



# A Comparison of the Effects of Caffeine and Acoustic Stimulation on Biophysical Profile Duration and Score

Shamsi Zareh<sup>1</sup>, Sanaz Moosavi<sup>1\*</sup>, Farnaz Zand Vakili<sup>2</sup>, Fatemeh Abbasalizadeh<sup>1</sup>, Farnaz Sahaf<sup>3</sup>, Parviz Ahmadi<sup>4</sup>

## Abstract

**Objectives:** Biophysical profile (BPP) is a method to check fetal health. The purpose of this study was to evaluate the effects of caffeine and acoustic stimulation on fetal BPP duration and score, and compare their results with control group with no intervention.

**Materials and Methods:** This randomized clinical trial was conducted on 150 women who had referred to Tabriz Al-Zahra hospital. The participants were divided randomly into three groups of 50; group I (control) without intervention; group II (caffeine-recipient) who had caffeine before the procedure; and group III (acoustic stimulation) who received acoustic stimulation during the procedure using a reflex hammer.

**Results:** Our results showed that both fetal BPP duration and fetal profile score were significantly different across the 3 groups. The fetal BPP duration was significantly shorter in the caffeine-receiving group ( $P=0.00$ ), and fetal profile score in the same group was significantly higher ( $P=0.00$ ).

**Conclusions:** Generally, using caffeine-containing drink before BPP tests may result in shorter test duration and higher test score.

**Keywords:** Biophysical profile, Caffeine, Acoustic stimulation, Pregnancy

## Introduction

Biophysical profile (BPP) is used to perform antenatal fetal surveillance to prevent fetal death and unnecessary interventions. A normal test is, therefore, highly reassuring of fetal condition, (1) And a normal BPP is a reliable measure of normal tissue oxygenation (2).

The indications for fetal BPP are pregnancies with the increased risk of antepartum fetal death such as diabetes mellitus, hypertensive disorder, intrauterine growth restriction (IUGR), and decreased fetal movement or postdate pregnancy, along with any other high-risk conditions.

The test focuses on five fetal biophysical findings, including movement, amniotic fluid, tone, breathing, and heart rate, which are used to assess fetal health (3). The test typically lasts 30 minutes. There is high incidence of false positive results, whilst there is a low false negative result with BPP (4) Although the test has satisfactory false-negative rates, nonreactive results may be a challenge. Any method that decreases the false positive results or shortens the time to get a normal test may be useful and would impact a busy fetal testing clinic.

There are a few factors that potentially affect the fetal activity (4). Previous studies have reported an increase in

fetal activity related to an external acoustic stimulation and caffeine which may result in a shorter test period (5). Caffeine is an alkaloid compound which is found in coffee, tea, and cola-containing drinks. It is easily absorbed in the gastrointestinal tract and can pass through the placenta and reach a concentration level similar to maternal plasma concentration (6). There are not sufficient data about which of these two stimulation methods are more effective in reducing the duration of BPP and reducing the false negative scores.

Therefore, the present study aimed to examine the comparative effects of caffeine and acoustic stimulation on BPP duration and final score.

## Materials and Methods

The study was conducted on 150 women who had attended Tabriz Al-Zahra hospital prenatal clinic with a request for BPP. The inclusion criterion was singleton pregnancy with the gestational age of 36 to 41 weeks. Exclusion criteria were fetal anomalies; administration of corticosteroids, psychological drugs, and narcotics in the latest week; smoking; IUGR with absent or reverse end diastolic flow and labor; and fasting for more than 3 hours. The subjects were randomly assigned to 3 groups

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<sup>1</sup>Women's Reproductive Health Research Center, Tabriz University of Medical Sciences, Tabriz, Iran. <sup>2</sup>Department of Gynecology and Obstetrics, Kurdistan University of Medical Sciences, Kurdistan, Iran. <sup>3</sup>Department of Gynecology and Obstetrics, Alzahra University Hospital, Tabriz University of Medical Sciences, Tabriz, Iran. <sup>4</sup>Department of Pediatrics, Tabriz University of Medical Sciences, Tabriz, Iran  
\*Corresponding Author: Sanaz Moosavi, Tel: +989143005102, Email: moosavisanaz@yahoo.com



by sequentially labeled, opaque sealed envelopes that were arranged by a computer-generated random list with equal numbers in each arm by a person not related to the protocol. They were asked to avoid eating 1 hour before the test in order to diminish the effect of meals on fetal activity (7). All ultrasound exams were performed by a fellow in maternal fetal medicine and in the clinic setting. The ultrasound machine was Phillips Affinity 50, and the used probe was C6-2.

The patients were in the supine position during the exam and a small bedroll was placed under their right buttock to keep them in the left lateral position. There were three groups of 50 participants: group I (control) received no intervention; group II (acoustic stimulation) received acoustic stimulation during the procedure using a reflex hammer and an iron tube, 3 times in first, 5th, and 10th minutes; and group III (caffeine-recipient) had caffeine as a cup of French coffee made with electronic coffee maker which contained 120 mg caffeine and up to 200 mL milk without sugar, 30 minutes before the procedure. The participants were then compared in terms of the BPP duration (to get the score of 8) and final score. The test duration was recorded using a timer. Then a non-stress test (NST) was done as a part of BPP after the BPP test in another room which lasted 20 minutes.

During BPP, five vital aspects of fetus are evaluated and each one is scored as 0 or 2:

1. Fetal breathing: Fetal chest movements when it rehearses breathing; if there is 30 seconds of breathing during 30 minutes of study, the score is 2 otherwise the score is 0.
2. Fetal heart rate: As NST; if there are 2 accelerations of 15 beats per minute with a duration of 15 seconds, the score is 2 otherwise it is 0.
3. Fetal movements: The number of movements recorded in 30 minutes; if there are 3 movements, the score is 2 otherwise it is 0.
4. Fetal tone: The act of 1 extending and then flexing limbs; if there is 1 action, the score is 2 otherwise it is 0;
5. Amniotic fluid volume: If there is a single pocket depth of at least 2 cm, the score is 2 otherwise it is 0.

Scores 8 to 10 are "reassuring" if the amniotic fluid score is 2. If the fetal score is 6, the test should be repeated

depending on the gestational age. By the score 4, the test should be performed the same day, and if the result is the same, termination should be considered. With a score less than 4, termination is mandatory (3).

The aim of this study was to evaluate the effect of caffeine on fetal activity, BPP score, and duration, as well as comparing the acoustic stimulation and caffeine with no stimulation on duration of BPP and the final score.

Statistical analyses were performed using the SPSS (Statistical Package for Social Science) version 15.0. Data were analyzed by one-way ANOVA and Pearson chi-square test. Results were reported as a mean  $\pm$  SD. Results were considered significant at  $P < 0.05$ .

## Results

A total of 150 women participated and completed the study.

The demographic characteristics of the participants are summarized in Table 1. All demographic variables had a normal distribution, and 3 groups were comparable regarding the variables.

Table 2 shows BPP duration for getting a full score or fulfilling the 30 minutes by three groups. Based on the results of the Kruskal-Wallis test, both variables of fetal BPP duration and fetal profile score significantly varied across the three groups ( $P = 0.00$ ); considering the mean rank value, the significant difference was seen in the caffeine-receiving group. The fetal BPP duration was significantly shorter in the caffeine-receiving group and fetal profile scores were significantly higher in the same group compared to other groups.

The chief complaints of patients are summarized in Table 3. Regarding the complications of pregnancy in patients, in group I, 13 patients had positive history, including 1 case with chronic hypertension, 7 cases with preeclampsia or pregnancy-induced hypertension, 3 cases with gestational diabetes mellitus, and 2 cases with epilepsies. In group II, 6 patients were recorded with positive history, including 5 patients with pregnancy-induced hypertension and 1 case with gestational hypertension. In group III, there were 16 patients with positive history, including 8 patients with preeclampsia or pregnancy-induced hypertension, 1 case with epilepsy, 1 case with overt diabetes mellitus, and 6 cases with gestational diabetes mellitus.

**Table 1.** Demographic Characteristics of Patients

Variable	Group I-Control	Group II- Acoustic	Group III-Caffeine	P-Value
Age	29.6 $\pm$ 5.7	29.8 $\pm$ 5.4	29.8 $\pm$ 5.8	NS
Gestational age (wk)	36.8 $\pm$ 0.9	36.8 $\pm$ 0.9	37.1 $\pm$ 1.0	NS
Gravid	2.3 $\pm$ 1.1	2.3 $\pm$ 1.0	2.1 $\pm$ 1.0	NS
Parity	1.0 $\pm$ 0.8	0.9 $\pm$ 0.8	0.9 $\pm$ 0.8	NS
Abortion	0.3 $\pm$ 0.6	0.4 $\pm$ 0.7	0.3 $\pm$ 0.5	NS
Alive	0.8 $\pm$ 0.7	0.7 $\pm$ 0.7	0.8 $\pm$ 0.8	NS
Weight	72.8 $\pm$ 8.2	74.6 $\pm$ 9.1	74.9 $\pm$ 6.9	NS

NS: Non-significant.

**Table 2.** BPP Results for 3 Groups

	Group I-Control	Group II- Acoustic	Group III-Caffeine	P Value
Duration of BPP (min)	28.5±3.1	27.9±3.8	13.3±6.6	0.00
Score of BPP	8.0±1.7	8.0±1.7	9.4±1.3	0.00

**Table 3.** The Chief Complaints of Patients in 3 Groups

	DM	Decreased Fetal Movements	High Risk Pregnancy	Oligohydramnios	IUGR	PPROM and Preterm Labor
Group I-control	5	10	10	8	8	9
Group II- acoustic	3	11	9	9	7	11
Group III-caffeine	4	10	11	7	9	9

Abbreviations: DM, Diabetes mellitus; IUGR, Intrauterine growth restriction; PPROM: Preterm premature rupture of membrane.

The reactive NST results were 64%, 72%, and 88% for groups I, II, and III, respectively. *P* value was 0.00 which shows a significant difference in the reactivity of NST among the groups. In the group III (caffeine-receiving group), the result was significant and more frequently reactive.

### Discussion

Decreased fetal activity may be the sign of a compromised fetus. In this regard, various fetal surveillance tests have been described to evaluate the movement of fetus in order to determine fetal well-being and oxygenation (2). BPP is regarded as one of the main techniques of fetal assessment. False positive results that lead to additional evaluations, are common, especially in scores of 6 to 8. A false positive result is an abnormal test result that is followed by a normal back-up test. If any factor can diminish the false positive rate, it will be useful in clinic. Several factors have been described in affecting fetal activity during fetal assessment. Researchers believe that fetal activity is influenced by various factors. For instance, maternal diet, caffeine consumption (7,8), and acoustic stimulation (9) are associated with the increased fetal activity. Some studies have shown that fetal breathing could be affected by caffeine use (8,12).

The results of the present study demonstrated that BPP duration was significantly shorter in the pregnant women who had caffeine 30 minutes before the ultrasound exam compared to the control group and acoustic stimulation group. In the group of acoustic stimulation, the test duration was shorter than that in the control group, though the difference was non-significant. Buscicchio et al demonstrated a significant stimulating action on the fetal movement by cocoa (6). Mulder et al reported increases in active wakefulness and general movements of fetus after coffee consumption (11).

Our results were in contrast with those of Esin et al who reported that the effect of bitter chocolate on maternal perception of fetal movements was not different from the group who received no intervention (5).

The BPP scores were significantly higher in the caffeine-

receiving group compared to the other two groups, meaning that caffeine could decrease false positive results. Similar BPP results were obtained for both acoustic stimulation group and control group. These results were in contrast with the results of previous studies in which effectiveness of acoustic stimulation on fetal movement was reported. Such discrepancy in results may be attributed to the technique of acoustic stimulation used in the present study. Devoe et al reported a rapid occurrence of acceleration in NST following the use of vibroacoustic stimulation (12). Turitz et al also reported a reduction in the time of reactivity of NST with vibroacoustic stimulation (13).

The NST results were significantly more reactive in the caffeine-receiving group, which is due to more fetal activity in this group. However, no significant difference was observed between the control and acoustic stimulation groups in terms of NST. This result was in contrast with that of Esin et al who reported no difference in the NST results between control and chocolate groups. Xi et al reported that acoustic stimulation decreased non-reactive NST (14), while in the present study, acoustic stimulation was used during BPP, so the results of NST were not different between the control and acoustic groups.

### Conclusions

This randomized clinical trial suggests that even a short-term consumption of caffeine-containing materials by mothers prior to the fetal BPP assessment can affect the test result and duration. The rate of false negative can also be reduced by the caffeine use.

### Conflict of Interests

Authors have no conflict of interests.

### Ethical Issues

This randomized clinical trial received the institutional review board exemption of Tabriz University of Medical Sciences, Iran (Human Research Review Committee No.: IR.TBZMED.REC.1398.031). The written informed consent was also obtained from the participants after

explaining the study design and purposes. This randomized clinical trial was registered in the Iranian Registry of Clinical Trials (identifier: IRCT20190304042912N2; <https://www.irct.ir/trial/38696>).

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