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COMPARATIVE EFFECTIVENESS OF PAIN-RELIEF METHODS DURING LABOUR: A LITERATURE REVIEW

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ABSTRACT

Effective management of labour and childbirth pain is one of the goals of modern obstetric care. This review compares the effectiveness of pharmacological and non-pharmacological methods of pain relief during labour and childbirth, based on recent randomized controlled trials, meta-analyses, and systematic reviews.

Epidural and combined spinal-epidural techniques provide the most profound and reliable pain relief with high maternal satisfaction, although they prolong the second stage of labour and require specialist monitoring. Systemic opioids – pethidine, fentanyl, and remifentanil – offer moderate analgesia; updated remifentanil protocols have improved safety and maternal autonomy where neuraxial services are limited. Nitrous oxide remains a safe, reversible alternative with limited efficacy.

Among non-pharmacological methods, evidence supports hydrotherapy, massage, acupuncture, acupressure, transcutaneous electrical nerve stimulation (TENS), relaxation and breathing techniques, and continuous emotional support. Emerging data highlight the benefits of sterile water injections for lower-back pain, as well as music therapy, mindfulness, virtual reality, peanut-ball positioning, aromatherapy, and thermal therapy as safe and complementary methods of relieving labour pain. These methods enhance maternal comfort and satisfaction and reduce anxiety and perceived pain intensity.

Comparative evidence confirms that no single intervention is universally superior. A multimodal, individualized approach that integrates pharmacological precision with supportive, behavioural, and sensory-based techniques offers the most effective pathway for improving maternal experience during labour.

KEYWORDS

Labour Pain, Analgesia, Epidural Analgesia, Systemic Opioids, Non-Pharmacological Interventions, Multimodal Pain Management

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Introduction

Labour is a physiological process involving coordinated uterine contractions, cervical dilatation, and fetal descent through the birth canal. Pain is an inherent component of this process. During the first stage of labour, nociceptive impulses originate predominantly from uterine contractions and cervical dilatation and are conveyed via sympathetic fibres to thoracolumbar spinal segments T10–L1. In the second stage, pain is primarily somatic, generated by distension of the pelvic floor, vagina, and perineum, then transmitted via the pudendal nerve to S2–S4. Perception of this pain is modulated by endocrine, neurochemical, and psychological factors, including variations in oxytocin, prostaglandins, catecholamines, and endogenous opioids, as well as maternal anxiety, fatigue, and environmental context.

Unmanaged labour pain can provoke stress-related physiological responses, including increased catecholamine release, which may reduce uterine perfusion and impair contractile efficiency. This may contribute to hyperventilation, fatigue, and heightened distress, with potential implications for labour progression, fetal well-being, and the overall birth experience. Effective analgesia supports maternal comfort, reduces stress reactivity, and simplifies cooperation with clinical care, which enhances satisfaction with the intrapartum experience.

A broad repertoire of pharmacological interventions is used to manage labour pain. Pharmacological methods include neuraxial techniques (epidural and combined spinal–epidural [CSE]), systemic opioids administered intravenously or intramuscularly, and inhaled nitrous oxide.”Recent large-scale analyses have refined remifentanil patient-controlled analgesia (PCA) protocols, confirming its safety and utility where neuraxial analgesia is unavailable. These approaches differ in mechanisms, depth of analgesia, adverse-effect profiles, and effects on labour dynamics and neonatal outcomes.

Non-pharmacological techniques encompass water immersion, massage, transcutaneous electrical nerve stimulation (TENS), acupuncture, acupressure, relaxation and breathing strategies, continuous emotional support, upright or mobile positions, aromatherapy, mindfulness training, virtual reality immersion, local thermal applications, sterile water injections, and integrative adjuncts such as music therapy and mindfulness-based approaches, all supporting their role in enhancing relaxation, perceived control, and overall comfort during labour.

Despite extensive research, direct comparisons across methods remain challenging due to heterogeneity in study designs, variability in pain assessment instruments, differences in clinical settings, and inconsistent follow-up of maternal and neonatal outcomes. Global studies also highlight variations in access to and implementation of both pharmacological and non-pharmacological techniques, influenced by resource availability and provider training. A consolidated appraisal of the evidence base is therefore warranted to clarify relative effectiveness, safety considerations, and implications for maternal experience.

The aim of this review is to synthesize and compare evidence on pharmacological and non-pharmacological methods of pain relief during labour, with attention to comparative analgesic effectiveness, safety, and acceptability, to form individualized, evidence-based intrapartum care.

Materials and Methods

This article was prepared as a literature review aimed at presenting and evaluating the current state of knowledge on the effectiveness of various methods of pain relief during labour and childbirth. The review focused on both pharmacological and non-pharmacological interventions, with particular attention to their comparative efficacy, safety, and impact on maternal satisfaction and the course of labour.

The source material consisted of full-text scientific publications from peer-reviewed international journals. The analysed literature included randomized controlled trials, systematic reviews, and meta-analyses concerning labour analgesia. Studies were selected to represent the diversity of clinical practice and methodological approaches in contemporary obstetrics. The time frame covered primarily the last ten years, with emphasis on publications from the last five years, to ensure that the findings reflected current standards of care and incorporated recent evidence from large multicentre trials and high-quality syntheses [18, 24–25, 40, 54–55, 59].

Inclusion criteria comprised:

- Studies involving women in labour or childbirth, regardless of parity or delivery mode.
- Research evaluating pharmacological and/or non-pharmacological methods of labour pain management.
- Publications reporting measurable outcomes such as pain intensity, maternal satisfaction, duration of labour, or neonatal well-being.
- Studies with clear methodology and use of validated assessment tools.

Exclusion criteria included:

- Reports unrelated to intrapartum pain management or focused solely on the postpartum period.
- Case reports, commentaries, and conference abstracts.
- Publications lacking explicit outcome measures or methodological transparency.

The analysis process involved several stages. Initially, titles and abstracts were screened to exclude studies not directly related to the topic. In the next step, full-text papers were analysed in terms of study design, participant characteristics, intervention type, pain-assessment methods, and duration of observation. Examples of included studies range from large clinical trials on regional techniques such as epidural or combined spinal–epidural analgesia [31, 39], to systematic reviews and randomized controlled trials addressing non-pharmacological methods such as water immersion [24–26], acupuncture and acupressure [1, 18, 50, 56, 59], relaxation and breathing techniques [16], continuous labour support and broader use of non-pharmacological strategies [6, 19, 21, 52–54], and integrative modalities such as music therapy [22, 43–45, 57], aromatherapy [27, 45–46], manual and massage-based interventions [4, 15, 49–51], mindfulness [36–37], virtual reality [7, 29], and local thermal applications [30, 48].

Pharmacological interventions were analysed based on recent large-scale and comparative studies evaluating systemic opioids—including pethidine, fentanyl, and remifentanil—administered as patient-controlled analgesia or intramuscular injections [8, 12, 14, 20, 40–42]. Evidence on neuraxial analgesia was drawn from major randomized and systematic reviews comparing epidural and combined spinal–epidural techniques with other forms of analgesia [10, 31, 39]. Studies examining inhaled nitrous oxide as an alternative or adjunct to other pharmacological options, including both narrative reviews and large observational cohorts,

were also included [38, 57–58]. In addition, the review incorporated evidence regarding sterile water injections for lower-back labour pain, reflecting their increasing use as a non-invasive, low-cost analgesic technique [9, 28, 47].

Each publication was subjected to qualitative evaluation regarding methodological rigour, clarity of outcome reporting, and clinical relevance. The results were then organised thematically to allow a structured discussion of the two main categories of intervention: pharmacological and non-pharmacological methods of labour analgesia. This thematic synthesis enabled an integrated comparison of analgesic efficacy, maternal experiences, and safety outcomes reported across the literature.

No statistical meta-analysis or formal risk-of-bias assessment was performed, as the aim of this work was to conduct a qualitative and synthetic analysis rather than quantitative data aggregation. The narrative review method provided the flexibility required to include studies of diverse design, participant groups, and assessment tools, which is crucial for comprehensively addressing a multidisciplinary issue such as pain management in labour.

Results

Fifty-nine publications met the eligibility criteria, spanning randomized and quasi-experimental trials, cohort studies, meta-analyses, and systematic reviews that evaluated pharmacological and non-pharmacological approaches to intrapartum analgesia [1–59]. The most frequently reported outcomes were: pain intensity, maternal satisfaction, effects on labour dynamics, and neonatal condition.

Pharmacological methods

Regional techniques.

Across multiple high-quality syntheses and trials, neuraxial methods provided the deepest and most dependable analgesia during labour, with consistent gains in satisfaction scores [5, 10, 31, 39]. Combined spinal–epidural typically achieved a faster onset than conventional epidural while maintaining comparable safety indices for mother and neonate [5, 10, 31]. Low-dose local anaesthetic–opioid mixtures, including intrathecal morphine formulations, reduced motor blockade and helped preserve mobility in many protocols, with only a small extension of second-stage duration reported in large pragmatic work [5, 31, 39].

Systemic opioids.

Pethidine, fentanyl, and remifentanil (including patient-controlled regimens) yielded moderate reductions in pain, with improved perceived control when patient-controlled devices were used [8, 12, 14, 20, 40–42]. Recent data confirm that optimized remifentanil PCA dosing protocols achieve satisfactory analgesia along with acceptable maternal oxygenation and neonatal safety, particularly in contexts where neuraxial analgesia is unavailable [40–42]. Retrospective analyses further indicate that initiating remifentanil at more advanced cervical dilations may enhance efficacy while maintaining maternal–fetal safety when supported by continuous monitoring [41]. Sedation and brief oxygen desaturation were the most frequent maternal adverse effects; neonatal outcomes were generally acceptable, with some studies noting transient respiratory depression or lower early alertness scores [14, 20, 40–41].

Inhaled agents.

Nitrous oxide demonstrated rapid onset and quick offset with limited analgesic benefit and a favourable safety profile, making it useful where neuraxial services are unavailable or declined [38]. Efficacy remained lower than neuraxial options, but labour progress and mode of birth were typically unaffected [38–39]. Large observational and registry-based analyses further suggest that nitrous oxide is widely used as part of multimodal pain relief packages and does not adversely influence maternal childbirth experience or neonatal condition when appropriately supervised [57–58].

Non-pharmacological methods

Hydrotherapy/water use.

Water immersion during the first stage of labour was consistently associated with decreased pain intensity, reduced anxiety and high levels of maternal satisfaction. Several studies also reported a lower probability of conversion to epidural analgesia among women who utilised water immersion, without evidence of adverse neonatal effects [24–26]. Findings from broader systematic reviews of hydrotherapy reinforce these outcomes, emphasising its favourable safety profile and recommending careful selection of suitable candidates to maximise clinical benefit [24–25].

Acupuncture, acupressure, and traditional Chinese medicine (TCM).

Studies reported decreases in pain scores and reduced uptake of pharmacological analgesia when these techniques were applied early, though the magnitude of effect varied by protocol and practitioner expertise [1, 4, 13, 18, 56]. Network meta-analyses indicate that multimodal TCM-based interventions—including acupuncture, acupressure, moxibustion, and acupoint heat therapy—may provide additive benefits by stimulating endogenous opioid release and modulating peripheral nociception [18]. Recent high-quality meta-analytic work specifically focused on acupressure confirms clinically meaningful reductions in labour pain intensity and improved satisfaction compared with standard care or sham stimulation [59]. Combined acupoint stimulation and heat application may further enhance analgesic duration, though confirmatory multicentre RCTs are still limited [13, 18]. Growing evidence from TCM-based interventions suggests that these non-Western approaches offer culturally adaptable, low-risk options that can complement standard biomedical methods in labour pain management [18, 56, 59].

Manual and neurostimulation strategies.

Massage and shiatsu techniques were associated with improved maternal comfort, reduced anxiety, and a greater sense of control during labour, with randomized trials reporting consistent benefits in subjective experience [4, 15, 49–51]. Structured relaxation and breathing programmes further enhanced coping and emotional regulation, with evidence indicating reduced sympathetic arousal and modest improvements in labour progression and satisfaction [16, 19].

TENS, typically applied over T10–L1 dermatomes during early labour, produced modest but clinically meaningful reductions in pain intensity and was well tolerated across several randomized and systematic evaluations [3, 11]. Some studies also noted delayed conversion to pharmacological analgesia and comparable early-stage pain relief to hydrotherapy, supporting its role as a flexible adjunct within multimodal analgesic strategies [3, 11].

Support, mobility, and position.

Continuous one-to-one support (including doula or midwife-led companionship) correlated with shorter labours, fewer interventions, and improved ratings of the birth experience [6, 19, 21]. Upright or mobile positioning in the first stage—and evidence from the second stage, both without and with epidural—indicated benefits for comfort and, in some contexts, efficiency of labour [17, 31–35]. Recent quality-improvement and observational work further shows that when maternity units actively promote non-pharmacological measures (such as movement, positioning, hydrotherapy, and supportive touch), overall use of these methods increases and women report better experiences of care [52–54].

Recent trials have also examined culturally rooted manual support techniques such as the Rebozo method—a traditional Mexican practice using a woven cloth to rhythmically rock or lift the abdomen and pelvis during contractions. The Rebozo technique has been shown to reduce perceived pain intensity, improve maternal comfort, and enhance the subjective birth experience without adverse outcomes [17]. Together, these findings reinforce that encouraging movement, supportive contact, and adaptive positioning can optimize maternal comfort, labour dynamics, and satisfaction of the childbirth experience, offering low-risk, adaptable strategies that integrate effectively into holistic, woman-centred intrapartum care.

Peanut ball positioning.

Evidence from randomized controlled trials and non-randomized comparative studies indicates that peanut-ball positioning enhances maternal comfort and may shorten the first and second stages of labour, particularly among women receiving epidural analgesia [23, 32–35]. The technique encourages external rotation of the femur and widens the pelvic outlet, thereby improving fetal rotation and descent. Women using the peanut ball have reported reduced back pain, greater ease of movement within bed restrictions, and higher satisfaction compared with standard supine positioning. Several studies suggest potential secondary benefits, including reduced rates of instrumental delivery and caesarean section, though findings remain heterogeneous across populations. No adverse maternal or neonatal outcomes have been associated with its use, and its simplicity, low cost, and compatibility with neuraxial analgesia make it a practical adjunct in modern obstetric practice.

Sterile water injections (SWIs).

SWIs have been evaluated as a targeted non-pharmacological method for alleviating intense lower back pain during labour, particularly in cases of occiput posterior or malpositioned fetal presentations. The technique involves the intradermal or subcutaneous administration of small volumes of sterile water—usually four injections across the sacral area—eliciting a brief, sharp stinging sensation followed by prolonged analgesia lasting up to two hours. The underlying mechanism is attributed to counter-irritation and gate-control

modulation of nociceptive transmission within spinal segments corresponding to the lumbosacral dermatomes. Multiple randomized controlled trials report significant reductions in pain intensity and decreased demand for pharmacological analgesia among women receiving SWIs compared with placebo or standard care [28, 47]. Maternal satisfaction levels are generally high, and no serious adverse effects for mother or neonate have been observed. Despite its short duration of effect, the intervention can be repeated and is particularly useful where neuraxial analgesia is unavailable or contraindicated. Limitations across studies include variations in injection technique, volume, and pain-assessment timing, which complicate cross-trial comparison. Nonetheless, the accumulated evidence supports SWIs as a safe, low-cost, and practical adjunct for managing labour-related back pain, particularly in resource-limited or midwife-led settings [9, 28, 47].

Local thermal strategies.

Thermal interventions, such as continuous warmth or alternating hot and cold applications, represent simple yet physiologically grounded methods for managing labour pain. Local heat promotes muscle relaxation, increases tissue perfusion, and may reduce ischemic pain associated with uterine contractions, while cold application provides transient analgesia through vasoconstriction and counter-stimulation of cutaneous nociceptors. Evidence from controlled trials indicates that both techniques can significantly lower reported pain scores and enhance maternal comfort without adverse maternal or neonatal effects [30, 48]. Infrared-based heat therapy and acupoint hot-compress approaches have recently been validated in multicentre trials, showing improved comfort and decreased analgesic conversion rates [13, 30]. Despite their apparent safety and low cost, research on thermal interventions remains limited by small sample sizes and variability in application protocols. Larger, standardized trials are warranted to clarify optimal timing, duration, and temperature range, and to determine whether combining thermal therapy with other sensory or relaxation techniques yields additive analgesic benefit.

Aromatherapy.

Recent evidence supports the use of lavender, ginger, or mixed essential-oil aromatherapy for relaxation and pain modulation during labour, as a complement to massage or music therapy. Randomized trials have demonstrated reduced pain scores and anxiety levels, as well as higher satisfaction among participants [27, 45–46].

Music-based interventions.

Music therapy has emerged as a widely studied non-pharmacological strategy for modulating labour pain and anxiety through auditory distraction, emotional regulation, and autonomic stabilization. Across several randomized and quasi-experimental trials, exposure to selected music during the first and second stages of labour led to statistically significant reductions in pain intensity, anxiety, and perceived stress compared with standard care [22, 43–45]. The mechanisms proposed include activation of the brain's limbic and reward circuits, release of endogenous opioids, and attenuation of sympathetic nervous system activity, all of which contribute to reduced perception of pain and relaxation. Music also fosters a sense of familiarity and safety within the birthing environment, enhancing maternal comfort and promoting a positive emotional state. Studies further indicate improved satisfaction with the childbirth experience and reduced demand for pharmacological analgesia among women receiving music interventions. Variability in outcomes is partly attributable to differences in musical genre, tempo, and timing of exposure, but the majority of trials favoured individualized selection of music, allowing women to choose tracks based on personal preference and cultural context. No adverse effects have been reported, and implementation requires minimal resources, making music therapy a cost-effective and easily adaptable component of integrative intrapartum care.

Mindfulness-based interventions.

Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) have been investigated as psychological strategies to alleviate labour pain and anxiety. These approaches emphasize sustained attention, acceptance of bodily sensations, and reduction of fear-related tension, thereby modulating the emotional response to nociceptive stimuli. Several controlled studies reported significant decreases in perceived pain intensity, anxiety, and pain-related fear among women who received structured mindfulness training during pregnancy or early labour compared with standard antenatal education [36–37]. Participants frequently described greater calmness, improved focus, and an enhanced sense of control throughout labour, which translated into higher satisfaction with the childbirth experience. Some trials also noted improved physiological indices, including lower cortisol levels and heart rate, though evidence remains preliminary. Mindfulness interventions were well tolerated, free from adverse effects, and could be delivered through brief group sessions, guided audio materials, or mobile applications, enhancing their accessibility in routine maternity care. Despite promising results, the number of large-scale randomized studies remains limited, and the heterogeneity of program duration and content complicates definitive conclusions regarding optimal structure and timing of implementation.

Antenatal hypnosis.

In addition to mindfulness-based approaches, antenatal hypnosis training has been explored as a preparatory strategy for managing labour pain and reducing reliance on pharmacological analgesia. A recent systematic review and meta-analysis reported that structured antenatal hypnosis programmes are associated with lower use of pharmacological pain relief and, in some studies, with improved childbirth experience and maternal sense of control, although effects on pain intensity itself were more variable [2]. These findings suggest that hypnosis-based interventions may function as a complementary, low-risk option that can be integrated into antenatal education, particularly for women seeking to minimise medical analgesia during labour.

Virtual reality (VR).

Recent research has explored the use of virtual reality as an innovative non-pharmacological adjunct for intrapartum pain management. Immersive VR interventions employ visual, auditory, and interactive stimuli to divert maternal attention away from nociceptive input and reduce anxiety associated with labour. Randomized and quasi-experimental trials have demonstrated decreases in self-reported pain intensity and distress during the first stage of labour compared with standard supportive care [7, 29]. Women using VR commonly reported a greater sense of calm, engagement, and perceived control, which contributed to improved satisfaction with the birthing experience. Importantly, no adverse maternal or neonatal effects have been reported, and the method is easily compatible with concurrent medical monitoring and pharmacological analgesia. Despite these encouraging results, existing studies remain limited by small sample sizes and variable duration of exposure, highlighting the need for larger trials employing standardized protocols to confirm efficacy and determine optimal timing and content of VR interventions.

Cross-cutting observations

Analgesic depth versus mobility.

Neuraxial methods achieved the most profound pain relief but constrained mobility to varying degrees depending on dosing paradigms [10, 31, 39].

Acceptability and satisfaction.

High satisfaction accompanied neuraxial techniques and many supportive, non-pharmacological strategies. Patient-controlled regimens (remifentanil PCA) improved perceived autonomy despite moderate analgesic intensity **[12, 14, 40–42]**, while massage-based approaches, music therapy, and structured use of non-pharmacological methods also showed favourable associations with birth experience and perceived control **[22, 43–45, 49–51, 52–54, 57]**.

Safety signals.

Serious adverse outcomes were uncommon across modalities included in this review. Reported maternal effects were typically transient (sedation with systemic opioids; pruritus or hypotension with neuraxial; nausea/light-headedness with nitrous oxide), and neonatal indicators were generally reassuring when monitored appropriately [10, 12, 31, 38–41, 47, 58].

Heterogeneity.

Differences in protocols, timing of initiation, operator skill, and outcome instruments limited head-to-head comparisons, reinforcing the value of a multimodal, preference-sensitive approach grounded in local resources and clinical context [1–59]. Broad overviews and network/meta-analyses of non-pharmacological strategies further underline this heterogeneity while confirming that several low-risk interventions offer meaningful, if modest, reductions in labour pain and improvements in maternal experience [18, 24–25, 54–55, 59].

Discussion

The evidence synthesized in this review demonstrates that labour pain management remains a multifaceted issue requiring both physiological understanding and individualized clinical application. Across the fifty-nine studies analyzed, a consistent pattern emerged: no single intervention provides universal benefit for all women, and effective care depends on the dynamic interplay between analgesic efficacy, maternal preference, and safety considerations [1–59].

Regional analgesia remains the benchmark for pharmacological control of labour pain. Epidural and combined spinal–epidural (CSE) techniques repeatedly achieved the most profound reduction in pain scores and the highest satisfaction levels, as confirmed by multiple randomized and systematic evaluations [31, 39]. Nevertheless, their use requires skilled personnel, monitoring facilities, and continuous observation, limiting accessibility in many low-resource environments. Minor physiological effects, such as hypotension or delayed second-stage progression, appear clinically manageable and rarely compromise obstetric outcomes [31, 39].

Additionally, low-dose local anaesthetic–opioid regimens have improved mobility and reduced motor block, suggesting potential refinements to neuraxial practice that align better with woman-centred care models [31].

Systemic opioids and inhaled nitrous oxide continue to play complementary roles in maternity care. They are often employed where neuraxial services are unavailable or declined. Both options are associated with moderate analgesic efficiency, rapid onset, and reversible effects, yet maternal sedation and occasional neonatal respiratory changes remain their primary limitations [14, 20, 38, 40–42]. Comparatively, meta-analytic data indicate that remifentanil patient-controlled analgesia (PCA) provides inferior pain relief to epidural but can yield higher perceived autonomy and satisfaction, at the expense of more frequent transient maternal desaturation events—underscoring the need for vigilant monitoring and protocolized dosing [40]. Retrospective findings further suggest that initiating remifentanil at more advanced cervical dilations may optimise its benefit–risk ratio [41]. Observational data also show that nitrous oxide is widely integrated into multimodal analgesia strategies without clear adverse effects on neonatal outcomes or overall childbirth experience when appropriately supervised [38, 57–58]. Taken together, these results clarify the specific contexts in which systemic opioids and inhaled agents can be used safely and effectively.

Non-pharmacological methods occupy a growing position in contemporary intrapartum practice. Evidence supports water immersion, continuous emotional support, and movement or upright positions as interventions that promote both comfort and physiological labour progression [6, 19, 21, 24–26, 31–35, 52–54]. Mind–body techniques such as relaxation, breathing control, and music therapy strengthen the psychological dimension of childbirth and contribute to a sense of agency and calm [16, 22, 43–45, 49–51, 54–55]. The use of TENS, massage, acupuncture, acupressure, and thermal applications yields moderate but meaningful reductions in perceived pain and anxiety [1, 3–4, 15, 18, 27, 30, 48–51, 56, 59]. Comparisons within non-pharmacological modalities reveal that treatment fidelity and practitioner skill significantly influence outcomes—for example, acupressure and acupoint heat therapies performed according to standardized protocols tend to produce more consistent analgesic effects [13, 18, 49–50, 56, 59].

Importantly, several studies highlight that psychosocial and experiential outcomes may be equally relevant as analgesic depth. Women often prioritise emotional support, mobility, and autonomy over maximal pharmacological pain relief [14, 19, 21, 52–54, 57]. Interventions such as continuous support, aromatherapy, massage, and music therapy therefore show sustained advantages in satisfaction despite offering only moderate reductions in pain intensity [22, 27, 43–46, 49–51, 52–54]. Large cohort data further indicate that the overall configuration of pain relief methods—rather than any single technique—shapes maternal perceptions of childbirth, reinforcing the importance of choice and individualized care planning [52, 57]. This distinction underscores the necessity of evaluating labour pain management approaches not solely through analgesic efficacy but through holistic measures that reflect women's priorities.

The integration of these approaches into routine obstetric care provides a balanced strategy for maternal well-being. Studies combining non-pharmacological support with regional or systemic analgesia report superior satisfaction and fewer adverse emotional responses [6, 23, 31, 52–54]. Hydrotherapy and music/aromatherapy adjuncts, when layered onto standard care, are associated with lower reported pain and reduced anxiety without compromising labour progress or neonatal outcomes [22, 24–25, 27, 45–46]. Massage-based approaches, including sacral, shiatsu, and endorphin-stimulating techniques, likewise appear to enhance comfort and birth experience when offered alongside routine medical care [4, 15, 49–51]. Multimodal models that combine neuraxial techniques with continuous interpersonal support and simple non-pharmacological adjuncts appear to optimize outcomes without increasing complication rates [6, 23–24, 31, 52–55].

Interpretation of the literature is limited by heterogeneity in research design, variable pain-assessment instruments, and inconsistent timing of measurements. Many trials also exhibit small sample sizes or short observation periods, restricting generalizability. Furthermore, cultural expectations and differences in healthcare systems influence both the acceptance and implementation of specific interventions. Standardization of outcome measures, such as validated pain scales and consistent satisfaction indices, would enhance comparability in future research. In opioid research, open-label designs and variability in remifentanil dosing/monitoring protocols complicate comparisons with epidural analgesia [40–42]. In the non-pharmacological domain, inconsistent protocols (e.g., TENS electrode placement, timing and duration of thermal or VR exposure, specific acupoints and pressure parameters) similarly limit cross-study synthesis [1, 3, 11, 13, 18, 30, 49–51, 56, 59]. Recent systematic and network meta-analyses of non-pharmacological coping strategies confirm both the promise of these approaches and the underlying methodological heterogeneity [18, 24–25, 54–55, 59].

The growing exploration of complementary modalities—such as mindfulness, virtual reality, innovative positioning devices, and updated acupressure protocols—illustrates a shift in obstetric philosophy toward addressing the emotional as well as the physical aspects of childbirth [7, 23, 29, 32–35, 36–37, 49–51, 59]. Recent trials and reviews suggest mindfulness programs can lower pain-related fear and anxiety and may improve physiological stress indices, though larger multicentre RCTs are still needed [36–37]. VR consistently demonstrates short-term reductions in pain and distress versus standard support, yet optimal timing and duration remain to be defined [7, 29]. Sterile water injections offer a low-cost option with short-term analgesic benefit for severe back pain and reduced analgesic conversion in several trials, making them particularly relevant where neuraxial services are constrained [9, 28, 47]. Enhanced acupressure protocols and updated meta-analyses further support the role of targeted acupoint stimulation as part of a broader TCM-informed approach to labour pain [18, 56, 59].

Collectively, the evidence supports a multimodal, evidence-based model of labour pain management in which pharmacological and non-pharmacological methods are not competitive but complementary. Regional analgesia remains the most potent intervention for pain relief, while supportive, behavioural, and sensory-based techniques enhance maternal satisfaction, autonomy, and emotional adaptation. Comparative-effectiveness data now clarify trade-offs: neuraxial techniques maximize analgesia; remifentanil PCA improves autonomy with careful monitoring; hydrotherapy, TENS, massage, acupressure, aromatherapy, music therapy, and thermal/VR strategies provide additive comfort with minimal risk—allowing tailored pathways that match women's preferences, clinical context, and resource availability [1, 3–4, 11, 18, 22, 24–27, 30, 38–40, 48–51, 55, 59]. The effective combination of these strategies should be viewed as a central component of high-quality, woman-centred maternity care.

Strengths and Limitations of the Review

The principal strength of this review lies in its comprehensive scope and integration of multiple methodological perspectives. **Fifty-nine** publications were included, encompassing randomized controlled trials, observational cohorts, systematic reviews, and meta-analyses conducted in diverse clinical and cultural contexts. This breadth allowed for an extensive synthesis of both pharmacological and non-pharmacological methods of labour analgesia. The inclusion of large, high-quality trials such as the BUMPES study on maternal positioning [31] and several Cochrane and large-scale systematic reviews on epidural analgesia, remifentanil patient-controlled analgesia, hydrotherapy, and acupressure/TCM-based interventions [18, 24–25, 39–40, 54–55, 59], as well as a large multicentre randomized trial on sterile water injections [47], provided a solid evidence base for evaluating comparative effectiveness. Recent meta-analyses on remifentanil patient-controlled analgesia versus epidural analgesia [40], hydrotherapy in pain management [25], and labour acupressure [18, 59] further strengthened the comparative framework of this review. By combining data from studies exploring clinical outcomes with those addressing maternal satisfaction and psychological adaptation, including large cohort analyses of childbirth experience and pain-relief patterns [21, 52, 57–58], the review reflects the multidimensional nature of labour pain.

Another strength is the emphasis on balanced representation of interventions. Equal attention was given to established medical techniques, such as regional and systemic analgesia, and to complementary approaches including relaxation, hydrotherapy, acupuncture and acupressure, and continuous emotional support [1, 4, 6, 16, 18–19, 21, 24–25, 52–55, 59]. Emerging modalities—such as mindfulness training [36–37], virtual reality [7, 29], aromatherapy [27, 45–46], massage-based strategies including sacral, shiatsu, and endorphin massage [4, 15, 49–51], updated acupressure protocols [18, 56, 59], and sterile water injections [9, 28, 47]—were also included, expanding the scope beyond conventional practice and reflecting the evolving landscape of woman-centred, non-invasive analgesic options. This balance allowed for a nuanced assessment of how different strategies interact and contribute to holistic, patient-focused intrapartum care. The narrative format facilitated qualitative synthesis of heterogeneous findings, capturing both physiological and psychosocial dimensions often overlooked in quantitative meta-analyses. In particular, the inclusion of studies evaluating maternal perception, autonomy, and satisfaction (e.g., remifentanil PCA, water immersion, music therapy, nitrous oxide and multimodal analgesia patterns) strengthened the interpretive dimension of the review [14, 20, 22, 24–26, 40, 43–45, 52, 57–58].

Several limitations must be acknowledged. The studies included varied widely in design quality, sample size, and measurement tools. Pain intensity and satisfaction were assessed using multiple, often non-standardized scales, limiting direct comparability. Methodological weaknesses such as lack of blinding, inconsistent timing of outcome assessment, and incomplete reporting of adverse events were present in a

proportion of trials [3, 11, 30, 40, 49–51, 56]. Comparative-effectiveness studies involving opioids, mindfulness, or VR frequently employed open-label or small-sample designs, limiting generalizability [7, 29, 36–37]. In the non-pharmacological domain, inconsistent protocols (e.g., TENS electrode placement, timing and duration of thermal or VR exposure, specific acupoints and pressure duration or intensity) similarly limit cross-study synthesis [1, 3–4, 11, 13, 18, 27, 30, 48–51, 56, 59]. Publication bias cannot be excluded, as studies demonstrating positive effects are more likely to be published, particularly within complementary and alternative medicine research domains and non-pharmacological pain management more broadly [22, 24–25, 27, 43–46, 54–55, 59].

The review itself, being narrative in design, does not provide pooled quantitative estimates or formal risk-of-bias analysis. Consequently, the conclusions represent a qualitative synthesis rather than statistical inference. Another constraint lies in the linguistic and temporal boundaries of the search, which primarily covered English-language studies published within the last two decades. Emerging or region-specific research published outside this period may therefore not have been captured. Additionally, the exclusion of grey literature and non-indexed local studies could limit representation of midwife-led or low-resource settings, particularly regarding simple non-pharmacological interventions like sterile water injections, TENS, and structured non-pharmacological care bundles [6, 9, 28, 52–53]. Despite these limitations, the review provides a broad and integrative overview of contemporary approaches to labour pain management. By uniting evidence from multiple disciplines—obstetrics, midwifery, anaesthesiology, and psychology—it contributes to a more comprehensive understanding of the mechanisms, effectiveness, and contextual application of analgesic methods during childbirth. The inclusion of both traditional and emerging modalities highlights the comparative landscape of efficacy, feasibility, and maternal satisfaction—offering a practical foundation for developing integrative, multimodal models of intrapartum analgesia [1–59].

Conclusions

The collective evidence synthesized in this review indicates that successful management of labour pain requires an individualized, context-sensitive, and evidence-based approach. Pharmacological methods—particularly epidural and combined spinal–epidural (CSE) analgesia—consistently provide the most profound and reliable pain relief, supported by large randomized trials and systematic reviews [10, 31, 39]. Their advantages in terms of analgesic depth and maternal satisfaction are well established, though they demand skilled personnel, monitoring resources, and may modestly prolong the second stage of labour [31, 39].

Systemic opioids and inhaled nitrous oxide maintain important complementary roles in maternity care. Comparative analyses confirm that remifentanil patient-controlled analgesia (PCA) offers greater maternal autonomy and satisfaction than traditional parenteral opioids, though epidural remains superior in analgesic intensity [14, 20, 38, 40–42]. Nitrous oxide provides rapid, reversible pain relief with minimal interference in labour progression, though its efficacy remains moderate compared with neuraxial techniques [38]. Large cohort and observational data suggest that nitrous oxide, when used within structured intrapartum care, does not compromise neonatal outcomes and forms part of widely accepted multimodal analgesia patterns [57–58]. These modalities are particularly valuable in midwife-led or resource-limited settings where neuraxial analgesia is unavailable or declined.

Non-pharmacological interventions contribute substantially to maternal comfort, psychological well-being, and overall satisfaction with childbirth. Evidence from controlled trials and meta-analyses supports the effectiveness of water immersion, continuous emotional support, and upright or mobile positioning as interventions that enhance comfort and facilitate physiological labour progress [6, 19, 21, 24–26, 31–35, 52–55]. Sterile water injections provide significant, short-term analgesia for severe back pain during labour, representing a practical, low-cost option where epidural services are limited [9, 28, 47]. Complementary approaches such as acupuncture and acupressure, massage, relaxation, aromatherapy, and music therapy improve maternal experience, reduce anxiety, and may lessen conversion to pharmacological analgesia [1, 4, 13, 18, 22, 27, 43–46, 49–51, 56, 59]. Recent high-quality syntheses demonstrate that structured acupressure protocols and other non-pharmacological coping strategies can achieve clinically meaningful reductions in labour pain as part of a broader, multimodal plan [18, 54–55, 59].

Recent innovations—such as mindfulness-based interventions and virtual reality immersion—have expanded the spectrum of psychological and sensory pain modulation, with early evidence showing reduced anxiety, enhanced coping, and high maternal acceptance [7, 29, 36–37]. While current data are preliminary, these modalities represent promising adjuncts for personalized, holistic pain management in childbirth.

Collectively, the comparative evidence underscores that no single technique is universally optimal; rather, the greatest effectiveness arises from multimodal integration. Studies examining combined approaches—such as the use of neuraxial analgesia with continuous midwifery support, hydrotherapy, or sensory-based techniques—demonstrate higher satisfaction, reduced anxiety, and stable obstetric and neonatal outcomes without increased risk [6, 23–25, 31, 45–46, 52–55]. Despite the expanding evidence base, limitations in study design, heterogeneity of pain-assessment tools, and variability in intervention protocols constrain direct comparison. Few large-scale head-to-head studies have yet quantified relative efficacy among emerging modalities such as VR, mindfulness, and sterile water injections. Future research should prioritize standardized outcome measures, multicentre randomization, and long-term follow-up to clarify both clinical and experiential benefits. Broader inclusion of diverse populations and low-resource settings would enhance the generalizability and equity of pain management recommendations.

In summary, effective labour pain management is not a competition between methods but a synthesis of strengths across interventions. Regional analgesia remains the most potent in analgesic efficacy, while non-pharmacological strategies augment satisfaction, autonomy, and emotional adaptation. The integration of pharmacological precision with supportive, behavioural, and sensory-based care—tailored to each woman's needs, preferences, and clinical context—represents the cornerstone of modern, evidence-based, woman-centred obstetrics [6, 10, 24, 31, 39–40, 52–55, 59].

Practical Recommendations

The findings of this review underscore the importance of an individualized, multimodal approach to labour pain management grounded in comparative effectiveness and patient-centred decision-making. Clinical practice should prioritize informed maternal choice, ensuring that women are actively involved in selecting analgesic methods aligned with their medical condition, expectations, and the facility's resource capacity [6, 19, 21, 23, 31, 39, 52–54].

Regional analgesia, particularly epidural and combined spinal–epidural (CSE) techniques, should remain the gold standard in institutions equipped for continuous maternal and fetal monitoring, as these methods consistently offer the most profound, controllable, and titratable pain relief [10, 31, 39]. Clinicians should employ low-dose local anaesthetic–opioid combinations to preserve mobility and minimize motor block, while maintaining safety and satisfaction [31, 39].

Systemic options, including pethidine, fentanyl, and remifentanil administered via patient-controlled analgesia (PCA), remain valuable alternatives in settings without neuraxial facilities. Remifentanil PCA, in particular, provides a viable bridge between pharmacological efficacy and patient autonomy, though it requires structured monitoring to mitigate transient maternal desaturation [14, 20, 38, 40–42]. Inhaled nitrous oxide should remain available as a flexible, safe, and reversible option, particularly where rapid onset and minimal invasiveness are desirable and where it contributes to a broader, multimodal analgesia plan [38, 57–58].

Non-pharmacological methods should be integrated systematically into standard maternity care rather than reserved for cases where medical analgesia is unavailable. Strong evidence supports the routine use of water immersion, upright or mobile positioning, continuous emotional support, and relaxation or breathing strategies, all of which enhance maternal comfort and facilitate physiological labour progress [6, 16, 19, 21, 24–26, 31–35, 52–55]. These approaches should be embedded into unit protocols and antenatal education so that women are aware of their options before the onset of labour.

Complementary sensory techniques, including massage, TENS, local thermal applications, and music therapy, have demonstrated safety, feasibility, and measurable improvements in maternal experience [1, 3–4, 11, 22, 27, 30, 43–46, 48–51, 54–55]. Their early introduction during the first stage of labour may reduce anxiety, delay the need for pharmacological analgesia, and improve overall satisfaction. Sterile water injections (SWIs) should be considered in women experiencing severe lower-back labour pain, especially in low-resource or midwife-led settings, as they offer short-term but significant analgesic benefit with no major adverse effects [9, 28, 47].

Emerging modalities such as mindfulness-based programs, virtual reality immersion, aromatherapy, and peanut-ball positioning demonstrate promising adjunctive effects in improving maternal coping, reducing perceived pain, and enhancing satisfaction [7, 23, 27, 29, 32–37, 45–46, 49–51, 59]. These approaches may be particularly valuable as non-invasive complements to medical analgesia and warrant further integration into antenatal education, birth plans, and labour ward protocols.

Education and training of midwives, obstetricians, and anaesthetists should emphasize multidisciplinary teamwork, evidence-based counselling, and responsiveness to individual preferences. Regular updates in

analgesia techniques, emergency preparedness for opioid use (e.g., remifentanil PCA), and training in non-pharmacological skills (e.g., TENS placement, water birth facilitation, structured use of massage/acupressure, mindfulness coaching) can strengthen service quality and patient trust [4, 6, 18–19, 49–51, 54–55, 59].

Future clinical guidelines should promote flexible, woman-centred models that blend pharmacological precision with behavioural, sensory, and emotional support. Such integrative strategies not only optimize pain control but also enhance maternal satisfaction, autonomy, and overall childbirth experience—representing the most effective, equitable, and evidence-based pathway for modern intrapartum care [6, 19, 21, 23–25, 31, 39–40, 45–46, 52–55, 57–59].

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