Journal of Neonatal-Perinatal Medicine 3 (2010) 103–107
DOI 10.3233/NPM-2010-0101
IOS Press

The effect of listening to lullaby music on physiologic response and weight gain of premature infants[1]

Ahmadshah Farhat[a], Rana Amiri[b,*], Sohaila Karbandi[c], Habibollah Esmaily[d] and Ashraf Mohammadzadeh[a]

[a]*Medical School, Neonatal Research Center, Mashhad University of Medical Science, and NICU of Emamreza Hospital, Mashhad, Iran*

[b]*Faculty of Nursing and Midwifery, Neonatal Research Center, Mashhad University of Medical Science, Mashhad, Iran*

[c]*Faculty of Nursing and Midwifery, Mashhad University of Medical Science, Mashhad, Iran*

[d]*Biostatistics Department, Mashhad University of Medical Science, Mashhad, Iran*

Received 18 June 2009
Revised 12 August 2009
Accepted 20 October 2009

Abstract. *Objectives:* The environment plays a key role in survival and brain development for premature infants. Recent interest lends consideration to non pharmacological interventions as a beneficial alternative. This study seeks to investigate the effect of lullaby music on the physiological response and weight gain of premature infants in Mashhad, Iran.
Method: In this study, 44 very low birth weight infants $\leqslant$ 34 weeks of gestational age that were admitted to the Neonatal Intensive Care Unit (NICU) of Imamreza Hospital in Mashhad, Iran were enrolled. Infants were randomly assigned to one of two groups: the Music group and the Control group. Lullaby music was played through earphones for the Music group. This continued for 8 days at 20 minutes per day. The Control group received routine auditory stimulation. Neonates in the two groups were in stable condition and kept in their isolettes. Infants were monitored for 40 minutes; 10 minutes baseline, 20 minutes into the intervention and 10 minutes post intervention. Data measures were heart rate, respiration rate, oxygen saturation and body weight.
Result: The two groups differed significantly in the respiratory rate ($p = 0.01$) and oxygen saturation ($p = 0.001$). There were no significant differences in the heart rate ($p = 0.24$) and weight gain ($p = 0.093$) between the two groups.
Conclusion: Preterm infants respond to lullaby music as evidenced by the changes in their respiratory rates and oxygen saturations. Although this study did not demonstrate an improvement in weight gain, further studies are recommended to examine the effect of music on other growth and developmental aspects.

Keywords: Lullaby music, physiologic response, weight gain, preterm infants

1. Introduction

The neonatal period is the most vulnerable period of human life, so it should be given careful consideration [1]. The incidence of premature birth varies from 6–15% and is related to geographic and demographic status [2]. Approximately 9% of all births are admit-

[1]This study has been funded by Mashhad University of Medical Science.

*Corresponding author: Rana Amiri, Neonatal Research Center, NICU, Emamreza Hospital, Mashhad, Iran. Tel.: +98 5112709006; E-mail: amirir1@mums.ac.ir.

ted to the Neonatal Intensive Care Unit (NICU), 7.7% of births are low birth weight (LBW) and 1.5% very low birth weight (VLBW) [3]. The major challenges preterm infants face is weight gain and lung development. Medical therapy such as assisted ventilation, antenatal steroids and surfactant replacement therapy have been increasingly effective in reducing mortality [4]. The environment provided to premature infants is important, not only for their survival but also for their development.

The nursing environment can be unpredictable and over stimulating exceeding the tolerance level of premature infants [5]. The environmental noise in the NICU contributes to increased stress, decreased sleep times with subsequent behavioral and physiological disturbances [6,7]. The source of noise may arise from crying infants, talking staff, ringing telephones, and alarming equipment which can peak to 80–90 db even inside an isolette. Recorded lullaby music is introduced into this environment as a more predictable and stable source of stimulation which masks intermittent and unpredictable sounds, thereby causing the amount of stress experienced by the infant to decrease [5]. Lullabies are an appropriate sedative music selection for infants because they contain lyrical predictable and tonic oriented melodies of around 8 bars in length with a steady rhythm of 60–80 beats /minute [8]. Auditory capability is an early, discriminative ability of a fetus. At 30–35 weeks the fetus hears and responds to maternal sounds; and it is also capable of distinguishing it from other sounds [9]. Some studies indicated favorable auditory stimulations as effective for weight gain and respiratory functions. Weight gain may be resultant of an increased sleep period, decreased caloric expenditure and regulated respiratory function [6,10–13]. Increasing oxygen saturation (Spo_2) without excessive O_2 therapy is an important in order to avoid oxygen related complications [14]. In this study we aimed to investigate the effect of lullaby music on the physiological responses and weight gain of premature infants.

2. Patients and methods

This study was a randomized, controlled trial consisting of a Control group who received no music intervention and a Music group that was exposed to lullaby music. The study was conducted in the NICU at Imam Reza Hospital in Mashhad, Iran from July 2006 to February 2007. Criteria for inclusion in this study were: adjusted gestational age $\leqslant$ 34 weeks; birth weight between 1000–1500 grams; post natal age of 4 days; and clinically stable neonates (not supported by ventilator assistance or oxygen therapy). Excluding criteria were: diagnosed hearing impairment; congenital anomalies; maternal drug addiction; and use of oxygen. Sample size was calculated by considering the mean and standard deviation (SD) of previous studies [5,10]. Sample sized was calculated for all variables including SPO_2, heart rate (HR), respiratory rate (RR) and weight gain and a sample of 40 infants (20 in each group) was considered adequate. All infants were checked for hearing loss by auto acoustic emission (OAE) before entering the study. Infants were randomly assigned to one of two groups. Infants in the Control group received routine NICU nursing care. Infants in the Music group received routine NICU care as well as 20 minutes of music intervention every day for 8 days. The music was commercially recorded lullabies sung by Iranian female vocalists; played by an MP3player at 60–65 db inside the isolette. The decibel levels were tested at the subject's ear using a sound level meter and the volume level on headphones was then adjusted and covered to avoid accidental unsafe changes in volume. Each subject was breast or bottle fed and their diapers were changed within half an hour before the intervention. Infants in the two groups were evaluated and observed for 40 minutes every day for 8 days. The data collection was divided into 40 one minute time samples. Heart rates and oxygen saturation levels as displayed on the pulse oximeter recorded every minute. Respiratory rate was recorded every 5 minutes and weight gain was measured daily by a digital weight scale. Neonates were evaluated during 3 phases: 10 minute baseline, 20 minute intervention and 10 minute post intervention. During the second observation the selected music was played via headphones for the music group and during the post observation period music was discontinued and the infant was observed by the researcher.

3. Statistical analysis

The anthropometric data are presented as means $\pm$ SD. For quantitative variables, comparisons between the groups were performed by using independent t-tests, and within the groups the paired t-test was used. Categorical variables were analyzed using the chi-square test and the Fisher exact test. If there was no normal distribution non-parametric tests, such as the Mann

Table 1
Characteristics of preterm neonates in two groups

Variable	Music group Mean ± SD ($n = 22$)	Control group Mean ± SD ($n = 22$)	P– value
Birth weight (g)	1279 ± 172	1298 ± 133	0.36
Gestational age (week)	30.5 ± 1.7	30.5 ± 1.7	0.96
Birth head circumference (cm)	28.7 ± 1.2	27.7 ± 1.5	0.008
Caloric intake before intervention	84.6 ± 23.6	83.1 ± 24.3	0.83
Caloric intake after intervention	117.6 ± 21.4	117.1 ± 30	0.95
Phototherapy (hours)	78 ± 2.56	72 ± 1.72	0.47
O_2 therapy (lit/min)	5.1 ± 1.8	4.2 ± 2.1	0.058
Start feeding (day)	2.5 ± 1.4	2.8 ± 1.3	0.29
Sex (male) N (%)	12 (54)	11 (48)	0.36

Whitney test, were used. To control for confounders, general linear model regression was used. The cut- off level for significance was chosen at $p < 0.05$. Changes from baseline were calculated (mean ± SD) for HR, RR and SPO_2 during the second phase (intervention) and the third phase (post intervention). The two groups were compared during the music period and post observation for any change from the baseline period for every day and means for a total of 8 days.

4. Results

A total of 44 preterm infants were studied (Music $n = 22$ and Control $n = 22$). As shown in Table 1 the two groups did not differ in demographic and clinical characteristics. For the duration of the intervention, the changes in SPO_2 in the intervention period were higher in the Music group than in the Control group ($p = 0.001$). Post intervention, the changes in the Music group was still significant when compared to the Control group ($p = 0.019$) (Table 2). When compared to the Control group, more stable SPO_2 (less fluctuation) was observed in the Music group at Days 7 and 8 ($p = 0.05$ and $p = 0.022$ respectively) (Fig. 1).

Throughout the entire study, changes in the RR during the second phase (intervention) were different between the two groups ($p = 0.017$). During the third phase (post intervention), changes in the RR were not different between the two groups ($p = 0.94$) (Table 2). Respiratory rate decreased in the Control group between Day 1 and Day 4, followed by an increase after Day 4. In the music group RR increased in Day 2, 3 and 6; it decreased in Day 4 and 5; and it remained steady in Day 7 and 8 (Fig. 1).

Throughout the entire study, changes in the HR in the second (intervention) and third phase (post intervention) did not differ between the two groups ($p = 0.24$ and $p = 0.32$ respectively) (Table 2), (Fig. 1).

Daily weight gain did not differ between the Music and Control groups (36.79 ± 31.83 and 18.63 ± 39.05 respectively, $p = 0.093$), (Fig. 1). In the linear model regression, after controlling for variables such as birth weight, gestational age, caloric intake before and after intervention, phototherapy, start feeding and sex, the difference between the groups remained significant.

5. Discussion

In this study, we demonstrated that SOP_2 and RR increased in the Music, but HR and daily weight gain did not change between the two groups. The SPO_2 and RR are important and effective variables on neonates. Most neonates in the NICU suffer from respiratory complications and they have apnea or low SPO_2. If an intervention can affect SPO_2 and RR, it is a considerable point to take into account when caring for neonates. Weight is a challenging issue among pre term infants and an effective intervention for it is important. Although, in this study, there was no difference in daily weight gain between the two groups, further studies are needed to confirm the lack of change ($p = 0.093$). Previous studies have shown harp music to be an effective intervention on weight gain and salivary cortisol of neonates. Their methods were very similar to this study but it was a pilot study and they studied only 8 neonates during 3 days. Their results showed that weight gain differed between the harp music group and the control group ($p < 0.05$). Music may enhance weight gain by decreasing activity and caloric expenditure [15]. In 1991, Collin and Kuck [11] observed that just one 10-minute music presentation significantly increased SPO_2 among preterm infants (gestational age of 24–37 weeks) who were in an agitated state. Chou and Wang [13] also found exposure to lullaby music caused increased SPO_2 in infants during tracheal suc-

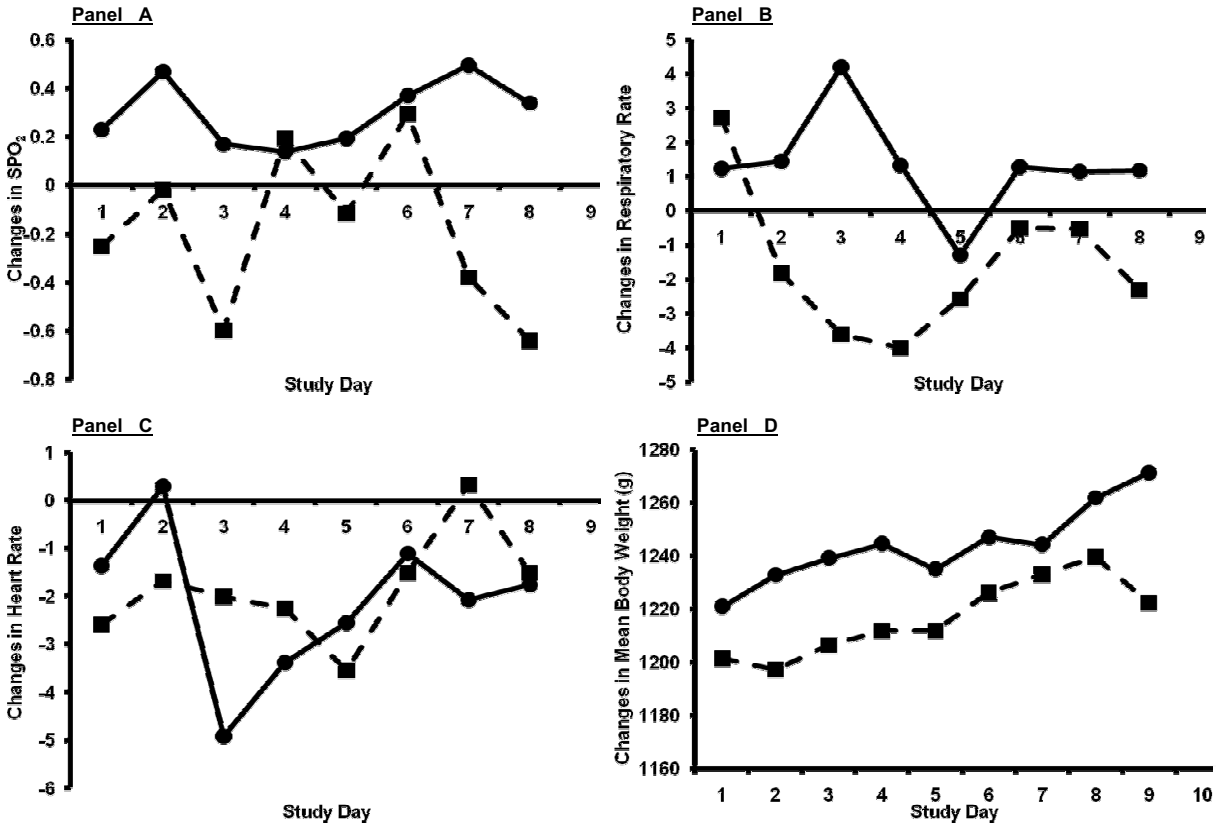

Fig. 1. Comparison between the Music group (solid lines) and Control group (dashed lines) during the duration of the study. The graphs illustrate the changes in SPO_2 (Panel A), respiratory rate (Panel B), heart rate (Panel C), and weight gain (Panel D). Data are expressed in means. Significant differences are observed in SPO_2 ($P = 0.001$) and respiratory rate ($P = 0.017$).

tioning. Caine [10] also observed that music can affect weight gain, caloric expenditure and hospital stay. Coleman and Pratt [16] observed that music decreased heart rate, increased oxygen saturation, reduced distressed behaviors and increased weight gain. Other studies [6,12] obtained the same results. Lullaby music may be useful because of its effect on the nervous canter (limbic and autonomic) thus decreasing stress, and inducing comfort and relaxation. When respiratory rates are regulated, oxygenation improves [17,18].

In their study, Cassidy and Standley [12] observed preterm infants responded music on the first day increased. However this response gradually decreased because of habitation. Our findings do not support this; in our study, response to the music fluctuated but we did not see a decreased response in the following days.

Standley and Moore compared baseline, intervention and post observation periods and found that lullaby music increases SPO_2. However after interrupting the music, physiological responses decreased below baseline. In our study there was a difference between the 2 groups; during the third phase (post-intervention), SPO_2 remained high so even after the lullaby music was interrupted the effect of music remained steady. In our study, we did not observe a significant difference in weight gain between the two groups ($p = 0.093$), (Table 3). However, we speculate that if lullaby music was presented more frequently (2–3 times) each day or the duration of the study period was increased (8+ days) then a significant difference would plausibly occur. This is the first study in Iran that evaluated the effect of lullaby music on preterm infants and more research is needed.

Acknowledgement

The authors would like to thank Research Vice Chancellor of Mashhad Science University for funding this study. Additionally, we would like to thank Mr. Farifteh (Music Training Professional), the Pejvak Hearing Center and Miss Sedighee (data collection).

Financial disclosure

The authors do not have any financial interest to disclose.

References

[1] S.J. Dureau, The effect of gender on one-day-old infants' behavior and heart rate responses to music decibel level, *J Music Ther* **42** (2005), 168–184.
[2] M. Michael and J. Slattery, Preterm Delivery, *Lancet* **36** (20020, 1489.
[3] J.S. Barbara and I. Adams-Chapman, The High-Risk Infant, Chapter 97, in: *Nelson Textbook of Paediatrics*, (18th ed.), R.M. Kliegman, Philadelphia: Saunders, 2006.
[4] M. Kennedy, Where does the music come from? A comparison case-study of the compositional processes of a high school and a collegiate composer, *Br J Music Educ* **16** (1999), 157–177.
[5] J.A. Calabro, R.O. Wolfe and H.E. Shoemark, The Effect of Recorded Sedative Music on Physiology & Behaviour of Premature Infants with Respiratory Disorders, *Australian J Music Therapy* **14** (2003), 3–19.
[6] J.M. Standley and R. Moore, Therapeutic Effects of Music and Mothers Voice on Premature Infants, *Pediatr Nurs* **21** (1995), 574.
[7] J. Kaminski and W. Hall, The Effect of Soothing Music on Neonatal Behavioural States in the Hospital Newborn Nursery, *Neonatal Netw* **15** (1996), 45–54.
[8] A.M. Unyk, S.E. Trehub, L.J. Trainor and E.G. Schellenberg, Lullabies and Simplicity: A Cross-Cultural Perspective, *Psych of Mus* **20** (1992), 15–28.
[9] J.M. Standley, The Effect of Contingent Music to Increase Non-Nutritive Sucking of Premature Infants, *Pediatr Nurs* **26** (2000), 493–499.
[10] J.A. Caine, The Effect of Music on the Selected Stress Behavioural, Weight, Caloric and Formula Intake and the Length of Hospital Stay of Premature and Low Birth Weight Neonate in a Newborn Intensive Care Unit, *J Music Ther* **24** (1992), 180–192.
[11] S. Collins and K. Kuck, Music Therapy in Neonatal Intensive Care Unit, *Neonatal Network* **9** (1991), 23–26.
[12] J.A. Cassidy and J.M. Standley, The Effect of Music Listening on Physiologic Response of Premature Infants in the NICU, *J Music Ther* **32** (1995), 208–227.
[13] L.L. Chou, R.H. Wang and S.J. Chen, Effect of Music Therapy on Oxygen Saturation in Premature Infants Receiving Endotracheal Suctioning, *J Nurs Res* **11** (2003), 209–216.
[14] M.X. Repka, Ophthalmologic problems of the premature infant, *Ment Retard ber disabil Res Rev* **8** (2002), 249–257.
[15] K.J. Kemper and C. Hamilton, Live harp music reduces activity and increases weight gain in stable premature infants, *J Altern Complement Med* **14** (2008), 1185–1186.
[16] J. Coleman, R. Pratt, R. Stoddard, D. Gerstmann and H. Abel, The Effects of Male and Female Singing and Speaking Voices on Selected Physiological and Behavioural Measures of Premature Infants in the Intensive Care Unit, *Int J Arts Med* **5** (1998), 4–11.
[17] K.J. Kemper and S.C. Danhauer, Music as therapy, *South Med J* **98** (2005), 282–288.
[18] C.H. Patrick and K.U. Ashir, Loud Noise or Soothing Notes, *Int Pediatr* **18** (2003), 204–208.