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**Original article**

# The effectiveness of music on the result of non-stress test

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**Abstract:** *Objectives:* Determined the effects of music on the result of non-stress test at 33 weeks of gestational ages for prenatal assessment. *Methods:* The cohort design was conducted between 89 women who had regular NST (without music), and 88 women who do NST with music. These are women with a single pregnancy of 33 weeks or older who are not in the risk pregnancy group, with no signs of preterm labor. **Results:** There were 178 pregnant women participating in the study. The median age of pregnant women in the study group who did not listen to music or listen to music was $30.0 \pm 4.60$ and $30.4 \pm 4.00$, respectively. The average gestational age in our study was $36.73 \pm 1.64$ and $36.07 \pm 1.91$, respectively, for with and without music group. Music increased the average number of fetal movements in the group of pregnant women listening to the music compared to the group that did not listen to music ($11.13 \pm 0.91$ and $17.52 \pm 1.63$) during the NST. Music also increased the number of accelerations ($5.54 \pm 0.43$ compared to $7.28 \pm 0.47$) and the resulting reactive NST in pregnant women. **Conclusion:** Music increased the average number of fetal movements and the number of accelerations the group of pregnant women listening to the music compared to the group that did not listen to during the NST. Music also increased the resulting reactive NSTs in pregnant women. We can consider using music during NSTs.

**Keywords:** Non-stress tests, fetal movement(s), music.

## 1. INTRODUCTION

One of the main tasks of midwives when monitoring pregnancy is assessing the health of the fetus. The medical staffs need to do this to detect abnormal signs of the fetus so that they can prevent complications of the fetus especially is a stillbirth. There are different methods of monitoring and evaluating the health of the fetus which have orders depending on the aim of the assessment, the health condition of the pregnancy, and the fetus. Fetal movement, Non-stress test, ultrasound, biological profile are methods to assess fetal health [1]. Recently, music is used in the process of performing these tests.

One of the methods of assessing the health of the fetus is widely used clinically which does not pose a risk to the pregnancy and the fetus, which is easy to implement and low cost, the reliable predictive value is the Non-stress test (NST) [2]. The goal of the Non-stress test is to assess the health of the fetus through the supply of oxygen to the fetus by examining the state of the fetal heart rate and the response of the acceleration (an increase of the fetal heart rate) when the fetuses move [3]. Usually, when there is the movement of fetuses, the fetal heart rate increases from the third trimester of pregnancy. Conditions such as fetal hypoxia will make the Non-stress test result non-reactive. Many factors affect non-

stress test results in pregnant women. In which, the fetal sleep-wake cycle is a factor that reduces variability, reduces the frequency and amplitude of acceleration, and reduces fetal movement [4].

Some studies by Ingemarsson, Keegan, Leader, Smith have shown that fetal sleep time can lead to the Non-stress test results that are not reactive, thereby increasing the risk of obstetric intervention not needed [1]. Intervention methods to increase fetal movements thereby increase the number of accelerations and increase the results reactive Non-stress test such as stimulating the fetuses by hand, giving pregnant women to use glucose but not effective [4], [5]. Nowadays, medical staffs such as midwives rarely use music but it is a method of support in the obstetrical treatment and has been proven effective in recent studies [2, 6, 7]. Music in obstetrics can be as active as music therapy, or as passive as listening to music. Particularly, according to the studies of Erkun, Khoshkholgh listening to classical music can be considered as a measure of awakening the fetus, stimulating fetal movement during the Non-stress test [7-9]. This will increase the number of accelerations and shorten the measurement time of Non-stress test. At the same time, the music also increases the rate of reactive Non-stress test, thus reducing the repeat measurement for non-reactive cases [7, 8, 10]. According to Gebuza's research 2018, Pyotr Tchaikovsky's "Swan Lake" is characterized by a rhythmic rhythm and an increase in gestational movements and a statistically significant increase in the number of beats [6]. The above study shows that music, especially classical music, in which the song "Swan Lake" has a positive effect on the Non-stress test results. However, the above studies were conducted in countries with developed economies and cultures. Besides, the musical perception behavior of different countries may have different effects on the Non-stress test results [6].

In the world, music is used in interventions to support obstetric and pediatric treatment [11], especially during the measurement of Non-stress test [6-8]. However, this has not been implemented or applied widely in Vietnam. In particular, at the Department of Obstetrics and Gynecology at the Medical University Hospital 2, it is an examination and monitoring facility for pregnancy about 25 cases/day. Each pregnant woman is diagnosed with a Non-stress test at different gestational ages in the third trimester depending on the condition of the pregnant woman and the fetus individually. To increase the number of fetal movements when awakening the fetus from the sleep state, the musical combination in the Non-stress test is expected to increase the number of fetal movements, increase the number of accelerations, improve the results of the Non-stress test and shorten the measurement time. Hence, we had the research question: **"How does music affect the results of assessing fetal health with the Non-stress test method?"**

The objective of the study was to determine the effects of music on fetal heart rate, fetal movement during Non-stress test from 33 weeks of gestational age.

## 2. MATERIALS AND METHOD

### Design

This was a prospective cohort study conducted on 178 pregnant women with gestational age from 33 weeks in March to May 2019. Eligible participants were single pregnancies aged 33 weeks, no signs of labor, and consent to participate in the study. The exclusion criteria for the study had risk factors (pre-eclampsia, diabetes, kidney disease, heart disease, endocrine disease, maternal malignancy), epilepsy, mental illness, and show signs of premature labor. We use the following formula for calculating sample size.

$$n = (\sigma1^2 + \sigma2^2)(Z1\text{-}\alpha/2 + Z1\text{-}\beta)^2 / \Delta^2$$

In that formula, n = number of participants in each group. The deviation of 2 averages: $\Delta = \mu1 - \mu2 = 19$. The hypothesis of an increase of 19 gestational movements when listening to the music of "Swan Lake" by Pyotr Tchaikovsky compared to not listening to music will make sense [6]. Type I error = 5%, type II error= 0,1. So n = 83 cases. It is expected that 10% of participants [12] would withdraw so the sample size should require 92 participants for each group to ensure sample capacity for the main research objectives.

### Data collection

Quota sampling technique was used. Every day at the Department of Obstetrics and Gynecology, University Hospital of Medicine 2, an average of 10 pregnant women were assigned to measure the Non-stress test. Depending on the gestational age and fetal condition as well as the health of the pregnant women, there will be indications for follow-up tests such as the Non-stress test, ultrasound, blood tests, and urine tests. We would invite all eligible women who were from 33 gestational weeks and had the order of the doctors to take the Non-stress test until both groups meet the minimum sample size. The grouping for pregnant women was completely random based on weekdays. On Monday, Wednesday, and Friday, women performed a Non-stress test as usual (without music). On Tuesday, Thursday, and Saturday, pregnant women will take a Non-stress test and listen to music during the measurement. All people including researchers, doctors, midwives, and pregnant women participating in the study did not allow to change participants' groups. The pregnant women signed the consent form and agreed to participate in the study between March 2019 and May 2019.

Eligible participants answered the prepared questionnaires consisted of two parts. Part 1 is the demographic information of mothers such as age, education level, and occupations, ethic. Part 2 is obstetric information such as prenatal, gestational age, attendance at antenatal classes, periodic antenatal care, ever measured Non-stress previous test. Then they did regular Non-stress test (without music) or listen to music depending on the day of the week. When measuring the Non-stress test of listening to music, we perform the test for pregnant women to listen to the song "Swan Lake" on the morning of Tuesday, Thursday, and Saturday. Music intensity averages 80 dB [13] and is no larger than 94 -105 dB [11]. Closing the door prevented noise, and dispersion phenomenon. If the pregnant woman did not agree to continue participating in the study, she would stop listening to music and performing routine Non-stress test. The termination of pregnancy or participation in research did not affect the pregnancy care process of pregnant women. After the doctors had read the results, the researchers copied and saved the tape recording the results of the Non-stress test. According to the classification of the American College of Obstetricians and Gynecologists in 2014 [4], the record included the following factors: the results of the Non-stress test (as reactive or non-

reactive), number of fetal movements, baseline, variability, accelerations, decelerations, time for at least 2 accelerations. Acceleration is the rate of fetal increase compared to the basic fetal heart at least 15 beats and lasts for at least 15 seconds. The Non-tress test is a response/reactive when there are at least 2 increases in 20-40 minutes [4].

In the case of the Non-stress test with suspicion / non-reactive within 40 minutes, the doctor assigned pregnant women to measure Non-stress test repeatedly. The researcher only recorded the Non-stress test results in the first time of each pregnant woman. There were 202 pregnant women during the study period. However, 24 cases were not eligible to participate in the study, including mothers with diabetes, pre-eclampsia, uterine contractions, and twins. One pregnant woman withdrew while performing the Non-stress test for personal reasons.

**Ethical approval**

The study was conducted in 2019 after the approval of the Medical Ethics Council of Ho Chi Minh City University of Medicine and Pharmacy decision numbered 50/ĐHYD-HĐĐĐ, the agreement of University Medical University Hospital 2 and based on the basic principles of the Helsinki Declaration. Participants in the study were explained about the purpose, benefits, disadvantages, and how to conduct the study. The research was conducted only when the research participant agreed and signed on the document. The information was encrypted and presented in digital form, confidential information. The research process did not affect the health of pregnant women and the fetus.

**Data analysis**

We used STATA 13.0 software, which is a statistical software package created and developed by StataCorp, The USA, to analyze the data. To describe demographic and obstetric characteristics (age, education level, occupation, and obstetric variables including prenatal, gestational age, attendance at antenatal classes, periodic antenatal care, ever measured Non -stress previous test), the ratios are presented as a percentage (%) and tested for differences between the ratios with the chi-square test ($\chi^2$), correcting the Fisher test when there is an expected value <5. Quantitative variables continually follow the standard distribution presented in average ± standard deviation. The quantitative characteristics were presented by the mean and SD standard deviation. The independent T-test was used to compare the difference between means, statistical significance when p <0.05.

## 3. RESULTS

The demographic factors of both music and non-music groups did not differ significantly (p> 0.05). The median age of pregnant women participating in the study in the group who did not listen and listen to music was 30.0 ± 4.60 and 30.4 ± 4.00 years old, respectively. The level of education is mainly from high school and above accounts for 87.57%, only 2 subjects study at primary school. The percentage of people living in urban areas (60.45%) is higher than in rural areas (39.55%). In our study, 100% of pregnant women ≥33 weeks gestation without medical and maternal and child medical conditions were able to affect the Non-stress test results. There was no significant difference (p> 0.05) in terms of gestational age, pre-pregnancy, attendance in antenatal classes, periodic antenatal care visits, and previous Non-stress tests in the past between two groups. The majority of pregnant women have regular antenatal care, accounting for more than 96%. However, only a small number of women attend antenatal classes (<8%) held at institutions or online. 56.18% of women had previously measured Non-stress tests in the group not listening to music compared to 50% of women in the group listening to music (p> 0.05).
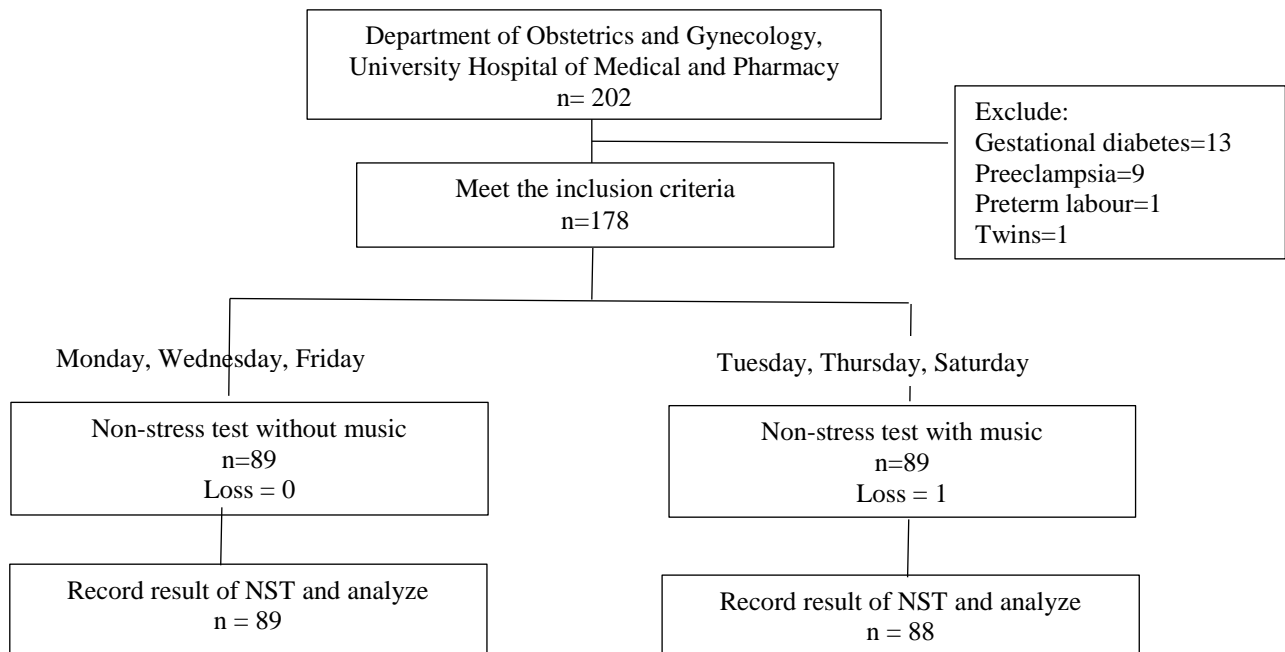


**Figure 1.** Implementation diagram

**Table1.**Characteristics of pregnant women participating in the study

| Characteristics | Without music (n=89) m±sd or n(%) | Music (n=88) m±sd or n(%) | Statistic |
|---|---|---|---|
| Age | 30.0±4.60 | 30.4±4.00 | t=-0.61 p=0.54 |
| Education | | | |
| ≤high school | 38(42.70) | 37(42.05) | X=0.007 |
| >high school | 51(57.30) | 51(57.95) | p=0.93 |
| Occupation | | | |
| Housewife | 23(25.84) | 17(19.32) | X=1.07 |
| Working | 66(74.16) | 71(80.68) | p=0.3 |
| Ethnic | | | |
| Kinh | 86(96.63) | 87(98.86) | X=0.04 |
| Hoa | 2(2.25) | 1(1.14) | p=0.56 |
| Resident | | | |
| Ho Chi Minh city | 55(61.8) | 52(59.09) | X=0.14 |
| Others | 34(38.2) | 36(40.91) | p=0.71 |
| Religion | | | |
| Have | 31(35.96) | 28(31.82) | X=0.23 |
| No | 57(64.04) | 60(68.18) | p=0.63 |
| Height | 157.4±5.59 | 156.5±4.59 | t=1.14 p=0.25 |
| Weight | 66.2±8.31 | 64.4±7.51 | t=1.52 p=0.13 |
| Blood pressure | | | |
| Systolic blood pressure | 109.0±9.11 | 110.9±10.38 | t=-1.28 p=0.20 |
| Diastolic blood pressure | 68.5±7.70 | 68.8±7.66 | t=-0.31 p=0.75 |
| Gestational age | | | |
| 33-34 week | 16(19.6) | 23(19.4) | X=1.82 |
| 35-36 week | 32(30.7) | 29(30.3) | p=0.609 |
| 37-38 week | 33(31.7) | 30(31.3) | |
| ≥39 week | 8(7) | 6(6.82) | |
| Prenatal | | | |
| Nulliparous | 44(49.44) | 40(45.45) | X=0.28 |
| Multiparous | 45(50.56) | 48(54.55) | p=0.596 |
| Join prenatal classes | | | |
| No | 82(92.14) | 85(96.59) | X=1.65 |
| Yes | 7(7.86) | 3(3.41) | p=0.199 |
| Routine antenatal check-up | | | |
| Not often | 3(3.37) | 0 | X=3.02 |
| Regular | 86(96.73) | 88(100) | p=0.082 |
| Previously performed Non-stress test | | | |
| Yes | 50(56.18) | 44(50) | X=0.68 |
| No | 39(42.82) | 44(50) | p=0.410 |

*t: t-test, X: Chi-square*

**Table 2.** Non-stress test results

| Characteristics | Without music (n=89) m±sd or n(%) | With music (n=88) m±sd or n(%) | Statistic |
|---|---|---|---|
| Baseline (beat/minute) | 137.9±0.99 | 139.3±0.96 | t = -0.99* p = 0.32 |
| Variability | | | |
| Lower limit(beat/minute) | 4.4±0.28 | 4.1±0.27 | t = 0.58* p =0.56 |
| Upper limit (beat/minute) | 21.1±0.77 | 19.9±0.65 | t = 1.21* p= 0.23 |
| Decelerations | | | |
| No | 87(97.75) | 86(97.73) | X=0.0001** |

| | | | |
|---|---|---|---|
| Have | 2(2.25) | 2(2.26) | p =0.991 |
| Accelerations (times) | 5.5±0.42 | 7.9±0.47 | t = -2.75* **p= 0.007** |
| Fetal movements (times) | 11.1±0.91 | 17.5±1.63 | t = -3.42* **p =0.0008** |
| Minimum time for Non-stress have 2 celeration (minutes) | 15.9±1.09 | 10.1±0.72 | t = 4.51 **p < 0.0001** |

*Independent t test, ** Fisher Exact*

There was no statistically significant difference in the baseline, the variability, and decelerations between the two groups (p> 0.05). However, there is a statistically significant difference in the accelerations, fetal movements, and the minimum time for Non-stress have two accelerations. The average number of accelerations in the non-music group was $5.5 \pm 0.42$ times and in the music-listening group, it was $7.9 \pm 0.47$ times (p = 0.007). On average, the number of fetal movements in the music listening group was $17.5 \pm 1.63$ times more than the non-music group $11.1 \pm 0.91$ times (p = 0.0008).

The minimum time for Non-stress has 2 accelerations in the non-music group $15.9 \pm 1.09$ minutes longer than the music listening group $10.1 \pm 0.72$ minutes (p <0.0001).

According to Table 3, the proportion of reactive the Non-stress test in the music listening group (97.73%) is higher than the group without listening to music (89.89%). Women who measured Non-stress test listening to music were 78% more likely to have Non-stress test than women who measured the Non-stress test without listening to music with p = 0.0308.

**Table 3.** The influence of music on Non-stress test results

| Music | Non-reactive NST | Reactive NST | RR | 95%CI | P(*) |
|---|---|---|---|---|---|
| With | 2 (2.27%) | 86 (97.73%) | 1 | | |
| Without | 9 (10.11%) | 80 (89.89%) | 0.22 | 0.05 – 1.01 | 0.0308 |
| Total | 11 (6.21%) | 166 (93.79%) | | | |

*(*)Poisson regression*

## 4. DISCUSSION

According to Table 1, the demographic and obstetrical characteristics of pregnant women participating for both listening and without music groups were not significantly different (p> 0.05). The age of pregnant women in the study at the University Medical University Hospital 2, the lowest age was 20, the highest age was 44.

The average gestational age in our study was $36.73 \pm 1.64$ and $36.07 \pm 1.91$ weeks, respectively, for non-music listening and listening to music. This is similar to Garcia's research [14], the average gestational age for NST was $37.59 \pm 0.56$ weeks in the music group and $37.61 \pm 0.64$ weeks in the control group. However, our gestational age was higher when compared with pregnant women in Oh $33.87 \pm 2.92$ weeks in the music group and $33.38 \pm 3.06$ in the control group [8]. This difference is due to differences in clinical practice across countries [4]. There are no specific guidelines for when the Non-stress test should begin, especially for normal pregnancies. There are no major clinical trials to guide the frequency or timing of the Non-stress test [3]. Therefore, the starting time and the optimal Non-stress test frequency have not been determined. It depends on several factors and should be personalized, based on clinical situations [15].

According to Table 2, we found that although the baseline were higher in the music group ($139.3 \pm 0.96$ beats/minute) than the non-music group ($137.9 \pm 0.99$ beats/minute), this difference is not statistically significant (p> 0.05). Erkun et al [7] found no significant difference between the control and control groups also. Khoshkholgh et al's study [9] performed a study of the impact of music on NST results and found no significant differences in the baseline during the first 10 minutes and the second 10 minutes of the trial. The results of that study are similar to the current ones. With the results, the rate of decelerations was 97.75% in the group not listening to music compared to 97.73% in the group listening to music;

the difference is not statistically significant. Current research indicates that music does not reduce the number of beats that decrease. Similar to our study, Kafali and colleagues found that listening to music did not affect the number of decelerations [10].

Uterine-placental circulation plays an important role in maintaining the health of the fetus. However, catecholamine, which is stress hormones, causes vasoconstriction, and disturb the uterine blood supply when pregnant women, the level of anxiety does not decrease. In the case of stress, listening to music affects the nerve centers that govern blood circulation, leading to vasodilation and increased blood circulation. Positive attributes of music such as pleasing to the soul, relieving the mind, getting rid of stress, and providing a distraction that reduces anxiety levels. This positive effect of music can alter physiological findings such as blood pressure, heart rate, and breathing by affecting the body's sympathetic nervous system. At the same time has an arousing effect on the fetus [7]. In this study, the result of the reactive NST rate was higher in the music listening group than the non-music group. In summary, listening to music in the NST has a positive impact on the testing team. Therefore, the proportion of NST with their response is higher. This result is similar to that of some other studies [6, 7, 15] shows that playing music increases the proportion of reactive NST. Similarly, Kucukkelepce [2] found that the NST results of the pregnant women in the experimental group were almost twice as likely to respond to the control group. Unlike this study, Toker examined the impact of music on pregnant women with pre-eclampsia and found no statistically significant difference in their NST results. Toker's findings, which may have been affected by the fact that the study was pre-eclampsia pregnant women [7].

About the minimum time for NST to have two fetal movements, the results of Kafali's study [10] are similar to ours, the time for NST to respond respectively to music and

control groups is $13.4 \pm 5.2$ and $15.6 \pm 6.1$ minutes. Listening to music shortens the time the NST responds to the group that does not listen to music. However, according to Oh's research [8], the difference in time for the Non-stress test response between control and intervention groups is not statistically significant. The reason for this difference may be due to the type of music being heard. According to Oh's research, pregnant women were allowed to choose five types of music according to their preferences, such as classical music, popular Korean songs, popular non-Korean songs, children's songs or folk songs, Anthem. However, the research should be observed with a larger sample size to have sufficient evidence to conduct recommendations on the genre of music as well as the time required to listen to music and conduct the NST [4].

In our study, the average of fetal movements in the music listening group $17.5 \pm 0.63$ times was higher than the non-music group $11.1 \pm 0.91$ times with $p = 0.0008$. Few studies have calculated the number of fetal movements under the impact of music. Kafali and colleagues examined the effects of music on fetal movements and the rate of fetal heart rate. The results of the study showed that music increased the number of fetal movements, $8.9 \pm 4.7$ groups of music listening compared to $5.9 \pm 3.9$ groups without music with $p <0.001$.[10]. Myung Ok Oh et al [8] found that the increased number of fetal beats in pregnant women in the experimental group $7.08 \pm 3.45$ was higher than the control group $5.95 \pm 3.23$ with $p = 0.04$. Khoshkholgh et al found that music increased the number of fetal beats, the mother group listened to $0.28 \pm 0.93$, the fetus listened to $0.53 \pm 1.01$, the control group $0.03 \pm 0.92$ with $p = 0.002$ [9]. Gebuza results show that the song "Swan Lake" significantly increased the number of fetal movements and the increased rhythm of women while listening to music compared to when not listening [6]. Simsek's research had also shown that music increases the number of fetal increases and fetal movements. The results of this study are similar to the results of the current study [2]. This discrepancy occurs because of the time it takes to measure the Non-stress test. In the study of Erkun [7] and Simsek [2], the Non-stress test was only measured in 10 minutes. In the Gebuza's study [6], a non-stress test was measured in 40 minutes. In our study, the Non-stress test time was 20 minutes, however, it can be extended to 40 minutes if, during the first 20 minutes, the Non-stress test does not have 2 accelerations. The measured time we took based on ACOG 2014 recommendations [4] for a full assessment of fetal health based on the Non-stress tests and associated factors. We do not extend the measured time to 40 minutes in all pregnant women because it can make pregnant women wait, cause anxiety for pregnant women as well as affect the results of the Non-stress test [8].

The results confirm that music increased the average number of fetal movements in the group of women who listened to music compared to the group that did not listen to music during the Non-stress test. Music also increased the number of accelerations and the results of reactive Non-stress tests. However, it does not affect the number of in the baseline, the variability, and decelerations. This is because music has a direct effect on generating nerve impulses that stimulate the fetal brain cells to cause the secretion of Endomorphin. Therefore, brain cells grow and develop better, arousing the fetus [7].

## Application of the study

The role of nurse-midwife is the main intervener to assist the doctor in the process of a Non-stress test. So, the results of the study has contributed evidence for doctors and midwives to apply music to obstetrics, especially during the Non-stress test. When the fetus is moving, it is possible to evaluate changes in the characteristics of the fetal heart's response (accelerations) to assess fetal health. Selecting the right music will increase the number of fetal movements and will help the doctor to evaluate fetal's health more easily. It is an easy, inexpensive application. Secondly, we can see the music, here the "Swan Lake" music piece works to increase the number of fetal movements so we can encourage pregnant women to listen to music at home. Thirdly, this study is also a prerequisite for further research to evaluate the effectiveness of non-pharmacological approaches in maternal and fetal care.

## 5. CONCLUSION

The music increased the average number of fetal movements, the number of accelerations, the reactive NSTs in the group of pregnant women listening to the music compared to the group that did not listen to during the NST. Music also shortens the time to have two accelerations. Music did not affect the baseline, the declarations, and the variability. We might consider using music during the NSTs.

### Limitation

Our study is limited firstly because this is a single-center study, not yet representative of the entire population. Doctors who read the Non-stress test result, midwives measured the Non-stress test, and the pregnant women involved in the study were not blinded to the clustering.

The research topic has only addressed the pregnancies that are not at risk. At the same time, the reaschers used only one song for all participants in the study. This is beneficial in reducing the confounding factors during data collection and analysis when conducting research. However, the drawback is that further studies are needed to diversify music genres as well as appropriate music tracks to effectively increase fetal movements during the Non-stress test and to be culturally appropriate in Vietnamese as well as the preferences of each pregnant woman in particular.

## CONFLICT OF INTEREST

The authors declared no conflict of interest.

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