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REVIEW PAPER

Implications of labor analgesia on labor outcomes – a systematic review

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ABSTRACT

Introduction and aim. Labor analgesia is a key component in ensuring maternal comfort during childbirth and impacts several maternal and neonatal outcomes. The selection of pharmacological and nonpharmacological analgesic methods significantly affects labor progression, delivery methods, neonatal health, and maternal satisfaction. This systematic review sought to assess the implications of labor analgesia on these outcomes by synthesizing evidence from various study designs.

Material and methods. Searches on the following electronic databases comprehensively: PubMed, Scopus, Web of Science, Cochrane Library, Embase, and CINAHL; Using Boolean operators and MeSH terms, six studies were included. These comprised randomized controlled trials, cohort studies, and observational studies that assessed maternal and newborn outcomes in the presence of labor analgesia. Data on types of analgesia, onset times, maternal hemodynamic outcomes, labor durations, delivery modes, neonatal Apgar scores, adverse events and maternal satisfaction were extracted. The exclusion criteria were studies that did not meet the inclusion criteria, such as reviews, editorials, and non-human studies.

Analysis of the literature. The analysis involved a wide range of studies employing analgesia methods such as epidural, combined spinal-epidural (CSE), programmed intermittent epidural bolus (PIEB), and non-pharmacological interventions. Ropivacaine (0.1–0.2%) with fentanyl (7.5–25 µg/mL) was the most commonly used combination. The onset times ranged from immediate to 200 minutes for prolonged durations of PIEB. Labor durations were variable. Some techniques, such as peripheral nerve blocks, reduced second stage labor by 33.8 minutes, whereas epidural analgesia prolonged labor duration in some cohorts. The modes of delivery outcomes were characterized by relatively minimal variations in cesarean rates between techniques, while operative vaginal deliveries were more likely with routine epidurals. Neonatal outcomes were otherwise favorable with normal Apgar scores, although some studies reported lower 1 minute Apgar scores with epidurals. Adverse events, such as motor blockade and postdural puncture headaches, were usually technique-dependent and minimal. Maternal satisfaction was high in all methods, with ultrasound-guided CSE, PIEB, and nonpharmacological methods receiving particularly positive feedback.

Conclusion. Labor analgesia showed overall safety and efficacy but varied impacts on labor duration, mode of delivery, and neonatal outcomes with the technique used. Although most of them had high maternal satisfaction and stable maternal hemodynamics, some increased operative deliveries or adverse newborn outcomes. These results underscore the importance of tailoring analgesic strategies to individual clinical needs to optimize maternal and neonatal outcomes.

Keywords. epidural analgesia, labor analgesia, maternal outcomes, newborn outcomes, patient satisfaction

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Introduction

Labor analgesia is today a part of routine obstetric practice to provide relief from pain in labor without risking the safety and welfare of the mother and fetus.[1] Pain in labor results from a multifactorial interaction of physiological processes involving uterine contractions, cervical dilation, and fetal transit through the birth canal, which activate visceral and somatic afferent nerves.[2] Unrelieved, this pain triggers a severe physiological stress response, expressed as increased catecholamine release, increased cardiac output, and hyperventilation, which can adversely affect maternal hemodynamics and fetal oxygenation.[3] Successful control of labor pain, thus, not only provides maternal comfort, but also optimizes maternal and neonatal outcomes.[4]

Among the many pharmacologic alternatives, epidural analgesia is well established as the gold standard for labor pain relief because of its effectiveness and the potential to preserve maternal awareness and activity during delivery.[5,6] The procedure consists of the injection of local anesthetics, usually combined with opioids, into the epidural space, providing focal and prolonged pain relief. Despite its benefits, epidural analgesia is controversial with respect to its possible correlation with adverse outcomes of labor, including prolonged second-stage labor, higher instrumental delivery, and maternal complications, such as hypotension and urinary retention.[7] Other pharmacologic approaches, such as parenteral opioids and nitrous oxide, are employed as alternatives or adjuncts to epidural analgesia, but tend to be less effective and accompanied by side effects such as nausea, sedation, and drowsiness.[8]

Currently, non-pharmacological methods such as transcutaneous electrical nerve stimulation (TENS), hydrotherapy, acupressure, and hypnosis have also become popular, especially in areas where limited medical intervention is desired or pharmacologic options are not available.[9] Although these modalities have demonstrated some effectiveness in alleviating pain and maternal satisfaction, their effect on labor outcomes such as labor duration and mode of delivery is less consistent owing to inconclusive evidence.[10] Additionally, cultural acceptability, access to healthcare, and provider skill also determine the use of pharmacologic versus non-pharmacologic analgesia between and within systems.[11]

In addition to pain relief, labor analgesia is also central to maternal and neonatal health outcomes. Epidural analgesia has been blamed for prolonged second-stage labor and rising rates of assisted vaginal delivery rates, with controversies about its larger implications.[12] Evidence for its link to cesarean delivery remains conflicting, some research attributing increased cesarean rates of cesareans to confounders in the form of maternal obesity, advanced age, and pre-existing pregnancy complications and not the analgesic method itself.[13] In the same vein, neonatal outcomes such as Apgar scores, umbilical cord pH, and the requirement for resuscitation have been the subject of investigation concerning labor analgesia, with evidence yielding conflicting conclusions.[12,13]

Considering the pivotal position of labor analgesia in obstetric practice and its multi-pronged effect on maternal and neonatal outcomes, it is imperative to have a systematic assessment of its effects.

Aim

The purpose of this review is to integrate the available data on the effect of various analgesic methods on key maternal and neonatal outcomes, such as labor progress, delivery method, maternal satisfaction, and neonatal health indicators.

Material and methods

Inclusion and exclusion criteria

The inclusion and exclusion criteria for this review were selected with great concern for the selection of relevant and quality studies. Only studies have been considered that have compared the effects of labor analgesia, pharmacological or non-pharmacological on maternal and neonatal outcomes. Only studies with adequate data on labor outcome – duration of labor, mode of delivery, level of maternal satisfaction, neonatal Apgar scores, or any adverse events reported were considered. For this review, RCTs, cohort studies, and observational studies conducted in human subjects who had received analgesia for labor were considered for this review. Studies were excluded if they were reviews, case reports, editorials, or conference abstracts, and if they lacked sufficient outcome data or focused on analgesia in non-labor settings. Also, studies involving nonhuman subjects or those not published in peer-reviewed journals were excluded.

PECOS protocol and PRISMA construction

The PECOS protocol was constructed to align with the systematic approach mandated by the PRISMA 2020 reporting guidelines.[14] The population (P) to be exposed was pregnant women when in labor and delivery. Exposure (E) was any type of analgesia for labor, pharmacological or non-pharmacological. The comparator (C) had no analgesia or alternatives forms of analgesia. Outcomes (O) encompassed maternal outcomes such as time elapsed by labor, delivery method as perceived by the mother, and others. Neonatal results including Apgar scores and adverse events that follow. The eligible study design (S) included RCT, cohorts, and case series / case control studies.

Protocol for database search

Six electronic databases were searched to find relevant studies for this review, PubMed, Scopus, Web of Sci-

ence, Cochrane Library, Embase, and CINAHL. The concept was further refined by having the first set of terms of all the databases using Boolean operators and MeSH terms. Some of the concepts that had been used were "labor analgesia", "pain management in childbirth", "maternal outcomes", "neonatal outcomes," and "epidural analgesia" with Boolean terms including AND, OR, and NOT to narrow the searches. Further narrowing was done using other MeSH terms such as "Analgesia, Obstetrical", "Labor, Obstetric," and "Maternal Health". Filters applied for language and type of study, such as RCTs, cohort, and observational studies.

Data extraction protocol and data items

Data were extracted using a structured protocol to ensure consistency and completeness in data extraction. A standardized data extraction form was developed that included identifiers (author, year, journal), study design, population characteristics (age, parity), details of exposure (type of analgesia, administration protocol), details of the comparator, and reported results (labor duration, mode of delivery, maternal satisfaction, neonatal Apgar scores, adverse events). The data were independently extracted by two reviewers, and any discrepancies were resolved by consensus or arbitration by a third reviewer. This process ensured that all relevant data items were captured for subsequent analysis.

Bias assessment protocol

The risk of bias was assessed using the ROBINS-I tool[15] for nonrandomized studies and Cochrane RoB 2.0 tool for RCTs.[16] For ROBINS-I, confounding domains, selection bias, intervention classification and outcome reporting were considered in the evaluation. For RoB 2.0 domains that comprise the randomization process, the deviation of patients from the intended interventions, as well as selective reporting, were studied. In all of these areas, risk was considered low, moderate or high risk, and general bias was applied to all of them.

Protocol for sensitivity analyses

Sensitivity analyzes were conducted to test the robustness of the review findings. The analyzes included exclusion of studies at high risk of bias, excluding study design-for example-and checking for the effects of key variables such as maternal age and parity. Subgroup analyzes were performed by type of analgesia used, for instance, pharmacological versus non-pharmacological, to explore the heterogeneity in outcomes.

Results

The process of selecting the studies was in accordance with the PRISMA guidelines, which included the stages of identification, selection, eligibility, and inclusion stages (Fig. 1). In the initial step, 451 records were identified from databases such as PubMed (81), Embase (91), Scopus (93), Web of Science (53), Cochrane Library (57), and CINAHL (76). After eliminating 58 duplicate records, the search was performed for 393 unique records. No records were excluded in the screening stage and a total of 393 reports were recovered for assessment. Of these 355 reports, 38 were not recovered. Of the remaining 355 reports, a total of 343 were excluded because they did not meet the PECOS criteria (86), were off topic (74), literature reviews (59), these articles (66), or editorials (58). In addition, 121 records identified through other methods (websites, organizations, citation search) were screened, and 28 were not retrieved. Among the 93 evaluated reports, 52 were excluded as in vitro studies and 41 as animal studies. Finally, 12 new studies [17-28] were included in the review.

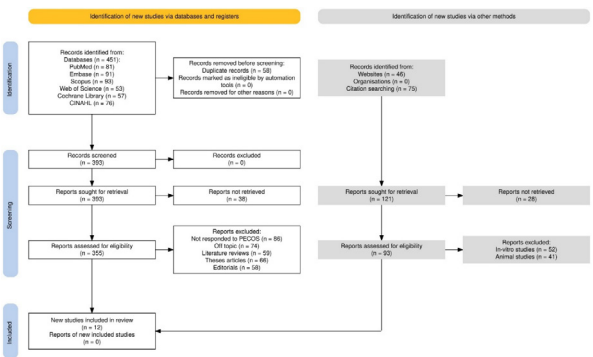

Fig. 1. Representation of the study selection process for this review

Baseline variables assessed

The included studies spanned various years, from 2014 to 2024, highlighting a diverse temporal range (Table 1).[21,23,27] From a geographical point of view, they represented studies performed within different countries: South Korea, USA, Australia, Brazil, Poland, Taiwan, Malaysia, Netherlands and China.[17-28] The study designs were quite diversified; most of the studies were RCTs focusing on methodological rigor.[17,19,20,23,24,26,28] Other designs included retrospective observational studies, retrospective cohorts, controlled before and after cohorts, prospective sampling, and a non-inferiority trial.[18,21,22,25,27] The sample sizes varied greatly, from as few as 71 participants to 16,852, reflecting a wide scope of investigation.[22,28] The mean age of participants also differed between studies, ranging from 21.5 years to the oldest mean age at 34.25 years, which implies that there was a wide demographic range of pregnant women.[17,20] Mean age was not reported in one study.[27] Follow-up periods ranged from immediate postpartum periods to longer durations as six weeks postpartum, or until certain milestones: neonatal outcomes, or discharge from the maternity unit.[17-21,23,25]

Table 1. Demographic characteristics of the included studies

Study ID	Year	Country	Study design	Sample size	Mean age (in years)	Follow-up Period
Bae et al [17]	2023	South Korea	Randomized controlled trial	84	34.25	Immediate postpartum
Bullingham et al [18]	2018	Australia	Controlled before-and-after cohort	397	28.1	Immediate postpartum
Cahill et al [19]	2018	USA	Randomized controlled trial	2414	26.5	6 weeks postpartum
Gallo et al [20]	2018	Brazil	Randomized controlled trial	80	21.5	Discharge from maternity unit
Hincz et al [21]	2014	Poland	Retrospective observational	5593	30.2	Neonatal outcomes
Hung et al [22]	2015	Taiwan	Retrospective cohort	16852	29.5	Perinatal period
Kim et al [23]	2024	South Korea	Randomized controlled trial	85	33	Immediate postpartum
Sharawi et al [24]	2023	USA	Randomized controlled trial	140	30.1	Postoperative day 1
Sra et al [25]	2016	Malaysia	Prospective sampling	110	28.7	Immediate postpartum
Tan et al [26]	2022	USA	Double-blind randomized controlled trial	132	29.5	Delivery and postpartum day 1
Wassen et al [27]	2014	Netherlands	Randomized non-inferiority trial	488	Not reported	Not specified
Xu et al [28]	2020	China	Randomized controlled trial	71	27.5	Until delivery

Sample type and type of analgesia

The included studies included various types of samples (Table 2), such as comparing ultrasound-guided techniques with palpation-guided techniques, epidural analgesia against controls or dural puncture against standard epidural techniques.[17,21,22,24,26] The types of analgesia were also vastly different, including combined spinal-epidural (CSE), neuraxial analgesia, dural puncture epidural, and programmed intermittent epidural bolus (PIEB).[17,19,23-26] Other comparator was non-pharmacological interventions that include massage, exercise and showers.[20] Such heterogeneity occurs as these strategies and their application of analgesia labor is diversified.

Dose and regimen

The dose and regimen varied according to the type of analgesia. Ropivacaine 0.1–0.2% was frequently used with fentanyl 7.5–25 μg/mL, whereas other studies administered boluses of chloroprocaine 15–20 ml.[22-26] Other studies utilized standard protocols without detailing the dosages.[17,18] This variability highlights institutional differences in the practices and preferences of labor analgesia.

Time to onset of analgesia

The onset of analgesia varied from immediate starts to more delayed onsets as 30–60 min after catheter insertion or 422 seconds after dural puncture epidurals.[18,22,24,28] PIEB had more protracted onset times, with the technique taking 200 minutes to begin.[23] CSE had quick onset.[25] The discrepancies between the onset times require the choice of technique be made based on the urgency of the clinical procedure and the needs of each individual patient.

Labor stage at onset

The onset of analgesia occurred at different stages of labor. Most interventions started in active labor, with thresholds for cervical dilation ranging from 2 cm to 4–7 cm.[20,27] Dural puncture epidurals were started during presurgical anesthesia, while others targeted the second stage of labour.[19,24,28] The heterogeneity is a reflection of the flexibility of analgesia strategies across the labor stages.

Maternal hemodynamic outcomes

Most studies demonstrated stable maternal hemodynamics without significant hypotension.[17,22,23,26] However, with routine epidural analgesia, increased hypotension (9.5% difference).[27] PIEB produced significantly reduced motor blockade compared to continuous infusion techniques.[18] Therefore, most of the analgesic methods show a high safety profile with minimal occurrence of hemodynamic complications.

Length of labor

The effects of analgesia on the duration of labor varied. Some techniques, such as peripheral nerve block (PNB), reduced the duration by 33.8 minutes, while nonpharmacological interventions led to an 18-minute reduction.[20,28] Conversely, epidural analgesia prolonged both the first and second stages of labor in some cohorts.[21,22] PIEB was associated with shorter second stages compared to continuous epidural infusion.[18]

Mode of delivery

The mode of delivery results showed little variation in the rate of cesareans in most techniques.[17,26] There were increased operative vaginal deliveries among routine epidural groups and nulliparous groups who received epidural analgesia.[22,27] Nonpharmacological interventions greatly reduced operative deliveries.[20] Therefore, these results indicate that although analgesia tends to promote vaginal delivery, certain methods would increase assisted delivery rates.

Neonatal outcomes

The newborn results were generally positive in all studies, with normal Apgar scores reported in most cases.[17,20,23,24,26,28] However, epidural analgesia was associated with lower 1-minute Apgar scores and increased risk of low cord pH in some cohorts.[21,22] Therefore, the results

Table 2. Outcomes related to labour analgesia as observed in all included trials

Study ID	Sample type assessed	Type of analgesia	Dose and regimen	Onset time of analgesia	Labour stage at initiation	Maternal hemodynamic outcomes	Duration of labour	Mode of delivery	Neonatal outcomes	Adverse events	Patient satisfaction
Bae et al [17]	Ultrasound-guided vs Palpation-guided CSE	Combined Spinal-Epidural (CSE)	Not specified; standard CSE protocols	134.5 seconds in ultrasound group	Active labour (dilation ≥3 cm)	Stable; no significant differences between groups	No significant difference in total duration	No significant difference in cesarean rates	No significant differences; normal Apgar scores	None significant; fewer dural punctures in ultrasound group	Higher in the ultrasound group (median 10/10)
Bullingham et al [18]	CEI vs PIEB + PCEA	Epidural analgesia	CEI: Ropivacaine 0.2% + Fentanyl; PIEB + PCEA: Ropivacaine 0.1% + Fentanyl	30-60 minutes post-catheter insertion	First stage	Stable with reduced motor block (21.8% vs 1.0%)	Second stage in PIEB + PCEA group (69.4 min vs 89.1 min)	No significant difference	No significant difference reported	Lower motor block with PIEB + PCEA	No significant difference between groups
Cahill et al [19]	Immediate vs Delayed Pushing	Neuraxial analgesia	Standard neuraxial protocols	Not reported	Second stage	Stable	Shorter in the immediate push group (102.4 min vs 134.2 min)	Similar spontaneous vaginal delivery rates (85.9% vs 86.5%)	Similar composite rates of neonatal morbidity rates (7.3% vs 8.9%)	Lower chorioamnionitis and postpartum hemorrhage in immediate group	High satisfaction reported
Gallo et al. [20]	Nonpharmacological Interventions vs Standard Care	Non-pharmacological techniques (massage, exercise, shower)	Not applicable (non-pharmacological)	Not applicable	4 to 7 cm dilation (stage-specific interventions)	Not measured	18 minutes faster in the experimental group (95% CI 5-30)	Reduced operative delivery in experimental group	Improved neonatal outcomes in experimental group	None reported	Higher satisfaction in experimental group
Hincz et al [21]	EA vs Control	Epidural Analgesia	Protocol not specified	Not reported	First stage (≥37 weeks)	Increased labor augmentation (EA group)	Prolonged first stage with EA	Higher forceps delivery rate with EA	Lower 1-min Apgar score with EA	Increased risk of low cord pH with EA	Not assessed
Hung et al [22]	Nulliparous vs Multiparous with EA	Epidural Analgesia	Ropivacaine 1mg/mL + Fentanyl 7.5 µg/mL	Immediate	First stage	Stable, no significant hypotension	Prolonged first and second stages (EA group)	Increased operative vaginal delivery in nulliparous	Higher rate of 1-min Apgar <7 in EA group	None significant beyond study-defined outcomes	Not explicitly reported
Kim et al [23]	PIEB vs Continuous vs Manual	Programmed Intermittent Epidural Bolus	Ropivacaine 0.2% + fentanyl 20 µg	PIEB: 200 min	Active labor (2-5 cm dilation)	Stable	Prolonged interval to breakthrough pain	Mixed (vaginal and cesarean)	Normal Apgar scores	None significant	High
Sharawi et al[24]	DPE vs Standard Epidural	Dural-puncture epidural	Chloroprocaine 15-20 mL	422 seconds	Pre-surgical anesthesia	Stable	Not applicable (cesarean)	Cesarean delivery	Normal Apgar scores	Minimal (e.g., PDPH)	High
Sra et al [25]	CSE vs Non-CSE	Combined Spinal Epidural (CSE)	Ropivacaine 0.2% + Fentanyl 25 µg	Rapid onset with CSE	Active labour (3-4 cm dilation)	Stable, no reported hypotension	No significant differences	Similar between groups	Similar Apgar scores between groups	Pruritus is most common in CSE group	High satisfaction with CSE
Tan et al [26]	Dural Puncture Epidural vs Standard Epidural	Dural Puncture Epidural	0.1% Ropivacaine + 2 µg/mL Fentanyl	Within 30 minutes	2 to 7 cm dilation	Stable with no significant hypotension	No difference in second-stage duration	No significant differences	No significant differences; normal Apgar scores	No significant adverse events reported	High satisfaction in both groups
Wassen et al[27]	Routine EA vs Analgesia on Request	Epidural analgesia	Routine EA: Continuous infusion of Ropivacaine/ Bupivacaine + Sufentanil	Immediate upon administration	Active labor (cervical dilation ≥2 cm)	Increased hypotension (difference of 9.5%)	No significant difference reported	Higher operative deliveries in the routine EA group (34.8% vs 26.7%)	No significant differences in Apgar scores or NICU admissions	Higher motor blockade with routine EA (6.8% difference)	Not explicitly reported
Xu et al [28]	PNB vs Control	Epidural + PNB	0.25% ropivacaine 10 mL per side	Immediate	Second stage	Stable	Reduced by 33.8 min	Vaginal delivery	Normal Apgar scores	None significant	High

show that, in general, the newborn is safe from analgesia methods but sometimes has adverse effects.

Adverse events

The frequency of significant adverse events is small. Common issues involved include pruritus with CSE, postpartum dural puncture headaches with dural puncture epidurals, and motor blockage with routine epidurals.[24,25,27] Motor block was substantially lower in PIEB than it was for continuous infusion.[18] Thus, adverse events generally occur infrequently and seem to depend on technique.

Patient satisfaction

Patient satisfaction was consistently high in all studies, with ultrasound-guided CSE and PIEB receiving particularly positive responses.[17,18,25] Non-pharmacological interventions also led to greater satisfaction than standard care.[20] This reflects the effectiveness of these techniques in meeting maternal expectations during labor.

Bias levels observed

The bias assessment across the included studies was analyzed using domain-specific evaluations for each study type. For RCTs, bias levels across seven domains (D1-D7) were determined to show heterogeneity in methodological rigor (Fig. 2). Bae et al. and Xu et al. were assessed as having a moderate overall risk due to moderate concerns in specific domains such as D3 and D6, respectively.[17,28] Cahill et al. Gallo et al., and Kim et al. are in general low risk.[19,20,23] Sharawi et al. and Tan et al. had low overall risk but presented moderate risks in specific domains.[24,26] Wassen et al. had moderate overall risk mainly due to serious concerns in D4.[27]

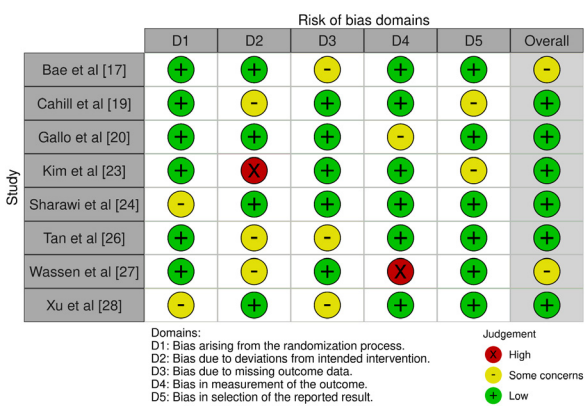

Fig. 2. Bias levels assessed across the RCTs included in the review

In cohort studies, the bias assessments were equally mixed (Fig. 3). Bullingham et al. were rated with moderate overall risk mainly due to moderate concerns in D2 and D6.[18] Hincz et al. and Hung et al. were rated with low general risk with consistent low ratings in most of the domains except with moderate concerns in D1 and D5 for Hincz.[21,22] Sra et al. scored with low general risk even though there were serious concerns on D2 with moderate concerns on several of the domains.[25]

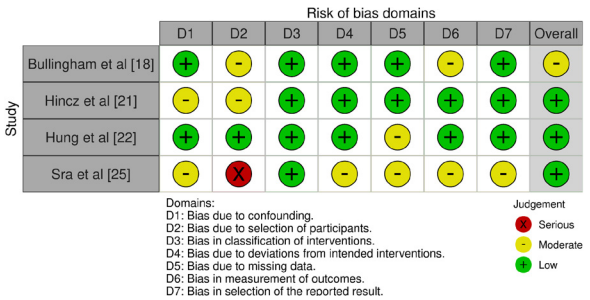

Fig. 3. Bias levels assessed across the cohort studies included in the review

Sensitivity analyses observations

A sensitivity analysis was performed to evaluate the robustness of the findings in all the studies included in the review. Study designs, sample sizes, analgesia techniques, and results were all taken into account to draw conclusions from the analysis. RCTs, such as those of Bae et al. Cahill et al., Kim et al., and Sharawi et al., comprised the bulk of the database, ensuring methodological stringency, while observational and cohort studies, such as those by Hincz et al. and Hung et al. offered additional context of real-world variability.[17,19,21-24] The trial by Hung et al. with 16,852 participants, had more weight in results concerning epidural analgesia but also reported longer duration of labor and higher operative deliveries.[22] Conversely, smaller trials such as Bae et al. with 84 participants and Gallo et al. with 80 participants, were successful in reporting benefits from ultrasound-guided CSE and nonpharmacological techniques with a higher level of maternal satisfaction and decreased complications during the procedure.[17,20] Although the size of the subjects was small, consistency of their findings across multiple parameters assured their reliability.

The nature of analgesia profoundly affected both maternal and neonatal outcomes. The epidurals differed significantly in hemodynamic stability and labor progression among the continuous infusion, PIEB, and dural puncture epidurals. Bullingham et al. and Kim et al. found consistent reductions in motor block and second-stage duration with PIEB by Bullingham et al. and Kim et al., whereas routine epidural techniques, as described by Wassen et al., were associated with increased operative delivery rates and maternal hypotension.[18,23,27] Gallo et al. and Xu et al., respectively, in which consistent benefits were derived in reducing operative delivery rates and enhancing patient satisfaction, thus agreeing with pharmacological methods in the context of neonatal safety.[20,28] The analysis has also considered varying follow-up periods that range from immediate postpartum in Bae et al. and Kim et al. to

six weeks in Cahill et al.[17,19,23] The long follow-up period in studies such as those of Cahill et al. enabled maternal morbidity to be assessed, thereby showing fewer complications in the postpartum period with immediate pushing during neuraxial analgesia.[19] Studies with

Discussion

Impact of labor pain on maternal and neonatal outcomes

The pain experienced during labor can exert multiple deleterious impacts on the mother. For example, pain can trigger the physiological stress response, disrupt uterine contractions, extends the time taken to complete labor, and contributes towards mental health disorders such as post-traumatic stress disorder or depression postdelivery.[1-4] Labor pain also has been reported to play a very significant role in the overall increasing rates of Caesarean delivery rates around the world.[28-29] The effects of uncontrolled labor pain could be transmitted to neonates and can result in complications such as neonatal hypoxia, metabolic acidosis, cognitive and emotional developmental problems, and even death in extreme situations.[30-33]

Our review offers a new and extensive synthesis of labor analgesia methods, with a focus on their effect on maternal and neonatal outcomes. It is the first to compare various methods, including pharmacological methods such as CSE, PIEB, and dural puncture epidurals, with non-pharmacological methods such as massage and hydrotherapy.[17,18,20,23,25] In contrast to earlier research, this review discusses variations in dosage regimens, including ropivacaine-fentanyl combinations and chloroprocaine boluses, and institutional and practitioner-specific preferences.[22-25] It also discusses differences in time to onset and stage of labor at initiation, offering key insights into the flexibility of analgesia strategies to clinical urgency and patient needs.[20,24,27]

The findings also highlight the new advantages of newer methods such as PIEB, which reduces motor block and hypotension compared to continuous epidural infusions.[18,27] The research also measures the extent to which non-pharmacological methods decrease operative delivery rates and improve maternal satisfaction, providing significant alternatives to scenarios where little medical intervention is desirable.[20] Also highlighted is neonatal safety, where most methods depict favorable results, while some procedures such as routine epidurals are questioned due to their suspected association with reduced Apgar scores and cord pH alteration.[21,22]

Role and implications of epidural labor analgesia (ELA)

ELA is the most widely used method to treat labor pain.[30] It effectively blocks the nociceptive signaling pathways and reduces maternal stress response.[15,16] Emerging evidence suggests that ELA can play a positive role in reducing the risk of postpartum depression and could probably reduce the risk of long-term depressive disorders.[31-35] The impact of ELA on neonatal outcomes, lactation, and long-term neurodevelopmental pathways is also being explored.[32-36] Findings in such areas are not conclusive enough and warrant further research to establish clarity on the long-term implications associated with this widely used analgesic approach.

Findings from included studies in this review

The findings of the studies included in this review showed similarities and differences in the implications of labor analgesia on the outcomes of both the mother and neonate. The main reason for the variability was the variation in the methods, regimens, and populations used for the studies. Several studies, including Bae et al., Xu et al., and Sra et al. demonstrated that ultrasound-guided CSE and peripheral nerve blocks improved maternal outcomes, reducing complications from procedure and length of second-stage labour.[17,25,28] This was consistent with what Gallo et al. showed regarding operative deliveries and neonatal results that were lower compared to the group receiving pharmacological interventions.[20] However, Hincz et al. and Hung et al. pointed out that epidural analgesia was protective against cesarean delivery, but had the disadvantages of prolonged labor durations and increased operative vaginal deliveries, demonstrating that different results were found based on the type of analgesia.[21,22]

Maternal hemodynamic stability

Regarding hemodynamic stability, most reports indicated that there was no statistically significant hypotension from studies such as Sharawi et al. Tan et al., and Kim et al.[23,24,26] However, Wassen et al.[27] reported increased maternal hypotension with routine epidural techniques, which means that there is some divergence in safety profiles.[27] PIEB, evaluated by Bullingham et al.,[18] had significant decreases in motor blockade from start to termination compared to a continuous infusion, as previously found and discussed in improved safety and efficacy such as in Sra et al.[25] Results of neonates were relatively good across most studies and were frequently given normal Apgar scores similar to studies such as Cahill et al., Sharawi et al., and Xu et al.[19,24,28] However, there was a trend for higher risks of adverse neonatal outcomes, including lower 1-minute Apgar scores and increased risk of low cord pH, in some cohorts receiving epidural analgesia, as reported by Hincz et al. and Hung et al.[21,22] These differences underscore the importance of careful technique selection with appropriate consideration to maternal and neonatal safety considerations.

Adverse events and patient satisfaction

Adverse events were generally minimal but technique-dependent. PIEB and non-pharmacological

methods had lower incidences of complications, as highlighted by Bullingham et al. and Gallo et al.[18,20] Conversely, dural puncture epidurals (Sharawi et al.[24]) and routine epidurals (Wassen et al.[27]) were associated with specific issues such as headaches after puncture and motor blockade, underscoring the importance of method-specific evaluations. Patient satisfaction was uniformly high for all techniques, most favorable responses to ultrasound-guided CSE by Bae et al., PIEB by Kim et al., and non-pharmacological interventions by Gallo et al.[17,20,23] Thus, this uniform satisfaction may suggest that most of the techniques do meet the expectations of their patients, although clinical results might vary.

Comparison with other reviews

The findings of the studies presented in this review show a number of tangential similarities, as well as differences with the other reviews conducted in this same regard.[37-42] Both our review and the studies by Halliday et al., Callahan et al., and Lu et al. recognized epidural analgesia (EA) as the most effective and widely used method for pain relief during labor.[37,40,42] The conclusions regarding the relationship of EA with the duration of first and second stages of labor were concurred in with the results reported by Callahan et al. and Lu et al., where a similar prolongation was observed in our results.[40,42] Also, the negative finding on increased rates of cesarean delivery after EA agreed with the conclusion reported by Callahan et al.[42] As reported by Liu et al., the decreased post-labor maternal depressive symptoms correlated well with our review's observations that techniques such as PIEB and non-pharmacological interventions have high maternal satisfaction levels.[4] Furthermore, the observation of transient maternal hypotension with EA, which was

Both our review and that of Guasch et al. noted advantages of CSE techniques: faster onset of analgesia with minimal effect on neonatal Apgar scores, ensuring their efficacy over standard EA.[39] Although our review identified an association of specific epidural techniques with an increased incidence of operative vaginal delivery, Callahan et al. noted that improvements such as low-concentration local anesthetics and PIEB have reduced this risk; more recent studies have failed to demonstrate a significant difference between EA and nonepidural analgesia.[42] This may represent a change in practice regarding the use of anesthesia. Unlike our results, where neonatal outcomes such as 1-minute Apgar scores and cord pH were sometimes affected, Callahan et al. and Liu et al. repeatedly reported no neonatal adverse effects and better acid-base status was found in neonates whose mothers received EA.[41,42]

Lu et al. and Liu et al. highlighted the elevated risk of intrapartum maternal fever with EA that was identified less often in our summary.[40,41] This is likely due to differences in the study population, the definition used for fever, or the type of analgesia applied. While Halliday et al. have pointed out significant heterogeneity in epidural technique research and a lack of standardized outcome reporting, our review has focused on synthesizing findings across diverse study designs and methods. This divergence points to a methodological limitation in both bodies of research.[37]

Limitations of the review

Although systematic, has a number of limitations that must be acknowledged. First, the included studies were highly heterogeneous with respect to sample populations, analgesia methods, doses, and outcomes, which could reduce generalizability of the results. For example, variation in institutional practice and regional taste dictated the selection and delivery of analgesia, resulting in heterogeneity of the results. Second, the heterogeneity in the timing of onset of analgesia, from the initiation of labor to the second stage of labor, complicates the comparison across studies. Third, some studies did not report high levels of detail on dosing regimens or information, which can affect the interpretation of efficacy and safety profiles of particular methods. An additional limitation was the reliance on various study designs, e.g., RCTs and observational studies. Although this allows for more richness in the analysis, it generates potential for bias because observational studies are more vulnerable to confounding. Furthermore, some of the included RCTs had small numbers, which could decrease statistical power to identify significant differences or rare adverse effects. Although sensitivity analyzes were performed to try to minimize these issues, the strength of evidence from larger trials could overbalance valuable findings from smaller trials. Brief follow-up intervals in most studies also constrain the ability to evaluate long-term maternal and neonatal outcomes, e.g. postpartum complications or neurodevelopmental impact. The absence of consistent outcome measures, especially for patient satisfaction and maternal hemodynamics, is also a problem in synthesis and comparing across studies. Furthermore, although bias evaluation was undertaken, moderate risks of bias in certain domains, especially in observational studies, remind us to be cautious when interpreting the results.

Recommendations for future research and implications

The focus of future research should be placed on multicenter trials with standardized protocols for reducing variability in methods and dosages of analgesia. Further studies would be required to explore the long-term outcomes of mother and newborn resulting from differing analgesia techniques, especially in the population or clinical settings. Integration of patient-reported outcomes, including satisfaction and quality of life, would be beneficial in offering a more holistic understanding of the effectiveness of labor analgesia. Other studies on cost-effectiveness

may be useful to inform the use of resources in clinical practice. Lastly, filling gaps in the evidence for non-pharmacological interventions could be useful in the exploration of alternative approaches to managing labor pain.

Conclusion

This systematic review was shown to have generally effectiveness and safety, with a high level of maternal satisfaction and favorable neonatal outcomes for labor analgesia. However, the effects of labor duration, mode of delivery and maternal or neonatal adverse events were quite varied depending on the type of analgesia used. Although non-pharmacological techniques and PIEB had benefit in reducing operative deliveries and diminishing adverse events, routine epidural techniques were associated with an increased incidence of maternal hypotension and prolonged labor in some cases. Therefore, it calls for the tailoring of analgesic approaches to specific clinical needs and maternal preferences.

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Author contributions

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Conflicts of interest

The authors have no conflicts of interest to declare.

Data availability:

All data generated or analyzed during this study are included in this published article as references.

Ethics approval

Not applicable.

References

1. Callahan EC, Lee W, Aleshi P, George RB. Modern labor epidural analgesia: implications for labour outcomes and maternal-fetal health. *Am J Obstet Gynecol.* 2023;228(5):S1260-S1269. doi: 10.1016/j.ajog.2022.06.017
2. Nanji, JA, Carvalho, B. Pain management during labor and vaginal birth. *Best Pract Res Clin Obstet Gynaecol.* 2020;67:100-112. doi: 10.1016/j.bpobgyn.2020.03.002
3. Kearns RJ, Kyzayeva A, Halliday LOE, Lawlor DA, Shaw M, Nelson SM. Epidural analgesia during labour and severe maternal morbidity: population-based study. *BMJ.* 2024;385:e077190. doi: 10.1136/bmj-2023-077190
4. Mazda Y. Labour neuraxial analgesia and clinical outcomes. *J Anesth.* 2022;36(4):453-455. doi: 10.1007/s00540-022-03043-w
5. Kearns RJ, Lucas DN. Neuraxial analgesia in labour and the foetus. *Best Pract Res Clin Anaesthesiol.* 2023;37(1):73-86. doi: 10.1016/j.bpa.2023.02.005
6. Roofthooft E, Filetici N, Van Houwe M, et al. High-volume patient-controlled epidural vs programmed intermittent epidural bolus for labour analgesia: a randomised controlled study. *Anaesthesia.* 2023;78(9):1129-1138. doi: 10.1111/anae.16060
7. Russell R. Preeclampsia and the anaesthesiologist: current management. *Curr Opin Anaesthesiol.* 2020;33(3):305-310. doi: 10.1097/ACO.0000000000000835
8. Mori Y, Toyama S, Sato M, Yamashita Y, Suzuki Y, Sago H. Influence of preterm labour epidural analgesia on neonatal and maternal outcomes: a single-centre retrospective study. *Br J Anaesth.* 2021;127(5):e154-e156. doi: 10.1016/j.bja.2021.07.017
9. Lawson J, Amaratunge L, Goh M, Selvaratnam RJ. Perinatal outcomes after regional analgesia during labour. *Aust N Z J Obstet Gynaecol.* 2024;64(4):334-340. doi: 10.1111/ajo.13797
10. Liu ZH, Wang DX. Potential impact of epidural labour analgesia on the outcomes of neonates and children. *Chin Med J (Engl).* 2020;133(19):2353-2358. doi: 10.1097/CM9.0000000000000900
11. Patel S, Ciechanowicz S, Blumenfeld YJ, Sultan P. Epidural-related maternal fever: incidence, pathophysiology, outcomes, and management. *Am J Obstet Gynecol.* 2023;228(5):S1283-S1304.e1. doi: 10.1016/j.ajog.2022.06.026
12. Shuai F, Jia J, Lin P. Effects of using epidural analgesia during delivery on maternal and infant outcomes. *Gynecol Obstet Invest.* 2022;87(1):46-53. doi: 10.1159/000522330
13. Goetzl L. Maternal fever in labour: etiologies, consequences, and clinical management. *Am J Obstet Gynecol.* 2023;228(5):S1274-S1282. doi: 10.1016/j.ajog.2022.11.002
14. Page MJ, Moher D, Bossuyt PM, et al. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ.* 2021;372:n160. doi: 10.1136/bmj.n160
15. Igelström E, Campbell M, Craig P, Katikireddi SV. Cochrane's risk of bias tool for non-randomized studies (ROBINS-I) is frequently misapplied: a methodological systematic review. *J Clin Epidemiol.* 2021;140:22-32. doi: 10.1016/j.jclinepi.2021.08.022
16. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ.* 2019;366:l4898. doi: 10.1136/bmj.l4898
17. Bae J, Kim Y, Yoo S, Kim JT, Park SK. Handheld ultrasound-assisted versus palpation-guided combined spinal-epidural for labour analgesia: a randomized controlled trial. *Sci Rep.* 2023;13(1):23009. doi: 10.1038/s41598-023-50407-7
18. Bullingham A, Liang S, Edmonds E, Mathur S, Sharma S. Continuous epidural infusion vs programmed intermittent

epidural bolus for labour analgesia: a prospective, controlled, before-and-after cohort study of labour outcomes. *Br J Anaesth.* 2018;121(2):432-437. doi: 10.1016/j.bja.2018.03.038
19. Cahill AG, Srinivas SK, Tita ATN, et al. Effect of immediate vs delayed pushing on rates of spontaneous vaginal delivery among nulliparous women receiving neuraxial analgesia: a randomized clinical trial. *JAMA.* 2018;320(14):1444-1454. doi: 10.1001/jama.2018.13986
20. Gallo RBS, Santana LS, Marcolin AC, Duarte G, Quintana SM. Sequential application of non-pharmacological interventions reduces the severity of labour pain, delays use of pharmacological analgesia, and improves some obstetric outcomes: a randomised trial. *J Physiother.* 2018;64(1):33-40. doi: 10.1016/j.jphys.2017.11.014
21. Hincz P, Podciechowski L, Grzesiak M, Horzelski W, Wilczyński J. Epidural analgesia during labour: a retrospective cohort study on its effects on labour, delivery, and neonatal outcome. *Ginekol Pol.* 2014;85(12):923-928.
22. Hung T-H, Hsieh T-T, Liu H-P. Differential effects of epidural analgesia on modes of delivery and perinatal outcomes between nulliparous and multiparous women: a retrospective cohort study. *PLoS One.* 2015;10(3):e0120907. doi: 10.1371/journal.pone.0120907
23. Kim D, Kim J, Choo H, Choi DH. Programmed intermittent epidural bolus as an ideal method for labour analgesia: a randomized controlled trial. *Korean J Anesthesiol.* 2024;77(1):106-114. doi: 10.4097/kja.23173
24. Sharawi N, Williams M, Athar W, et al. Effect of dural-puncture epidural vs standard epidural for epidural extension on onset time of surgical anesthesia in elective cesarean delivery: a randomized clinical trial. *JAMA Netw Open.* 2023;6(8):e2326710. doi: 10.1001/jamanetworkopen.2023.26710
25. Singh SKSC, Yahya N, Misiran K, Masdar A, Nor NM, Yee LC. Combined spinal-epidural analgesia in labour: its effects on delivery outcome. *Rev Bras Anestesiol.* 2016;66(3):259-264. doi: 10.1016/j.bjane.2014.09.006
26. Tan HS, Reed SE, Mehdiratta JE, et al. Quality of labour analgesia with dural puncture epidural versus standard epidural technique in obese parturients: a double-blind randomized controlled study. *Anesthesiology.* 2022;136(5):678-687. doi: 10.1097/ALN.0000000000004137
27. Wassen MM, Smits LJ, Scheepers HC, et al. Routine labour epidural analgesia versus labour analgesia on request: a randomised non-inferiority trial. *BJOG.* 2015;122(3):344-350. doi: 10.1111/1471-0528.12854
28. Xu J, Zhou R, Su W, et al. Ultrasound-guided bilateral pudendal nerve blocks of nulliparous women with epidural labour analgesia in the second stage of labour: a randomised, double-blind, controlled trial. *BMJ Open.* 2020;10(8):e035887. doi: 10.1136/bmjopen-2019-035887
29. Tan HS, Zeng Y, Qi Y, et al. Automated mandatory bolus versus basal infusion for maintenance of epidural analgesia in labour. *Cochrane Database Syst Rev.* 2023;6(6):CD011344. doi: 10.1002/14651858.CD011344.pub3
30. Silverman M, Zwolinski N, Wang E, et al. Regional analgesia for cesarean delivery: a narrative review toward enhancing outcomes in parturients. *J Pain Res.* 2023;16:3807-3835. doi: 10.2147/JPR.S428332
31. Heesen P, Halpern SH, Beilin Y, et al. Labour neuraxial analgesia and breastfeeding: an updated systematic review. *J Clin Anesth.* 2021;68:110105. doi: 10.1016/j.jclinane.2020.110105
32. Chen X, Zhang Y, Ni X, Liu Z. Effects of labour analgesia with different concentrations of ropivacaine on maternal body temperature and inflammatory factor: a randomised controlled study. *Anaesth Crit Care Pain Med.* 2022;41(2):101030. doi: 10.1016/j.accpm.2022.101030
33. Haidl F, Tronstad C, Rosseland LA, Dahl V. Maternal haemodynamics during labour epidural analgesia with and without adrenaline. *Scand J Pain.* 2021;21(4):680-687. doi: 10.1515/sjpain-2020-0176
34. Vilkko R, Räisänen S, Gissler M, et al. Busy day effect on the use of obstetrical interventions and epidural analgesia during labour: a cross-sectional register study of 601,247 deliveries. *BMC Pregnancy Childbirth.* 2022;22(1):481. doi: 10.1186/s12884-022-04798-6
35. Yu K, Ding Z, Yang J, et al. Bibliometric analysis on global analgesia in labour from 2002 to 2021. *J Pain Res.* 2023;16:1999-2013. doi: 10.2147/JPR.S416142
36. Liu LY, Lange EMS, Yee LM. Association between maternal neuraxial analgesia and neonatal outcomes in very preterm infants. *AJP Rep.* 2023;13(4):e65-e70. doi: 10.1055/s-0043-1776147
37. Halliday L, Nelson SM, Kearns RJ. Epidural analgesia in labour: a narrative review. *Int J Gynaecol Obstet.* 2022;159(2):356-364. doi: 10.1002/ijgo.14175
38. de Verastegui-Martín M, de Paz-Fresneda A, Jiménez-Barbero JA, et al. Influence of labouring people's mobility and positional changes on birth outcomes in low-dose epidural analgesia labour: a systematic review with meta-analysis. *J Midwifery Womens Health.* 2023;68(1):84-98. doi: 10.1111/jmwh.13446
39. Guasch E, Brogly N, Gilsanz F. Combined spinal epidural for labour analgesia and caesarean section: indications and recommendations. *Curr Opin Anaesthesiol.* 2020;33(3):284-290. doi: 10.1097/ACO.0000000000000866
40. Lu R, Rong L, Ye L, Xu Y, Wu H. Effects of epidural analgesia on intrapartum maternal fever and maternal outcomes: an updated systematic review and meta-analysis. *J Matern Fetal Neonatal Med.* 2024;37(1):2357168. doi: 10.1080/14767058.2024.2357168
41. Liu ZH, Wang DX. Potential impact of epidural labour analgesia on the outcomes of neonates and children. *Chin Med J (Engl).* 2020;133(19):2353-2358. doi: 10.1097/CM9.0000000000000900
42. Callahan EC, Lee W, Aleshi P, George RB. Modern labour epidural analgesia: implications for labour outcomes and maternal-fetal health. *Am J Obstet Gynecol.* 2023;228(5):S1260-S1269. doi: 10.1016/j.ajog.2022.06.017