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POSTOPERATIVE PAIN AFTER CAESAREAN SECTION WITH ENHANCED RECOVERY AFTER CAESAREAN SURGERY (ERACS) VERSUS CONVENTIONAL CARE: A COMPARATIVE CROSS-SECTIONAL STUDY IN BANDUNG, INDONESIA

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ABSTRACT

Introduction: Caesarean section (CS) is one of the most frequently performed major operations worldwide and is still followed by moderate-to-severe acute pain in a substantial proportion of women, compromising early mobilisation, breastfeeding and maternal–infant bonding. Enhanced Recovery After Caesarean Surgery (ERACS) is an evidence-based, multidisciplinary perioperative pathway centred on opioid-sparing multimodal analgesia; nevertheless, comparative real-world data from Indonesian private hospitals remain scarce. This study aimed to compare postoperative pain intensity after CS managed with ERACS versus conventional perioperative care.

Methods: A comparative analytical cross-sectional study was conducted in the obstetrics and gynaecology inpatient ward of Hermina Arcamanik General Hospital, Bandung, Indonesia, from September to October 2025. One hundred and sixteen post-caesarean women (58 ERACS; 58 conventional) were enrolled by accidental (consecutive convenience) sampling. Pain intensity was self-rated once within 12–48 hours after surgery using the 11-point Numeric Rating Scale (NRS) and categorised as mild (1–3), moderate (4–6) or severe (7–10). The Mann–Whitney U test was applied as the primary analysis, supplemented by the effect size r and the risk ratio (RR) for moderate-to-severe pain.

Results: The groups were comparable in age, parity and occupation, whereas tertiary education was more frequent in the ERACS group (43.1% vs 24.1%; $p = 0.03$). Mild pain predominated after ERACS (75.9% vs 29.3%), while moderate (20.7% vs 53.4%) and severe pain (3.4% vs 17.2%) were less frequent than after conventional care. ERACS was associated with significantly lower pain ranks (mean rank 44.50 vs 72.50; $U = 870.0$; $Z = -5.005$; $p < 0.001$; $r = 0.46$). Moderate-to-severe pain occurred in 24.1% versus 70.7% of women (RR 0.34; 95% CI 0.21–0.55), corresponding to a number needed to treat of approximately three.

Discussion: The lower pain burden is biologically plausible in view of the synergistic, opioid-sparing analgesia, the neuraxial strategies and the early functional-recovery elements embedded in ERACS, and it accords with international meta-analyses and Indonesian single-centre studies. Non-randomised allocation, the educational imbalance between groups and a single, non-standardised assessment time point nonetheless warrant cautious interpretation.

Conclusion: ERACS was associated with clinically and statistically lower pain intensity during the first 12–48 postoperative hours compared with conventional care. Standardised institutional implementation with protocol auditing is recommended, together with prospective studies incorporating repeated pain assessments, analgesic consumption and patient-reported recovery outcomes.

Keywords: Caesarean Section; Enhanced Recovery After Surgery; ERACS; Postoperative Pain; Numeric Rating Scale; Multimodal Analgesia.

INTRODUCTION

Background: Caesarean Section, Postoperative Pain and the Rationale for Enhanced Recovery

Caesarean section (CS) has become one of the most commonly performed major surgical procedures among women of reproductive age. Nationally representative data from 154 countries indicate that 21.1% of women worldwide now give birth by caesarean, and projections suggest that this proportion will reach 28.5%, equivalent to approximately 38 million operations annually, by 2030, the vast majority of which will take place in low- and middle-income countries (Betran et al., 2021). The number of caesarean births almost doubled between 2000 and 2015, driven both by the expansion of facility-based births and by the increasing use of CS within health facilities, with marked disparities across and within countries (Boerma et al., 2018).

Indonesia mirrors this global trajectory. Analyses of successive Indonesia Demographic and Health Surveys show that the national caesarean rate rose from 1.6% in 1991 to 17.6% in 2017, with the highest rates concentrated in western Indonesia and among more affluent and more educated women (Zahroh et al., 2020). Over the same period, caesarean rates in urban areas reached almost twice those in rural areas, the richest wealth quintile experienced nearly three times the rate of the poorest quintile, and private-sector services contributed disproportionately to the absolute increase (Wyatt et al., 2021). Consequently, an increasing number of Indonesian women each year face the dual challenge of recovering from major abdominal surgery while simultaneously initiating breastfeeding and newborn care (Zahroh et al., 2020).

Despite its frequency, CS remains one of the most painful surgical procedures. In a prospective multicentre registry analysis of 11,932 women, the median maximal pain score on the first postoperative day was 7 on the 0–10 numeric rating scale (NRS), and 53.9% of women reported severe pain, which was associated with impairment of mood, ambulation, deep breathing and sleep (Emrich et al., 2023). In a prospective cohort of 1,062 women, moderate-to-severe postoperative pain occurred in 78.4%, with preoperative anxiety emerging as an independent predictor (Borges et al., 2016), and a recent meta-analysis of 28 studies estimated the pooled prevalence of acute post-caesarean pain at 58% (Demilew et al., 2024).

Inadequately controlled acute pain carries consequences that extend beyond immediate discomfort. Women experiencing severe acute pain after childbirth have a 2.5-fold higher risk of persistent pain and a threefold higher risk of postpartum depression at eight weeks compared with women reporting mild pain (Eisenach et al., 2008). Chronic postsurgical pain affects an estimated 15.2% of women three months after caesarean delivery (Wang et al., 2025), consistent with an earlier meta-analytic estimate of 15.4% (Weibel et al., 2016), and severe acute postoperative pain is among the factors most consistently associated with persistent incisional pain (Komatsu et al., 2020). Optimisation of acute analgesia therefore represents a modifiable target with potential short- and long-term maternal benefits (Gamez & Habib, 2018).

Enhanced Recovery After Surgery (ERAS) represents a paradigm shift in perioperative medicine: a multimodal, multidisciplinary and evidence-based care process designed to attenuate the surgical stress response and preserve physiological homeostasis, which has reduced the length of hospital stay by 30–50% across surgical specialties (Ljungqvist et al., 2017). Its adaptation to obstetric surgery, termed Enhanced Recovery After Caesarean Surgery (ERACS) in Indonesia and Enhanced Recovery After Cesarean (ERAC) internationally, has been formalised through the ERAS Society guidelines covering the antenatal and preoperative (Wilson et al., 2018), intraoperative (Caughey et al., 2018) and postoperative phases (Macones et al., 2019), as well as through the consensus statement of the Society for Obstetric Anesthesia and Perinatology (Bollag et al., 2021).

The analgesic core of ERACS comprises neuraxial anaesthesia with a long-acting neuraxial opioid, prevention of spinal hypotension, scheduled paracetamol and non-steroidal anti-

inflammatory drugs (NSAIDs), and restriction of systemic opioids to rescue use, complemented by patient education, limited fasting, early oral intake, early mobilisation and early urinary catheter removal (Bollag et al., 2021; Patel & Zakowski, 2021). The procedure-specific PROSPECT recommendations similarly endorse intrathecal morphine 50–100 µg, regular paracetamol, NSAIDs and intravenous dexamethasone for elective CS performed under neuraxial anaesthesia (Roofthoof et al., 2021).

Evidence regarding the effectiveness of ERACS is accumulating. A meta-analysis of ten studies involving 16,391 patients reported lower postoperative pain scores (weighted mean difference –1.23), reduced opioid use and shorter hospital stay with enhanced recovery compared with conventional care (Meng et al., 2021). Subsequent meta-analyses confirmed reductions in length of stay, time to mobilisation, time to urinary catheter removal and opioid consumption without increases in readmission (Sultan et al., 2021; Pinho & Costa, 2024; Lestari et al., 2025), and large implementation studies have documented substantial reductions in inpatient opioid exposure following ERACS adoption (Hedderson et al., 2019; Mullman et al., 2020). Nevertheless, the certainty of this evidence has been graded as low to very low, largely because of heterogeneous interventions and outcome measures (Sultan et al., 2020).

Research Objectives

The primary objective of this study was to compare postoperative pain intensity between women undergoing CS managed with the ERACS pathway and those managed with conventional perioperative care at Hermina Arcamanik General Hospital, Bandung, Indonesia. Pain intensity was selected as the primary outcome because the provision of optimal analgesia constitutes a core outcome domain for enhanced recovery research in caesarean delivery (Sultan et al., 2022). The specific aims were:

1. To describe the sociodemographic and obstetric characteristics of participants in each perioperative group.
2. To determine the distribution of postoperative pain intensity among women managed with conventional perioperative care.
3. To determine the distribution of postoperative pain intensity among women managed with the ERACS pathway.

4. To compare postoperative pain intensity between the two perioperative approaches and to quantify the magnitude of any difference using effect sizes, risk ratios and numbers needed to treat.

Significance of the Study

Clinically, robust local evidence on the analgesic performance of ERACS can inform perioperative policy in Indonesian private hospitals, where ERACS is increasingly offered and where women's preferences regarding birth are strongly influenced by promotional messaging that portrays ERACS as an advanced, comfortable and virtually painless technique (Zahroh et al., 2024). Objective, patient-reported data are therefore required to support evidence-based counselling, realistic expectations and responsible implementation rather than commercially driven adoption, particularly in a context of rising caesarean rates (Betran et al., 2021; Zahroh et al., 2024).

Academically, the study contributes Indonesian data to an evidence base dominated by high-income settings, provides effect-size and absolute-risk estimates that facilitate comparison and future evidence synthesis, and offers a methodological reference for subsequent prospective or randomised studies in comparable settings (Sultan et al., 2020; Lestari et al., 2025).

Hypothesis

It was hypothesised that postoperative pain intensity within the first 12–48 hours after CS differs significantly between the ERACS and conventional groups, with women managed under the ERACS pathway reporting lower pain intensity owing to the synergistic, opioid-sparing multimodal analgesia and the early functional-recovery elements inherent to the pathway. The corresponding null hypothesis stated that no difference in postoperative pain intensity exists between the two groups (Bollag et al., 2021; Meng et al., 2021).

Research Gap and Novelty

Most published ERACS evaluations originate from high-income countries and rely on before-and-after implementation designs, with length of stay, opioid consumption and costs as the principal endpoints rather than patient-reported pain intensity (Hedderson et al., 2019; Mullman et al., 2020; Sultan et al., 2021). Where pain-related outcomes have been assessed, the results have

not been uniform; a randomised trial in the United States, for example, found no reduction in postoperative opioid consumption with ERAS despite a modestly shorter length of stay (Teigen et al., 2020).

Indonesian studies, although consistently favouring ERACS, have been small (52–140 participants), have used heterogeneous pain instruments and time points, and have generally analysed pain scores as interval data (Silitonga & Amalia, 2024; Rahayu et al., 2023; Utami & Rosa, 2023; Ruspita et al., 2023). The novelty of the present study lies in (i) its setting within a private hospital in Bandung, (ii) the use of clinically meaningful NRS categories, (iii) an analytical approach consistent with the ordinal measurement properties of the NRS, and (iv) the reporting of effect sizes, risk ratios and numbers needed to treat that facilitate clinical translation (Stijic et al., 2024; Fritz et al., 2012).

METHODS

Study Design and Setting

This was a quantitative, comparative analytical study with a cross-sectional design, reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (von Elm et al., 2014). The study was conducted in the obstetrics and gynaecology inpatient ward of Hermina Arcamanik General Hospital, a private general hospital in Bandung, West Java, Indonesia, that provides both ERACS and conventional perioperative care for women undergoing CS. Data were collected from September to October 2025. A comparable cross-sectional design has previously been used to compare post-caesarean pain between ERACS and conventional care in another hospital in Bandung (Silitonga & Amalia, 2024).

Study Population and Eligibility Criteria

The target population comprised women who had undergone CS at Hermina Arcamanik General Hospital. Participants were selected on the basis of predefined inclusion and exclusion criteria designed to minimise the influence of conditions known to modify post-caesarean pain perception, including psychological vulnerability and complicated recovery (Pan et al., 2013; Gamez & Habib, 2018).

Inclusion Criteria:

- **Procedure:** Women who underwent CS at Hermina Arcamanik General Hospital during the study period.
- **Timing:** Women in the 12–48-hour postoperative period at the time of assessment.
- **Consent:** Willingness to participate, documented by written informed consent.
- **Communication:** Ability to communicate and to rate pain intensity using the NRS.

Exclusion Criteria:

- Medical or psychological conditions that could alter pain perception, such as psychiatric disorders.
- Receipt of additional analgesic agents outside the prescribed perioperative protocol.
- Postoperative surgical or anaesthetic complications.

Sample Size and Sampling Technique

The minimum sample size was calculated using the formula for comparing two independent means with a two-sided hypothesis:

$$n_1 = n_2 = [(s_1^2 + s_2^2/k) (Z_{1-\alpha/2} + Z_{1-\beta})^2] / (\bar{x}_1 - \bar{x}_2)^2$$

where s_1 and s_2 are the assumed standard deviations of pain scores in the ERACS and conventional groups (1.88 and 1.89, respectively), $\bar{x}_1$ and $\bar{x}_2$ the assumed mean pain scores (4.83 and 5.93), k the allocation ratio ($n_2/n_1 = 1$), $Z_{1-\alpha/2} = 1.96$ for a two-sided α of 0.05, and $Z_{1-\beta} = 0.84$ for a statistical power of 80%. Substitution yielded $n = [(3.534 + 3.572)(2.80)^2]/(-1.10)^2 = 46.04$, rounded up to 47 women per group; after allowance for 10% attrition, the minimum requirement was 52 women per group. Ultimately, 58 women per group ($N = 116$) were enrolled, exceeding both the calculated minimum and the sample sizes of most previous Indonesian comparative ERACS studies (Silitonga & Amalia, 2024; Ruspita et al., 2023).

Participants were recruited by accidental (consecutive convenience) sampling, whereby all women who fulfilled the eligibility criteria and were encountered in the inpatient ward during the data-collection period were invited to participate until the target number for each group had been reached. The same sampling approach has been applied in previous single-centre ERACS evaluations in Indonesia (Silitonga & Amalia, 2024).

Study Groups and Perioperative Pathways

Participants were classified according to the perioperative pathway documented in their medical records. The ERACS group comprised women managed under the hospital's ERACS pathway, which is conceptually based on international recommendations comprising preoperative elements (patient education and counselling, limited fasting), intraoperative elements (neuraxial anaesthesia with opioid adjuvants, prevention of spinal hypotension, maintenance of normothermia) and postoperative elements (scheduled non-opioid multimodal analgesia, early oral intake, early mobilisation and early urinary catheter removal) (Wilson et al., 2018; Caughey et al., 2018; Macones et al., 2019; Bollag et al., 2021).

The conventional group comprised women managed with standard perioperative care, namely neuraxial anaesthesia and routine postoperative management without the structured ERACS bundle. Conceptually, conventional obstetric anaesthesia focuses primarily on intraoperative analgesia, whereas ERACS integrates multimodal, opioid-sparing analgesia with the deliberate acceleration of functional recovery. Individual anaesthetic drug doses, intraoperative adjuvants and postoperative analgesic consumption were not abstracted for analysis (Ituk & Habib, 2018; Patel & Zakowski, 2021).

Study Variables, Operational Definitions and Research Instrument

The independent variable was the perioperative pathway (ERACS or conventional), measured on a nominal scale from the medical record. The dependent variable was postoperative pain intensity, conceptualised in line with the revised definition of the International Association for the Study of Pain as an unpleasant sensory and emotional experience linked to actual or potential tissue damage (Raja et al., 2020). The operational definitions are presented in Table 1.

Table 1: Operational Definitions of Study Variables

No	Variable	Operational Definition	Instrument	Measurement Result	Scale
1	Perioperative pathway (independent variable)	Type of perioperative care received for CS: ERACS, a multidisciplinary, evidence-based perioperative pathway aimed at optimal analgesia and accelerated functional recovery; or conventional care, standard perioperative management without the ERACS bundle	Medical record	1 = ERACS 2 = Conventional	Nominal
2	Postoperative pain intensity (dependent variable)	Self-reported intensity of the unpleasant sensory and emotional experience related to surgical tissue injury, rated by the participant 12–48 hours after CS	Numeric Rating Scale (0–10)	0 = no pain 1–3 = mild 4–6 = moderate 7–10 = severe	Ordinal

CS: caesarean section; ERACS: Enhanced Recovery After Caesarean Surgery; NRS: Numeric Rating Scale.

Pain was measured using the 11-point NRS, on which 0 represents no pain and 10 the worst imaginable pain. Scores were categorised as no pain (0), mild (1–3), moderate (4–6) or severe (7–10). The threshold of NRS ≥ 4 corresponds to the level at which postoperative patients typically regard pain as no longer tolerable and would prefer additional analgesia (Gerbershagen et al., 2011). Because NRS response categories are ordered but not equidistant, the outcome was treated as an ordinal variable (Stijic et al., 2024).

Data Collection Procedure

Primary data were collected through a structured questionnaire comprising sociodemographic and obstetric items (age, parity, occupation and educational attainment) and the NRS. After institutional permission and written informed consent had been obtained, each participant completed the questionnaire personally, without proxy completion, on a single occasion between 12 and 48 hours after surgery, a period during which severe post-caesarean pain is frequently reported (Emrich et al., 2023). The research procedure comprised: (i) determination of the study setting, period and variables; (ii) ethical clearance and institutional permission; (iii) screening of eligible women and collection of informed consent; (iv) administration of the questionnaire; (v) data processing and statistical analysis; and (vi) reporting and dissemination of the findings (von Elm et al., 2014).

Data Processing

Data processing comprised four stages: editing, to verify the completeness, consistency and clarity of each questionnaire; coding, to assign numerical codes to categorical variables; processing, in which coded data were entered into IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA); and cleaning, to identify missing, inconsistent or out-of-range values before analysis. These procedures were applied to ensure transparent and reproducible reporting of the observational data (von Elm et al., 2014).

Statistical Analysis

Univariate analysis described all categorical variables as frequencies and percentages. Between-group comparability of baseline characteristics was examined using the χ^2 test or, when expected cell frequencies were below five, the Fisher–Freeman–Halton exact test estimated by Monte Carlo simulation with 50,000 permutations. Reporting of baseline comparability followed the STROBE recommendations for observational research (von Elm et al., 2014).

For the primary bivariate analysis, the distribution of pain categories was compared between groups using the two-tailed Mann–Whitney U test, which is appropriate for ordinal outcomes and does not assume interval properties or normality. Statistical significance was set at $p < 0.05$. The effect size was expressed as $r = |Z|/\sqrt{N}$ and interpreted as small (0.1), medium (0.3) or large (0.5), with the rank-biserial correlation reported as a complementary estimate (Fritz et al., 2012; Stijic et al., 2024).

In a secondary analysis, pain was dichotomised at the clinically relevant threshold of NRS ≥ 4 (moderate-to-severe pain), and severe pain (NRS ≥ 7) was examined separately. Risk ratios (RR) with 95% confidence intervals (CI) were estimated using the logarithmic method, absolute risk differences (ARD) with Wald 95% CI, and numbers needed to treat (NNT) as the reciprocal of the ARD; proportions were compared using the χ^2 test or Fisher's exact test, as appropriate. These complementary metrics were chosen to support clinical interpretation in line with recommended core outcome reporting for enhanced recovery research (Gerbershagen et al., 2011; Sultan et al., 2022).

Ethical Considerations

The study was conducted in accordance with the principles of the World Medical Association Declaration of Helsinki. Ethical clearance was obtained from the Health Research Ethics Committee **committee name and approval number to be inserted by the authors**, and permission for data collection was granted by the management of Hermina Arcamanik General Hospital. All participants received verbal and written information about the study and provided written informed consent; participation was voluntary, refusal did not affect clinical care, and all data were anonymised and kept confidential in order to respect participant autonomy (World Medical Association, 2025).

RESULTS

Characteristics of the Participants

A total of 116 post-caesarean women were enrolled and analysed, comprising 58 women managed with ERACS and 58 managed with conventional perioperative care, with no missing outcome data. Most participants were aged 20–29 years (58.6%), multiparous (62.1%), homemakers (74.1%) and educated to senior secondary level (58.6%) (Table 2).

The two groups were comparable with respect to age ($p = 0.86$), parity ($p = 0.66$) and occupation ($p = 0.89$). However, the distribution of educational attainment differed significantly ($p = 0.03$): tertiary education was more frequent in the ERACS group (43.1% vs 24.1%), whereas senior secondary education predominated in the conventional group (69.0% vs 48.3%). This pattern is consistent with national data showing greater use of caesarean-related services among more educated Indonesian women (Zahroh et al., 2020).

Table 2: Sociodemographic and Obstetric Characteristics of the Participants

Characteristic	Category	ERACS (n = 58)	Conventional (n = 58)	Total (N = 116)	p-value
Age (years)	20–29	32 (55.2)	36 (62.1)	68 (58.6)	0.86†
	30–39	23 (39.7)	19 (32.8)	42 (36.2)	
	≥40	3 (5.2)	3 (5.2)	6 (5.2)	
Parity	Primipara	18 (31.0)	24 (41.4)	42 (36.2)	0.66†
	Multipara	39 (67.2)	33 (56.9)	72 (62.1)	

	Grande multipara	1 (1.7)	1 (1.7)	2 (1.7)	
Occupation	Housewife	42 (72.4)	44 (75.9)	86 (74.1)	0.89†
	Private-sector employee	13 (22.4)	12 (20.7)	25 (21.6)	
	Civil servant	3 (5.2)	2 (3.4)	5 (4.3)	
Educational attainment	Primary school	4 (6.9)	1 (1.7)	5 (4.3)	0.03†*
	Junior secondary school	1 (1.7)	3 (5.2)	4 (3.4)	
	Senior secondary school	28 (48.3)	40 (69.0)	68 (58.6)	
	Tertiary education	25 (43.1)	14 (24.1)	39 (33.6)	

Data are presented as n (%). †Fisher–Freeman–Halton exact test (Monte Carlo, 50,000 permutations). Statistically significant at $p < 0.05$. ERACS: Enhanced Recovery After Caesarean Surgery; grande multipara: ≥ 5 previous births; civil servant: Aparatur Sipil Negara* (ASN).

Distribution of Postoperative Pain Intensity

No participant reported complete absence of pain (NRS 0). In the ERACS group, the majority of women reported mild pain (44/58; 75.9%), whereas moderate and severe pain were reported by 12 (20.7%) and 2 (3.4%) women, respectively. In contrast, moderate pain predominated in the conventional group (31/58; 53.4%), followed by mild pain (17/58; 29.3%) and severe pain (10/58; 17.2%). The overall distribution of pain categories differed significantly between groups ($\chi^2 = 25.68$, $df = 2$, $p < 0.001$) (Table 3; Figure 1). Pain categories were defined according to established NRS thresholds for postoperative pain (Gerbershagen et al., 2011).

Table 3: Distribution of Postoperative Pain Intensity (12–48 Hours) According to Perioperative Pathway

Pain Intensity (NRS)	ERACS (n = 58)	Conventional (n = 58)	Total (N = 116)
Mild (1–3)	44 (75.9)	17 (29.3)	61 (52.6)
Moderate (4–6)	12 (20.7)	31 (53.4)	43 (37.1)
Severe (7–10)	2 (3.4)	10 (17.2)	12 (10.3)
Total	58 (100.0)	58 (100.0)	116 (100.0)

Data are presented as n (%). NRS: Numeric Rating Scale. No participant reported NRS 0 (no pain).

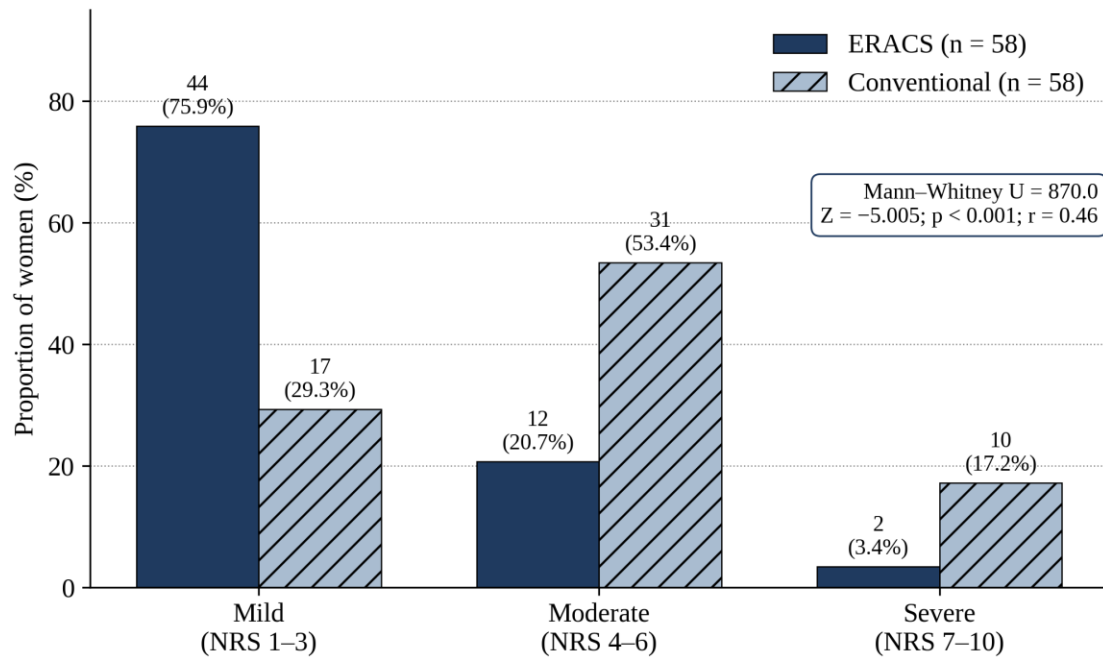


Figure 1. Distribution of postoperative pain intensity categories 12–48 hours after caesarean section in the ERACS and conventional groups

Comparison of Pain Intensity Between Groups

The Mann–Whitney U test demonstrated a statistically significant difference in postoperative pain intensity between the groups ($U = 870.0$; Wilcoxon $W = 2,581.0$; $Z = -5.005$; $p < 0.001$). The mean rank was lower in the ERACS group (44.50; sum of ranks 2,581.0) than in the conventional group (72.50; sum of ranks 4,205.0), indicating systematically lower pain intensity among women managed with ERACS (Table 4). The corresponding effect size was $r = 0.46$ (rank-biserial correlation 0.48), representing a medium-to-large effect according to conventional benchmarks (Fritz et al., 2012).

Table 4: Mann–Whitney U Test of Postoperative Pain Intensity Between the ERACS and Conventional Groups

Variable	Group	n	Mean Rank	Sum of Ranks
Postoperative pain intensity (NRS category)	ERACS	58	44.50	2,581.00
	Conventional	58	72.50	4,205.00
	Total	116	–	–

Test statistics	Mann–Whitney U = 870.000; Wilcoxon W = 2,581.000; Z = −5.005; Asymp. Sig. (two-tailed) $p < 0.001$; effect size $r = 0.46$; rank-biserial correlation = 0.48
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The analysis was performed on ordinal NRS categories (mild, moderate, severe). A lower mean rank indicates lower pain intensity. Effect size $r = |Z|/\sqrt{N}$; rank-biserial correlation = $1 - 2U/(n_1n_2)$.

Clinically Relevant Pain Thresholds

Moderate-to-severe pain (NRS ≥ 4) was reported by 14 of 58 women (24.1%) in the ERACS group compared with 41 of 58 women (70.7%) in the conventional group (RR 0.34; 95% CI 0.21–0.55; ARD −46.6 percentage points; 95% CI −62.6 to −30.5; $p < 0.001$). This corresponds to an NNT of 3 (95% CI 2–4); that is, for approximately every three women managed with ERACS rather than conventional care, one additional woman avoided moderate-to-severe pain. Severe pain (NRS ≥ 7) was likewise less frequent with ERACS (3.4% vs 17.2%; RR 0.20; 95% CI 0.05–0.87; Fisher's exact $p = 0.029$; NNT 8) (Table 5). The NRS ≥ 4 threshold corresponds to the level at which postoperative patients commonly request additional analgesia (Gerbershagen et al., 2011).

Table 5: Moderate-to-Severe and Severe Postoperative Pain According to Perioperative Pathway

Outcome	ERACS n/N (%)	Conventional n/N (%)	RR (95% CI)	ARD, % points (95% CI)	NNT (95% CI)	p-value
Moderate-to-severe pain (NRS ≥ 4)	14/58 (24.1)	41/58 (70.7)	0.34 (0.21–0.55)	−46.6 (−62.6 to −30.5)	3 (2–4)	< 0.001‡
Severe pain (NRS ≥ 7)	2/58 (3.4)	10/58 (17.2)	0.20 (0.05–0.87)	−13.8 (−24.6 to −3.0)	8 (5–34)	0.029§

RR: risk ratio (logarithmic method); ARD: absolute risk difference (Wald method); NNT: number needed to treat, rounded up to the next whole number. ‡ χ^2 test; §Fisher's exact test (two-tailed).

DISCUSSION

Principal Findings

This study demonstrates that women managed under the ERACS pathway reported substantially lower pain intensity within the first 12–48 hours after CS than women receiving conventional perioperative care. Three-quarters of ERACS patients experienced only mild pain, whereas more than two-thirds of conventionally managed women experienced moderate-to-severe pain. The difference was statistically robust, of medium-to-large magnitude ($r = 0.46$) and

clinically meaningful, with approximately one additional case of moderate-to-severe pain prevented for every three women managed with ERACS, thereby supporting the study hypothesis (Fritz et al., 2012; Gerbershagen et al., 2011).

The burden of moderate-to-severe pain observed in the conventional group (70.7%) is consistent with the high prevalence reported in prospective cohorts and meta-analyses of women recovering from CS outside structured enhanced recovery programmes (Borges et al., 2016; Emrich et al., 2023; Demilew et al., 2024). Conversely, the predominance of mild pain in the ERACS group suggests that the pathway, as implemented in this setting, achieved the central analgesic objective of enhanced recovery, namely adequate pain control that enables early functional recovery while sparing opioids (Bollag et al., 2021).

Interpretation: Mechanisms Underlying Lower Pain With ERACS

First, the multimodal analgesic architecture. Post-caesarean pain combines a somatic incisional component and a visceral uterine component, transmitted through distinct nociceptive pathways and amplified by peripheral and central sensitisation. ERACS targets several of these mechanisms simultaneously: neuraxial opioids act on spinal opioid receptors, NSAIDs attenuate prostaglandin-mediated peripheral sensitisation and uterine cramping, and paracetamol provides centrally mediated analgesia. Scheduled rather than on-demand administration avoids analgesic troughs, and the additive or synergistic interaction of these agents yields superior analgesia compared with single-agent regimens while limiting opioid-related adverse effects (Macones et al., 2019; Roofthoof et al., 2021; Patel & Zakowski, 2021).

Second, the neuraxial dosing strategy. Enhanced recovery pathways commonly favour reduced intrathecal local anaesthetic doses combined with opioid adjuvants. Low-dose spinal bupivacaine reduces the incidence of spinal hypotension and of nausea and vomiting, although excessively low doses compromise anaesthetic efficacy (Arzola & Wiecek, 2011). In an Indonesian randomised trial, 7.5 mg of hyperbaric bupivacaine with 25 µg of fentanyl provided more reliable anaesthesia than 5 mg, whereas the lower dose accelerated motor recovery (Chandra et al., 2019). Improved haemodynamic stability and faster motor recovery facilitate earlier mobilisation and may lessen discomfort and pain-related distress in the early postoperative hours, although intraoperative doses were not recorded in the present study (Bollag et al., 2021).

Third, the functional-recovery and psychological components. Early oral intake, early mobilisation and early catheter removal restore autonomy and eliminate several sources of postoperative discomfort; mobilisation, relaxation and conversation have been identified as protective factors against severe post-caesarean pain (Emrich et al., 2023). Structured preoperative education may also reduce anxiety and recalibrate expectations, which is important because preoperative anxiety and anticipated pain are consistent predictors of post-caesarean pain intensity (Pan et al., 2013; Borges et al., 2016; Gamez & Habib, 2018). Accordingly, antenatal patient education is a strongly recommended element of enhanced recovery after caesarean delivery (Wilson et al., 2018).

Comparison With Previous Studies

The direction of the present findings is consistent with the international and Indonesian literature summarised in Table 6. Meta-analytic evidence indicates a pooled reduction of approximately 1.2 points in post-caesarean pain scores with enhanced recovery (Meng et al., 2021), and a randomised trial in Uganda found a lower incidence of severe pain after emergency CS managed with a modified ERAS protocol (Baluku et al., 2020). Among Indonesian studies, ERACS has been associated with lower NRS scores in another Bandung hospital (Silitonga & Amalia, 2024), lower visual analogue scale (VAS) scores at rest and on movement 24 hours after surgery (Utami & Rosa, 2023), lower pain together with better quality of recovery (Ruspita et al., 2023) and reduced postoperative pain without a measurable effect on the onset of colostrum excretion (Rahayu et al., 2023).

The magnitude of the difference observed in this study appears larger than pooled international estimates, and several explanations are plausible. In many high-income settings, the “conventional” comparator already includes neuraxial morphine and scheduled non-opioid analgesics, which narrows the contrast with ERACS; one randomised trial found no reduction in postoperative opioid consumption with ERAS (Teigen et al., 2020), and a large implementation study reported only a modest increase in the proportion of time with acceptable pain scores, from 82.1% to 86.4%, despite halving opioid exposure (Hedderson et al., 2019). Conventional care in the present setting may have relied more heavily on single-agent or on-demand analgesia. Furthermore, the categorisation of pain scores, selection effects and the educational imbalance

between groups may have accentuated the observed contrast, reflecting the heterogeneity that characterises the current ERACS evidence base (Sultan et al., 2020).

Table 6: Comparison of the Present Findings With Selected Previous Studies on Enhanced Recovery and Post-Caesarean Pain

Study (Year), Setting	Design and Sample	Pain Assessment	Principal Pain-Related Findings
Meng et al. (2021), international	SR/MA of 4 RCTs and 6 observational studies; n = 16,391	Postoperative pain scores	Lower pain scores with enhanced recovery (WMD −1.23); reduced opioid use and shorter LOS
Hedderson et al. (2019), United States	Pre–post implementation study; n = 9,313 elective CS	Proportion of time with acceptable pain; opioid exposure	Time with acceptable pain increased from 82.1% to 86.4%; mean daily inpatient opioid exposure approximately halved
Baluku et al. (2020), Mbarara, Uganda	RCT of emergency CS; n = 160 (80/80)	Incidence of severe pain	Lower incidence of severe pain with modified ERAS (p = 0.001); LOS shorter by 18.5 hours
Silitonga & Amalia (2024), Bandung, Indonesia	Analytical cross-sectional, accidental sampling; n = 52	NRS on postoperative days 1, 2 and 6	Lower pain intensity with ERACS (p < 0.001); no difference in wound healing on the REEDA scale (p = 0.136)
Utami & Rosa (2023), Indonesia	Quasi-experimental post-test only; n = 140 (70/70)	VAS at rest and on movement, 24 hours	Lower pain at rest and on movement with ERACS (p < 0.001); satisfaction comparable
Ruspita et al. (2023), Indonesia	Quasi-experimental post-test control; n = 70 (35/35)	VAS; ObsQoR-11	Lower pain scores and higher quality of recovery with ERACS (p < 0.001)
Rahayu et al. (2023), Indonesia	Quasi-experimental with control group; n = 60 (30/30)	Postoperative pain score	ERACS effective in reducing postoperative pain (p < 0.001); no effect on onset of colostrum excretion (p = 0.267)
Present study (2025), Hermina Arcamanik General Hospital, Bandung	Comparative cross-sectional; n = 116 (58/58)	NRS, single assessment at 12–48 hours	Mild pain 75.9% vs 29.3%; U = 870.0, p < 0.001, r = 0.46; RR for moderate-to-severe pain 0.34 (95% CI 0.21–0.55)

CS: caesarean section; LOS: length of stay; NRS: Numeric Rating Scale; ObsQoR-11: Obstetric Quality of Recovery-11; RCT: randomised controlled trial; REEDA: Redness, Oedema, Ecchymosis, Discharge, Approximation scale; SR/MA: systematic review and meta-analysis; VAS: visual analogue scale; WMD: weighted mean difference.

Clinical Significance and Potential Long-Term Implications

The NRS ≥ 4 threshold represents the level at which patients commonly consider postoperative pain intolerable and desire additional analgesia (Gerbershagen et al., 2011). An absolute reduction of 46.6 percentage points in moderate-to-severe pain is therefore of direct

clinical relevance to maternal comfort, mobility, breastfeeding and newborn care. Moreover, because the severity of acute post-delivery pain predicts persistent pain and postpartum depression (Eisenach et al., 2008; Komatsu et al., 2020), more effective early analgesia may plausibly reduce the burden of chronic postsurgical pain after CS, which affects approximately one in seven women three months after surgery; this potential long-term benefit, however, remains a hypothesis that requires longitudinal confirmation (Wang et al., 2025).

Strengths and Limitations of the Study

This study has several strengths. It included an adequately powered sample that exceeded the calculated minimum and was larger than most previous Indonesian comparisons, with balanced group sizes and no missing outcome data. Pain was assessed with a widely used patient-reported instrument completed personally by participants, the analytical strategy was aligned with the ordinal properties of the NRS, and effect sizes, risk ratios and NNTs were reported to facilitate clinical interpretation and future evidence synthesis (Fritz et al., 2012; Stijic et al., 2024).

Several limitations must nevertheless be acknowledged. First, the non-randomised cross-sectional design precludes causal inference; allocation to ERACS may reflect patient preference, socioeconomic status or surgical urgency, and promotional messaging may have shaped the expectations of women who chose ERACS (Zahroh et al., 2024). Second, the groups differed in educational attainment, and potential confounders, including elective versus emergency surgery, labour before CS, previous CS, body mass index, preoperative anxiety, surgical duration, incision characteristics and anaesthetic dosing, were neither recorded nor adjusted for; preoperative anxiety and the use of spinal anaesthesia without adjuvants are established predictors of post-caesarean pain (Borges et al., 2016; Demilew et al., 2024). Third, pain was assessed once within a broad 12–48-hour window, without distinguishing pain at rest from pain on movement, and categorisation of the NRS reduced the information available compared with continuous scores. Fourth, analgesic consumption, rescue opioid use, protocol compliance and patient-reported quality of recovery, which are core outcomes for ERACS research, were not measured (Sultan et al., 2022). Finally, the exclusion of women with complications and the single-centre setting limit the generalisability of the findings (von Elm et al., 2014).

Implications for Clinical Practice and Health Policy

The findings carry several practical implications for obstetric and anaesthetic services in Indonesia, particularly in private hospitals where ERACS is increasingly offered (Zahroh et al., 2024; Bollag et al., 2021):

- **Standardise and audit the ERACS pathway.** Hospitals should adopt written ERACS protocols that specify preoperative, intraoperative and postoperative elements, with regular audits of compliance and outcomes, because heterogeneous implementation has been a major limitation of the existing evidence (Sultan et al., 2020; Bollag et al., 2021).
- **Systematise postoperative pain assessment.** Pain should be assessed at fixed intervals, both at rest and on movement, and documented together with analgesic consumption and validated recovery measures such as the Obstetric Quality of Recovery score (Sultan et al., 2022).
- **Extend multimodal analgesia to all caesarean births.** Core analgesic elements, namely neuraxial opioids, scheduled paracetamol and NSAIDs, with opioids reserved for rescue, are inexpensive and should be offered to all women undergoing CS, irrespective of whether the complete ERACS package is selected (Macones et al., 2019; Roofthoof et al., 2021).
- **Ensure balanced, evidence-based counselling.** ERACS should be presented as a perioperative quality-improvement pathway for women who require CS rather than as an incentive for non-indicated caesarean birth, and counselling should convey accurate information on the benefits and risks of both modes of birth (Betran et al., 2021; Zahroh et al., 2024).

CONCLUSION AND RECOMMENDATIONS

Conclusion

Postoperative pain intensity within the first 12–48 hours after caesarean section was significantly lower among women managed with the ERACS pathway than among those managed with conventional perioperative care at Hermina Arcamanik General Hospital, Bandung. Mild pain predominated after ERACS, whereas moderate-to-severe pain predominated after conventional care, with a medium-to-large effect size and a number needed to treat of approximately three.

These findings support ERACS as an effective, patient-centred strategy for improving early post-caesarean analgesia and recovery, while underscoring the need for standardised implementation and for confirmation in studies with stronger causal designs (Bollag et al., 2021; Meng et al., 2021).

Recommendations for Future Research

On the basis of the findings and limitations of this study, the following directions for future research are recommended (von Elm et al., 2014; Sultan et al., 2022):

1. **Stronger study designs:** Prospective cohort studies analysed with multivariable ordinal regression, or pragmatic randomised trials, should be undertaken to control for confounders such as surgical urgency, previous CS, labour status, body mass index, educational attainment and preoperative anxiety (Sultan et al., 2020).
2. **Repeated and standardised measurements:** Pain should be measured at fixed time points (for example, 6, 12, 24 and 48 hours), at rest and on movement, together with opioid consumption expressed in morphine milligram equivalents (Sultan et al., 2022).
3. **Patient-reported recovery and long-term outcomes:** Future studies should incorporate quality of recovery, maternal satisfaction, breastfeeding success, postpartum depression and chronic postsurgical pain at three months (Eisenach et al., 2008; Wang et al., 2025).
4. **Component analysis and implementation science:** Research should identify which ERACS components contribute most to analgesic benefit and how protocol fidelity can be sustained across Indonesian hospitals with differing resources (Lestari et al., 2025).

Recommendations for Health Professionals, Patients and the Hospital

- **Health professionals:** Physicians, nurses and midwives involved in perioperative care should maintain up-to-date competence in ERACS, ensure close interprofessional coordination and provide clear, reassuring preoperative education, since anxiety is a modifiable contributor to postoperative pain (Wilson et al., 2018; Borges et al., 2016).
- **Patients, families and the community:** Women undergoing CS should be supported to participate actively in recovery through early mobilisation, correct breathing techniques and adherence to analgesic and wound-care instructions, while families should provide

practical and emotional support that reduces anxiety and facilitates early mobilisation (Emrich et al., 2023).

- **Hermine Arcamanik General Hospital:** The hospital is encouraged to standardise its ERACS protocol and to evaluate adherence periodically in order to maintain consistent quality of post-caesarean care (Bollag et al., 2021).

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