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Effects of prenatal music stimulation on fetal cardiac state, newborn anthropometric measurements and vital signs of pregnant women: A randomized controlled trial

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ABSTRACT

Background: Music has been used for medicinal purposes throughout history due to its variety of physiological, psychological and social effects.
Objective: To identify the effects of prenatal music stimulation on the vital signs of pregnant women at full term, on the modification of fetal cardiac status during a fetal monitoring cardiotocograph, and on anthropometric measurements of newborns taken after birth.
Material and method: A randomized controlled trial was implemented. The four hundred and nine pregnant women coming for routine prenatal care were randomized in the third trimester to receive either music (n = 204) or no music (n = 205) during a fetal monitoring cardiotocograph. All of the pregnant women were evaluated by measuring fetal cardiac status (basal fetal heart rate and fetal reactivity), vital signs before and after a fetal monitoring cardiotocograph (maternal heart rate and systolic and diastolic blood pressure), and anthropometric measurements of the newborns were taken after birth (weight, height, head circumference and chest circumference).
Results: The strip charts showed a significantly increased basal fetal heart rate and higher fetal reactivity, with accelerations of fetal heart rate in pregnant women with music stimulation. After the fetal monitoring cardiotocograph, a statistically significant decrease in systolic blood pressure, diastolic blood pressure and heart rate in women receiving music stimulation was observed.
Conclusion: Music can be used as a tool which improves the vital signs of pregnant women during the third trimester, and can influence the fetus by increasing fetal heart rate and fetal reactivity.

1. Summary box

1.1. What does this paper contribute to the wider global clinical community?

- Exposure of pregnant women to relaxing and instrumental music can reduce their vital signs: systolic and diastolic blood pressure and heart rate during fetal monitoring cardiotocograph.
- Music stimulation was able to influence the fetus through increased fetal heart rate, basal heart rate, and higher fetal reactivity over time when exposed to music during fetal monitoring cardiotocograph.
- Music stimulation could be used to provide quality nurse care using this kind of procedure for relaxation in women at prenatal stage.

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2. Introduction

Pregnancy is an important phase in the life of a woman because there are physiological and psychological changes that can influence their daily life and the progress of gestation [1,2]. Music therapy has benefits that match all holistic levels of the person, changing the physiological, emotional, intellectual and social aspects of pregnant women [3]. It should be considered one of the cheaper and more productive non-pharmacological methods, and it should be applied as nurse intervention in the field of healthcare [4,5].

The fetus can hear sounds from outside the womb. At 24 weeks gestation, the ears are the most developed organs in the fetus and the mechanism is structurally comparable to that of an adult [6]. Generally, movement and heart rate will rise in response to sounds, especially if they are high frequency sounds [7]. The effects produced by musical vibrations trigger responses of the autonomic nervous system, such as: neural impulses that trigger reactions of our autonomous system; changes in breathing; changes in heart rate (HR) and blood pressure (BP); muscle tone change; brain frequencies; galvanic skin responses; pilomotor reflexes; pupillary reflexes; gastric motility; anxiety and mood; and the release of corticotropin, a hormone secreted by the hypothalamus, or norepinephrine, a hormone from the sympathetic nervous system (SNS) [8]. Music therapy is the systematic use of music to encourage relaxation and decrease psychophysiological stress, thus reducing cortisol levels [9,10]. Prenatal music stimulation allows the central nervous system to excite the fetus, causing the baby's heartbeat to increase. Therefore, the excitement beats allow more fluid exchange between the baby and the placenta, which receives the largest amount of oxygenated blood. The mother must be as relaxed as possible so that this exchange of fluids between the placenta and the baby occurs in the best way [7].

Although not all music can induce responses in the SNS, those responses can be influenced by personal musical preference and the number of cycles per second (Hertz) of the selected music [11]. Prenatal music stimulation at high frequencies is mainly used to cause babies' reactive responses during a fetal monitoring cardiotocograph (antepartum fetal heart rate testing), as a sign of fetal well-being [12–14]. Regarding prenatal heart rate, several studies have found that music stimuli provide fetal responses with higher accelerations of fetal heart rate (FHR) and elevations of FHR [15–17]. Prenatal music stimulation also shows a higher rate of fetal motor responses, flickers and other movements of the body (head, arms and legs) [18,19]. Music is increasingly being used in neonatal units to improve behavioral or physiological outcomes, or to manage pain during common medical procedures [20]. In addition, modifications in vital signs of adult individuals show that stimulation with slow music induces a decrease in the HR, BP, respiratory rate (RR), and increased oxygen saturation (SaO2) and, consequently, a higher state of relaxation occurs [21–24].

The application of music therapy is increasingly recognized as a nurse intervention. It is reflected in the Nursing Interventions Classification (NIC) and achieves great importance as a noninvasive technique to promote relaxation and well-being and, consequently, to obtain health benefits [25]. The need to go deeper into this field of investigation drives the aim of this paper; that is, to identify the effects of prenatal music stimulation on the vital signs of pregnant women at full term (HR and systolic and diastolic blood pressure) during a fetal monitoring cardiotocograph, and to investigate the influence of prenatal music stimulation on the modification of fetal cardiac status (fetal heart rate and fetal reactivity) during a fetal monitoring cardiotocograph and on anthropometric measurements of newborns taken after birth (weight, height, head circumference and chest circumference).

3. Hypotheses

Pregnant women who receive musical stimulation during the third trimester of pregnancy show improved vital signs (systolic blood pressure, diastolic blood pressure and heart rate), and in the fetus the heart rate is improved, inducing an optimal state of fetal reactivity and a state of fetal cardiac well-being during the fetal monitoring cardiotocography, compared to pregnant women who do not receive musical stimulation during pregnancy. Also, anthropometric measurements of newborns will be improved in the intervention group with music stimulation.

4. Methods

4.1. Design

A randomized controlled trial with two groups, using prenatal music stimulation as an intervention (independent variable).

4.2. Setting and participants

The study involved 409 pregnant women coming for routine prenatal care. They all belonged to the obstetric general population of Spanish Southeast Hospital (in Murcia, Spain) from August 2013 to August 2014. Of the total sample, 204 women formed the group of “intervention” subjects, receiving prenatal music stimulation, and 205 were included in the group “without intervention”, who did not receive prenatal music stimulation. All participants signed their informed consent, and were given prior approval to take part in the study by the ethics committee of the hospital. The inclusion criteria for this study were as follows: pregnant women $\geq$18 years; pregnant women in their third trimester (28 weeks); pregnant women at a gestational age of 36 weeks during antepartum testing; pregnant women who wanted to participate in the study voluntarily; pregnant women without obstetric complications or previous history of uncontrolled chronic disease; no maternal exposure to drugs, other than the ones prescribed by their gynecologist; pregnant women (intervention group) who listened to the music for 14 sessions; and pregnant women without pre-eclampsia and diabetes diagnoses. In the group with intervention by music stimulation, pregnant women received prenatal music stimulation at home and a fetal monitoring cardiotocograph during the third trimester. In the group without intervention by stimulation, pregnant women did not receive prenatal music stimulation at home nor at the antepartum fetal monitoring cardiotocograph during the third quarter.

4.3. Sample size calculation

In order to detect a medium effect size at 0.5 to achieve a power of 80% with an α level at 0.05 (two-sided), a total of 398 participants, with 199 pregnant women in each group, is required. We decided to include 204 pregnant women in each group, with 409 participants in total to account for drop-out or potential problems with women with intervention by music stimulation.

4.4. Randomization

Throughout the study (August 2013–August 2014), on average 127 neonates per month were born in the participating hospital. Every Tuesday and Thursday morning during the study period, 10–12 pregnant women in their third trimester were assessed by the Head Midwife for eligibility for the study. The pregnant women who met the selection criteria and agreed to participate in the study were recruited. Before the study began, the main researcher