Effect of vocal stimulation on responses of premature infants:  
A randomized controlled trial

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Abstract

Background and Objectives:  There are studies that support music and singing as appropriate  
developmental care for premature infants, thus, we conducted this study to investigate the  
physiological and behavioral responses of premature infants to Quran recitation, lullaby music  
and silence.

Methods:  In a randomized controlled trial (2011-2012), 120 premature infants in the Neonatal  
Unit (NNU) at Izadi Hospital, were randomly assigned to experimental (holy Quran recitation,  
lullaby music and silence) and control groups. The four groups were surveyed for physiological  
responses including, oxygen saturation, respiratory rate and heart rate and behavioral states. The  
data were analyzed using SPSS-PC software and quantitative tests.

Results:  66 females and 54 male infants with gestational age 28-36 weeks entered into the  
study. The four groups were not significantly different in terms of demographic variables (P>0.05).  
The comparison of changes in the infant’s responses in the end of the intervention compared to the  
baseline lines, showed no statistically significant differences between groups (P>0.05). Repeated measures  
ANOVA and Friedman test did not indicate any significant differences in the mean of responses within  
any of the four groups during the course of study (P>0.05).

Conclusion: Although fluctuations were observed in the mean of physiological responses and  
behavioral states in premature infants who listened to the recitation of the holy Quran and lullaby  
music, but these fluctuations were not significant. Findings of this study demonstrated that the  
preterm infants did not display any adverse reactions to the carefully designed acoustic  
intervention.

Keywords: Complementary Therapy; Holly Quran recitation; Music Therapy; physiological and  
behavioral response; premature infants.

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Please Site This Article As: Eskandari N , Alipour Z, Ahmari Tehran H, Eshagh Hossaini K,  
Sangi S. Effect of vocal stimulation on responses of premature infants: A randomized controlled  
Introduction

Preterm infants are those born after the beginning of the 20th week of gestation and before the end of the 37th week. According to the latest statistics, 23.5% of babies are born prematurely in Iran in 2003 (1). Despite significant advancements in the care of preterm infants during the past 40 years, (2) preterm birth is on the rise causing neonatal mortality and is a major determinant of early childhood mortality and morbidity in the United States. Numerous preterm infants suffer from neurodevelopmental disability including cerebral palsy; visual and hearing impairments; learning difficulties; and psychological, behavioral, and social problems (3).

Hence, besides focusing on medical procedures for survival, studies on premature infants in NICU have evaluated developmental care (4). Developmental care comprises a range of medical and nursing interventions that suggest to decrease the stress imposed on premature infants in NICUs and to facilitate their optimal neurobehavioral development (5). Light and noise management, music therapy, positioning/bundling, use of pacifiers and kangaroo care (skin contact with the mother or a caregiver) are the different approaches to developmental care for premature infants in NICU (3). Thus, we compared the effects of Quran recitation, lullaby music and silence on short-term physiological and behavioral responses of stable premature infants during their stay in the neonatal care unit of a hospital in (Qom) Iran.

Methods

To evaluate the effects of Quran recitation, recorded lullaby music and silence on physiological and behavioral responses of premature infants a double-blind randomized controlled trial was conducted. The final group size was considered as 30 infants for each group as recommended by a biostatistician. All premature infants were randomly assigned to either the intervention or control groups.

Sample and setting

This study was carried out in the Neonatal Care Unit of IzadiTeaching Hospital (Qom, Iran).
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Iran). The participants were 120 premature infants with gestational ages of 28-37 weeks, Apgar scores ≥ 7 and appropriate weight for gestational age who had been hospitalized in the neonatal care unit. None of the infants received sedative drugs such as phenobarbital. They did not have disease such as intraventricular hemorrhage, necrotizing enterocolitis, sepsis, acute lung diseases, congenital defects, neonatal anemia, acute illnesses, hypersensitivity to sound, and history of maternal drug or alcohol abuse. Only the clinically and physically stable infants participated in these studies.

Infant’s responses
The dependent variables in this study were short-term physiological responses (oxygen saturation, respiratory rate, heart rate) and behavioral states of the premature infants.

Experimental intervention
The interventions included Quran recitation (Yusuf chapter, verse 7-23, by Shahhat Mohammad Anvar sound), lullaby music (good night kid, produced by the national radio of Iran) that played via headphones for 20 min for the premature infants. The loudness of sounds was maintained at 50-60 dB, using the A-scale of a Cirrus (cr274) sound level meter. In the silence group, the headphones were secured over the infants’ ears for 20 min but no sound was played. The control group, however, did not receive any type of intervention.

Procedure
The study protocol was approved by the Ethics Committee of Qom University of Medical Sciences (Qom, Iran). During December 2011-August 2012, the purpose and procedure of the study were described to the parents of the eligible infants when they were visited in the neonatal care unit. If they desired to take part in this study, formal written consents were obtained from them.

The demographic characteristics of the infants were extracted from hospital records, and if they had no contraindications to the intervention and did not require any sort of nursing care during the 40-min study, infants were included.

While the infants in Quran recitation, lullaby and silence groups were placed in a supine position in an incubator, headphones (A4TECH model EST1987) attached to a MP3 player were placed on both of their ears.

Behavioral state instrument (BSI) was used to determine the behavioral states of premature infants via observations. In this instrument, six different behavioral states were distinguished: State 1 quiet sleep, State 2 active sleep, State 3 drowsy, State 4 quiet awake, State 5 active awake and State 6 crying (3). An Oxyleth pulse oximeter (model A520, USA) was used to measure oxygen saturation level and heart rate whose sensors were attached to the infant’s foot. The same device was used for all measurements. Respiratory rate (breaths per minute) was calculated based on the number of infants’ chest movements in one minute.

Heart rate, respiratory rate, oxygen saturation, and behavioral states of the infants were recorded every five min before, during, and after the intervention.

For all infants, the measurement of variables started 30 min after the last feeding and other routine nursing care. The infants were placed in their incubators, the equipment was set up and baseline data was recorded five and 10 min after placing the earphones and sensors. Then, the Quran recitation or lullaby music was played for the infants in Quran or lullaby group. Data recording was repeated at the 5th, 10th, 15th and 20th min of intervention and at the 5th and 10th min post-intervention. After 20 min play of Quran recitation or lullaby, the player was stopped without handling the infants. No sound was played for the silence group. Physiological responses and behavioral states of the silence and control groups were recorded at defined times. All data were collected by a fellow researcher blinded to the type of interventions.

If the infants experienced any significant medical problems or handling during the intervention or within the following 10 min, they were excluded from the study. Overall, nine infants were excluded (one for crying from Quran recitation group, one from the
lullaby group for vomiting, two from the silence group for crying, and two from the control group for crying and handling, one for abnormal OAE test and two infants because their mother refuses). None of the infants experienced heart rates above 200 beats per min or oxygen saturation less than 80%. Normal hearing of all infants was ensured by otoacoustic emissions (OAE) tests when they were discharged from the hospital.

**Limitations of data collection**
The absence of a sound level meter to measure ambient noise and a monitor to record respiratory rate were the limitations of this study.

**Data analysis**
SPSS for Windows version 16.0 (SPPS Inc., Chicago, IL, USA) was used for data analysis. The characteristics of the sample were described through descriptive statistics. The normality of the data distribution was assessed by Kolmogorov-Smirnov tests. Analysis of variance (ANOVA), Chi-square, Kruskal-Wallis, Repeated Measures and Friedman tests were used to analyze the collected data. P values less than 0.05 were considered significant for all statistical tests.

**Results**
In the nine-month recruiting period, 120 (66 females and 54 males) infants in four groups; Quran recitation, lullaby music, silence, and control (30 infants in each group) were included. The mean gestational and chronological age of infants were 33.49 ± 2.34 weeks (range: 28-36) and 5.29 ± 4.56 days (range: 1-25), respectively. The mean birth weight of infants was 2120.29 ± 326.68 grams (range: 1300-2700) and Apgar scores at the first and fifth min ranged from 7 to 10. While 43 babies were born by vaginal delivery, 77 were born by cesarean section. Moreover, 104 infants were breastfed but 16 received formula.

According to Kolmogorov-Smirnov test, respiratory rate, heart rate, Apgar score, and birth weight had normal distributions. Based on chi-square test, ANOVA, and Kruskal-Wallis tests, four groups were not significantly different in terms of demographic characteristics (Table 1).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Quran recitation group (30)</th>
<th>Lullaby group (30)</th>
<th>Silence group (30)</th>
<th>Control group (30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female/male(number)</td>
<td>16.14</td>
<td>14/16</td>
<td>22.8</td>
<td>14.16</td>
<td>0.12*</td>
</tr>
<tr>
<td>Caesarian section/normal vaginal delivery(number)</td>
<td>20.10</td>
<td>22.3</td>
<td>18.12</td>
<td>17.13</td>
<td>0.54*</td>
</tr>
<tr>
<td>Breast fed / formula fed(number)</td>
<td>25.5</td>
<td>27.3</td>
<td>24.6</td>
<td>28.2</td>
<td>0.41*</td>
</tr>
<tr>
<td>Apgar score (first minute) (Mean±SD)</td>
<td>8.16±0.64</td>
<td>8.03±0.71</td>
<td>8.06±0.69</td>
<td>8.06±0.78</td>
<td>0.90#</td>
</tr>
<tr>
<td>Apgar score (fifth minute) (Mean±SD)</td>
<td>9.26±0.58</td>
<td>9.23±0.67</td>
<td>9.2±0.61</td>
<td>9.4±0.62</td>
<td>0.59#</td>
</tr>
<tr>
<td>Gestational age (weeks) (Mean±SD)</td>
<td>33.03±2.42</td>
<td>33.50±2.47</td>
<td>33.80±2.29</td>
<td>33.63±2.23</td>
<td>0.58$</td>
</tr>
<tr>
<td>Age (days) (Mean±SD)</td>
<td>5.9±4.36</td>
<td>5±3.39</td>
<td>3.76±3.66</td>
<td>6.3±6.12</td>
<td>0.10$</td>
</tr>
<tr>
<td>Birth weight (gr) (Mean±SD)</td>
<td>1980±362.4</td>
<td>2086.03±388.92</td>
<td>2158.73±306.38</td>
<td>2116.23±298.32</td>
<td>0.90#</td>
</tr>
</tbody>
</table>

*Chi-square # ANOVA $Kruskal-Wallis

Comparison of the changes in infant responses in the end of intervention compared to the base lines, showed no statistically significant differences between groups (table 2).

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Quran recitation group (30)</th>
<th>Lullaby group (30)</th>
<th>Silence group (30)</th>
<th>Control group (30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen saturation</td>
<td>1.00±4.00</td>
<td>-0.63±2.18</td>
<td>-0.63±3.82</td>
<td>0.26±3.68</td>
<td>0.11*</td>
</tr>
<tr>
<td>Heart rate</td>
<td>-0.23±11.82</td>
<td>-2.40±11.87</td>
<td>-2.26±11.82</td>
<td>0.20±12.18</td>
<td>0.76#</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>0.46±5.87</td>
<td>-2.30±7.56</td>
<td>0.03±5.76</td>
<td>1.03±5.30</td>
<td>0.17#</td>
</tr>
<tr>
<td>Behavioral state</td>
<td>-0.20±1.06</td>
<td>-0.13±0.77</td>
<td>0.26±0.78</td>
<td>0.33±0.96</td>
<td>0.22*</td>
</tr>
</tbody>
</table>

*Kruskal Wallis Test     # ANOVA

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Table 3 Compare the changes in the infant response’s mean and SD 10 min after end of intervention and the base lines.

<table>
<thead>
<tr>
<th>dependent variable</th>
<th>Quran recitation group (30)</th>
<th>Lullaby group (30)</th>
<th>Silence group (30)</th>
<th>Control group (30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen saturation</td>
<td>0.76±3.25</td>
<td>-0.20±2.12</td>
<td>-0.26±4.05</td>
<td>-0.13±2.48</td>
<td>0.50*</td>
</tr>
<tr>
<td>Heart rate</td>
<td>-1.66±9.57</td>
<td>-1.16±11.12</td>
<td>2.06±11.60</td>
<td>1.40±11.72</td>
<td>0.47#</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>0.23±5.33</td>
<td>-1.83±6.63</td>
<td>0.86±6.40</td>
<td>0.30±5.57</td>
<td>0.32#</td>
</tr>
<tr>
<td>Behavioral state</td>
<td>-0.03±1.12</td>
<td>-0.03±0.80</td>
<td>0.16±0.91</td>
<td>0.03±0.99</td>
<td>0.79*</td>
</tr>
</tbody>
</table>

*Kruskal Wallis Test  # ANOVA

Charts 1, 2, 3, 4 show the means of oxygen saturation, respiratory rate, heart rate, and behavioral states of premature infants in different min of intervention, in four groups.

Repeated measures ANOVA and Friedman test did not indicate any significant differences in the mean of premature infant responses within any of the four groups during the study.
Discussion

The results of the current study do not show any significant changes in short term responses of premature infants including oxygen saturation, respiratory rate, heart rate, and behavioral states, following interventions by Quran recitation, lullaby music and silence. Also, no significant differences were seen between four groups in any time of study. Although no significant differences have been found in the changes of dependent variable between the four groups, but results of table 2 shows that most increase in oxygen saturation and most decrease in behavioral state scores occur in Quran recitation group in the end of the intervention comparing to the base line. Infants in the lullaby group experience most decrease in heart rate and respiratory rate in the end of the intervention comparing to the other groups.

The results of table 3 show most increase in oxygen saturation and decrease in heart rate in 10 min after the end of intervention comparing to the base lines occur in Quran recitation group, decrease of respiratory rate is seen only in lullaby group and the infants in Quran recitation and lullaby group display decrease in behavioral state scores 10 min after the end of intervention. The results of Wood (2008) and Collabra’s (2003) studies support our findings (20, 18). In a study by Wood (2008), 15 min of live music (55-70 dB) did not significantly change behavioral scores, heart rate, and oxygen saturation in premature infants (20). Collabra et al. (2003) replayed Brahms lullaby music (65-76 dB, 20 min for four days) for premature infants. They found no significant differences in heart rate, respiratory rate, and oxygen saturation between music and control groups (18).
Keshavars et al. (2010) replayed Quran recitation (50-60 dB, 20 min) for the premature infants via headphones. Their results show that during and after the intervention, oxygen saturation was significantly higher and respiratory rate was significantly lower in Quran group compared to the control (8).

Keshavars et al. (2010) reported significant differences in the mean values of oxygen saturation, respiratory and heart rates in the experimental group in different times of study. But in our study, on the Repeated Measures and Friedman tests, respiratory and heart rates, oxygen saturation, and behavioral states of four groups had no significant differences at various time intervals (8).

Burke et al. (1995) reported decreased heart rate of premature infants after listening to recorded lullaby (1). These results do not support our findings. Farhat (2010) and Amiri (2009) used headphones to play 20 min of lullaby music (65-75 dB) for the premature infants for eight days. They placed headphones without music on the ears of the control group (2, 3). Farhat (2010) observed no changes in heart rate but reported significant increase in respiratory rates during intervention compared to baseline (22). On the other hand, Amiri (2009) indicated that oxygen saturation in the lullaby group significantly increased during the intervention compared to baseline. However, significant reductions in oxygen saturation were detected in the control group (23).

In contrast, Coleman (1998) reported an increased respiratory rate during 20 min of lullaby intervention (15), whereas Collabra (2003) found no effect of music (18). Decrease (Coleman 1998) (15) and increase (Elander & Hellstrom 1995) (24) in heart rate during music intervention are the two others.

The reasons of these disagreement between results of studies maybe was the difference in sample size, inclusion criteria, type and sound level of intervention, methods of response measurement, environmental ambient noise, circumstance, condition and others that can influence the response of the premature infants.

Conclusion
Vocal interventions such as Quran recitation and music had no unwanted effects on the oxygen saturation, respiratory rate, heart rate, and behavioral states of the premature infants and did not interfere with technical aspects or routine care. More researches are strongly recommended to be done.

Acknowledgement
This study was registered in the Iranian Registry of Clinical Trials (ID: IRCT201110097746N1). The authors appreciate all parents who allow their infants to participate in this study, and the staff of neonatal unit.

Funding/Support
Qom University of Medical Sciences

Conflict of Interest
The authors declare no conflict of interest.

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