ORIGINAL ARTICLE

Effect of Music Listening on Shortening the Time for a Biophysical Profile Assessment of Pregnant Women: A Randomized Control Trial

Bhanubhan Meepon, MBBS[1], Noochanart Pattanapanyasat, MD[1], Onanong Noomcharoen, MD[1]

[1] Department of Obstetrics and Gynecology, Queen Savang Vadhana Memorial Hospital, Chonburi, Thailand

Objective: To compare the duration of the biophysical profile assessment (BPP) between pregnant women listening to music and those who did not.

Materials and Methods: The present study recruited a cohort of 50 pregnant women with low-risk pregnancies and gestational ages over 32 weeks. The participants were selected from the Department of Obstetrics and Gynecology at Queen Savang Vadhana Memorial Hospital between February and December 2022. Participants were divided equally into two distinct groups, the experimental group and the control group, with 25 participants each. The experimental group was equipped with headphones playing music, while the control group wore headphones without music. The assessment was conducted until both groups fulfilled the BPP criteria. Unpaired t-test and chi-square test were employed to compare continuous and categorical variables between the two groups. A p-value of less than 0.05 was considered statistically significant.

Results: The present study found that using music during BPP led to a reduction in the overall evaluation time or the time required for each component. The experimental group during the assessment exhibited a significantly shorter testing time at 4.88±2.42 minutes compared to the control group at 7.04±4.22 minutes (p=0.013).

Conclusion: The present study demonstrated that inclusion of music in the assessment process leads to a significant reduction in total BPP assessment time while simultaneously enhancing maternal satisfaction. Nevertheless, further research is required to elucidate the underlying mechanisms of this phenomenon and investigate strategies for integrating music into the assessment process.

Keywords: Fetal biophysical profile; Music; Duration; Antepartum ultrasound; Fetal surveillance

Received 16 October 2023 | Revised 26 December 2023 | Accepted 2 January 2023

J Med Assoc Thai 2024;107(1):14-20

Website: http://www.jmatonline.com

During the prenatal phase, it is imperative to prioritize the assessment of fetal well-being to offer comprehensive care to pregnant women, particularly those with high-risk pregnancies, with the aim of reducing fetal mortality rates. The Royal Thai College of Obstetricians and Gynecologists (RTCOG) endorses a variety of established methods for monitoring fetal health prior to childbirth. These methods include the non-stress test (NST), fetal movement counting, the contraction stress test (CST), the modified biophysical profile (mBPP), umbilical artery Doppler velocimetry, and the traditional BPP[1]. Adhering to these guidelines enables healthcare professionals to diligently monitor and safeguard the well-being of both the expectant mother and the developing fetus throughout the entire pregnancy.

Within this array of tools, the BPP emerges as a significant approach. The BPP seamlessly integrates real-time fetal observations with four pivotal parameters derived from ultrasound technology, which are fetal breathing, fetal movement, fetal tone, and the amniotic fluid index. When combined with NST, the BPP provides a reliable method for evaluating fetal well-being[1]. However, the execution of the NST is a time-intensive process for general obstetricians. A typical BPP result indicates a 0.8 probability of infant mortality within a week for every 1,000 cases. This underscores BPP's value as a dependable instrument for assessing fetal well-being and guiding obstetric decision-making[2]. Despite the requirement for expertise in ultrasonography and an assessment duration of 30 to 60 minutes for BPP, efforts have been made to improve the assessment process through systematic enhancements.

The study by Pourissa and Refahi[3] in 2008

Correspondence to:

Meepon B.

Department of Obstetrics and Gynecology, Queen Savang Vadhana Memorial Hospital, Chonburi 20110, Thailand.

Phone: +66-64-2498150

Email: t_op038@hotmail.com

How to cite this article:

Meepon B, Pattanapanyasat N, Noomcharoen O. Effect of Music Listening on Shortening the Time for a Biophysical Profile Assessment of Pregnant Women: A Randomized Control Trial. J Med Assoc Thai 2024;107:14-20.

DOI: 10.35755/jmedassocthai.2024.1.13931

reported a reduction of 19 minutes in BPP testing time using acoustic stimulation. The Cochrane Library[4] emphasized the importance of considering fetal vibroacoustic stimulation (VAS) when interpreting cardiotocography outcomes. Consequently, numerous investigations have aimed to reduce BPP evaluation time. These findings have significant implications for improving the efficiency and effectiveness of antepartum fetal monitoring, which could lead to enhanced outcomes for both the mother and the developing fetus. However, concerns linger regarding the safety of VAS due to documented intrauterine sound pressure levels exceeding 120 dB during the procedure, prompting questions about potential risks. While Sherer et al.[5] have remarked on the utility of intrapartum external VAS, researchers continue to explore alternative methods to reduce BPP assessment time, moving beyond relying solely on acoustic stimulation[6-11].

Essential hormones and neurotransmitters, including acetylcholine, endorphins, enkephalins, and serotonin, released during pregnancy, play a crucial role in influencing the patient's emotions and perception of pain. An increase in catecholamines causes vasoconstriction, reducing uterine blood flow (UBF) and increasing maternal-fetal stress. Maternal stress contributes to fetal development, especially in early pregnancy when there is limited expression of glucocorticoid receptors, potentially resulting in adverse fetal outcomes. A study conducted by Shin and Kim showed that music therapy could significantly alleviate patient anxiety by tapping into their inherent capacities, providing temporary relief from stress[12]. When patients are exposed to classical music, a significant decrease in catecholamine, along with an increase in the previously mentioned neurotransmitters, is observed. Changes in the levels of catecholamines and neurotransmitters cause vasodilation, improving uterine-placental circulation[13]. A study by Araki et al. demonstrated an increase in fetal arm movement when Mozart's Sonata for Two Pianos in D Major, K. 448, was presented to the mother[14]. However, it is crucial to note that this study found no significant differences in fetal responses between headphones and direct contact.

The authors conducted the present study to understand how classical music could be used in prenatal assessments. Surprisingly, not much research has explored how music affects the time it takes to do biophysical profile (BPP) evaluations during pregnancy, despite growing interest in the potential benefits of music. Therefore, the authors decided to investigate further and see if music could speed up BPP assessments. This could be a wonderful way to make these evaluations more efficient without using invasive methods. The present study main goal was to compare time it took pregnant women to do BPP assessments with and without listening to music.

Materials and Methods

Trial design

The present study was a single-center, randomized, controlled clinical intervention trial with single-blind evaluation. The randomization was generated using a computer-generated block of four with a 1:1 ratio. A non-research team member sealed the group assignments and kept them secure until the interventions began. The research team members opened the envelopes sequentially after obtaining consent from each participant. The control group wore headphones without music while the experimental group wore headphones with music playing.

Participants, eligibility criteria, and setting

The participants were pregnant women who visited the outpatient department for prenatal care of Queen Savang Vadhana Memorial Hospital. Sample size estimation was based on the two-mean difference formula. In the pilot study, the authors initially had ten cases per group. The authors found that the average duration of BPP assessments for the experimental group was 4.9±1.97 minutes, while the control group took 18.5±4.81 minutes, including their respective standard deviations (SD). However, the authors later decided to increase the sample size to 25 cases per group. This decision stemmed from the authors' recognition that the initial sample size was too small and considered the non-invasive nature of the ultrasound technique. Another motivating factor for the larger sample size was that on average, the present study hospital had 20 to 25 high-risk cases requiring BPP assessments each week.

Fifty participants were successfully enrolled in the present study, and none were subjected to exclusion criteria. Among these participants, 25 participants were purposefully assigned to the experimental group, while the remaining 25 were designated to the control group. It was noteworthy that the entire cohort was meticulously included in the subsequent data analyses, as outlined in Figure 1.

The eligibility criteria were 1) pregnant women aged 18 to 35 years, 2) having a singleton pregnancy,

Table 1. Biophysical profile components[2]

Component	Criteria
Fetal breathing	Greater than or equal 1 episode of rhythmic breathing lasting greater than or equal 30 seconds
Fetal movement	Greater than or equal 3 discrete body or limb movements
Fetal tone	Greater than or equal 1 episode of extremity extension and subsequent return to flexion
Amniotic fluid volumes	A pocket of amniotic fluid that measures at least 2 cm in two planes perpendicular to each other (2×2 cm pocket)

Modified from table 20-2, Antepartum Fetal Assessment, 389, Williams ed., 26th

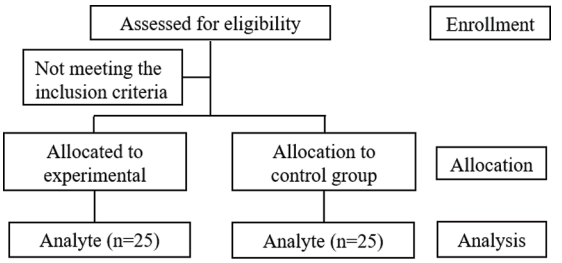

Figure 1. Enrollment and outcomes.

3) gestational age of 32 weeks or more, 4) absence of comorbid diseases, and 5) absence of fetal deformities.

The exclusion criteria included pregnant women who had been exposed to certain drugs or substances that could potentially affect fetal well-being and pregnant women with hearing impairments or difficulties using headphones.

The discontinuation criteria included pregnant women who experienced uterine contractions during the examination, individuals who withdrew from the assessment, and those who did not fulfill the criteria for BBP assessment as outlined in Table 1 within a 30-minute timeframe.

Intervention

Participants received detailed instructions on assessment procedures before the study began. They were instructed to have a meal two to three hours prior to the assessment and refrained from consuming tea, coffee, and other caffeinated beverages. Prior to the assessment, participants were advised to empty bladders.

The present study was conducted in a closed room. The authors used the H240 Quantum Ultrasound Machine from Thailand for abdominal ultrasounds. During the assessment, Beethoven's Piano Concerto No. 5, Movement II was turned on as an instrumental duet. The sound source was accurately calibrated before the study, and all participants listened through headphones for a consistent auditory experience. In the experimental group, participants were exposed to music for five minutes before the initiation of the assessment. The control group did not receive any musical intervention. To ensure an unbiased assessment, the ultrasonologists responsible for evaluating the BPP were blinded to the group allocation. This was achieved by providing headphones to both groups, which helped conceal any auditory cues that might have influenced the assessment process.

Considering the prevailing COVID-19 pandemic, stringent hygiene measures were implemented to protect the participants and researchers. All devices used in the study were thoroughly cleaned with 70% alcohol before each use, adhering to recommended disinfection protocols. The MP3 files containing music were meticulously wrapped in plastic and replaced after each use, minimizing the risk of contamination. The specific MP3 model utilized was the Sony NW-55 edition, a 16GB version in an appealing pink color.

To ensure accurate and consistent data recording, a trained research assistant diligently documented all clinical variables in the case record form. This approach helped maintain a systematic and organized method for data collection, enabling efficient analysis and interpretation.

Outcomes measured

The primary outcome measure was the total time, in minutes, required for BPP assessment, which began with the ultrasound procedure. Additionally, the present study aimed to evaluate the time taken for each individual component of the BPP assessment, as indicated in Table 1.

The secondary outcome measured the participants' satisfaction with the music intervention during the test. To evaluate participants' perceptions and satisfaction regarding the influence of music on fetal response during the assessment, a visual scale questionnaire was used.

Statistical analysis

Values for continuous variables were expressed

Table 2. Comparison of clinical data and parameters by ultrasound between the experimental and control groups

Clinical data	Experimental group (n=25)	Control group (n=25)	p-value
Age (years); mean±SD	28.72±4.63	30.04±5.62	0.370
Parity; n (%)			0.333
Nulliparity	5 (20)	8 (32)	
Multiparity	20 (80)	17 (68)	
Gestational age (weeks); mean±SD	34.96±2.03	35.16±1.62	0.702
BMI (kg/m^2); mean±SD	22.71±4.74	27.31±3.77	0.741
Estimate fetal weight (g); mean±SD	2,346.64±468.31	2,425.84±340.45	0.497
Parameters by ultrasound; mean±SD			
DVP (W) (cm)	4.17±1.25	4.95±1.43	0.045*
DVP (H) (cm)	4.29±1.26	4.82±1.96	0.258

BMI=body mass index; DVP=deepest vertical pocket; W=width; H=height; SD=standard deviation
* p<0.05, statistical significance

as mean±SD. Continuous and categorical variables were compared between the two groups using an unpaired t-test and the chi-square test. The Mann-Whitney U test was used to compare two independent groups when the data did not meet the assumptions of normal distribution required for parametric tests like the t-test. A p-value less than 0.05 was considered statistically significant. The data were analyzed using IBM SPSS Statistics, version 28.0 (IBM Corp., Armonk, NY, USA). The participants' perceptions and satisfaction were summarized using percentages.

Ethical approval

The trial received approval (004/2565) and funding from the Ethics Committee of Queen Savang Vadhana Memorial Hospital, Thailand. Prior to participating, all individuals provided written informed consent. The present study was registered as a randomized clinical trial on clinicaltrial.gov (ID: NCT05729750). It was conducted between February 2021 and December 2022 at Queen Savang Vadhana Memorial Hospital, Thailand. Informed consent was obtained from all individual participants included in the study.

Results

According to the clinical data analysis in Table 2, there were no significant differences between the experimental and the control groups in terms of age, number of pregnancies, gestational week, body mass index, or estimated fetal weight. The findings indicate that the groups were well-matched and comparable at baseline, which reduces potential confounding factors in the study. Only deepest vertical pocket (DVP) measurement was statistically different, which may not alter the outcome. DVP measurements were marginally higher in the control group at 4.95±1.43 compared to the experimental group at 4.17±1.25, with a p-value of 0.045.

The total testing duration for the BPP assessment exhibited a significant difference between the experimental and the control cohorts. Specifically, the experimental group demonstrated a noteworthy reduction in testing time compared to the control group, with mean durations of 4.88±2.42 minutes and 7.04±4.22 minutes, respectively (p=0.013). Furthermore, the interval from the initiation of the test to the onset of fetal movement also attained statistical significance, displaying intervals of 3.36±1.68 minutes for the experimental group and 4.64±2.98 minutes for the control group (p=0.034). It was essential to underscore the findings pertaining to the remaining components of the BPP, as detailed in Table 3, did not manifest statistical significance. Nevertheless, it was noteworthy that all these components within the experimental group exhibited shorter durations in comparison to their counterparts in the control group.

Figure 2 illustrates the disparity in BPP time for each parameter between the experimental and control groups. The findings reveal a shorter duration from breathing to fetal movement in the experimental group compared to the control group at 1.8 minutes versus 2.84 minutes.

The present trial also assessed participants' emotions and reactions. Firstly, there was no significant difference in the time from the start of the test to the first perceived fetal movement at 1.68±1.75 minutes versus 1.76±1.96 minutes (p=0.88). Since the mean result appeared to be considerably skewed, the Mann-Whitney U test was applied for further

Table 3. Comparison of primary outcomes and BPP components between the experimental and control groups

Primary outcomes and BPP components	Experimental group (n=25); mean±SD	Control group (n=25); mean±SD	p-value
Primary outcome			
All testing times for the BPP assessment (minutes)	4.88±2.42	7.04±4.22	0.013*
BPP components			
Time from the start of the test to fetal breath (minutes)	1.56±1.29	1.80±1.22	0.252
Time from the start of the test to fetal movement (minutes)	3.36±1.68	4.64±2.98	0.034*
Time from the start of the test to fetal tone (minutes)	4.12±2.67	5.68±4.51	0.072

BPP=biophysical profile; SD=standard deviation

* p<0.05, statistical significance

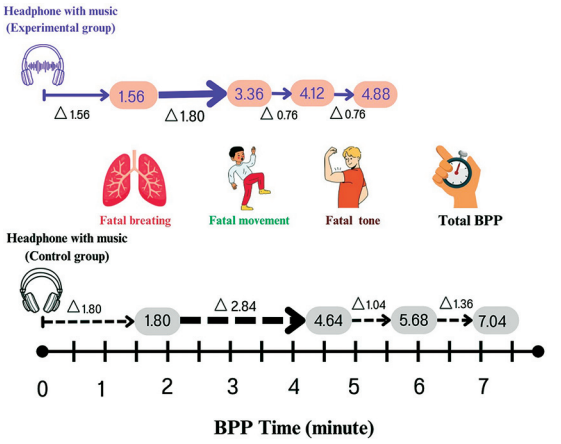

Figure 2. BPP time of the experimental and control groups.

analysis. Second, a question evaluated the level of fetal response to music, with 60% of participants reporting the highest level of response, while 40% indicated a moderate level of response. This suggested that a significant majority of participants noticed fetal responses during the assessment when music was played. Lastly, an overall satisfaction question was asked. Results showed that 80% of the participants were satisfied, while 16.67% were not satisfied.

Discussion

In the context of healthcare in Thailand, hospitals frequently confront a common and formidable challenge, managing a substantial influx of patients within the constraints of limited ultrasound resources and time limitations for comprehensive BPP assessments. This challenge is notably accentuated in healthcare institutions catering to individuals reliant on social security programs for their healthcare access. The present study hospital, with an annual caseload of 10,000 to 14,000 antenatal care visits, places significant emphasis on streamlining the patient assessment process.

The outcomes derived from the present trial unambiguously demonstrate that music serves as a potent tool for significantly expediting the BPP assessment procedure. This innovative approach broadens the array of techniques available for evaluating fetal well-being, signifying a noteworthy advancement in prenatal care clinics. Importantly, the present study not only yielded favorable results but also blazed a trail by introducing the use of music through headphones as a viable alternative to the visual analog scale in BPP assessments.

The results, as presented in Table 3, are in alignment with a study conducted by Küçükkelepçe and Taşhan[15]. Their research also confirmed the positive effects of music, particularly during NST, where it led to increased fetal movement, at 3.02±1.81 in the experimental group versus 2.06±0.90 in the control group, and heightened levels of maternal contentment, at 66% in the experimental group versus 34% in the control group. Additionally, a study conducted in Saudi Arabia delved into the repercussions of prenatal exposure to music on fetal behavior, comparing it with responses to human voices[16]. This study encompassed 20 pregnant women carrying singletons, in their gestational period between 37 and 40 weeks. The findings unveiled a substantial divergence in acceleration between the music and voice stimulus conditions in contrast to the sham condition (p=0.014 and 0.033, respectively). However, no significant variance in fetal heart rate acceleration was discerned between the music and voice conditions (p=0.493).

On the other hand, Araki et al.[14] conducted a study scrutinizing fetal responses to Mozart's music when mothers actively listened to it. In their investigation, which involved a music presentation group, they meticulously observed maternal music exposure and concurrently monitored fetal arm movements. Over a five-minute duration of silence, an average of 5.2±2.7 fetal arm movements were

recorded. However, during another five-minute interval when mothers played Mozart's music, the count stood at 4.2±3.4 fetal arm movements. Notably, their meticulous analysis disclosed no statistically significant difference between these two periods (p=0.21). It is imperative to underscore that the findings from Araki's study diverge from the authors' own research. The present study adhered scrupulously to the guidelines outlined in the BPP. This rigorous approach necessitated not merely the quantification of any fetal movement but specifically mandated the identification of three distinct episodes of movement. These findings were confirmed in Figure 2 as it illustrated the shorter duration from breathing to fetal movement in the experimental group compared to the control group at 1.8 minutes versus 2.84 minutes.

In the present study, the total duration of the BPP was observed to be significantly shorter compared to the pilot study, with respective durations of 7.04±4.22 and 18.5±4.81 minutes. Notably, distinct environmental conditions characterized the pilot study, differing from those of the current study. To enhance control over potential variables, the study environment was carefully managed in a private room, aiming to minimize any extraneous sounds that could potentially contribute to an increased total BPP time.

Subsequent inquiries, conducted after evaluating the experimental group, have affirmed their increased satisfaction with the integration of music during the assessment process, echoing the discoveries of Küçükkelepçe and Taşhan[15]. This underscores the profoundly positive impact it had on their overall experience. Notably, the authors' findings are consistent with the research conducted by Erkun Dolker and Basar[17], specifically regarding the mean anxiety score of expectant mothers in the experimental group, which recorded 44.32±4.0 following music intervention compared to 41.54±4.2 in the control group.

The present study forwards a proposition for the integration of music into BPP assessments, with a targeted focus on high-risk groups, particularly individuals with overt diabetes mellitus, chronic hypertension, or fetal growth restriction. Within these contexts, BPP assessments assume a pivotal role in ensuring fetal well-being and delivering optimal prenatal care. By introducing music as a prospective intervention, the present study aimed to scrutinize its efficacy in enhancing the assessment procedure and potentially augmenting outcomes for this vulnerable demographic.

Conclusion

In conclusion, the present study showed that music significantly reduced BPP assessment time in the experimental groups. Most participants were satisfied with the music intervention. Nevertheless, further research is required to elucidate the underlying mechanisms of this phenomenon and investigate strategies for integrating music into the assessment process.

What is already known on this topic?

The BPP is widely regarded as the most dependable method for fetal assessment, particularly in high-risk pregnancies. Nevertheless, its practicality is hampered by the considerable time and human resources it demands. VAS represents one approach to shift the fetal sleep cycle to an awake state but concerns about its safety persist.

What does this study add?

The addition of music to the experimental group led to a reduction in the total time required for BPP evaluations. This reduction can be beneficial for timely assessments, as recommended for all pregnancies.

Acknowledgment

The authors acknowledge the collaboration of Chuenrutai Yeekian, PhD, Center for Supporting and Developing Research, Queen Savang Vadhana Memorial Hospital, Chonburi, Thailand; Alisara Wongsuttilert, MD, Faculty of Medicine, Burapha University, Thailand; and Wanlop Jaidee, PhD, Faculty of Public Health, Burapha University, Thailand, for their contributions to the present study.

Funding disclosure

This project was support by Queen Savang Vadhana Memorial Hospital, Chonburi, Thailand. This has no role in the design of the study or the collection, analysis, and interpretation of data.

Conflicts of interest

The authors declare that they have no conflicts of interest.

References

1. American College of Obstetricians and Gynecologists. Practice bulletin no. 145: Antepartum fetal surveillance. Obstet Gynecol 2014;124:182-92.
2. Cunningham FG, Leveno KJ, Dashe JS, Hoffman BL, Spong CY, Casey BM. Antepartum fetal assessment.

In: Cunningham F, Leveno KJ, Dashe JS, Hoffman BL, Spong CY, Casey BM, editors. Williams's obstetrics. 26th ed. New York, NY: McGraw Hill; 2022. p. 383-95.
3. Pourissa M, Refahi S, Majd MJ, Mardi A. Effects of acoustic stimulation on biophysical profile testing time. Acta Med Iran 2008;46:1-4.
4. Tan KH, Smyth RMD. Fetal vibroacoustic stimulation for facilitation of tests of fetal wellbeing. Cochrane Database Syst Rev [Internet] 2004 [cited 2004 Sep 20]. Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002963/full.
5. Sherer DM, Abramowicz JS, Hearn-Stebbins B, Woods JR Jr. Sonographic verification of a nuchal cord following a vibratory acoustic stimulation-induced severe variable fetal heart rate deceleration with expedient abdominal delivery. Am J Perinatol 1991;8:345-6.
6. Trudinger BJ, Boylan P. Antepartum fetal heart rate monitoring: value of sound stimulation. Obstet Gynecol 1980;55:265-8.
7. Nyman M, Arulkumaran S, Jakobsson J, Westgren M. Vibro-acoustic stimulation in high-risk pregnancies; maternal perception of fetal movements, fetal heart rate and fetal outcome. J Perinat Med 1992;20:267-74.
8. Inglis SR, Druzin ML, Wagner WE, Kogut E. The use of vibroacoustic stimulation during the abnormal or equivocal biophysical profile. Obstet Gynecol 1993;82:371-4.
9. Sarinoglu C, Dell J, Mercer BM, Sibai BM. Fetal startle response observed under ultrasonography: a good predictor of a reassuring biophysical profile. Obstet Gynecol 1996;88:599-602.
10. Smith CV, Phelan JP, Platt LD, Broussard P, Paul RH. Fetal acoustic stimulation testing. II. A randomized clinical comparison with the nonstress test. Am J Obstet Gynecol 1986;155:131-4.
11. Bolnick JM, Garcia G, Fletcher BG, Rayburn WF. Cross-over trial of fetal heart rate response to halogen light and vibroacoustic stimulation. J Matern Fetal Neonatal Med 2006;19:215-9.
12. Shin HS, Kim JH. Music therapy on anxiety, stress and maternal-fetal attachment in pregnant women during transvaginal ultrasound. Asian Nurs Res (Korean Soc Nurs Sci) 2011;5:19-27.
13. Rakers F, Bischoff S, Schiffner R, Haase M, Rupprecht S, Kiehntopf M, et al. Role of catecholamines in maternal-fetal stress transfer in sheep. Am J Obstet Gynecol 2015;213:684.e1-9.
14. Araki M, Nishitani S, Miyamura T, Masuzaki H, Oishi K, Shinohara K. Fetal response to Mozart's music. Acta Med Nagasaki 2010;55:7-12.
15. Küçükkelepçe D, Taşhan S. The effect of music on the results of a non-stress test: A non-randomized controlled clinical trial. Eur J Integr Med 2018;18:8-12.
16. Al-Qahtani NH. Foetal response to music and voice. Aust N Z J Obstet Gynaecol 2005;45:414-7.
17. Erkun Dolker H, Basar F. The effect of music on the non-stress test and maternal anxiety. Complement Ther Clin Pract 2019;35:259-64.