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Evidenced-Based Recommendation for Involving Mothers to Reduce the Procedural Pain and Stress in High-Risk Neonates

A Systematic Review and Meta-Analysis of Randomized Controlled Trials

N. Siva, RN, RM, MSc, PhD; Manisha Praharaj, RN, RM, MSc; Kshirabdhi Tanay, RN, RM, MSc; Sasmita Das, RN, RM, MSc, PhD; Baby S. Nayak, RN, RM, MSc, MPhil, PhD; Leslie Edward S. Lewis, MBBS, DCH, DNB; Judith A. Noronha, RN, RM, MSc, M.Phil, PhD

ABSTRACT

Background: Neonates admitted to the neonatal intensive care unit (NICU) undergo several painful procedures, causing significant stress. Maternal involvement in neonatal care significantly reduces pain and stress, thereby supporting better neurodevelopment in neonates.

Clinical Question: How do maternal involvement strategies reduce neonatal pain and pain-related stress in the NICU?

Data Sources: A systematic search was conducted on CENTRAL, PubMed Medline, EMBASE, CINAHL, Scopus, Web of Science, ProQuest databases, and Google Scholar for studies published between January 2007 and March 2024.

Study Selection: A search across 7 databases yielded a total of 1360 studies, which were exported to Rayyan software for screening. Two independent authors conducted the screening based on the eligibility criteria.

Data Extraction: Cochrane data collection forms were used to extract the data from the included studies.

Results: Out of 1360 titles identified during the initial search, a total of 27 randomized controlled trials were eligible and were included. Although there is a slight inconsistency in results, meta-analysis findings revealed that skin-to-skin care, holding, massage, feeding the baby, and maternal voice stimulation, significantly reduce procedural pain and pain-related stress, in neonates admitted to the NICU.

Implications for Practice and Research: Given the consistent results, this systematic review strongly supports NICU healthcare professionals in encouraging mothers to engage in neonatal care activities to reduce procedural pain and related stress. More research is needed, including navigating the mothers on the importance of their involvement in neonatal care throughout the NICU admission and after hospital discharge.

Key Words: health, high-risk neonate, mother, neonatal intensive care unit, pain, stress

Author Affiliations: *Department of Child Health Nursing, Manipal College of Nursing, Manipal Academy of Higher Education, Manipal, Karnataka, India (Dr Siva); Department of Child Health Nursing, SUM Nursing College, Siksha 'O' Anusandhan University, Bhubaneshwar, Odisha, India (Ms Praharaj) Department of Psychiatry Nursing, SUM Nursing College, Shiksh 'O' Anusandhan University, Bhubaneshwar, Odisha, India(Ms Tanay); Department of Medical and Surgical Nursing, SUM Nursing College, Shiksh 'O' Anusandhan University, Bhubaneshwar, Odisha, India (Dr Das); Department of Child Health Nursing, Manipal College of Nursing, Manipal Academy of Higher Education, Manipal, Karnataka, India(Dr Nayak); Department of Pediatrics, Kasturba Medical College, Academy of Higher Education, Manipal, Karnataka, India (Dr Lewis); and Department of Obstritics and Gynaecology and Dean Manipal College of Nursing, Manipal Academy of Higher Education, Manipal, Karnataka, India (Dr Noronha).*

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Correspondence: *Baby S Nayak, RN, RM, MSc, MPhil, PhD, Department of Child Health Nursing, Manipal College of Nursing, Manipal Academy of Higher Education, Manipal, Karnataka, India (baby.s@manipal.edu)*

Neonates admitted to the Neonatal Intensive Care Unit (NICU) are exceptionally susceptible to pain and pain-related stress.[1-3] NICU admission is associated with neonatal medical illnesses, compounded by necessary medical interventions and nursing procedures, which subject these infants to considerable distress.[4] During their NICU stay, neonates typically undergo around 70 medical procedures, many of which can have a significant impact on their neurodevelopment,[5] these vulnerable infants often endure between 10 to 15 painful procedures each day.[6] In addition to repeated procedures, the extrauterine environment of the NICU, characterized by noise, bright lights, frequent handling by healthcare professionals, positioning, and non-invasive procedures, can cause significant stress among neonates.[4,7] Acknowledging the well-established correlation between stress and heightened pain perception across all demographics, neonatal care presents unique challenges in discerning these 2 phenomena,

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What This Study Adds

- Enhanced Pain Management in High-Risk Neonates: The study provides robust evidence supporting the involvement of mothers in reducing procedural pain in high-risk neonates. By systematically reviewing and analyzing randomized controlled trials, it highlights that maternal presence and engagement, such as skin-to-skin contact or breastfeeding during procedures, significantly alleviate pain and stress in neonates.
- Improved Neonatal Outcomes: This study highlightes the positive impact of maternal involvement on neonatal outcomes beyond pain reduction. It shows that such practices not only soothe the infant during painful procedures but also contribute to better physiological stability, reduced stress levels, and improved overall well-being, offering a comprehensive approach to neonatal care.
- Evidence-Based Recommendations for Clinical Practice: By synthesizing data from multiple high-quality trials, the study provides strong, evidence-based recommendations for healthcare providers. It advocates for integrating maternal involvement into standard neonatal care practices, emphasizing its role as a non-pharmacological intervention that can be easily implemented to enhance the quality of care for high-risk neonates.

particularly among preterm infants.[6,8] Given the inability of nonverbal neonates to self-report discomfort, accurate assessment of pain and stress intensity becomes paramount for effective management and mitigation of their adverse effects during this critical developmental period.[9-11]

Painful procedures and related stress induce immediate physiological and behavioral changes, disrupt feeding and sleep patterns, and increase energy expenditure, potentially leading to complications necessitating prolonged and intensified care.[2,4] The release of cortisol is one such physiological change occurring in response to pain. Cortisol, a steroid hormone regulated by the hypothalamic-pituitary-adrenal axis, is synthesized in the adrenal cortex, displaying adaptive and systemic effects.[12] The elevation of cortisol in the plasma serves as a stress indicator, reflecting the mental and physical pressure response.[7] Prolonged exposure to high cortisol levels can lead to adverse effects such as hyperlipidemia, insulin resistance, immune deficiencies, and detrimental changes in the hippocampus such as reducing neurogenesis, limiting the growth of new neurons, and potentially hindering normal brain development.[4,13] It can also cause structural atrophy in hippocampal neurons, resulting in shrinkage that affects learning and memory functions.[13] These changes increase the risk of long-term cognitive and behavioral issues as the child grows, highlighting the importance of managing stress and cortisol exposure in vulnerable neonates.[14] The underdeveloped nervous system of these neonates, coupled with repeated exposure to pain, can lower pain thresholds, rendering them more sensitive to subsequent painful stimuli.[12]

Due to immature drug metabolism and well-documented adverse effects, such as hypotension and respiratory depression, pharmacological pain management must be judiciously used.[10] In addition, analgesics like opioids and sedatives such as benzodiazepines can cause neurophotonic effects by suppressing neural responses, potentially disrupting the neonate's sensory processing and brain development.[14] In high-risk neonates, whose brains are still maturing, these drugs may also interfere with the processing of photic stimuli, leading to altered sensory experiences and potential developmental outcomes.[1] To mitigate reliance on pharmacotherapy, nonpharmacological interventions, and compassionate care practices are widely adopted, including techniques like breastfeeding and skin-to-skin contact.[10]

Understanding sensory pathways is essential for distinguishing how the brain processes different types of stimuli. Painful stimuli primarily activate nociceptive pathways, which send signals to the brain that result in discomfort and distress.[5] In contrast, a gentle, reassuring touch stimulates tactile pathways, promoting feelings of comfort and relaxation.[2] Maternal touch is particularly significant, as it is believed to modulate pain in infants through neuroendocrine regulation.[9] When a mother provides touch, it triggers the release of oxytocin, a hormone known to promote bonding and reduce stress. Oxytocin is thought to activate pain-inhibitory pathways, decreasing the perception of pain and enhancing the infant's ability to cope with discomfort . This interplay between sensory pathways and hormonal regulation underscores the importance of maternal touch in promoting well-being and pain relief in infants.[15]

Maternal involvement and participation methods, such as skin-to-skin contact, voice stimulation, gentle touching, holding, singing, speaking, massage, and overall gentle care provision, hold immense importance in high-risk neonatal care activities within the NICU.[4] Skin-to-skin contact, commonly known as kangaroo care, provides numerous benefits, including stabilization of the infant's temperature, heart rate, and breathing, which in turn can reduce pain perception and stress levels.[16,17] The soothing sound of a mother's voice and gentle touch offer comfort and reassurance to the neonate, helping to alleviate distress.[8,18,19] Holding and cuddling the baby not only promotes bonding but also regulates the infant's physiological responses, promoting relaxation and reducing pain-related stress.[20,21] Singing and speaking with the baby also create a nurturing environment that supports emotional well-being . Massage techniques, when applied with care, can help soothe tense muscles and promote relaxation, further aiding in pain management.[2] Based on the available evidence, the researchers conducted this systematic review to determine how maternal involvement strategies could reduce procedural pain and pain-related stress in neonates admitted to the NICU.

PURPOSE

Numerous studies have sought to alleviate neonatal pain and stress in the NICU by engaging mothers in care activities and ensuring their presence during procedures, whether invasive or non-invasive. However, to the best of our knowledge, no systematic reviews have comprehensively assessed the impact of maternal involvement on neonatal pain and related stress in the NICU setting. Thus, this systematic review aims at enhancing evidence-based policy recommendations on the effects of maternal engagement, encompassing practices such as skin-to-skin care, tactile stimulation, massage, vocal interaction, and participation in caregiving activities, in mitigating neonatal pain and associated stress within the NICU environment. This further helps in evidence-based policy recommendations.

METHODS

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to report the findings.[22] See Supplemental Digital Content 1 for the PRISMA checklist, available at http://links.lww.com/ANC/A309. The study protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO: CRD-42024540788).

Eligibility Criteria

All types of randomized controlled trials (RCTs) meeting the eligibility criteria were included: the eligibility criteria were explained as per the Population, Intervention, Comparator or control, and Outcome (PICO) framework in Table 1.

Literature Search

Articles were identified by searching CENTRAL, MEDLINE via PubMed, EMBASE, CINAHL via EBSCOhost, Scopus, Web of Science, ProQuest, and Google Scholar from January 2007 to March 2024. The PICO framework was used in the search strategy. The search was performed using a series of search terms following the inclusion criteria of the review for the literature search (Table 1). Reference lists from relevant reviews and retrieved studies were reviewed and searched to identify additional records.

Identification and Selection of Studies

Initial records identified from electronic database searching, relevant reviews, and retrieved studies were imported into Rayyan software. After the removal of duplicates, titles and abstracts were screened independently by 2 reviewers (S.N. and T.K.). Eligible articles were retrieved for full-text screening to include in the final analysis. Agreement for inclusion and exclusion of studies was 100% between reviewers.

Data Extraction

Data extraction was done among 27 included studies by 2 independent reviewers (S.N. and T.K.) following the Cochrane Library data extraction guidelines.[23] Microsoft Excel was used to facilitate this process.

Quality Assessment

The risk of bias in the included studies was assessed by 2 independent reviewers (S.N. and P.M.) using the Cochrane Collaboration's Risk of Bias Assessment Tool (RoB-2),[24] which addresses the following domains: (i) bias arising from the randomization process, (ii) bias due to deviations from intended interventions, (iii) bias due to missing outcome data, (iv) bias in measurement of the outcome, and (v) bias linked to the selection of the reported result. The included studies were rated as having "low risk," "some concerns," or "high risk" of bias in each domain as well as overall.

Data Synthesis

Studies that utilized the same research instruments and reported mean and standard deviation were included in the meta-analysis. Studies that used different research instruments or did not mention proper outcome statistics (mean and standard deviation [SD]) were included in the narrative synthesis.

Statistical Analysis

We did random-effects meta-analyses and calculated the standardized mean difference in scores of interventions versus control conditions (Hedges' g). For continuous variables, mean differences were determined with the associated 95% confidence intervals (CIs) using random-effects models. Absolute effects and 95% CIs were calculated by multiplying pooled relative risks (RRs) and 95% CIs by baseline risk estimates derived from the largest included RCT in the meta-analysis. Heterogeneity was assessed using the I^2 statistic, which was classified as low, moderate, and high with values of 25%, 50%, and 75%, respectively.[23] Variability in results across studies was addressed using the I^2 statistic and the p-value obtained from the Cochran Q (χ^2) test.

RESULTS

Selection and Inclusion of Studies

A total of 1360 records were initially identified from database searching including forward and backward reference review. After a careful assessment of the identified citations with the eligibility criteria, finally, 27 studies were included in the review

TABLE 1. Eligibility Criteria and Search Terms

Components	Eligibility Criteria: Inclusion Criteria	Eligibility Criteria: Exclusion Criteria
Population	Mothers and their high-risk neonates admitted in the NICU irrespective of gestational age, type of delivery, neonatal medical condition, gender, and neonatal birth weight.	Fathers and others family members.
Intervention	Maternal involvement in neonatal care activities such as skin to skin care, voice stimulation, holding and touching, massage, feeding the baby during painful procedures.	Any type of participation done by fathers or family members and healthcare professionals reduce the pain and pain related stress among high-risk neonates at NICU.
Comparison	Routine care and interventions implemented by the healthcare professionals in NICU.	
Outcomes	High-risk neonatal pain levels and pain related stress levels (salivary cortisol levels)	Neonatal physiological and clinical outcomes, maternal, parental, or family members stress in NICU.
Timeline	Research articles published in English between January 2007 and March 2024.	
Study design	Randomized Control Trials (RCTs)	Non-RCTs, quasi-experimental studies, Qualitative studies, study protocols, editorials, conference abstracts, letters to the editor
	Search Terms	
Population	"Newborn" OR "Intensive Care Units, Neonatal" OR "Premature Birth" OR "Infant, Low Birth Weight" OR "Infant, Extremely Low Birth Weight" OR "Infant, Very Low Birth Weight"	
Intervention	"Intensive Care Units, Neonatal" OR "Family Nursing" OR "Family-integrated care" OR "Family-based nursing" OR "Nursing Care" OR "Kangaroo-Mother Care Method" OR "Mother Involvement" OR "Mother Participation" OR "Touch" OR "Singing" OR "Massage" OR "Holding" OR KMC	
Outcomes	"Pain" OR "Acute Pain" OR "Pain Management" OR "Pain Perception" OR "Stress Disorders, Traumatic, Acute" OR "Stress, Psychological" OR "Stress, Physiological" OR "Neonatal pain" OR "Neonatal Stress"	

analysis. The included studies assessed neonatal pain levels using the Premature Infant Pain Profile (PIPP), Neonatal Infant Pain Scale (NIPS), Neonatal Infant Acute Pain Assessment Scale (NIAPAS), and the Neonatal Intensive Care Unit Network Neurobehavioral Scale (NNNS). Neonatal pain-related stress was evaluated by measuring salivary cortisol levels. The process of screening and selecting studies is detailed through the PRISMA flowchart in Figure 1.

Characteristics of Included Studies

In total, 27 studies encompassed participants (N = 2103), with sample sizes varying from 20 to 242. Out of 27 studies, 18 were from developed countries, and 9 were from upper and middle-income countries. All included studies were registered under a clinical trial registry, with a total of 17 studies receiving funding from government and non-government agencies to conduct the research study. Descriptive characteristics of these studies are provided in Supplemental Digital Content 2, available at http://links.lww.com/ANC/A310.

Sample Characteristics of Included Studies

A total of 15 studies included preterm babies, 7 studies focused on late neonates, and 5 studies involved all neonates admitted to the NICU. The mean age of mothers was 31 (SD = 2.1) years and the mean gestational age of the neonates was 32 weeks (SD = 2.8). The mean birth weight of the neonates was 1890 (SD = 213) grams with the average proportion of the male gender being 54.9%. Sample characteristics are reported in Supplemental Digital Content 2, available at http://links.lww.com/ANC/A310.

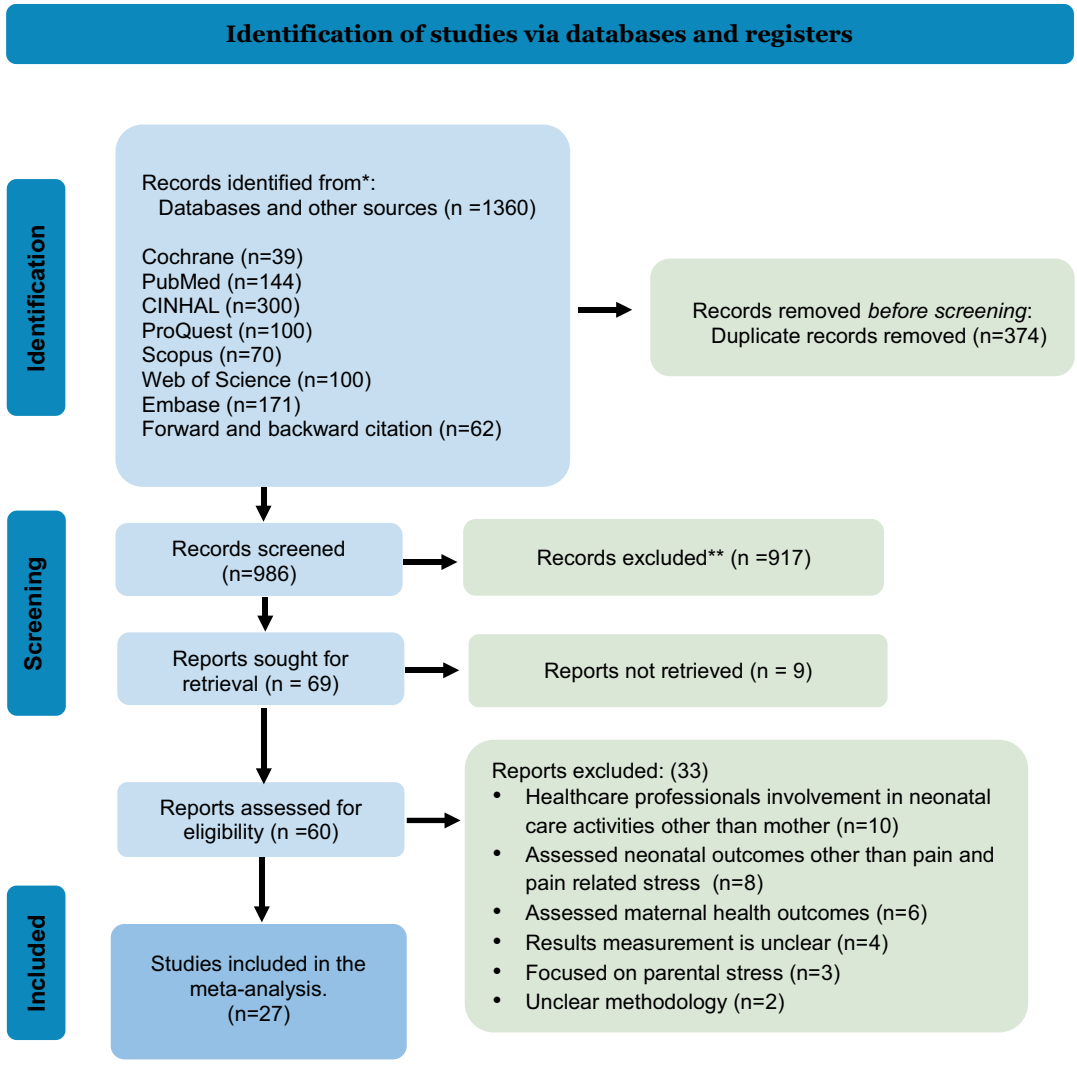
Risk of Bias in Included Studies

The overall quality of included studies was reported as low to moderate risk of bias as per the RoB-2 quality assessment checklist (see Supplemental Digital Content 3, available at http://links.lww.com/ANC/A311). Based on the RoB 2 checklist, out of the 27 included studies, 7 were assessed as having a low risk of bias, 16 showed some concerns, and 4 were considered high risk, depending on the adequacy of their randomization processes (random allocation, concealed assignment, blinding of outcome assessors), implementation of the intervention, missing outcome data, measurement of the outcome, selection of reported results, intention to treat analysis, between-group comparisons, and point estimates and variability.

Kangaroo Mother Care

A total of 13 studies involving 917 participants (460 in the intervention group and 457 in the control

FIGURE 1



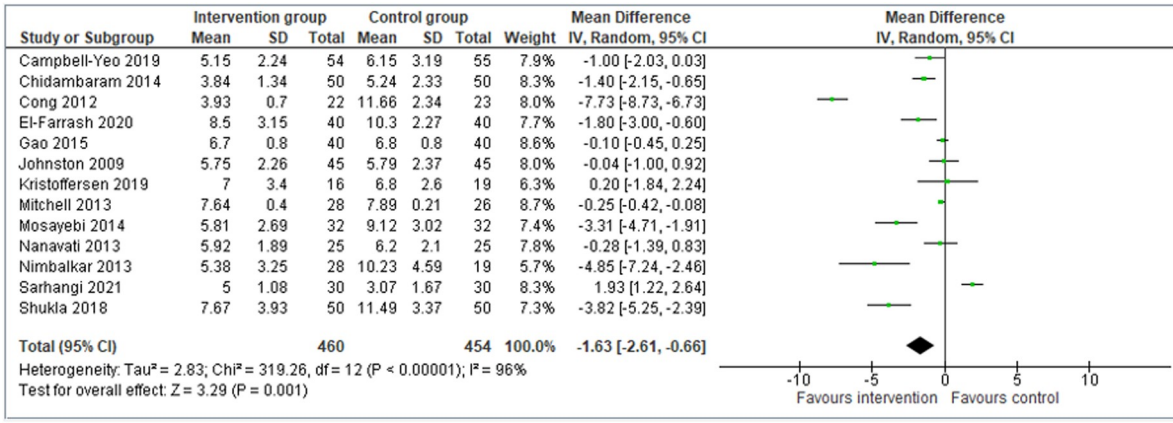
PRISMA flow diagram at each stage of the selection process.

group) assessed the effectiveness of maternal involvement in reducing procedural pain among high-risk neonates.[3,9,25-35] A random-effects model meta-analysis revealed that skin-to-skin care significantly decreased procedural pain among high-risk neonates (pooled mean deference = −1.63, indicating a large effect size; 95% confidence interval [CI]: −2.61 to −0.66). There was a statistically significant difference between the skin-to-skin care and control groups ($Z = 3.29$, $P = .001$). However, the quality of evidence is rated as moderate to high, given the low to moderate risk of bias, along with considerable heterogeneity and inconsistency, as reflected by an I^2 statistic value of 96% (Figure 2). The studies implemented kangaroo mother care (KMC) 5 to 10 minutes before the procedure, with durations ranging from 30 to 120 minutes during and after. Pain intensity was assessed within 1 to 5 minutes post-procedure, showing that KMC effectively reduced pain in high-risk neonates, regardless of the duration provided afterward.

Massage and Feeding the Baby

A total of 5 studies involving 277 participants (137 in the intervention group and 140 in the control group) assessed the effectiveness of maternal involvement in reducing procedural pain among high-risk neonates.[21,36-39] A random-effects model meta-analysis revealed that massage and feeding the baby by the mother significantly decreased procedural pain among high-risk neonates (pooled mean deference = −2.76, indicating a large effect size; 95% CI: −4.72 to −0.80). There was a statistically significant difference between the intervention group and

FIGURE 2



Meta-analysis on the effect of kangaroo mother care on neonatal procedural pain.

control group (Z = 2.77, P = .006). However, the quality of evidence is considered moderate to high due to low to moderate risk of bias, considerable heterogeneity, and inconsistency, as indicated by an I^2 statistic value of 88% (Figure 3).

Maternal Voice Stimulation

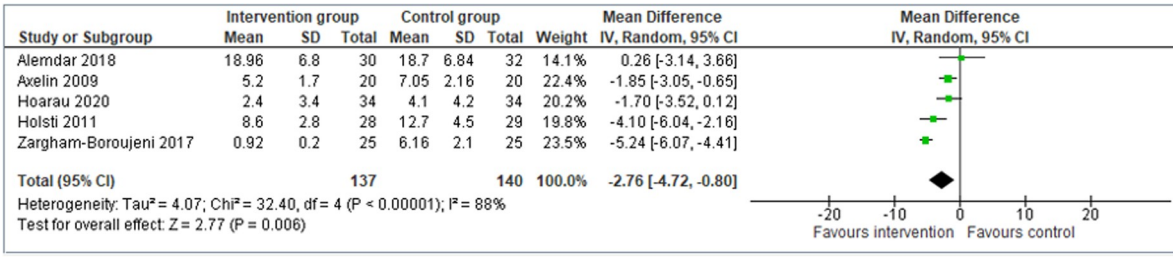
A total of 5 studies involving 290 participants (144 in the intervention group and 146 in the control group) assessed the effectiveness of maternal involvement in reducing procedural pain among high-risk neonates.[6,18,19,37,40] A random-effects model meta-analysis revealed that direct maternal voice stimulation significantly decreased procedural pain among high-risk neonates (pooled mean deference = –2.26, indicating a large effect size; 95% CI: –4.00 to –0.52). There was a statistically significant difference between the intervention and control groups (Z = 2.55, P = .001). However, the quality of evidence is considered moderate to high due to low to moderate risk of bias, considerable heterogeneity, and inconsistency, as indicated by an I^2 statistic value of 85% (Figure 4).

One study could not be included in the meta-analysis because it did not report the mean and standard deviation values in the results section. The findings of this study indicated that during the heel lancing procedure, the PIPP scores of preterm infants were significantly lower in the mothers' speaking condition compared to both the mothers' singing condition and the control group, where the mother's voice was absent (χ^2 (1) = 7.45, P = .006).[1]

Salivary Cortisol Level of High-Risk Neonates

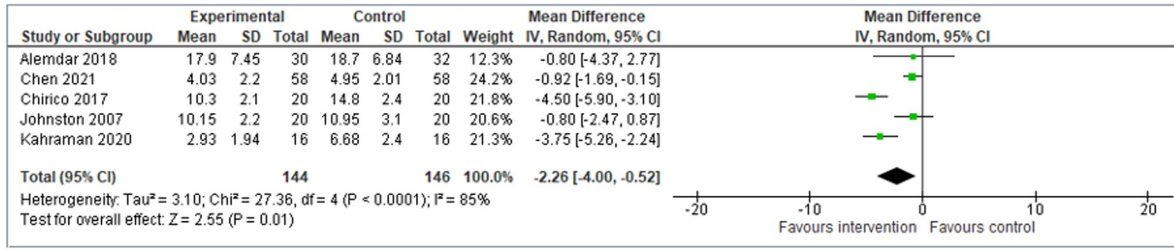
A total of 6 studies, involving 432 participants (219 in the intervention group and 213 in the control group), evaluated the effectiveness of maternal involvement, in various forms, in reducing procedural pain-related stress among high-risk neonates.[4,7,9,11,20,28] A random-effects model meta-analysis revealed that overall maternal involvement significantly decreased salivary cortisol levels among high-risk neonates (pooled mean deference = –17.4, indicating a large effect size; 95% CI: –17.09 to –4.73). There was a statistically significant difference between the intervention group and control group

FIGURE 3



Meta-analysis on the effect of massage and feeding on neonatal procedural pain.

FIGURE 4



Meta-analysis on the effect of maternal voice stimulation on neonatal procedural pain.

(Z = 5.21, *P* = .001). However, the quality of evidence is considered moderate to high due to low to moderate risk of bias, considerable heterogeneity, and inconsistency, as indicated by an I^2 statistic value of 99% (Figure 5).

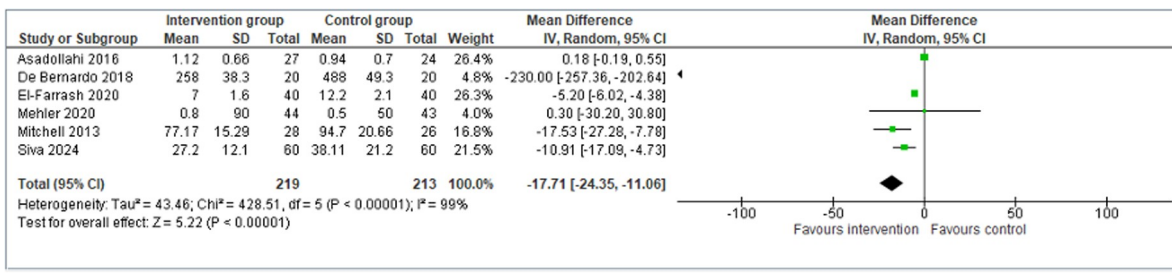
DISCUSSION

This systematic review consolidated all types of RCT-implemented maternal involvement strategies, such as skin-to-skin care, massage and feeding the baby, and maternal voice stimulation, to reduce procedural pain and pain-related stress in high-risk neonates at NICU. The quality and risk of bias of the studies were assessed using the RoB-2 tool, indicating a low to moderate risk of bias overall. One study was excluded from the meta-analysis due to inconsistencies in reporting statistical results.[1] Additionally, a few studies reported that there is no significant difference between the maternal involvement and control group in minimizing pain and pain-related stress among high-risk neonates.[9,19,20,29,37] These inconsistencies may be attributed to variations in the type of maternal involvement, duration of maternal presence, type of maternal voice stimulation, environmental factors (such as physical layout, background noise levels, NICU care level, and degree of maternal participation), frequency and duration of skin-to-skin care, type of feeding, neonatal gestational age, birth weight, and medical conditions.

All studies included in the meta-analysis utilised standardised pain assessment scales, with scores ranging from 7 to 25, where a score of 0 indicated no pain and higher scores represented increased pain intensity. Despite slight variations in total scores, all scales assessed physical, behavioral, and contextual indicators. Each intervention KMC, massage and feeding, and maternal voice were analysed individually to determine its specific contribution to the pooled outcomes. Study methodologies, including sample size, timing, and intervention protocols, were carefully reviewed, with variations in protocol duration and frequency identified as potential sources of heterogeneity. While the pooled results suggest a potential benefit in reducing infant pain scores, the interventions included in this category were diverse. For example, the studies analysed involved holding facilitated tucking, and breastmilk odor were different in their mechanisms and approaches. This variability likely contributed to the high heterogeneity in the results and underscores the complexity of drawing definitive conclusions about the effectiveness of massage and feeding as singular interventions. As such, while the findings are promising, they should be interpreted with caution.

KMC is particularly effective due to skin-to-skin contact, which facilitates thermoregulation,

FIGURE 5



Meta-analysis on the effect of overall mother involvement on the neonatal salivary cortisol response.

stabilizes heart rate, and reduces cortisol levels, thereby lowering stress[16,30] Findings from the systematic review suggest that involving both mothers and fathers in providing skin-to-skin care during painful interventions for preterm infants is beneficial for pain reduction.[41] Maternal voice, on the other hand, provides familiarity and comfort that can reduce pain perception by activating neonates' auditory pathways and linking them to maternal sounds, which are associated with safety and bonding.[42] Massage and holding-cuddling are similarly beneficial in creating soothing physical contact, which may help regulate autonomic responses and promote a sense of security.[20] Similarly, a systematic review demonstrated that massage therapy administered by mothers reduced pain and the intensity of crying in high-risk neonates in the NICU.[2] Breastfeeding combines multiple elements skin contact, suckling, and the analgesic properties of breast milk creating an effective method, especially for acute pain relief during minor procedures. Regarding feeding practices, breastfeeding has been significantly associated with reducing neonatal pain and stress compared to bottle-feeding or non-nutritive sucking administered by mothers.[43]

Previous systematic reviews identified barriers to KMC practice, including facility environment/resource issues, negative staff attitudes, lack of help with KMC or other obligations, low awareness of KMC/infant health, maternal pain/fatigue, increased staff workload, and concerns about other medical conditions. Key facilitators included support from hospital management, mother-infant attachment, and support from family and friends.[44,45] Despite studies on barriers and facilitators of involving mothers in neonatal care in Asian countries such as Nepal, India, Pakistan, Bangladesh, Vietnam, the Philippines, and Indonesia,[45] developing countries may have unique challenges (availability of healthcare personnel, resources, and communication) and facilitators in involving mothers in neonatal care in complex NICU settings due to specific policies and standard healthcare protocols.[46] Findings emphasize that maternal participation in neonatal care activities is crucial for providing comfort and emotional support to the infant, helping to reduce stress and pain perception.[4] The presence of the mother can enhance the baby's physiological stability, potentially improving vital signs and promoting faster recovery.[3] Moreover, maternal involvement fosters bonding and attachment, which are essential for the infant's long-term emotional and developmental health.[15]

These findings suggest that methods involving direct, familiar sensory input (touch, voice, and scent) are most effective for managing pain and stress, especially during short procedures or routine NICU interventions. Circumstances that call for prolonged calming effects or stress reduction, such as lengthy procedures, may particularly benefit from strategies like KMC and breastfeeding, where sustained contact or familiar cues offer prolonged relief. This integration of physiological and psychological mechanisms highlights how maternal involvement in various forms can optimize pain management and stress reduction in neonates, particularly by addressing both sensory and emotional comfort. However, not all studies have found consistent results regarding maternal involvement in reducing neonatal pain and stress. For example, qualitative and longitudinal studies found that a lack of appropriate interaction and cooperation between parents and care providers can create barriers for both mothers and staff.[31,46,47]

This evidence highlights the need for healthcare professionals and the healthcare system to be aware of the importance of maternal involvement in neonatal care activities to minimize neonatal pain and stress in the NICU. For nurses, as the primary care providers in the NICU, this entails not only caring for the baby but also maintaining constant communication with the mother and parents of the neonate.[15] Implementing new methodologies, such as family-centred care approaches, navigation models, and guiding mothers in daily routines, can encourage active participation in neonatal care activities and involvement in decision-making throughout the neonatal admission and even after discharge from the hospital.[4,48] Maternal involvement and active participation in neonatal care can also enhance mothers' self-efficacy and competencies in caring for their babies after discharge from the NICU, potentially preventing readmission rates.[15]

Implications for Practice

This systematic review findings suggest that mothers should be encouraged to participate in routine NICU care, including frequently touching and holding their baby, providing skin-to-skin care according to the neonatal medical condition, feeding the baby (either breastfeeding or bottle-feeding), and speaking or singing to their infant. To facilitate this, the neonatal nurse navigator model can be implemented to encourage and guide mothers throughout neonatal admission, ensuring their involvement in high-risk neonatal care activities. Additionally, continued capacity-building programs need to be conducted for neonatal nurses to enhance their ability to communicate with mothers and guide them appropriately during painful procedures. Incorporating these strategies into neonatal care protocols is essential for improving the overall well-being of neonates in the NICU, emphasizing the crucial role of maternal involvement in reducing neonatal pain and stress.

Implications for the Future Research

Future research implications include the necessity of well-designed interventions that can quantify the

Summary of Recommendations for Practice and Research	
What we know:	• Various maternal involvement strategies are used in NICUs to manage neonatal pain and stress. • Strategies like maternal voice and touch were not significantly effective compared with skin to skin acre and breastfeeding. • Maternal involvement is more effective and significant than sedation and other healthcare professional interventions in reducing neonatal pain and stress during procedural pain.
What needs to be studied:	• Inconsistencies in findings need to be identify related to variations in (i) gestational age, (ii) birth weight, (iii) intervention duration, and (iv) barriers for implementing massaging the baby and skin-to-skin care. • Future research should quantify maternal involvement and correlate it with the type of painful procedure, interaction time, and pain intensity in neonates.
What can we do today:	• Encourage and guide mothers to participate in neonatal care activities regardless of the procedure schedule and type. • Create a safe NICU environment and empower mothers to provide routine care, continuous skin-to-skin contact, and breastfeeding, based on the neonate's medical condition. • Incorporate these strategies into neonatal care protocols to improve the well-being of neonates, emphasizing the importance of maternal involvement in reducing neonatal pain and stress.

degree of maternal involvement in neonatal care activities, establishing precise guidelines for optimal maternal involvement in reducing neonatal pain and stress. It is also crucial to investigate the effects of maternal involvement during specific painful procedures to identify the most beneficial practices and timings. Moreover, further research is needed to examine how various factors such as gestational age, birth weight, and medical conditions influence the effectiveness of maternal involvement in neonatal care. Understanding these variables will help refine care protocols and improve outcomes for high-risk neonates in the NICU.

Limitations

The inherent limitations of our study include the exclusion of detailed information regarding the degree of mothers' participation in therapeutic interventions such as kangaroo care, massage, and voice stimulation, as this was outside the scope of the review. Additionally, we did not focus on the effects of maternal participation during specific painful procedures, nor did we restrict our analysis to particular gestational ages, birth weights, babies' medical conditions, or NICU admission levels leading to a clinical heterogeneity that could alter the results. Assessment of stress responses was limited to only those that included salivary cortisol as the outcome. Thus, studies using other measures of physiologic stress responses were not included. Similarly, the differences in the pain measurement scale used, the type of intervention or type of control group and the dose used could have influenced the homogeneity of the studies. No studies have been found from low-income countries, making it difficult to generalize the findings geographically. Due to all these issues, the findings should be interpreted with caution.

CONCLUSION

To our knowledge, this is the first systematic review conducted on randomized controlled trials to address the effects of maternal involvement in reducing pain and pain-related stress among neonates admitted to the NICU. Overall, the evidence predominantly supports the positive impact of maternal participation in reducing neonatal pain and stress in the NICU. Implementing these evidence-based strategies into neonatal care protocols is essential for promoting the overall well-being and development of the child and ensuring greater maternal role satisfaction.

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