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THE IMPACT OF LULLABY MUSIC THERAPY ON PHYSIOLOGICAL STABILITY IN LOW BIRTH WEIGHT INFANTS

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Abstract

Physiological instability, which encompasses fluctuations in body temperature, heart rate, respiration rate, and oxygen saturation, is a substantial concern for low birth weight infants (LBWI). Lullaby music therapy is a non-pharmacological treatment that assists in the stabilization of the physiological condition of neonates with extremely low birth weight. This study aimed to investigate the physiological status of low-birth-weight neonates in response to lullaby music therapy. This study was designed as a quasi-experimental pretest-posttest study that involved 20 low-birth-weight infants. A lullaby music treatment was administered for 45 minutes on each of the three consecutive days, with a frequency of 60-70 dB. The intervention was implemented through a speaker that was situated in close proximity to the infant's feet within the incubator. Before and during the treatment, the physiological parameters assessed were body temperature, heart rate, respiration rate, and oxygen saturation. The Wilcoxon signed-rank test was employed to analyze the data. Significant discrepancies were observed between pre- and post-therapy measurements for all parameters, including body temperature ($Z = -2.591$; $p = 0.010$), heart rate ($Z = -2.765$; $p = 0.006$), respiratory rate ($Z = -3.930$; $p < 0.001$), and oxygen saturation ($Z = -3.934$; $p < 0.001$). In hospital environments, lullaby music treatment has the potential to serve as an effective supportive intervention in stabilizing the physiological state of neonates with Low Birth Weight (LBWI) and significantly enhances their physiological condition.

***Keywords*:** *Lullaby Music Therapy, Low Birth Weight Infants, Physiological Status*

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INTRODUCTION

Low birth weight infants are those that were born weighing less than 2,500 grams. These infants are particularly susceptible to physiological instability, which includes fluctuations in body temperature, pulse rate, respiratory rate, and oxygen saturation (Bell et al., 2006). Neonatal intensive care for low birth weight infants has advanced significantly, incorporating close monitoring and the provision of supportive therapies. However, invasive procedures and the highly stimulating hospital environment may induce stress in infants, potentially disrupting their physiological stability (Oka, 2025).

The risk of severe complications in low birth weight infants is elevated by physiological instability, which may result in a prolonged stay in the neonatal intensive care unit (NICU) and a negative impact on the infant's growth and health (Als et al., 2004). Stress in low birth weight infants may exacerbate health conditions and negatively impact long-term neurological development (Seassau et al., 2023).

Various studies have shown that environmental stress in preterm infants can trigger activation of the sympathetic nervous system, leading to significant alterations in vital signs (Cong et al., 2012). Other studies have also demonstrated that prolonged stress in newborns, particularly those admitted to the NICU, is closely associated with physiological dysregulation, including increased heart rate variability and decreased oxygen saturation (McMahon et al., 2012). Music therapy is a clinical intervention that is founded on the arts and employs structured musical elements to enhance, support, or restore an individual's physical, emotional, and psychological well-being (Emaliyawati et al., 2017).

One form of complementary therapy is lullaby music therapy, which is implemented as a method to help stabilize the physiological condition of preterm and low birth weight infants (Lawrence, 2019). Lullaby music with soft rhythms and a slow tempo is believed to influence the infant’s autonomic nervous system, thereby reducing physiological stress and enhancing the stability of vital signs (Haslbeck et al., 2020). Research has demonstrated that lullaby music therapy can decrease tension levels and regulate vital signs, including oxygen saturation, respiratory rate, and pulse rate (Amini et al., 2013)

Studies conducted in Neonatal Intensive Care Unit (NICU) settings on preterm and low birth weight infants have demonstrated that live music therapy, particularly lullabies sung by parents or therapists, can effectively reduce heart rate, improve sleep quality, and stabilize respiratory patterns (Loewy et al., 2013). Music therapy with soft melodies such as lullabies, when administered regularly to preterm infants, has been shown to improve sleep efficiency and weight gain, as well as reduce stress caused by excessive noise in the Neonatal Intensive Care Unit (NICU) (Keith et al., 2009)

Although several studies have explored music therapy in preterm infants, few have focused specifically on low-birth-weight infants using standardized lullaby interventions and simultaneous assessment of multiple physiological parameters, especially in developing countries.

METHODS

Pre-experimental design was implemented in this investigation, which employed a pretest-posttest methodology with a single group. The objective of this investigation was to ascertain the impact of lullaby music therapy on the physiological status of low-birth-weight infants (LBWIs). This design involved the administration of the lullaby music intervention to a single group of subjects. Physiological parameters, such as heart rate, respiratory rate, oxygen saturation, and body temperature, were assessed both before (pretest) and after (posttest). The study concentrated on the physiological reactions of the same group subsequent to the therapy, as no control group was incorporated.

The study population consisted of all low-birth-weight infants admitted to the neonatal care unit at Hermina OPI Hospital in Jakabaring. A total of 20 LBWIs who met the inclusion and exclusion criteria were selected as the sample. The sampling technique used was purposive sampling, whereby subjects were deliberately selected based on specific criteria relevant to the study objectives and feasibility of receiving lullaby music therapy. The inclusion criteria included: infants with a birth weight of less than 2,500 grams, aged less than 7 days, clinically stable, and whose parents or guardians provided informed consent to participate in the study.

The physiological state was evaluated utilizing newborn vital sign monitors that accurately measure heart rate, respiration rate, and oxygen saturation in real time. Body temperature was measured using a digital thermometer designed specifically for infants to ensure quick and precise readings. Lullaby music therapy was administered using an audio player with a standardized volume level between 60 and 70 decibels (dB), ensuring that the sound delivered to the infants remained comfortable and safe. All instruments were properly calibrated and used according to standard procedures to ensure data validity and reliability.

All study procedures were carried out in accordance with research ethics principles, including maintaining data confidentiality, ensuring the safety and comfort of the participants, and obtaining written informed consent from the infants’ parents or legal guardians prior to the

intervention. The researcher also ensured that the lullaby music was played at a safe volume that did not pose any risk to the infants' health.

The Shapiro–Wilk test was employed to evaluate the normality of the data. Due to the non-normal distribution of the data, the Wilcoxon signed-rank test, a non-parametric statistical technique, was utilized to compare the physiological parameters pre and post intervention.

RESULTS AND DISCUSSION

The results of the univariate analysis of physiological status (temperature, heart rate, respiratory rate, and oxygen saturation) before the lullaby music therapy in low birth weight infants are presented in Table 1 below:

Table 1. Physiological Status of Low-Birth-Weight Infants Before Lullaby Music Therapy

Physiological Status	Unit	Median	Min-Max
Temperature	°C	36,6	36,4-36,7
Heart Rate	bpm	131	110-190
Respiratory Rate	breaths/min	63,5	54-70
Oxygen Saturation	%	89,5	70-98

Table 1 shows that the median body temperature of low-birth-weight infants before lullaby music therapy was 36.6°C, within the physiological range for newborns. The temperature ranged from 36.4°C to 36.7°C, indicating some fluctuations. The median heart rate was 131 bpm (range 110–190 bpm), reflecting individual cardiovascular variability. Median respiratory rate (63.5 breaths/min) and oxygen saturation (89.5%) also varied, providing important baseline physiological data before the intervention.

The outcomes of the univariate analysis of physiological parameters (temperature, heart rate, respiratory rate, and oxygen saturation) following lullaby music treatment in low birth weight infants are displayed in Table 2 below :

Table 2. Physiological Status of Low-Birth-Weight Infants After Lullaby Music Therapy

Physiological Status	Unit	Median	Min-Max
Temperature	°C	36,70	36,5-36,8
Heart Rate	bpm	115	100-160
Respiratory Rate	breaths/min	53,5	50-60
Oxygen Saturation	%	98	96-99

Table 2 shows that after lullaby music therapy, low birth weight infants had a median body temperature of 36.7°C (range 36.5–36.8°C), a median heart rate of 115 bpm (100–160 bpm), a median respiratory rate of 53.5 breaths/min (50–60 breaths/min), and a median oxygen saturation of 98% (96–99%). These results indicate improved and more stable physiological parameters following the intervention.

Table 3. Normality Test Results of Physiological Data Before and After Therapy

Physiological Status	Before Therapy (*p-value*)	After Therapy (*p-value*)
Temperature	0,002	0,000
Heart Rate	0,022	0,039
Respiratory Rate	0,023	0,019
Oxygen Saturation	0,000	0,003

According to the results in Table 3, all variables emperature, heart rate, respiratory rate, and oxygen saturation exhibited p-values < 0.05 before and after the intervention. This signifies that the data for each variable does not follow a normal distribution. Consequently, the next statistical study utilized the Wilcoxon signed-rank test to evaluate the physiological condition of low-birth-weight babies prior to and during lullaby music treatment.

Table 4. Effect of Lullaby Music Therapy on Physiological Status in LBW Babies

Physiological Status	Z	*p-Value*
Temperature (Post–Pre)	-2,591	0,010
Heart Rate (Post–Pre)	-2,765	0,006
Respiratory Rate (Post–Pre)	-3,930	< 0,001
Oxygen Saturation (Post–Pre)	-3,934	< 0,001

Based on the statistical analysis using the Wilcoxon signed-rank test, all physiological variables (temperature, heart rate, respiratory rate, and oxygen saturation) showed negative Z-values, indicating changes in measurements after the therapy compared to before. The significance values (p-values) for all four variables were below 0.05 (temperature = 0.010; heart rate = 0.006; respiratory rate = < 0.001; oxygen saturation = < 0.001), demonstrating statistically significant differences.

The analysis showed an increase in median body temperature from 36.6°C before therapy to 36.7°C after therapy. The Wilcoxon test yielded a p-value of 0.010, indicating a significant difference. Lullaby music may have a calming effect and stimulate the autonomic nervous system, contributing to improved thermoregulation. By reducing stress and excessive metabolic activity, music helps maintain body temperature within a normal and stable range (Loewy et al., 2013). The increase in body temperature observed in low birth

weight (LBW) infants following the administration of music therapy indicates that lullaby music may exert a relaxing effect that contributes to the stabilization of body temperature. This finding is consistent with previous studies demonstrating that soft music can stimulate the parasympathetic nervous system, enhance peripheral vasodilation, and aid in maintaining the body temperature of preterm infants (Liwang et al., 2018). Other studies have also reported that music therapy can stimulate the thermoregulatory center in the hypothalamus, thereby enhancing the infant's ability to maintain homeostasis (Alipour et al., 2013).

The median heart rate decreased from 131 to 115 beats per minute following the therapy. A p-value of 0.006 indicates a statistically significant reduction. This decrease in heart rate suggests a relaxation effect induced by the music therapy. The study Cardiovascular, Cerebrovascular, And Respiratory Changes Induced By Different Types Of Music In Musicians And Non-Musicians highlights that slow-tempo music increases heart rate variability (HRV), reflecting parasympathetic system dominance, whereas fast-tempo music decreases HRV (Bernardi et al., 2006). A meta-analysis by de Witte et al. (2022) also concluded that music interventions consistently reduce heart rate across diverse populations (d = 0.456), reinforcing the underlying mechanism of achieving physiological balance in preterm infants (De Witte et al., 2022).

The infants' heart rate showed a decrease following the therapy, from a median of 131 to 115 beats per minute. This reduction reflects a state of relaxation and decreased sympathetic nervous system activity. These findings support those of Loewy et al. (2013), who demonstrated that live music interventions, such as lullabies and rhythmic sounds, have positive physiological effects on neonates. Heart rate significantly decreased during music exposure (P < 0,001 and *p value* = 0,004), indicating relaxation and reduced sympathetic activation. Furthermore, rhythmic auditory stimulation was also associated with an improvement in infant sucking behavior (P = 0.03) (Loewy et al., 2013). This is further supported by the findings of Standley (2002), who stated that lullaby music with a slow tempo and soft tones can reduce physiological stress, slow down sympathetic nervous system activity, and stabilize vital parameters in neonates (Standley, 2002).

There was a decrease in the median respiratory rate from 63.5 to 53.5 breaths per minute following the therapy, with a p-value of 0.000. This reduction indicates a state of relaxation in the respiratory system. Lullaby music played at an intensity level of 60–70 dB provides calming auditory stimulation, which can reduce excessive respiratory activity in infants experiencing stress (Arnon et al., 2006). This calming effect is essential for reducing energy expenditure and enhancing respiratory efficiency. The respiratory rate also decreased from a median of 63.5 to 53.5 breaths per minute, indicating that the infants experienced relaxation and more efficient breathing. A study reported a reduction in respiratory rate of up to −8.8 breaths per minute and an increase in oxygen saturation by +1.6% in preterm infants during sleep following a live music session (Kobus et al., 2021). A meta-analysis study that examined 16 randomized controlled trials (RCTs) demonstrated that music therapy significantly reduced the respiratory rate in preterm infants, with an average decrease of 3.91 breaths per minute. These findings underscore the relaxing effect of music on the neonatal respiratory system (Bieleninik et al., 2016).

The median oxygen saturation increased from 89.5% to 98% following the therapy, with the Wilcoxon test indicating a statistically significant result (p = 0.000). This demonstrates a substantial improvement in tissue oxygenation. A study conducted by Emaliyawati et al. (2017), titled The Effect of Lullaby Music Therapy on Heart Rate, Respiration Rate, and Oxygen Saturation in Preterm Infants, showed that administering lullaby music for three consecutive days significantly reduced heart rate and respiratory rate, and increased oxygen saturation in preterm infants (p < 0.05). This therapy has been proven effective in promoting relaxation and enhancing physiological stability, suggesting its potential applicability in neonatal care units utilizing respiratory support (Emaliyawati et al., 2018).

The results align with the study titled The Effect of Recorded Mum's Lullaby and Brahms' Lullaby on Oxygen Saturation in Preterm newborns: A Randomized Double-Blind Clinical Trial by Jabraeili et al. (2016), which included 66 preterm newborns aged ≥3 days and weighing ≤2800 grams. The newborns were randomly allocated to three groups: control, Brahms' lullaby, and mother lullaby. Oxygen saturation was assessed throughout three successive sessions. The findings indicated a notable elevation in oxygen saturation 15 minutes post-intervention in both the Brahms' lullaby and maternal lullaby groups relative to the control group (Jabraeili et al., 2016).

The findings suggest that lullaby music, whether from mothers or classical composers, positively influences the physiological stability of preterm newborns and may serve as a non-pharmacological intervention in neonatal care. Lullaby music treatment has been demonstrated to significantly affect physiological parameters in preterm newborns, namely by decreasing heart rate and breathing rate, while enhancing oxygen saturation. This strategy can be considered a safe and effective non-pharmacological method to enhance physiological stability in newborn care units.

CONCLUSION

There was a significant increase in the body temperature of low birth weight (LBW) infants from a median of 36.6 °C to 36.7 °C ($p = 0.010$), reflecting stabilization of the thermoregulatory system. Heart rate decreased from a median of 131 to 115 beats per minute ($p = 0.006$), indicating activation of the parasympathetic nervous system resulting in cardiovascular relaxation. Respiratory rate also decreased from a median of 63.5 to 53.5 breaths per minute ($p = 0.000$), suggesting improved respiratory efficiency. Meanwhile, oxygen saturation increased from a median of 89.5% to 98% ($p = 0.000$), indicating enhanced tissue oxygenation.

The analysis demonstrated statistically significant differences in all four physiological parameters of LBW infants before and after the lullaby music therapy intervention. Body temperature increased from a median of 36.6 °C to 36.7 °C ($p = 0.010$), heart rate decreased from 131 to 115 beats per minute ($p = 0.006$), and respiratory rate decreased from 63.5 to 53.5 breaths per minute ($p < 0.001$).

Lullaby music therapy is recommended as a complementary nursing intervention in LBW infant care units due to its proven effectiveness and safety. Hospitals are encouraged to integrate this therapy into neonatal care standard operating procedures (SOPs). Further research with larger sample sizes and controlled variables is needed to strengthen the generalizability of these findings.

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