Effect of White Noise and Brahms' Lullaby on Infants' Pain, and Physiological Parameters during Invasive Interventions

Amal Abo El-Azm Abd El-Rahman Younis[1], Basma Mahmoud Abd Elhamid Dawood[2], Nahla Abd ELnaby Elkandoz[3]

[1]Lecturer of Pediatric Nursing, Faculty of Nursing, Tanta University, Egypt.
[2,3] Assistant Professor of Pediatric Nursing, Faculty of Nursing, Tanta University, Egypt.

Corresponding author: Amal Abo El-Azm Abd El-Rahman Younis
Email: amal_aboelazm@nursing.tanta.edu.eg

Abstract

Background: Pain relief is achieved through pharmacological and non-pharmacological methods. White noise and lullaby sounds are suggested as non-pharmacologic strategy to relief pain that can be applied to infants during invasive interventions. **Aim:** Evaluate the effect of white noise and Brahms' lullaby on infants' pain and physiological parameters during invasive interventions**. Design:** randomized controlled trial. **Subjects & Setting:** purposive sample of 90 infants from Neonatal and Pediatric Intensive Care Unit of Tanta Main University Hospital and Elmabara Hospital. **Tools: Tool I:** Infants' bio-social characteristics, **Tool II:** Infants' Physiological Parameters, **Tool III**: Infant Pain Scale. **Results:** The infants in the white noise group had none to mild pain, while the lullaby group experienced mild to moderate pain as compared to the control group who experienced severe pain. **Conclusion:** White noise and Brahms' lullaby were effective in reducing infants' pain and improve physiological parameters during invasive interventions**. Recommendation**: Pediatric nurses should adopt non-pharmacological approaches including white noise and Brahms' lullaby to relieve pain during invasive interventions on infants.

Keywords: Brahms' lullaby, infants, invasive interventions, pain, physiological parameters &white Noise

Introduction

Pain can be identified as a special sensation with emotional and psychological issue. It is one of the most common feelings among newborns and infants, which can be brought on by illness, trauma, and different medical interventions (**Bourgois, Shaha, Vanoni, Jaques, Newman& Simonetti, 2020).** Infants requiring intensive care undergo on average between 7 times to 17 numerous invasive painful interventions per day during their hospital stay. The most common interventions are heel lancing, suctioning, In addition to, venous or arterial catheterization, blood samples from the vein, intubation of chest tube, aspiration, injections and surgical operations that can cause pain. Thus, it is crucial to manage infants' pain in order to assess and eradicate it so; both non-pharmacological and pharmacologica l approaches are employed **(Gilam, Gross, Wager, Keefe, Mackey, 2020 & Kassab, Alhassan, Alzoubi& Khader, 2019).** Nurses are responsible for reducing the discomfort felt by infants undergoing painful invasive interventions. Non-pharmacologic strategies are the strongest evidence used to mitigate pain following invasive interventions. **(Yıldırım& Gerçeker, 2023& Wang, Guo& Xiong, 2022).**

White noise and lullaby are non-pharmacological approaches that utilize audio based stimulants that work well as a cognitive technique to help and divert infants' attention from the discomfort. **(Kahraman, et al., 2020).** White noise is a continuous, monotonous sound that conceals distracting sounds from the outside world and has a relaxing effect. The sounds in a mothers' womb are comparable to white noise. The infant is influenced by the mother's heartbeat while still in the womb, and after delivery, being exposed to these comforting sounds and rhythms has a calming effect **(Komann, Weinmann, Schwenkglenks& Meissner, 2019).**

Lullaby is a relaxing music that can be used to divert attention from pain as it increase endorphins and regulate vital signs. Lullaby sounds are warm, gentle, and soothing, which can help an infant to relax and fall asleep. This is crucial to shield the brain from the detrimental impacts of stress and suffering in early life. During painful procedures, lullabies can help infants feel less pain **(See, Ng & Ignacio, 2023& Özgürbüz, Bahar, Tuna &Çopur, 2024).** So this study aims to evaluate the effect of white noise and Brahms' lullaby on pain, and physiological parameters during invasive interventions applied to infants.

Significance of the study

Pain is one of the worst sensations for infants. Non-pharmacological interventions become very important to alleviate it. White noise is similar to sounds heard in the mothers' womb. It influencing the nervous system and altering pain perception. Specifically, it can reduce activity in the auditory cortex and thalamus, key areas involved in processing sensory information, including pain. Lullaby music is work as distractor of attentions by influencing

physiological parameters like heart rate and blood oxygen saturation, and also by affecting pain perception through cognitive and emotional engagement. This may involve a combination of sensory input, emotional responses, and cognitive distraction, ultimately leading to a state of relaxation and reduced pain. It is difficult to assess the efficacy of pain management therapies for infants due to their nonverbal communication. Behavioral (cries, facial expression), physiological indicators (heart rate, respiration rate, oxygen saturation), and pain scores by observers are commonly used to evaluate nonpharmacological interventions for pain relief. **(Walco et al., 2018)**

Aim of the study

Evaluate the effect of white noise and Brahms' lullaby on infants' Pain and physiological parameters during invasive interventions.

Research hypotheses

- Both white noise and Braham's lullaby are expected to improve infants' pain and physiological parameters in the studied groups than the control group.
- White noise is expected to relief infants' pain and improves physiological parameters during invasive interventions than Brahms' lullaby

Subjects and method

Study design

A randomized controlled trial study design was used for this study.

Setting

This study was conducted at Neonatal and Pediatric Intensive Care Unit of Tanta Main University Hospital which is affiliated to the Ministry of Higher Education and Scientific Research and Elmabara Hospital which is affiliated to the Ministry of Health and Population.

Subjects

A purposive sample of 90 infants. The size of sample was based on the following equation n= M/({(S^2 X (M-1)) ÷ pq} + 1) (n) sample size, (M) population size, (S) desired confidence level equal 1.69 ,(P) the desired level of precision equal 0.5, (q) the estimated proportion of an attribute that is present in the population and equal 1 – p. They were randomly assigned into three groups. The researcher uses simple random technique to classify infants into groups. A slip of paper with the infants' identification code was inscribed in each place, tucked inside a container, thoroughly mixed, and then a subject was chosen at random. The first selection was for white noise group. The second one for Brahms' lullaby group and the third one was for control group. Each group consisted of 30 infants

Criteria for infants' selection

- Age from birth until one year
- Full term
- Has no hearing or nervous problem
- Conscious

Tools of the study

Tool I: Infants' bio-social characteristics as: it was developed by the researchers as age, sex, residence, types of invasive procedures.

Tool II: Infants' Physiological Parameters: as respiratory rate, heart rate and o_2 saturation.

Tool III: Infants' Pain Scale: it **was** adopted from **(Lawrence, et al., 1993)**, it can be used to assess pain in infants. It assesses five behavioral indicators: arms, legs, crying facial expression, and degree of alertness. The total pain score ranges from 0 to 7, with 0–2 points representing mild to no pain, 3–4 points representing mild to moderate pain, and scores greater than 4 points representing severe pain.

Method

An official permission was secured from the directors of the previous settings of Tanta Main University Hospital and Elmabara Hospital after outlining the goal of the research, setting the time for beginning the study.

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Nursing, Tanta University. The code number was 611-3-2025.

Consent to participate in the study from the parents of infants was taken after explaining the goal of the study and giving them the option to withdraw at any time without having to give a reason or affecting their infants' care,

The study tools were constructed after revision of recent related literatures

Tool Validity: Pediatric nursing specialists evaluated the study's instruments for content validity. It was 96%.

A pilot study was carried out before the actual data gathering phase on (10%) of infants to assess the tool's feasibility, clarity, and application as well as to identify any possible obstacles throughout the data collection process.

Content reliability: The study tools were tested by the pilot subjects. High reliability of the tools was indicated by Cronbach's alpha and the value was 0.89 for tool I, II and 0.960 for tool III.

The study was carried out through four phases

- **Assessment Phase**: The researcher was conducted an assessment of all the infants to gather baseline data regarding their bio-socio characteristics and physiological parameters using tool I,II prior to the intervention.
- **Planning Phase**: the researcher reviewed relevant literatures and prepared the non-pharmacological approaches used in the current study (white noise & Braham's lullaby).
- **Intervention Phase:** The researchers were attended to the study settings alternately, three days/week at the morning shift. The researchers began collecting the data of infants (Tool I) within 10 minutes. Physiological parameters were assessed during and after invasive interventions by (tool II) and pain was assessed after invasive interventions by (Tool III). The researchers were presented in the place of the study and applied white noise sound or Brahms' lullaby for infants in each group.

White noise group: The infants were prepared by placing them in a comfortable position according type of intervention. Prior to painful procedures, they listened to white noise sound for an average of one minute, and this lasted during the interventions. The duration of white

noise application depended on how long the interventions lasted. The white noise was played at a minimum distance of 30 cm and a maximum of 45 cm from the infant. In the meantime, the behavioral reactions to pain were documented during intervention. The infant's heart, breathing, and oxygen saturation rates were assessed both during and after the intervention.

Brahms' lullaby group: The infants were prepared by placing them in comfortable position according to invasive technique and then the infants listened to Brahms' lullaby that downloaded in mobile for an average of one minute before painful interventions and continued during the procedure. The duration of the listening varied depending on the duration of interventions. The playing of the lullaby was carried out at a minimum distance of 30 cm and a maximum of 45 cm from the infant. In the meantime, the behavioral reactions to pain were documented during intervention. The infants' heart, breathing, and oxygen saturation rates were assessed both during and after the intervention.

Control group: Infants were exposed to different painful interventions without any intervention (white noise and lullaby not played). Behavioral responses of the infants' pain were recorded during interventions and the heart rate, respiration, and oxygen saturation rates were measured during, and after the interventions**.**

Data collection was performed from March to May 2025

- **Evaluation Phase:** Evaluation was carried out during and after invasive interventions using tool (II & III) for the three groups and compared them to each other. Data was collected through three months from March to May 2025.

Statistical analysis

The collected data were organized, tabulated and statistically analyzed using SPSS software (Statistical Package for the Social Sciences, version 26, SPSS Inc. Chicago, IL, USA). For quantitative data, the range, mean and standard deviation were calculated. For qualitative data, which describe a categorical set of data by frequency, percentage or proportion of each category comparison between two groups and more was done using Chi square test ($\chi 2$). For comparison between more than two means of parametric data, F value of ANOVA test was calculated. Correlation between variables was evaluated using Pearson's correlation coefficient (r). Significance was adopted at $P < 0.05$ for interpretation of results of tests of significance, highly significance was adopted at $P < 0.001$ for interpretation of results of tests of significance **(White, 2019)**

Results:

Table (1): shows distribution of infants' bio-social characteristics. Similar results of bio-social characteristics were found in the three groups. Regarding their sex, it was found that 66.7 % of infants in both white noise group and lullaby group were male while 63.3 % of infants were male in control group. It was evident that mean of infants' age in month was 4.07±1.55, 4.07±1.55 and4.00±1.54 in white noise, lullaby and control group respectively. It was

clear that 70.0% of infants in both white noise and lullaby group were from urban, while 73.3% of the infants in the in control group were from rural areas. As regards different invasive procedures. It was evident that infants were exposed to injection procedures 30%, 33.3% and 43,3% in white noise, lullaby and control group respectively while, blood draws were experienced between 53.3%, 56.7% & 40% in the same order.. It was found that 10% in white noise and lullaby groups had aspiration compared to 16.7% of the control group.

Table (2): illustrates total mean score of physiological parameters of infants in white noise, lullaby and control groups during and after invasive interventions. Regarding white noise group, it was observed that physiological parameters were within the normal range during and after invasive intervention as the mean of respiratory rate, heart rate during and after were 32.83, 33.20, 116.20 and 116.20 respectively. As regard lullaby group, it was founded that the mean of respiratory rate, heart rate during and after were increased but still with normal rang as it become 36.27, 47.90, 135.57 and 136.80 respectively. In control group, the mean of respiratory rate, heart rate during and after were increased more. The mean of respiratory rate, heart rate during and after were43.55, 43.55, 158.00 and 160.69 respectively. Oxygen saturation was observed to be in the normal range in white noise and lullaby group but decrease little in the control group during and after invasive intervention as the mean values were 95.93, 96.07, 95.93, 96.07, 93.41 and93.41 respectively. There were a highly statistical significance difference of all items of physiological parameters during and after invasive interventions for all three groups as p value=<0.001 except in respiratory rate after as p value= 0.274.

Table (3): shows total infants' pain level during invasive interventions for white noise, lullaby and control groups. It was observed that all infants in the white noise group (100%) had no pain to mild pain during procedures, while, all of the infants in the lullaby and control groups (100%) had mild to moderate pain and severe pain respectively with highly statistical significance difference (p = 0.001).

Table (4): shows correlation between Infants' pain level and physiological parameters during and after invasive interventions for white noise, lullaby and control groups. It was observed that there were positive correlation between infants' pain during invasive interventions and respiratory rate during and after invasive interventions in white noise and lullaby groups with high statistical significant correlations as P value = 0.009, <0.001, 0.014and <0.001 respectively. There were also positive correlation between Infants' pain during invasive interventions and heart rate during and after invasive interventions in white noise and lullaby groups as P value = <0.001, <0.001, 0.005and <0.001respectively.

Table (1): Distribution of infants' bio-social characteristics (no=90)

Infants' bio-social characteristics	White noise group (30)		Brahms' lullaby group (30)		Control group (30)		Tests	
	N	%	N	%	N	%	f/ X^2	P-value
Sex								
Male	20	66.7	20	66.7	19	63.3		
Female	10	33.3	10	33.3	11	36.7	0.098	0.952
Age (months.)	4.07±1.55		4.07±1.55		4.00±1.54		0.018	0.982
Residence								
Urban	21	70.0	21	70.0	22	73.3		
Rural	9	30.0	9	30.0	8	26.7	0.108	0.947
Different invasive procedures								
Injection	9	30.0	10	33.3	13	43.3		
Blood draws	16	53.3	17	56.7	12	40.0		
Aspiration	5	16.7	3	10.0	5	16.7	6.767	0.149

Table (2): Total mean score of physiological parameters of infants in white noise, lullaby and control groups during and after invasive interventions (n=90).

Physiological parameters	White noise group (30)	Brahms' lullaby group (30)	Control group (30)	ANOVA	
	Mean±SD	Mean±SD	Mean±SD	f	P-value
Respiratory rate					
During	32.83±1.49	36.27±1.01	43.55±2.98	220.637	<0.001*
After	33.20±1.37	47.90±61.98	43.55±2.98	1.316	0.274
Heart rate					
During	116.20±9.79	135.57±5.28	158.00±18.26	85.839	<0.001*
After	116.20±9.79	136.80±4.03	160.69±3.80	343.673	<0.001*
O^2 saturation					
During	95.93±0.78	95.93±0.78	93.41±0.68	109.430	<0.001*
After	96.07±0.69	96.07±0.69	93.41±0.68	145.125	<0.001*

*** Significant Difference at (P<0.05), ** Highly statistical significant difference at (p≤0.001)**

Table (3): Total infants' pain level during invasive interventions for white noise, lullaby and control groups. (n=90).

Infant Pain during invasive interventions	White noise group (30)		Brahms' lullaby group (30)		Control group (30)		Chi-square	
	N	%	N	%	N	%	X^2	P-value
No pain to mild	30	100.0	0	0.0	0	0.0		
Mild to moderate pain	0	0.0	30	100.0	0	0.0	180.000	<0.001**
Sever pain	0	0.0	0	0.0	30	100.0		

*** Statistically Significant difference at (P<0.05)**
**** Highly statistical significant difference at (p≤0.001)**

Table (4): Correlation between infants' pain level and physiological parameters during and after invasive interventions for white noise, lullaby and control groups

Physiological parameters during and after invasive interventions	infants' Pain during invasive interventions					
	White noise		Brahms' lullaby		Control	
	r	P-value	r	P-value	r	P-value
Respiratory rate						
During	0.453	0.009*	0.359	0.014*	0.300	0.107
After	0.516	<0.001*	0.645	<0.001*	0.300	0.107
Heart rate						
During	0.507	<0.001*	0.497	0.005*	-0.177	0.350
After	0.626	<0.001*	0.565	<0.001*	0.204	0.280
O2 saturation						
During	0.259	0.167	0.186	0.325	-0.287	0.124
After	0.033	0.864	0.185	0.329	-0.287	0.124

*** Statistically Significant difference at (P<0.05)**
**** Highly statistical significant difference at (p≤0.001)**

Discussion

Sounds and music can be a powerful stimulator for pain relief. Audial stimulation distracts the attention effectively and provides a cognitive strategy for pain control and suppression of the pain response **(Bergomi, Scudeller, Pintaldi & Molin, 2018).** It is well recognized that non pharmacological pain management techniques are simple, inexpensive, time-efficient, and free of adverse effects. There are also effective non-pharmacological audial interventions, which are employed in distraction **(Inan & Inal, 2019)** the current study aimed to evaluate the effect of white noise and Brahms' lullaby on infants' pain and physiological parameters during invasive interventions.

As regards mean score of studied infants related to their physiological parameters in both white noise and lullaby groups. The present study revealed that physiological parameters were within the normal range during and after invasive intervention in white noise group. While in lullaby group, it was increased but still within normal rang. This may be due to positive effect of both approaches on physiological parameter as it affects neurobehavioral development. These results were contradict with the result of **Çuhacı, Efe & Güneş (2024)** who founded that music did not affect the physiological parameters positively.

The study conducted by **Fooladi, Ghaljaei, Keikhaei& Miri-Aliabad (2019)** who discovered that the heart rate changed before and after distraction, indicating a decreasing in the intervention group and more stable conditions with statistically significant differences, was in accordance with the current study's findings. The results of **Kozlowski, Koepf, Timothy, Kayleigh & Victor (2018)** who mentioned that the pulse rates and breathe rate of the distraction techniques groups were lower than in the control group during inhalation therapy was also on the same line with the present study.

Regarding oxygen saturation in the current study, it was observed that oxygen saturation was within normal range in white noise and lullaby group but decrease little in the control group during and after invasive intervention. This may be due to oxygen saturation are not sensitive and specific indicators to evaluate the effects of interventions in infant pain relief. This result was disagreeing with the results of **Sajedi , Kashaninia, Rahgozar& Noghabi (2017)** who concluded that non-pharmacological pain management techniques, such as distraction, could have a substantial impact on SaO2, resulting in more stable arterial blood oxygen saturation levels for infants in the intervention group following traumatic operations. **Taplak & Bayat (2021)** who reported that heart rate and oxygen saturation were not different during the procedure were in the same line of the present study. The study conducted by **Kahraman et al., (2020)** showed that the white noise group's mean SpO2 was higher than the control group was also in agreement with present study.

Regarding pain level in the current study. It was observed that all infants had no to mild pain, mild to moderate pain and severe pain in white noise, lullaby group and control group during invasive interventions respectively. It might be because white noise white noise distracts infants' attention away from painful stimulus, influencing nervous system and potentially blocking pain pathway distract infants' attention away from painful stimulus, influencing nervous system and potentially blocking pain pathway. These results were in agreement with **Taplak & Bayat (2021)** who showed that score of pain in the experimental group decreased close to mild pain faster than in the control group after the needle withdrawal.

Regarding white noise, it was founded that the pain scores of the infants in the white noise group were

significantly lower than those in the control group, both during and after the invasive interventions. The reason for this could be that it is a constant, repetitive sound that is comparable to the sound the fetus hears in the mother's uterus, so it can conceal distracting environmental sounds and have a calming, relaxed impact. Pain score of the premature neonates in the white noise group were significantly lower than in the control group which reported by **Kahraman et al., (2020)** was in agreement with the present study. Also, in the same line with the present study, white noise was more effective in minimizing the pain experienced by infants undergoing potentially painful procedures as mentioned by **Martins ., et al (2025).** The study by **Cetinkaya, Yavas & Özdemir (2022)** who mentioned that during painful treatments, white noise was a simple and efficient technique. **Döra & Büyük (2021)** discovered that infants' pain levels were higher in the control group and lower in the white noise group. **Ren, Wang, Yang, Kong & Feng (2019)** discovered that white noise helped preterm infants feel less pain after retinopathy scans.**Taplak & Bayat (2021)** They indicated that white noise was good at relieving pain in infants prior to endotracheal aspiration**. Ren, Li, Lin, Zhong& Wang (2022)** discovered that in infants experiencing procedural pain, a white noise intervention had no positive effects on pain-related brain responses, pain ratings, or behavioral and physiological indicators.

In the present study, infants' pain scores in the lullaby group were significantly lower than those in the control group, both during and after the invasive interventions. It is believed that relaxation and distraction play an important role in decreasing pain. **Shabani, Nayeri, Karimi, Zarei & Chehrazi (2024)** and **Tekgündüz, Polat, Gürol & Apay (2019)** supported this result who reported that music had positive effects on preterm infants' physical and behavioral responses during a blood draw and conclude in their study that exposure to lullabies in infants significantly reduce pain during the removal and replacement of the tracheal tube. **Döra & Büyük (2021)** who mentioned that the lullaby group had a lower pain score compared to the control group was also in agreement with the present study. **Uematsu & Sobue (2019)** reported that Brahms' lullaby facilitated the addition and holding of sucking in non-nourishing mothers, and that it resulted in a reduction in pain levels in infants during heel lance. In the same line, **Barandouzi, Keshavarz, Montazeri, Ashayeri& Rajaei (2020)** report that music had a soothing effect on pain in infants during the establishment of vascular access. In addition to, **Rossi, Molinaro & Savi (2018)** who used the neonate pain scale to assess three music-based therapies in infants and discovered that the experimental group of newborns' perceptions of pain was much lower than those of the control group.

The present study revealed that there was statistical significance difference in total infant's pain level based on neonatal infant pain scale during

invasive interventions for white noise, lullaby and control groups .In the same line with current results**, Midilli & Ergin (2023)** reported that, both during and after the surgery, the infants' pain mean scores of the babies in the Brahms' lullaby and white noise groups were noticeably lower than those of the control group.

Conclusion

It can be concluded from the results of the current study that: White noise and Brahms' lullaby were effective in reducing infants' pain and improve physiological parameters during invasive interventions**.** White noise was the most effective method in reducing infants' pain and improves physiological parameters during invasive interventions.

Recommendations

The following are suggested and recommended:

- Integration of pain assessment and physiological parameters into the usual assessment of infants.
- Pediatric nurses should adopt non-pharmacological approaches including white noise and Brahms' lullaby to relieve pain and enhance physiological parameters during invasive interventions.

References

Barandouzi, A., Keshavarz, M., Montazeri, A., Ashayeri, H., Rajaei, Z. (2020). Comparison of the analgesic effect of oral sucrose and/or music in preterm neonates: a doubleblind randomized clinical trial. *Journal of Complementary Therapies in Medicine*, *48*(12), 33-55 DOI: 10.1016/j.ctim.2019.102271

Bergomi, P., Scudeller, L., Pintaldi, S., Molin, A. (2018). Efficacy of non-pharmacological methods of pain management in children undergoing venipuncture in a pediatric outpatient clinic: a randomized controlled trial of audiovisual distraction and external cold and vibration. *Journal of Pediatric Nursing, 42*(11), 66–72. DOI: 10.1016/j.pedn.2018.04.011

Bourgois, C., Shaha, M., Vanoni, F., Jaques, C., Newman, J., Simonetti, D. (2020). A systematic review of clinical practice guidelines for acute Procedural Pain on Neonates. *Journal of Clinical Pain, 36*(5):390-98. DOI: 10.1097/AJP.0000000000000808

Çetinkaya, S., Yavas, M., Özdemir, S. (2022). Effect of white noise on alleviating the pain of new-born during invasive procedures. *Journal of Maternal Fetal Neonatal Medicine*, *35*(8), 1426-1432. DOI: /10.1080 14767058.2020.1755652

Çuhacı, A ., Efe, A ., Güneş, T. (2024). The effect of music on pain, comfort, and physiological parameters during premature retinopathy examination. *Journal of Pediatric Nursing*, *78*(6), 149-157. DOI: 10.1016/j.pedn.2024.06.020

Döra, O., Büyük, E. (2021). Effect of White Noise and Lullabies on Pain and Vital Signs in Invasive Interventions Applied to Premature Babies. *Journal of Pain Management Nursing, 22*(6):724-

729. DOI: 10.1016/j.pmn.2021.05.005

Fooladi, S., Ghaljaei, F., Keikhaei, A., Miri-Aliabad, G. (2019). Effect of distraction therapy on physiological indices and Pain Intensity Caused by Intra-Spinal Injection of Chemotherapy Drugs in Cancerous Children: A Clinical Trial. *Journal of Medical surgical nursing, 1*(8), 55. DOI: 10.5812/msnj.90409

Gilam, G., Gross, J., Wager, D., Keefe J, Mackey, C. (2020). What is the relationship between pain and emotion? Bridging constructs and communities. *Journal of Neuron*, *107*(1), 17–21. DOI: 10.1016/j.neuron.2020.05.024

Inan, G., Inal, S. (2019). The impact of 3 different distraction techniques on the pain and anxiety levels of children during venipuncture. *Clinical Journal of Pain*,*35*(2),140–147 DOI: 10.1097/AJP.0000000000000066

Kahraman, A., Gümüş, M., Akar, M., Sipahi, M., Bal Yılmaz, H., Başbakkal, Z. (2020). The effects of auditory interventions on pain and comfort in premature newborns in the neonatal intensive care unit. *Journal of Intensive Critical Care Nursing*, *61*(12), 10-29. DOI: 10.1016/j.iccn.2020.102904

Kassab, M., Alhassan, A., Alzoubi, H., Khader. S.(2019). Number and frequency of routinely applied painful procedures in university neonatal intensive care unit. *Journal of Clinical Nursing Research*, *28*(4), 488–501. DOI: 10.1177/1054773817744324

Komann, M., Weinmann, C., Schwenkglenks, M., Meissner, W. (2019). Non-pharmacological methods and post-operative pain relief: an observational study. *Journal of Anesthesia Pain Medicine*, 9(2), 1–7. DOI: 10.5812/aapm.84674

Kozlowski, S., Koepf, N., Timothy, J., Kayleigh, W., Victor, R. (2108). Physiological effects experienced after introduction of a distraction and its effects on performance. *Journal of Advanced Student Science, 11*(23), 303-7.

Lawrence, J., Alcock, D., McGrath, P., Kay, J., MacMurray, B., Dulberg, C. (1993). The development of a tool to assess neonatal pain. *Journal of Neonatal Network, 12*(6), 59-66.

Martinsa, l., Sage, M., Visitação,M., Cruz ,M., Sacoto, M., Ramos, A.(2025). The effect of white noise in minimizing pain caused by invasive procedures performed during the hospitalization of newborn infants: A systematic literature review. *Journal of Neonatal Nursing*, *31*(2),1-7. Doi.org/10.1016/j.jnn.2024.12.014.

Midilli ,T., Ergin,E.(2023). The Effect of White Noise and Brahms' Lullaby on Pain in Infants during Intravenous Blood Draw: A Randomized Controlled Study. *Journal of Alternative Therapies in Health and Medicine*, *29*(2):148-154.

Özgürbüz, N., Bahar A., Tuna,A., Çopur, E.(2024). The effect of lullaby played

to preterm infants in neonatal intensive care units on physiological parameters and pain. *Journal of Pediatric Nursing*, *79*(11), 133-140. DOI: 10.1016/j.pedn.2024.08.019

Ren, X., Li, L., Lin, S, Zhong, C., Wang, B. (2022). Effects of white noise on procedural pain related cortical response and pain score in neonates: a randomized controlled trial. International *Journal of Nursing Science,* 9(22), 269–277. DOI: 10.1016/j.ijnss.2022.06.007

Ren, X., Wang, Z., Yang, L., Kong, X., Feng, C. (2019). Clinical effect of white noise combined with glucose in reducing the pain of retinopathy screening in preterm infants. *Chinese Journal of Contemn Pediatric, 21*(12), 1159–1163. DOI: 10.7499/j.issn.10088830.2019.12.002

Rossi, A., Molinaro, A., Savi, E. (2018). Music reduces pain perception in healthy newborns: A comparison between different music tracks and recoded heartbeat. *Journal of Early Human Development. 124*(3), 7–10. DOI: 10.1016/j.earlhumdev.2018.07.006

Sajedi, F., Kashaninia, Z., Rahgozar, M., Noghabi, A. (2017). The effect of kangaroo care on physiologic responses to pain of an intramuscular injection in neonates. Iran *Journal of Pediatirc, 17*(4),339-44. DOI: 10.1111/j.1744615.2008.00165.x

See, C., Ng, M., Ignacio, J. (2023). Effectiveness of music interventions in reducing pain and anxiety of patients in pediatric and adult emergency departments: A systematic review and meta-analysis. *Journal of International Emergency Nursing*, *66*(10) 12-31. DOI: 10.1016/j.ienj.2022.101231

Shabani, F., Nayeri, N., Karimi, R., Zarei, K., Chehrazi, M. (2024). Effects of music therapy on pain responses induced by blood sampling in premature infants: a randomized cross-over trial. *Iran Journal of Pediatric, 24*(l 2):75–77. DOI: 10.4103/1735-9066.185581

Taplak, S., Bayat, M. (2021). Comparison the effect of breast milk smell, white noise and facilitated tucking applied to Turkish preterm infants during endotracheal suctioning on pain and physiological parameters. *Journal of Pediatric Nursing, 56*(5), 19-26**.** DOI: 10.1016/j.pedn.2020.07.001

Tekgündüz, Ş., Polat, S., Gürol, A., Apay, E. (2019). Oral glucose and listening to lullaby to decrease pain in preterm infants supported with NCPAP: a randomized controlled trial. *Journal of Pain Management Nursing, 20*(1):54–61. DOI: 10.1016/j.pmn.2018.04.008

Uematsu, H., Sobue, I. (2019). Effect of music (Brahms' lullaby) and non-nutritive sucking on heel lance in preterm infants: a randomized controlled crossover trial. *Journal of Pediatric Child Health*, *24*(1), 33–39. DOI: 10.1093/pch/pxy072

Walco, A., Kopecky, A., Weisman, J., Stinson, J., Stevens, B., Desjardins, J, et al. (2018). Clinical trial designs and models for analgesic medications for acute pain in neonates, infants, toddlers, children, and adolescents: actions, recommendations. *Journal of International Association for the Study of Pain*, *159*(2), 193-205. DOI: 10.1097/j.pain. 00000000001104

Wang, Y., Guo, L., Xiong X. (2022). Effects of virtual reality-based distraction of pain, fear, and anxiety during needle-related procedures in children and adolescents. *Journal of Frontiers in Psychology, 13*(8), 842-47. DOI:10.3389/fpsyg.2022.842847.

White, S.(2019). Reading the medical literature: Basic & Clinical Biostatistics. Medical Publication Division. New York. 5th ed: Lange Medical Book/ McGraw – Hill Co., Ch. 3-10, PP 20 – 233.

Yıldırım, B., & Gerçeker, G. (2023). The effect of virtual reality and buzzy on first insertion success, procedure-related fear, anxiety, and pain in children during ıntravenous ınsertion in the pediatric emergency unit: A randomized controlled trial. *Journal of Emergency Nursing, 49*(1), 62–74 DOI: 10.1016/j.jen.2022.09.018.