caribbean region have the highest Caesarean section rate of 40.5%, Northern America 32.3% and Europe 25% and in Austria 17.7% to 50.4% has been reported.^{2,3} A study carried out in Enugu, Nigeria, found an incidence of 27.6% in 2009 and another study in Osogbo, South-western, Nigeria, reported caesarean section rate of 35.5%.^{4,5} According to World Health Organization in 2016, any pregnant woman that deserves caesarean section to save her life and/or that of her baby should be offered the surgery as long as it is medically indicated.⁶

As with any surgery, caesarean section is associated with more complications when compared with vaginal delivery but striving at a particular rate should not justify its non-performance.^{2,6} To ensure quicker return to functional state to guarantee immediate commencement of nursing of the newborns and to prevent the complications associated with postoperative immobilization, enhanced recovery after caesarean section (ERAC) has been introduced.⁷ ERAC protocol is an evidence-based, multi-dimensional system that aimed to improve maternal outcome, functional recovery, maternal-infant bonding and positive patient experience following delivery via caesarean section.^{7,8} In this system of care, emphasis is now being placed on faster return to preoperative state through multi-dimensional approach rather than a previous one-dimensional analgesic administration.⁸ The components of ERAC have been divided into preoperative, intraoperative and postoperative elements.⁹ The preoperative components include patient education, limiting fasting intervals and intake of clear carbohydrate liquid (juice) about 2 hours before surgery. Intraoperative measures include administration of prophylactic antibiotic, use of regional anaesthesia, delayed umbilical cord clamping and multimodal analgesia while postoperative elements include early commencement of oral intake, early removal of urethral catheter, early mobilization, continue effective multimodal analgesia, venous thrombo-embolic prophylaxis, breastfeeding support and early discharge from the hospital.⁹⁻¹² These measures have beneficial effects on the mother and the newborn with overall reduction in cost. An important benefit is the positive experience of the mother who may wish to have same treatment in her next caesarean delivery. The review of this important protocol of caesarean section is therefore necessary to synthesize available literature evidence in the last 10 years to support the practice of ERAC especially in low and middle income countries where health resources are limited.

Objectives

To systematically identify and review the researches published on the practice of ERAC and its components as well as to identify any existing knowledge gap especially in low and middle income countries where health resources have competing alternatives. The research questions in this study are: what are the components of enhanced recovery after caesarean section protocol as it is

currently being practised? How is enhanced recovery after caesarean section protocol different from the traditional technique? What are the effects of maternal socio-demographic factors on the outcome of ERAC? Can ERAC protocol fully replace the traditional technique in developing countries based on the outcomes?

METHODS

Settings

Studies from all settings were included (low, middle, high income countries).

Eligibility criteria

To be included in the study, the articles needed to be in agreement with the conceptual framework of this study and to also focus on promoting faster recovery after caesarean section, highlighting the components of ERAC, stating advantages/benefits of ERAC and discussing the pregnancy outcomes.

Peer-reviewed articles were included if they were published between January 2015 and December 2024, written in English language, discussed the components of ERAC protocol, advantages of ERAC over traditional technique and the outcomes of ERAC. Journal papers that have different conceptual framework, written prior to 2015 or in languages other than English and not in agreement with the subject matter, were excluded from this study as they would not meet the study objectives.

Sources of information

To identify the relevant documents, a librarian with experience in systematic searching of medical databases was recruited to draft search strategy using the phrases, "Enhanced recovery after caesarean section, components, benefits, and outcomes of ERAC as well as other relevant keywords and headings. The following 4 databases were searched in January 2025: MEDLINE via EBSCO, CINAHL via EBSCO, SCOPUS via Elsevier and Google scholar (Table 1). Additional search of citations of the articles was conducted. Results were inputted in EndNote manager for the purpose of evidence synthesis.

Selection of sources of evidence synthesis

The search was conducted initially by including articles and journals that addressed the ERAC, its components, its benefits, its outcomes and comparing them with the traditional caesarean section technique. Those papers that were not in tandem with the conceptual framework, written prior to 2015 or in languages other than English or deviated from the study objectives were excluded. The screening process involved two teams of researchers that read the abstracts of the articles and voted as individuals to determine whether to include or exclude a particular paper. Any conflict in the selection process was discussed

between the reviewers to reach a consensus which ultimately resolved the impasse. Articles that passed the initial screening were read in full and again voted on to determine their inclusion in the review process.

Data charting

A data extraction form was created using Excel Software application. The following data were retrieved from those papers included: year of publication, first author's country of origin, sample size, study design, gestational age at caesarean section, indication for caesarean section, type of caesarean section and other key findings. Any discrepancies in data interpretations were noted, discussed and resolved.

Data items

The following article features were extracted: year of publication, first author's country of origin, sample size, study design, gestational age at caesarean section, indication for caesarean section, type of caesarean section and other key findings. The other key information obtained (when available in the articles) were the type of anaesthesia, preoperative fasting period, postoperative time of oral intake, opioid consumption, postoperative pain scores, length of hospital stay, infant breastfeeding practice, surgical site infections, parental sense of security, nurses' knowledge and practice scores, operational cost, re-admission rate or contact with health-care system after hospital discharge and maternal satisfaction.

RESULTS

Selection of sources of evidence synthesis

The search of four electronic databases and scrutiny of articles for citations during the period under review identified 467 citations. Following removal of 251 articles due to duplications, 208 articles were arrived at and with further screening for titles and abstracts, using the inclusion and exclusion criteria, 35 full text articles remained. Out of the 35 citations, 6 articles were excluded because of languages other than English, 9 articles were excluded due to contexts not meeting our set targets, and 6 excluded for lacking in outcomes of interest. The full

articles remaining from the search of 4 electronic databases were 14. Also, from other source (citations of articles) 8 records were identified, out of which 5 articles were excluded with only 3 full text articles remaining. Therefore, from both the four electronic databases and other source, 17 full text articles were finally included in our systematic review as shown in the figure that depicted the preferred reporting in systematic review and meta-analysis (PRISMA) flowchart.

Characteristics of sources of evidence

Of the 17 full text articles included in the review, the first authors originated from 8 different countries: India (4/17; 23.5%), Egypt (3/17; 17.6%), United States of America (3/17; 17.6%), Indonesia (2/17; 11.8%), Serbia (2/17; 11.8%), Denmark (1/17; 5.9%), Thailand (1/17; 5.9%) and Algeria (1/17; 5.9%). Publication years of the 17 included articles ranged from 2018 to 2024 with 2022 having the highest number of article publications (5/17; 29.4%) and closely followed by 2021 (4/17; 23.5%). The commonest of the study design was randomized controlled trials accounting for 6 of the included articles (35.3%) and closely followed by cohort (3 prospective; 2 retrospective) (5/17; 29.4%). Other study designs of the include articles were: quasi-experimental studies (2/17; 11.8%), cross-sectional (1/17; 5.9%), comparative observational (1/17; 5.9%), retrospective case-control (1/17; 5.9%), Hospital survey (1/17; 5.9%).

The lowest sample size in the include articles was 43 women while the highest was 1192 pregnant women. Majority of the CS was carried out at term (≥ 37 weeks of gestation) with only one article (5.9%) stating gestational age at caesarean section to be ≥ 34 weeks. All the articles (100%) talked about the maternal outcome in terms of length of hospital stay and postoperative pains. One article (5.9%) discussed exclusive breast breastfeeding and early initiation of breastfeeding while another article (5.9%) talked about the parental sense of security after discharging from the hospital. Interestingly, two articles (11.8%) assessed the knowledge and practice scores of health professionals (nurses) on the practice of enhanced recovery after caesarean section. Other key findings answered the research questions and met the objectives of this review

Table 1: Search strategy.

Search	Search query	Number of results
Medline via EBSCO	Enhanced recovery after caesarean + components + "outcome" OR "benefits"	104
Google Scholar	"ERAC" + caesarean section + outcome + effectiveness + study	215
CINAHL via EBSCO	"ERAS", "caesarean section", "traditional", "benefits"	42
Scopus via Elsevier	Enhanced recovery after caesarean delivery + effectiveness + traditional + comparison	98
Others (citations from other articles)	-	8
Total from databases and other source	-	467

ERAC: Enhanced recovery after caesarean section; ERAS: enhanced recovery after surgery

Table 2: Sources of evidence synthesis.

Year	First author's country/ SN	Study design	Sample size	Gestational age at CS	Indication for CS	Type of CS	Other key findings
2024	India /1	RCT	142	≥34	One previous caesarean, no PIH or chronic hypertension, no placenta accreta, elective CS excluded	Emergency	Shorter hospital stay, lower VAS pain score, better quality of life in ERAS compared with conventional CS care
2022	Egypt /2	RCT	300	NA	Repeat CS, CPD, placenta previa, DM	Elective CS	Shorter hospital stay, less time to eat and walk, lower pain level and better maternal satisfaction in ERAC than regular CS care
2019	USA /3	Retrospective cohort study	1192 (531/661)	NA	Any woman that had CS with no medical condition needing special care	Both elective and emergency	Shorter LOS, reduced postoperative direct cost but similar re-admission rate in ERAC than historic CS controls
2022	India /4	Prospective observational	200	NA	NA	Elective CS	Shorter hospital stay, reduced hypotension, lower VAS scores, earlier ambulation and oral intake in ERAC than traditional CS
2021	Egypt /5	Quasi-experimental design	50 nurses 250 women	NA	NA	Both elective and emergency	Improved knowledge and practice scores of nurses, reduced LOS and postoperative complications in ERAC than standard care
2021	USA /6	Retrospective cohort study	250 (122 pre-ERAS/128 post-ERAS)	NA	NA	Scheduled prelabour CS	Decreased LOS by 7.9 hours, opioid consumption decreased by average of 36.5 mg of oxycodone per patient, but no difference in pain scores between postoperative day 1-4
2022	Thailand /7	RCT	43 (21/22)	NA	Term (≥37) pregnancy for which CS is indicated	Elective	Mean pain scores were 3.1(±1.9) and 5.1 (±1.9) in ERAS versus standard CS respectively. No reported postoperative complications in groups
2020	USA /8	RCT	118 (58/60)	NA	Scheduled or non-emergent CS at term under regional anaesthesia	Elective	Reduced LOS in ERAC than standard care, better exclusive breastfeeding in ERAC (67.2%) versus standard CS (48.3%), no difference in postoperative narcotic use.
2021	Egypt /9	Quasi-experimental study	250 (50 nurses/ 200 women for CS)	NA	Term women for elective with no pregnancy or intraoperative complication	Elective	Improved nurses' knowledge and practices, less mean pain score, reduced LOS, improved mother's performance in ERAC compared with standard care.

Continued.

Year	First author's country/ SN	Study design	Sample size	Gestational age at CS	Indication for CS	Type of CS	Other key findings
2023	India /10	Comparative observational study	200 (100/100)	NA	Uncomplicated pregnancies with valid indications such as previous CS, and malpresentation	Elective	Time for mobilization was shorter in ERAS than conventional protocol (11.19±1.7 versus 24.02±1.3 hours), reduced LOS (average of 2.5 days reduction) also observed in ERAS compared with conventional CS, but postoperative nausea was similar (7% in both groups)
2021	Denmark /11	RCT	143 (72/71)	NA	Term (≥37) pregnancy for planned elective	Elective	No difference in parental postnatal sense of security, pain scores, use of analgesics, step count or contact with the health-care system between the intervention and standard CS care groups
2024	Indonesia /12	Cross sectional comparative study (ERAC versus non-ERAC)	192 (96/96)	NA	NA	NA	Exclusive breastfeeding and early initiation of breastfeeding is better in ERAC compared with non-ERAC (vaginal delivery and standard CS) 78.1% versus 74% versus 58.3% respectively
2024	Indonesia /13	Retrospective, case-control	71	NA	All CS with no condition contraindicating ERAC	Elective and emergency	ERAC women had shorter LOS and low operational cost
2022	India /14	Prospective cohort study	237 (156/81)	NA	Repeat CS, CPD, placenta previa, breech	Elective	Both conventional and ERCD passed flatus at 6 hours and return of bowel sound at 24 hours, VAS pain score is better in ERCD
2022	Serbia /15	RCT	200 equally into group E (ERAC) and C (control)	NA	NA	NA	Better postoperative pain control with lower pain scores at all times in ERAC compared with existing (standard) care, improved patient satisfaction
2018	Serbia /16	Hospital survey (questionnaire based)	46 centres	NA	NA	NA	Only 24% of the hospitals (46) partially used ERAC with 36% of patients managed with ERAC discharged within 3days and none in non-ERAC
2023	Algeria /17	Prospective cohort study	99	NA	1 previous CS with no co-morbidity	Elective	Mean LOS was 1.97 days for ERAS versus 4.14 days for previous CS (non-ERAS), mean maternal satisfaction was also better. At 6 th week postoperative 92.6% wished to have ERAS protocol at a future caesarean section

CS: Caesarean section; RCT: randomized controlled trial; ERAC: enhanced recovery after caesarean section; CPD: cephalopelvic disproportion; DM: diabetes mellitus; PIH: pregnancy induced hypertension; ERCD: enhanced recovery after caesarean delivery; ERAS: enhanced recovery after surgery; LOS: length of stay; VAS: visual analogue scale; USA: United State of America; NA: Not available; SN: serial number; vs: versus; etc: et cetera

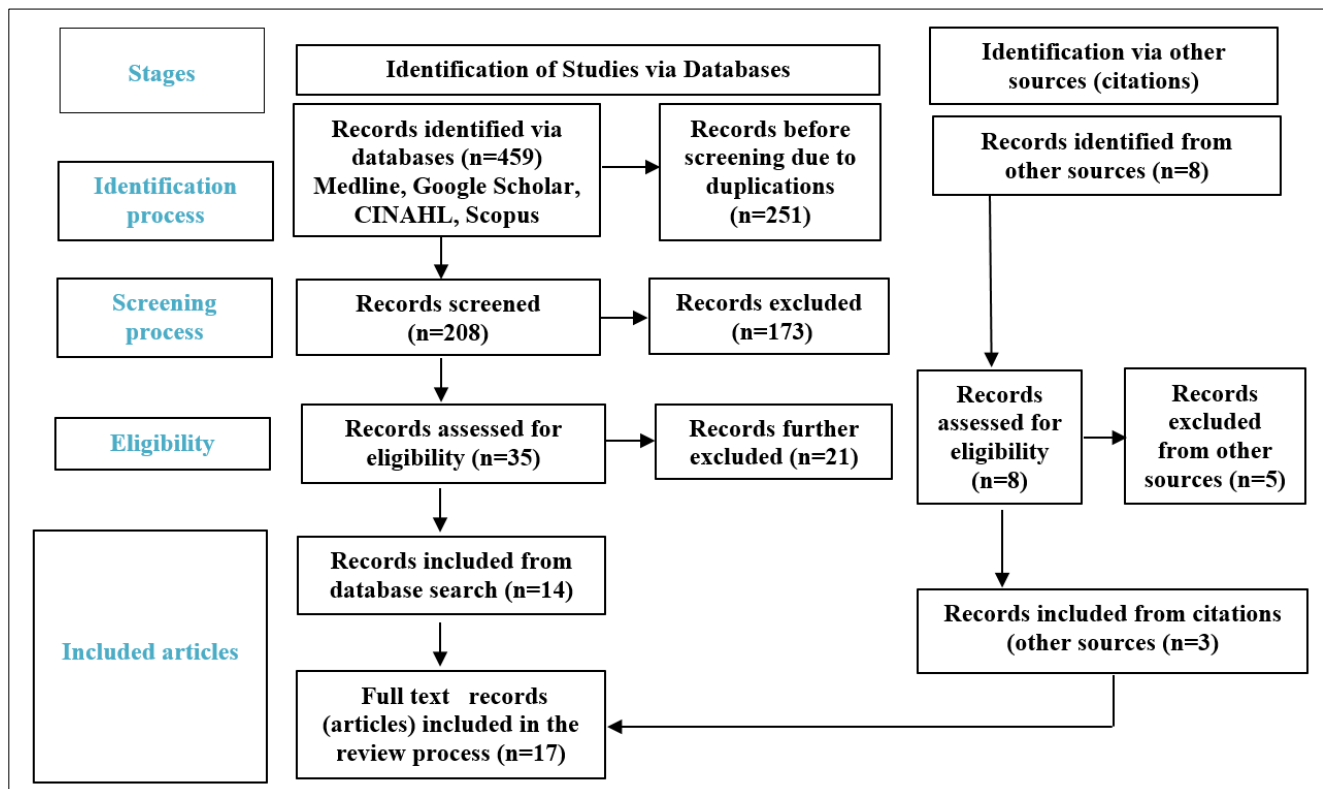


Figure 1: PRISMA chart.

DISCUSSION

This systematic review was able to explore the literature for relevant articles and synthesized evidence to support the practice of ERAC to improve both maternal and neonatal outcomes. The components of ERAC include pre-operative, intra-operative and post-operative elements which are usually implemented in varying degrees.⁹ In general, most studies placed emphasis on the post-operative components and elucidated the benefits such as early postoperative oral intake, early removal of urethral catheter, reduced time of immobilization, less postoperative pain through multimodal analgesia, better breastfeeding practices, reduced length of stay in the hospital, reduced overall cost and improved maternal satisfaction. One study conducted in Serbia revealed that only 24% of hospitals partially implemented ERAC protocol and most of the implemented components are postoperative elements.¹³

ERAS as a concept was introduced in patients that had colorectal surgery with good success as far back as 1997-2003.^{14,15} This protocol of surgical care was formally introduced into caesarean section in 2018 with similar benefits, thus revolutionizing the approach to the management of women going for caesarean delivery.¹³ Our study shows that article publications on ERAC started coming up in 2018 with 88.2% of the articles published in the last 5 years.^{13,16-20} Majority (76.5%) of these articles came from Asia, Europe and America while 23.5% came from Africa. This disparity shows clearly the pattern of

implementation of ERAC protocol across the globe with Africa still behind the developed countries in term of full implementation.

Two articles (11.8%) mentioned that with ERAC protocol there was improvement in the knowledge and practice scores of nurses.^{17,21} The practice of ERAC is a multidisciplinary and multidimensional in nature rather than the old concept of one-dimensional approach.^{9,11,12} All stakeholders in health such as obstetricians, anaesthesiologists, pharmacists, mid-wives, perioperative nurses and others should be involved in the implementation of ERAC protocol. When implementing ERAC all levels should be considered and to include patient education, limiting preoperative fasting time, intake of clear carbohydrate juice about 2 hours before surgery, prophylactic antibiotics, multimodal analgesia and anaesthesia, early postoperative oral intake, continue multimodal analgesic regimens, early removal of urethral catheter, early mobilization and shorter hospital stay.^{9,11,12} Overall there is reduction in opioid consumption and hospital cost as reported by some of the existing studies.^{22,23}

One article, nevertheless, reported no difference in postoperative narcotic use when ERAC group was compared with the standard care.¹⁶

In spite of the obvious benefits of ERAC pathway such as reduced length of hospital stay, some authorities still thought of parental concerns after being discharged but an

article published by Kruse et al stated no difference in parental postnatal sense of security following hospital discharge.²⁴

There was also no difference in the rate of maternal hospital re-admissions or contact with health-care system between the ERAC and standard caesarean section care.^{24,25} Maternal satisfactions with ERAC protocol was widely reported in some of the articles.^{13,26,27}

In general, ERAC is beneficial with better postoperative pain control, early ambulation, early return of bowel function, reduced hospital stay, improved maternal-neonatal bonding, low operational cost and improved quality of life.²⁸⁻³¹

Limitations

Some articles published on the subject matter were written in languages other than English, making their inclusion to be declined which otherwise might have affected keys findings from this review. Also, the review included articles published in the last 10 years (January 2015 to December 2024) which is an attempt to prevent outdated information that might also affect the findings and outcome of the study. Lastly, secondary studies such as systematic reviews were excluded in the study thus limiting the findings of the review to primary studies published in the last 10 years.

CONCLUSION

The outcome of ERAC is determined by maternal socio-demographic and clinical factors. When compared with the traditional technique, majority of the articles revealed that ERAC is more beneficial to both the mother and her infant. The practice of ERAC will help and guarantee a faster return to preoperative functional state and thus facilitate maternal-neonatal bonding. Overall, improved maternal satisfaction and better quality of life are some of the findings that make the pregnancy experience a positive one in ERAC protocol.

Recommendations

A long period of systematic review might be more appropriate in assessing the practice, advantages and outcomes of the ERAC. Therefore, going forward, the authors agreed that further studies spanning more years should be conducted on this subject matter to really ascertain that the keys findings are of greater benefits to the mothers and their infants. Also, the area of the parental concerns following early discharge from the hospital should be further investigated especially in the low and middle income countries where health personnel home visit is not widely practised.

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