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Effects of Lullaby Exposure on Pain and Physiological Outcomes in Preterm Infants in Neonatal Intensive Care Units: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Preterm infants in neonatal intensive care units (NICUs) are frequently exposed to painful procedures and environmental stressors that may disrupt autonomic regulation and neurodevelopment. Lullaby-based auditory interventions have been proposed as safe, non-pharmacological strategies to reduce pain and improve physiological stability, yet evidence specific to lullabies has not been systematically synthesized.
Objective: This review evaluated the effects of lullaby exposure on pain and physiological parameters in preterm infants in NICUs.
Methods: A systematic search of PubMed, Scopus, and Cochrane was conducted in accordance with PRISMA guidelines. Randomized controlled trials and quasi-experimental studies involving preterm infants (<37 weeks' gestation) were included. Lullaby interventions were compared with standard care or other auditory controls. Neonatal pain assessed by the Neonatal Infant Pain Scale (NIPS) was meta-analyzed using a random-effects model, while physiological outcomes were narratively synthesized.
Results: Nine studies were included. Meta-analysis showed a non-significant trend toward lower pooled NIPS scores in the lullaby group, with an approximate one-point reduction favoring lullaby exposure. Descriptively, most studies reported significant within-group reductions in pain scores following lullaby interventions, particularly during post-procedural recovery. Maternal voice–based lullabies consistently demonstrated greater analgesic effects than recorded or instrumental lullabies. Physiological outcomes showed generally favorable trends, including more stable heart rates, reduced respiratory rates, and modest improvements in oxygen saturation, especially at delayed post-intervention time points.
Conclusion: Lullaby exposure, particularly maternal voice–based interventions, may have potential as an adjunctive non-pharmacological approach for short-term pain management and physiological regulation in preterm infants. However, the non-significant pooled effect and methodological heterogeneity across studies warrant cautious interpretation.
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1. Introduction

Preterm birth remains a major global public health challenge, affecting approximately 15 million infants each year and contributing to nearly one million deaths worldwide.[1] The burden is disproportionately higher in low- and middle-income countries, where prematurity represents the leading cause of mortality among children under five years of age.[2] Due to their physiological immaturity, most preterm infants require prolonged hospitalization in neonatal intensive care unit (NICU).[2]

While neonatal intensive care is indispensable for the survival of preterm infants, the NICU environment inherently exposes them to numerous stressors, including excessive auditory stimulation, intense lighting, frequent handling, invasive procedures, and reduced parental contact.[3] These stressors can interfere with normal sleep–wake cycles, elicit maladaptive physiological and behavioral responses, and repeatedly activate the immature autonomic nervous system (ANS).[4] Persistent disruption of ANS maturation may contribute to impair stress regulation capacity and adversely affect long-term neurodevelopmental outcomes.[4] Although neonates are unable to verbally communicate pain, a growing body of evidence demonstrates that pain and stress are prevalent during NICU hospitalization, as reflected by objective physiological and behavioral markers such as tachycardia, oxygen desaturation, altered cortisol secretion, and observable distress behaviors.[5]

Consequently, there has been growing interest in non-pharmacological interventions that can minimize stress and promote physiological stability without introducing additional

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risks associated with medications.[6] Among developmental care strategies, auditory stimulation has emerged as a promising approach.[7] Music, particularly lullabies, is considered inherently soothing due to its rhythmic and repetitive structure, which resembles intrauterine auditory experiences and maternal vocalizations.[8] Lullabies are characterized by slow tempo, simple melodies, and gentle rhythms, and have been hypothesized to promote autonomic regulation, enhance comfort, and support neurobehavioral organization.[9]

Emerging evidence indicates that lullaby exposure may beneficially modulate physiological parameters and attenuate behavioral indicators of pain and distress in preterm infants.[10,11] However, findings specific to lullaby-based interventions remain scattered across individual studies and have not yet been systematically synthesized. Therefore, a focused systematic review is warranted to critically evaluate the effects of lullaby exposure on pain responses, physiological parameters, and overall clinical stability in preterm infants admitted to neonatal intensive care units, thereby supporting the development of evidence-based developmental care practices.

2. Materials and Methods

Protocol and Eligibility Criteria

This study was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA). The study was registered before conducting a preliminary search in PROSPERO. The included studies involving preterm infants (<37 weeks of gestation) admitted to neonatal intensive care units. Eligible studies evaluated the effect of lullaby interventions, including live or recorded vocal or instrumental lullabies, compared with standard NICU care without additional auditory stimulation. Studies were required to report at least one pain-related outcome or physiological parameter. Randomized controlled trials and quasi-experimental studies were included. Studies involving term infants, non-NICU settings, non-lullaby auditory interventions, multimodal interventions without separable effects, observational designs, or non-original articles were excluded.

Search Strategy and Data Source

A comprehensive literature search was conducted in PubMed, Scopus, and the Cochrane Library in November 2025. The keywords for this study were the following: ("lullaby" OR "infant-directed singing" OR "live lullaby" OR "recorded lullaby" OR "maternal voice") AND ("preterm" OR "premature" OR "very low birth weight" OR "infants") AND ("Neonatal Intensive Care" OR NICU). In addition, the reference lists of all included studies were manually reviewed to identify any further eligible publications.

Study Selection and Data Extraction

All records identified through database searches and manual screening were imported into Rayyan.ai for duplicate removal. The remaining studies underwent a two-stage screening process, consisting of title and abstract screening followed by full-text assessment. Two independent reviewers manually screened the titles and abstracts using Rayyan.ai. Disagreements were resolved through discussion with a third reviewer. Data extraction was conducted independently using a standardized form, collecting information on authorship, publication year, study design, sample size, interventions, comparators, and main outcomes.

Quality Assessment

The methodological quality of the included randomized controlled trials was assessed using the Cochrane Risk of Bias (RoB) tool, which evaluates seven domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other potential sources of bias. Each domain was independently rated by two reviewers as having low, high, or unclear risk of bias based on the information provided in the published reports. Any discrepancies were resolved through discussion until consensus was achieved.

Outcome of Interest and Data Analysis

Neonatal pain assessed using the Neonatal Infant Pain Scale (NIPS) was the primary outcome and was quantitatively synthesized in the meta-analysis using forest plots. Pooled effect estimates for continuous outcomes were calculated as mean differences (MDs) with 95% confidence intervals (CIs) under a random-effects model. Statistical heterogeneity was evaluated using the I^2 statistic and chi-square test, with a two-sided p value < 0.05 considered statistically significant. Analyses were performed using Review Manager (RevMan) version 5.4.1. Secondary outcomes, including oxygen saturation (SpO_2), heart rate, and other reported clinical parameters, were heterogeneously reported and therefore synthesized descriptively and presented narratively.

3. Result

The Study Selection

Process is summarized in the PRISMA flow diagram (Figure 1). A total of 981 records were identified through database searches, including PubMed (n = 164), Scopus (n = 681), and Cochrane (n = 136). After removal of 302 duplicate records, 679 records were screened based on titles and abstracts, of which 647 were excluded for not meeting the inclusion criteria. Thirty-two reports were subsequently sought for full-text retrieval, all of which were successfully obtained and assessed for eligibility. Following full-text evaluation, 23 reports were excluded due to irrelevant outcomes (n = 10), different populations (n = 6), different interventions (n = 5), study protocol design (n = 1), or being a book chapter (n = 1).

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Ultimately, nine studies met the eligibility criteria and were included in the final review.

Risk of Bias Assessment

Risk of bias was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool for randomized controlled trials and the ROBINS-I tool for the non-randomized study (Figures 2). Eight randomized controlled trials were evaluated using RoB 2. Overall, five studies were judged to have a high risk of bias, while three studies presented some concerns, no study was rated as low risk overall. The primary source of high risk was bias due to deviations from intended interventions (D2), indicating potential issues with intervention adherence or blinding. Bias related to the randomization process (D1), outcome measurement (D4), and selective reporting (D5) was mostly rated as having some concerns. In contrast, bias due to missing outcome data (D3) was consistently low across all trials. The non-randomized study by Shin et al. (2022) was assessed using ROBINS-I and was judged to have an overall critical risk of bias. Critical risk was identified in confounding (D1) and selection of participants (D2), while other domains showed moderate to low risk. In summary, the included studies demonstrated overall moderate to high methodological limitations, which should be considered when interpreting the study findings.

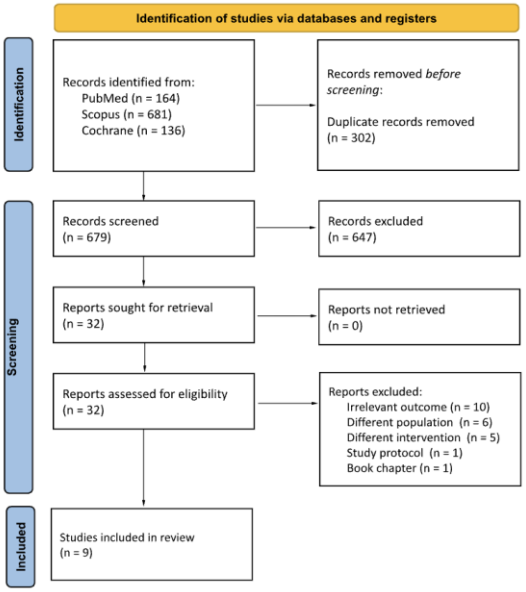


Figure 1. PRISMA flowchart of the literature selection

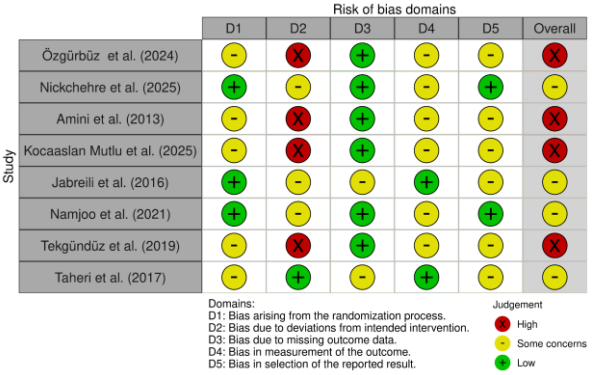


Figure 2. Risk of Bias Assessment

Characteristics of Included Studies

A total of nine studies were included in this systematic review, comprising eight randomized controlled trials and one quasi-experimental study, published between 2013 and 2025.[10–18] The studies were conducted in Turkey (n = 4), Iran (n = 4), and South Korea (n = 1), with sample sizes ranging from 25 to 110 preterm infants. All studies investigated the effects of lullaby-based auditory interventions delivered in NICU settings, including maternal lullabies, live or recorded lullabies, and standardized vocal or instrumental lullabies. Comparators included standard care, no auditory intervention, classical music, white noise, nature sounds, or oral glucose administration. The mean gestational age of participants ranged from approximately 30 to 34 weeks, and birth weights varied widely across studies, reflecting heterogeneous preterm populations. Most studies evaluated short-term outcomes during or after clinical procedures, with pain-related measures and physiological parameters such as oxygen saturation and heart rate being the most commonly reported outcomes. The key characteristics of the included studies are summarized in Table 1.

Descriptive Analysis and Meta-Analysis of Pain Scores

Pain outcomes across the included studies were predominantly measured using the Neonatal Infant Pain Scale (NIPS), with several trials also reporting Premature Infant Pain Profile (PIPP) scores.[10,11,17] Descriptively, most studies consistently showed that preterm infants experienced moderate to severe procedural pain, with NIPS scores frequently exceeding 5 during invasive procedures.[11,13,17] Following auditory interventions, pain scores generally declined across all groups. Although between-group comparisons were not uniformly significant, within-group analyses demonstrated statistically significant reductions in pain scores among infants receiving lullaby-based interventions, particularly at 15 minutes post-procedure, whereas reductions in control groups were often smaller and non-significant.[11,13]

Comparative analyses revealed variability in analgesic effects across different auditory stimuli. Several studies reported significantly lower pain scores in lullaby or maternal voice groups compared with standard care during and after procedures, with maternal voice occasionally producing the

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greatest pain reduction.[15] Other trials found that alternative auditory interventions, such as white noise or nature sounds, resulted in greater pain attenuation than lullabies.[13] Studies incorporating both NIPS and PIPP outcomes consistently showed lower post-intervention pain severity and fewer cases of severe pain in lullaby groups, supporting a potential calming and analgesic effect.[17]

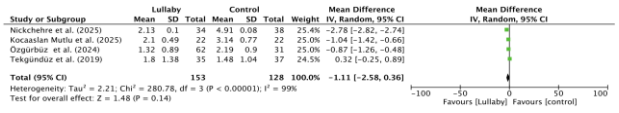


Figure 3. Forest plot of NIPS Scores during stay in NICU

These descriptive findings align with the results of the meta-analysis, which demonstrated a trend toward lower pooled NIPS scores among infants exposed to lullabies compared with standard care, although the overall effect did not reach statistical significance. The pooled mean difference indicated an approximate one-point reduction in NIPS scores, which may be clinically meaningful given the NIPS range of 0–7 and the importance of even modest analgesic effects in neonatal procedural care. Importantly, the lack of statistical significance at the pooled level should be interpreted in the context of between-study heterogeneity in intervention modality, timing and duration of exposure, neonatal characteristics, and procedural context, which may have contributed to variation in effect estimates. Variations in lullaby modality (live versus recorded), timing and duration of exposure, neonatal characteristics, and procedural context likely contributed to heterogeneity in effect estimates. Collectively, the integrated descriptive and quantitative evidence suggests that lullaby-based interventions may reduce procedural pain in neonates, particularly during the recovery phase, although the magnitude of effect varies across clinical settings and study designs.

Descriptive Analysis of Physiological Parameters

Across the included studies, lullaby-based auditory interventions demonstrated generally favorable effects on physiological stability in preterm infants, although the magnitude and consistency of effects varied by parameter, timing, and type of auditory stimulus.[8,15,16]

Heart rate (HR) was the most frequently reported parameter. Several studies found no significant between-group differences at baseline; however, lullaby exposure was commonly associated with reduced or more stable HR during and after procedures. Within-group analyses showed significant post-procedural decreases in HR in lullaby groups, particularly when compared with control conditions. Studies incorporating maternal voice interventions reported more pronounced and consistent reductions in HR than recorded lullabies, whereas some trials observed only transient or non-significant differences across time points.[14,15,17,18]

Respiratory rate (RR) findings were less consistently reported but suggested a calming effect of lullabies. While between-group differences were often non-significant, within-group analyses indicated significant reductions in RR following lullaby exposure, especially in experimental groups and during the post-intervention period. Maternal voice interventions appeared to maintain more stable respiratory patterns compared with both recorded lullabies and control conditions.[8,11,12,15,16]

Oxygen saturation (SpO_2) showed mixed but overall positive trends. Several studies reported significant increases in SpO_2 after lullaby exposure, particularly at delayed post-intervention time points (15–45 minutes), while others found no immediate or sustained differences compared with controls. Maternal voice interventions consistently demonstrated higher SpO_2 levels across procedural phases, whereas recorded lullabies produced more variable effects. Overall, the descriptive evidence suggests that lullabies, especially maternal voice, may contribute to improved physiological regulation in preterm infants, with effects more evident after intervention rather than during immediate exposure.[10,12,14,17,18]

4. Discussion

This systematic review evaluated the effects of lullaby exposure on pain and physiological stability in preterm infants in NICUs, a clinically important issue given the high prevalence of prematurity and frequent exposure to painful procedures. Owing to immaturity of the central and autonomic nervous systems, preterm infants are particularly vulnerable to stress-related physiological instability and adverse neurodevelopmental outcomes. Lullabies, characterized by slow tempo and soothing, repetitive patterns, represent a developmentally appropriate and non-invasive auditory intervention. Across nine included studies, lullaby-based interventions were generally associated with reduced procedural pain and improved physiological parameters, particularly heart rate and oxygen saturation.[10–18] Although the meta-analysis did not show a statistically significant pooled reduction in NIPS scores, the observed trend toward an approximate one-point decrease may be clinically meaningful and appears to be influenced by substantial between-study heterogeneity rather than a true lack of effect.

The findings of this review are broadly consistent with prior research demonstrating beneficial effects of auditory and music-based interventions in NICU settings. Previous systematic reviews have reported that music therapy can reduce neonatal pain, stabilize physiological parameters, and improve neurobehavioral outcomes.5 However, most earlier reviews grouped diverse auditory stimuli including classical

music, instrumental tracks, white noise, and maternal voice into a single intervention category, limiting conclusions regarding specific modalities.[19] By focusing specifically on

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Table 1. baseline characteristics of the included studies

1	Özgürbüz et al. (2024)	RCT (Turkey)	93	**Group 1:** lullabies sung by the babies' own mothers (N=31) **Group 2:** lullabies sung by standard female vocal recording (N=31)	Control Group: no intervention is applied to the babies (N=31)	NR	**Group 1:** 1630.21 ± 385.40 **Group 2:** 2352.01 ± 310.55 **Control Group**: 2335.16 ± 310.04
2	Nickchehre et al. (2025)	RCT (Iran)	110	**Group 1:** Lullaby sound (N=34)	**Group 2:** Nature Sound (N=24) **Group 3:** White Noise (N=25) **Group 4:** Control, no intervention (N=38)	NR	**Group 1:** 1486.132 ± 3184.28 **Group 2:** 1828.63 ± 258.81 **Group 3:** 1460 ± 371.80 **Group 4:** 1686.53 ± 432.29
3	Amini et al. (2013)	RCT (Iran)	25	**Group 1:** Lullaby sound	**Group 2:** classical music **Group 3:** Control	32.45 ± 1.67	1658 ± 404.03
4	Kocaaslan Mutlu et al. (2025)	RCT (Turkey)	66	**Group 1:** Lullaby sound (N=22) **Group 2:** Maternal Voice (N=22)	**Group 3:** Control (N=22)	**Group 1:** 31.41 ± 2.13 **Group 2:** 30.59 ± 1.96 **Group 3:** 30.68 ± 2.21	**Group 1:** 1713 ± 562.87 **Group 2:** 1496.27 ± 362.86 **Group 3:** 1469 ± 417.45
5	Jabreili et al. (2016)	RCT (Iran)	66	**Group 1:** Mum's Lullaby (N=21) **Group 2:** Brahm's Lullaby (N=25)	**Group 3:** Control (N=20)	**Group 1:** 31.45 (1.63) **Group 2**: 32.16 (1.31) **Group 3:** 31.80 (1.83)	**Group 1:** 792.50 (464.21) **Group 2:** 762.40 (390.01) **Group 3:** 690.47 (436.88)
6	Namjoo et al. (2021)	RCT (Iran)	90	**Group 1:** Live Lullaby (N=30) **Group 2:** Recorded Lullaby (N=30)	**Group 3:** Control (N=30)	**Group 1:** 34.03 ± 2.52 **Group 2**: 34.53 ± 1.87 **Group 3:** 34.30 ± 1.95	**Group 1:** 2286.6 ± 901.127 **Group 2:** 2525.4 ± 577.91 **Group 3:** 2368.3 ± 631.96
7	Tekgündüz et al. (2019)	RCT (Turkey)	106	**Group 1:** Lullaby sound (N=35)	**Group 2**: Glucose group (N=34) **Group 3**: Control group (N=37)	**Group 1**: 31.57 ± 3.18 **Group 2:** 30.57 ± 3.47 **Group 3**: 30.26 ± 3.54	**Group 1:** 1774.14 ± 647.74 **Group 2:** 1582.50 ± 680.06 **Group 3:** 1460.67 ± 684.91
8	Taheri et al. (2017)	RCT (Iran)	52	**Group 1:** Lullaby sound (N=26)	**Group 2:** Control group (N=26)	**Group 1:** 33 ± 4 **Group 2:** 33 ± 4	**Group 1:** 1687.54 ± 551.2 **Group 2:** 1751.05 ± 46
9	Shin et al. (2022)	quasi-experimental (Korea)	65	**Group 1:** mother's lullaby (N=22) **Group 2:** Mozart's lullaby (N=22)	**Group 3:** Control group (N=21)	**Group 1:** 32.13 ± 2.12 **Group 2**: 32.56 ± 1.66 **Group 3:** 32.05 ± 1.86	**Group 1:** 1,618.64 ± 423.62 **Group 2:** 1,678.18 ± 300.12 **Group 3:** 1,661.43 ± 462.95

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lullabies, the present review extends existing evidence and suggests that lullabies may confer calming and analgesic effects comparable to, or in some cases less pronounced than, other auditory stimuli such as white noise or nature sounds.[13] A notable advantage of lullabies, particularly maternal voice, is their ecological validity and emotional salience, which may enhance infant comfort and parent–infant bonding.[20] Conversely, variability in effectiveness across studies highlights potential limitations, including inconsistent delivery methods, short intervention durations, and the influence of contextual factors such as procedural type and baseline infant stability.

Several physiological and neurodevelopmental mechanisms may underlie the observed effects of lullaby exposure. Auditory stimulation with predictable, low-frequency, and rhythmic characteristics is thought to promote parasympathetic activation while attenuating sympathetic stress responses.[21,22] Lullabies may facilitate autonomic regulation by synchronizing respiratory and cardiac rhythms, thereby reducing heart rate and stabilizing oxygen saturation.[23] Maternal voice–based lullabies may further enhance these effects by activating recognition and familiarity pathways, potentially involving limbic system modulation and reduced hypothalamic–pituitary–adrenal axis activation.[24] From a neurodevelopmental perspective, such auditory input may support sensory integration during a critical period of brain plasticity.[25] Importantly, no adverse effects of lullaby exposure were reported across the included studies, suggesting that the intervention is safe when delivered at appropriate sound levels and durations. Potential risks, such as overstimulation or noise-related stress, appear minimal and can be mitigated through careful protocol design.[26–28]

Beyond pain and immediate physiological measures, this review highlights several additional insights. The beneficial effects of lullaby exposure were more consistently evident during the post-procedural recovery phase rather than during the procedures themselves, suggesting that lullabies primarily facilitate calming and recovery rather than providing immediate analgesia.[11,13,15,17] A limited number of studies also reported secondary benefits, such as increased sleep duration and improved feeding volumes, particularly with maternal or recorded lullabies, although effects on longer-term outcomes such as weight gain were inconsistent.[10,12]

This review also highlights several strengths and limitations within the existing evidence base. Strengths include the predominance of randomized controlled trial designs, the use of validated pain assessment tools such as NIPS and PIPP, and the inclusion of diverse comparators that allow contextual interpretation of effects. However, methodological limitations were common, including small sample sizes, short follow-up periods, heterogeneity in intervention delivery, and inconsistent reporting of outcomes. Additionally, most studies were conducted in middle-income countries, which may limit generalizability to other healthcare settings. Future research should prioritize larger, well-designed trials with standardized lullaby protocols, longer-term outcomes, and stratification by gestational age and clinical condition to better define the role of lullaby exposure in neonatal intensive care.

5. Conclusion

The available evidence suggests that lullaby exposure, particularly maternal voice–based interventions, may have potential as an adjunctive non-pharmacological approach for short-term pain management and physiological regulation in preterm infants. However, the non-significant pooled effect for pain, variation in intervention protocols, and methodological limitations across studies warrant cautious interpretation. Further well-designed trials with standardized lullaby protocols, clinically relevant outcome measures, and longer follow-up are needed to clarify the effectiveness and clinical applicability of lullaby interventions in NICU care.

Ethical Approval

There is no ethical approval.

Conflicts of Interest

The authors declare no conflict of interest.

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Author Contributions

H.H.P.: Conceptualization, Methodology, Data Curation, Investigation & Analysis, Writing – Original Draft, D.R.H. & A.T.F.: Methodology, Software & Validation, Visualization, Writing – Review & Editing, M.L.: Data Curation, Project Administration, Resources, Writing – Review & Editing. All authors read and approved the final manuscript.

References

1. Chawanpaiboon S, Vogel JP, Moller AB, Lumbiganon P, Petzold M, Hogan D, et al. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. Lancet Glob Health. 2019 Jan 1;7(1):e37–46.
2. Lopes TCP, da Silva Vieira AG, Cordeiro SA, Miralha AL, de Oliveira Andrade E, de Lima RL, et al. Effectiveness of non-pharmacological interventions in reducing pain in preterm infants: A systematic review and network meta-analysis. Vol. 84, Intensive and Critical Care Nursing. Churchill Livingstone; 2024.
3. Dewan MV, Ader M, Kleinbeck T, Dathe AK, Schedlowski M, Engler H, et al. The effect of live-performed music therapy with physical contact in preterm infants on parental perceived stress and salivary cortisol levels. Front Psychol. 2024;15.

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4. Yakobson D, Gold C, Beck BD, Elefant C, Bauer-Rusek S, Arnon S. Effects of live music therapy on autonomic stability in preterm infants: A cluster-randomized controlled trial. Children. 2021 Nov 1;8(11).
5. Ou Y, Chen L, Zhu X, Zhang T, Zhou Y, Zou L, et al. The effect of music on pain management in preterm infants during daily painful procedures: a systematic review and meta-analysis. Vol. 12, Frontiers in Pediatrics. Frontiers Media SA; 2024.
6. Anand KJS. Defining pain in newborns: need for a uniform taxonomy? Vol. 106, Acta Paediatrica, International Journal of Paediatrics. Blackwell Publishing Ltd; 2017. p. 1438–44.
7. Zhao W, Li H, Guo H, Yuan E, Cao F, Shi Y, et al. Application of Music Intervention Combined with Multidimensional Nursing in Very Low Birth Weight Infants: A Retrospective Cohort Study. Noise Health. 2025 Jul 1;27(127):422–9.
8. Alay B, Esenay FI. The clinical effect of classical music and lullaby on term babies in neonatal intensive care unit: A randomised controlled trial. J Pak Med Assoc [Internet]. 2019 Apr;69(4):459–63. Available from: http://uknowledge.uky.edu/music_etds/42.
9. Loewy J. NICU music therapy: Song of kin as critical lullaby in research and practice. Ann N Y Acad Sci. 2015 Mar 1;1337(1):178–85.
10. Namjoo R, Mehdipour-Rabori R, Bagherian B, Nematollahi M. Comparing the effectiveness of mother's live lullaby and recorded lullaby on physiological responses and sleep of preterm infants: a clinical trial study. J Complement Integr Med. 2022 Mar 1;19(1):121–9.
11. Özgürbüz N, Bahar A, Tuna A, Çopur E. The effect of lullaby played to preterm infants in neonatal intensive care units on physiological parameters and pain. J Pediatr Nurs. 2024 Nov 1;79:133–40.
12. Shin HJ, Park J, Oh HK, Kim N. Comparison of Effects of Mothers' and Mozart's Lullabies on Physiological Responses, Feeding Volume, and Body Weight of Premature Infants in NICU. Front Public Health. 2022 May 30;10.
13. Nickchehre S, Rasuli M, Shoghi M. Comparison of the effect of listening to the white noise, lullaby, and nature sounds on pain during intravenous line insertion in premature neonates in the neonatal intensive care unit. Anaesthesia, Pain and Intensive Care. 2025 Sep 1;29(6):607–17.
14. Amini E, Rafiei P, Zarei K, Gohari M, Hamidi M. Effect of lullaby and classical music on physiologic stability of hospitalized preterm infants: A randomized trial. J Neonatal Perinatal Med. 2013;6(4):295–301. Kocaaslan Mutlu EN, Zafer Dinçkol R. Effectiveness of Maternal Voice and Lullabies on Pain and Physiological Parameters in Preterm Infants During Aspiration: A Randomized Controlled Study. Adv Neonatal Care. 2025 Oct 1;25(5):413–23.
15. Jabraeili M, Sabet T, MustafaGharebaghi M, Asghari Jafarabadi M, Arshadi M. The Effect of Recorded Mum's Lullaby and Brahm's Lullaby on Oxygen Saturation in Preterm Infants: a Randomized Double-Blind Clinical Trial. J Caring Sci. 2016 Mar 1;5(1):85–93.
16. ekgündüz KŞ, Polat S, Gürol A, Apay SE. Oral Glucose and Listening to Lullaby to Decrease Pain in Preterm Infants Supported with NCPAP: A Randomized Controlled Trial. Pain Management Nursing. 2019 Feb 1;20(1):54–61.
17. Taheri L, Jahromi MK, Abbasi M, Hojat M. Effect of recorded male lullaby on physiologic response of neonates in NICU. Applied Nursing Research. 2017 Feb 1;33:127–30.
18. Yue W, Han X, Luo J, Zeng Z, Yang M. Effect of music therapy on preterm infants in neonatal intensive care unit: Systematic review and meta-analysis of randomized controlled trials. Vol. 77, Journal of Advanced Nursing. Blackwell Publishing Ltd; 2021. p. 635–52.
19. Bekar P, Efe E. Effects of mother-sung lullabies on vaccination-induced infant pain and maternal anxiety: A randomized controlled trial. J Pediatr Nurs. 2022 Jul 1;65:e80–6.
20. Bilgiç FŞ, Karaahmet AY, Okay B. Effects of non-pharmacological interventions on sleep in premature infants: meta-analysis. Vol. 70, Revista da Associacao Medica Brasileira. Associacao Medica Brasileira; 2024.
21. Loewy J, Stewart K, Dassler AM, Telsey A, Homel P. The effects of music therapy on vital signs, feeding, and sleep in premature infants. Pediatrics. 2013 May;131(5):902–18.
22. Karakuş Selçuk A, Karaarslan D, Ergin E, Salğin E. The Effect of White Noise and Recorded Lullaby during Breastfeeding on Newborn Stress, Mother's Breastfeeding Success, and Comfort: A Randomized Controlled Trial. J Pediatr Nurs. 2025 Mar 1;81:e16–23.
23. Epstein S, Arnon S, Markova G, Nguyen T, Hoehl S, Eitan L, et al. Mother–Preterm Infant Contingent Interactions During Supported Infant-Directed Singing in the NICU—A Feasibility Study. Children. 2025 Sep 1;12(9).
24. Bombell EG. "Music is considered my skin to skin with her": Music therapy with parents and their extremely preterm infants in the NICU. Arts in Psychotherapy. 2025 Feb 1;92.
25. Shahbazi F, Fattahi-Darghlou M, Moslehi S, Dabiri-Golchin M, Shahbazi M. Effect of music therapy on behavioral and physiological neonatal outcomes: A

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systematic review and dose-response meta-analysis. PLoS One. 2025 Jan 1;20(1).
26. Rashvand F, Qolizadeh A, Momeni M. Music Therapy Intervention Using a Holy Quran Recitation Improves Feeding Status, Weight Gain and Length of Stay Among Preterm Infants in the Neonatal Intensive Care Unit: A Randomized Clinical Trial. Advances in Neonatal Care. 2025 Apr 1;25(2):E10–6.
27. SefidHaji S, Aziznejadroshan P, Mojaveri MH, Nikbakht HA, Qujeq D, Amiri SRJ. Effect of lullaby on volume, fat, total protein and albumin concentration of breast milk in premature infants' mothers admitted to NICU: a randomized controlled trial. Int Breastfeed J. 2022 Dec 1;17(1).

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