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Impacts of maternal anxiety on non-stress test parameters

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Summary

Objective: To determine the association between antenatal maternal anxiety with non-stress test (NST) parameters, which is an indicator test of fetal well-being in the third trimester. *Materials and Methods:* Between January and December of 2013, 212 pregnant women, with 36-41 weeks of gestation were assessed with measures of distress and anxiety with Beck Anxiety Inventory (BAI) and with NST. The new National Institute Child Health and Human Development (NICHD) 2008 guideline criteria were used for interpretation of NST. Anxiety scores were grouped as minimal, mild, moderate, and severe. The impact of anxiety on NST parameters were investigated. *Result:* Anxiety scores were inversely correlated with fetal heart rate (FHR) accelerations (r = -0.631, and r = -0.855), number of fetal movements (r = -0.633, r = -0.860), FHR variability scores (r = -0.650, r = -0.877). and NST scores (r = -0.505, r = 0.729), (for all $p < 0.001$). NST scores were lower in severe anxiety group than the others. *Conclusion:* The study showed that severe form of anxiety significantly affects NST parameters in near-term pregnancies.

Key words: Anxiety; Antenatal; Non-stress test.

Introduction

Non-stress test (NST) is one of major basic components of antenatal care and nowadays it is the most dedicated test to assess the fetal wellbeing in the third trimester [1]. A normal NST test result is associated with a low probability of fetal distress [2]. It is based on an increase in fetal heart rate (FHR) in response to fetal movement. Nowadays, new standards for electronic fetal monitoring were recommended at the National Institute of Child Health and Human Development (NICHD) workshop. Most important features of NST indicating fetal well-being are heart rate variability and FHR accelerations, besides absence of FHR decelerations [2].

Anxiety is defined as the psychological result of exposure to a real or imagined stress [3]. Pregnant women may be exposed to various environmental stressors. These may include absence of social support, intimate partner violence, psychological distress, nicotine, and alcohol and drug abuse. It was also shown that women from low- and middle-income countries, especially, have high levels of psychological distress [4]. Some studies have determined that prenatal occurrence of stress factors may have also deleterious impacts on fetal and subsequently, infant development and behavior [5, 6] and for pregnant woman [7, 8]. The stress factors in pregnancy have been associated with increased risk of gestational hypertension, low birth weight, and preterm birth [9-11]. As mentioned above anxiety may have some adverse effects on pregnancy. This study was conducted to investigate impacts of anxiety on NST parameters for assessment of fetal well-being.

Materials and Methods

The present study was approved by the local ethic committee, where the study was conducted. All singleton pregnant women gestational aged between 36 and 41 weeks, who were referred to Adnan Menderes University hospital clinic between January and December of 2013, were included. All participants were informed about the study and a written consent was obtained from each participant. The study followed principles in the declaration of Helsinki. Patients with any systemic disease, twin gestations, and fetal congenital malformations were excluded from study. Materials for data collection included questionnaires, external fetal electronic monitoring instrument to monitor FHR with a marker for controlling and recording fetal movements. Questionnaires included maternal demographic information and personal characteristics such as age, educational level, economic status and income level, number of alive children, number of abortions, last menstrual period, gestational age on the basis of last menstrual period, and first trimester ultrasonography of pregnancy. Anxiety and stress levels of all participants were assessed by Beck Anxiety Inventory (BAI) prior to NST. The inventory consisted of 21 items descriptive of subjective, somatic, or panic-related symptoms of anxiety. In that inventory, answers were based on a 4-point Likert scale. All patients were asked to scale responses of 'not at all' to 'severe' in terms of the experience of that symptom over the past month. A high total score indicated more severe levels of anxiety. When levels of anxiety were classified; a score of 0-7 indicated minimal anxiety; 8-15 indicated mild anxiety; 16-25 indicated moderate anxiety, and a score of 26 and above indicated severe anxiety [12].

All pregnant women in the study underwent NST in the same environmental conditions and in the same resting position (mothers were lying on their left side in all of the tests). FHR parameters were monitored with the same fetal electronic monitors. The NST parameters considered were: time (minutes) of minimum

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length of NST defined as reactive, number of fetal movements, basal FHR, number of large accelerations ≥15 beats per minute (bpm)-15 s, variability score and number of variable decelerations. The NICHD (2008) guideline [2] criteria were used for interpretation of NST.

FHR tracings were normal when the baseline FHR was between 110 and 160 bpm. Baseline FHR was defined as fluctuations in the baseline of irregular amplitude and frequency. These fluctuations were quantified in terms of the amplitude of the peak-to-trough in bpm. Bradycardia was defined by a baseline FHR less than 110 bpm. Tachycardia was defined by a baseline FHR greater than 160 bpm. FHR accelerations were defined as the minimum increase of 15 bpm for 15 seconds or more in FHR, and suggested optimum number of FHR accelerations was one to five in a period of 20-30 minutes [13]. On the other hand, assessment of variability was an important part of evaluation of a FHR pattern. Absence of variability and non-reactivity of NST was defined as no peak-to-trough changes in FHR detected. Minimal variability if amplitude was > 0 and ≤ 5 bpm, moderate variability if amplitude was 6–25 bpm, and marked variability was amplitude > 25 bpm. The occurrence of moderate and marked variability was accepted as normal fetal acid–base status. The minimum length of reactive NST was the time in minutes of trace including the second large acceleration of FHR. Therefore, NICHD 2008 guidelines classified all FHR patterns into three categories. Category I FHR pattern included the following four characteristics: baseline rate, 110–160 bpm, moderate variability (6–25 bpm), absence of late or variable decelerations, absence or presence of early, decelerations or accelerations. Patterns in Category I were almost always associated with normal fetal acid–base status. Category III was diagnosed when baseline FHR variability was absent and any one of the following was present: sinusoidal heart rate, recurrent late decelerations, recurrent variable deceleration, bradycardia. Category II comprised all FHR patterns not in Category I or III. In present study, Category I NST's according to NICHD criteria were scored as 2, Category 2 NST's as 1, and Category III NST's as 0 points.

Statistical analyses were performed by using SPSS 18 version. The Kolmogorov-Smirnov test was used to assess the normality of numeric variables. Numeric variables that were not normally distributed, therefore descriptive statistics are presented as median (25-75 percentiles). Kruskall Wallis test was computed to compare NST parameters including basal FHR, number of accelerations ≥ 15 bpm-15 s, variability score, decelerations, duration of NST, NICHD NST scores, and number of fetal movements between patients with minimal, mild, moderate, and severe anxiety groups. Pearson correlation test was also computed to quantify associations between maternal anxiety score and NST parameters mentioned before. The authors used classification and regression trees (C&RT) method in order to determine parameters affecting NST variables. The p-values < 0.05 were considered statistically significant.

Results

The flow chart in Figure 1 shows the selection of the study population. Six hundred and twenty women, who were referred to the present clinic between January - December 2013 were included; however, only 212 women were accepted and available to answer the questions of BAI.

Among six hundred and twenty women, 218 women had systemic illnesses like diabetes mellitus, chronic hypertension or gestational hypertension or preeclampsia, liver diseases, neurologic illness, etc. Also, 39 patients had twin gestations and 11 women had fetal congenital malformation. Therefore, only 140 patients were really denied to answer BAI.

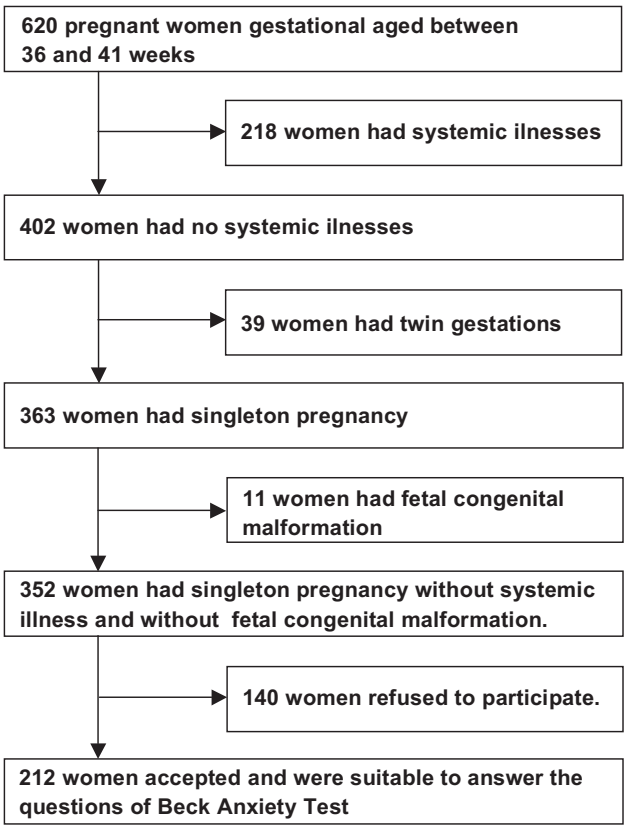

Figure 1. — Flow of participants through the study.

Mean age of all participants was 29.37 ±6.05 (16-43) years, and mean gestational age was 37.82 ±1.32 (36-41) weeks. In addition, mean number of gestations (gravity) and parity were; 2.64 ± 1.55 (1-9), and 1.19 ± 1.13 (0-7), respectively. Demographic characteristics of women in all groups are described in Table 1.

In the present study, 12 (5.7%) patients had minimal, 31 (14.6%) patients had mild, 101 (47.6%) patients had moderate, and 68 (32.1%) patients had severe form of anxiety. Also anxiety scores were inversely correlated with FHR accelerations (r = -0.855), fetal movements (r = -0.860), variability scores (r = -0.877) and NST scores (r = -0.729) (for all, $p < 0.001$). Number of FHR decelerations were significantly correlated with maternal anxiety scores (r = 0.327, $p < 0.001$) (Table 2). A significant difference was observed between moderate and severe anxiety groups in terms of number of decelerations ($p = 0.028$). However there was no significant difference between the other anxiety groups ($p > 0.05$).

The NST parameters are described in Table 3. There were no significant differences in basal FHR, duration of NST with severity of anxiety ($p = 0.562$, $p = 0.959$, re-

Table 1. — *Demographic characteristics of participants.*

	Group 1 (n=12) minimal anxiety (median)	Group 2 (n=31) mild anxiety (median)	Group 3 (n=101) moderate anxiety (median)	Group 4 (n=68) severe anxiety (median)	*p*
Age (years)	27.5 (25.25−34)	29 (25−34)	29 (25−34)	29 (24.25−34)	0.987
Gravity (n)	2 (1−3)	3 (2−4)	2 (1−4)	2 (1−3)	0.561
Parity (n)	1 (0−1.75)	1 (0−2)	1 (0−2)	1 (0−2)	0.423
Gestational Age (weeks)	38 (37−38)	38 (37−39)	38 (37−39)	38 (37−39)	0.465

Statistical significance: $p < 0.05$.

Table 2. — *Correlation of NST[1] parameters with maternal anxiety scores.*

	Maternal Anxiety Score Correlation coefficient-r/p	
Duration (min[2])	-0.005	0.947
Basal FHR[3](bpm[4])	0.098	0.156
Fetal movements (n. / 20 min)	-0.860	<0.001
Acceleration (n. / 20 min)	-0.855	<0.001
Deceleration (n. / 20 min)	0.327	<0.001
Variability score	-0.877	<0.001
NICHD[5] score of NST[1]	-0.729	<0.001

NST[1]: non-stress test; min[2]: minute; FHR[3]: fetal heart rate; bpm[4]: beats per min; NICHD[5]: National Institute of Child Health and Human Development, r: correlation coefficient; statistical significance: $p < 0.05$.

spectively). On the other hand, number of fetal movements, number of large accelerations ≥ 15 bpm-15 s, variability scores, and NST scores were low in patients with severe anxiety ($p < 0.001$). Difference in number of fetal movements, number of FHR accelerations, and FHR variability score were significant in severe-minimal, severe-mild, severe-moderate, moderate-mild, moderate-minimal, but no significant difference was determined between minimal and mild forms of anxiety. Furthermore, NST scores were determined lower especially in severe anxiety group when compared to mild, minimal, and moderate forms of anxiety (Table 3).

There has been no research investigating anxiety on NST parameters in literature. In the present study, the authors determined experimental power of study for indicating the relationship between anxiety and NST parameters. They have performed the study step-by-step and when they determined > 90% experimental power at a = 5%, they stopped the study. C&RT method was used in order to determine affecting NST parameters including, number of FHR accelerations, number of fetal movements, FHR variability, basal FHR score and NST scores were shown in Figures 2-5. For accelerations, fetal movements and NICHD, anxiety score proved the best predictor variable at < 27.5 (67.9% for all). However, when the anxiety scores were at the range of 27.5 to 15.5 for accelerations and fetal movement, and 27.5 to 16.5 for NICHD, they proved a very weak predictor variable (32.1%, 32.1% respectively). The best predictor proved for variability was again anxiety score variable at < 15.5 (79.7%). For baseline FHR, anxiety score proved to be non-predictor variable.

Discussion

This study showed that anxiety scores were inversely correlated with FHR accelerations, number of fetal movements, FHR variability scores, and NST scores. NST scores were determined low, especially in severe anxiety group when compared to mild, minimal, and moderate anxiety groups. Also, anxiety score variable proved to be a better predictor for NST parameters except baseline FHR. Similarly, in the literature there have been data suggesting that prenatal ma-

Table 3. — *Comparison of NST[5] parameters with severity of maternal anxiety*

	Group 1 (n=12) minimal Anxiety (median)	Group 2 (n=31) mild Anxiety (median)	Group 3 (n=101) moderate Anxiety (median)	Group 4 (n=68) Severe Anxiety (median)	*p*
Duration (min[1])	21 (17.25−21.75)	20 (17−25)	20 (18−22)	20 (18−23)	0.959
Basal FHR[2] (bpm[3])	140 (130−146)	140 (130−147)	140 (130−146)	140 (130−150)	0.562
Fetal movements (n. / 20 min)	7 (7−8)[ab]	5 (5−6)[cd]	4 (3−4)[ace]	2 (1−2)[bde]	<0.001
Acceleration (n. / 20 min)	8 (8−8.75)[ab]	6 (6−7)[cd]	4 (3−5)[ace]	1 (1−2)[bde]	<0.001
Variability score	3 (3−3)[ab]	2 (2−2)[cd]	1 (1−1)[ace]	0 (0−0)[bde]	<0.001
NICHD[4] score of NST[5]	2 (2−2)[b]	2 (2−2)[d]	2 (2−2)[e]	1 (0−1)[ebd]	<0.001

Min[1]: minute; FHR[2]: fetal hHeart rate; bpm[3]: beats per min; NICHD[4]: National Institute of Child Health and Human Development;
NST[5]: non-stress test, median (interquartile range); statistical significance: $p < 0.05$.
[a]: Staistical significance between minimal and moderate form of anxiety, $p < 0.001$; [b]: statistical significance between minimal and severe form of anxiety, $p < 0.001$;
[c]: statistical significance between mild and moderate form of anxiety, $p < 0.001$; [d]: statistical significance between mild and severe form of anxiety, $p < 0.001$;
[e]: statistical significance between moderate and severe form of anxiety, $p < 0.001$.

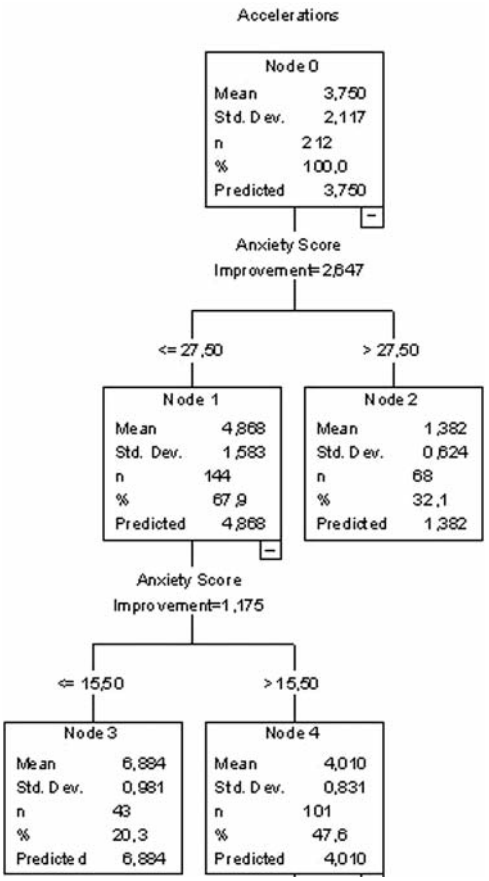

Figure 2. — C&R tree of FHR accelarations.

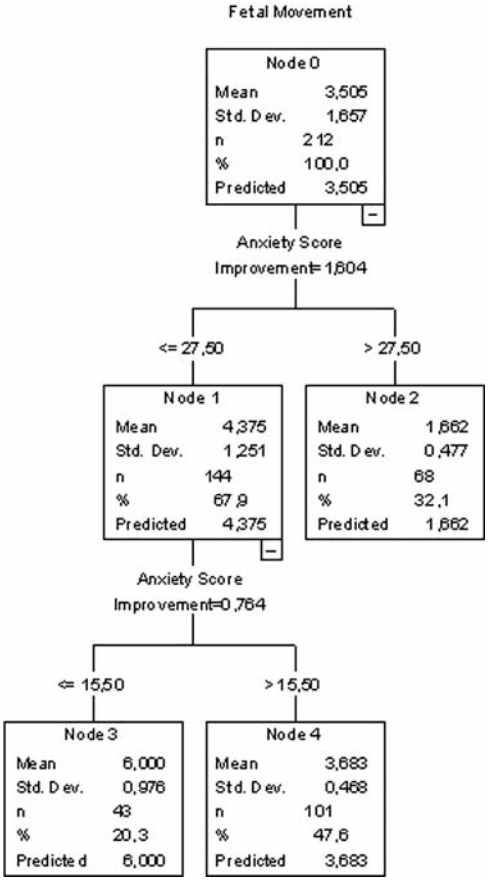

Figure 3. — C&R tree of fetal movements

ternal stress, anxiety, and emotions affect fetal functioning, as evidenced by changes in FHR and movements [14]. There have been limited number of studies supporting the fact that maternal anxiety affected FHR patterns. One study performed in midwifery school with 84 pregnant women, showed that relaxation improved NST results and increased FHR accelerations [15]. Again, in another study performed with 204 pregnant women determined that listening to music had positive impact on FHR accelerations [16].

Some studies have tried to explain how maternal anxiety and stress affects the fetus. Animal studies have determined that chronic stress might inhibit the fetal cortisol barrier enzyme response resulting in increased exposure of the fetus to maternal cortisol levels [17]. High placental corticotropin releasing hormone (CRH) levels cause vasodilatation resulting in reduced oxygen and nutrient delivery to the fetus [18]. If this condition is prolonged, then disordered metabolism develops [19] predisposing to type II diabetes and obesity in later life [20]. On the other hand, anxiety or stress stimulates of the autonomic nervous system (ANS), results in secretion of catecholamines, such as noradrenaline, that causes increased uterine artery resistance and arterial pressure. Thus, uterine blood flow and oxygen delivery to the fetus decreases [21]. As a result, for example, high noradrenaline levels in pregnancy were negatively correlated with fetal head and abdominal circumferences [22]. In accordance with the literature, the results of this study showed that fewer numbers of fetal movements and fewer numbers of large accelerations ≥ 15 bpm-15 s, and low NST scores were observed in pregnant women with severe anxiety.

The results of this study revealed that the number of FHR decelerations was directly correlated only with maternal anxiety scores; however there was significant difference in number of decelerations, between only moderate and severe anxiety. Similarly it was reported that, as FHR decelerations had low specificity and might occur during reactive, as well as non-reactive NSTs. Hence, when FHR decelerations occurred, as they might signify some form of abnormal cord position, further evaluation was advised and required [23].

It is known that the NST is a useful, conventional test to measure FHR which is the most commonly used diagnostic tool to monitor fetal health, especially in the antepartum period and intrapartum periods. FHR recording also helps

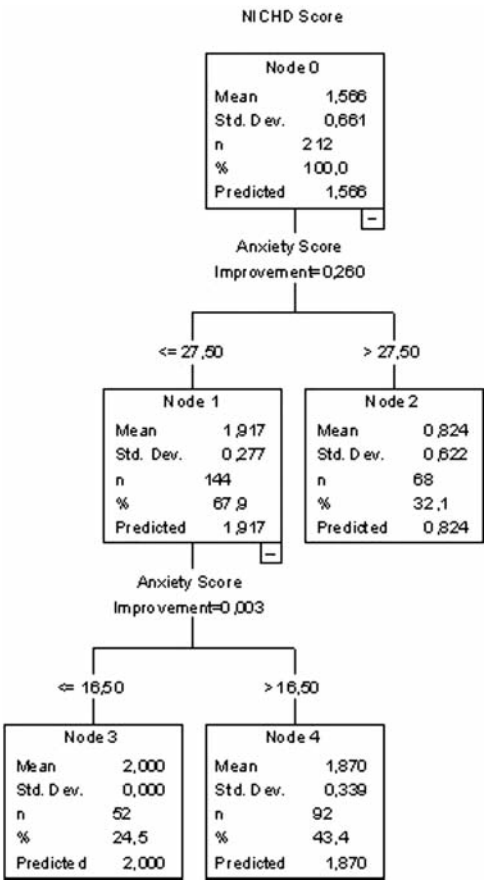

Figure 4. — C&R tree of NICHD scores.

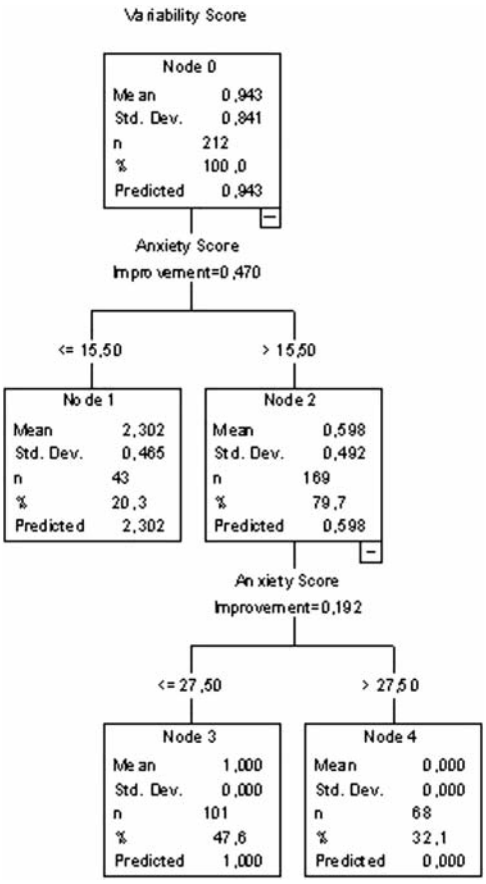

Figure 5. — C&R tree of FHR variability score.

for assessment of the maturation of the fetal central nervous system (CNS) and ANS [24]. An increase in heart rate directly relates to the sympathetic and parasympathetic ANS, which may not exist normally before 26–27 weeks of gestation [13]. In determining fetal wellbeing, variability is the most important FHR characteristic alone. Normal variability is associated with intact neurologic modulation and normal cardiac responsiveness of the FHR [25]. Accordingly, we generally perform NST after 36 weeks of gestation if there is no pregnancy related complication. As decreased variability may be observed in prematurity [25] and women with signs of preterm labor may have higher amount of anxiety about her baby than women at term, preterm pregnant women were excluded in this study.

The vast majority participants of this study had high anxiety scores whereas the number of cases with minimal anxiety is fewer. The possible explanation might be the anxiety scores of pregnant women may arise as they approach to term than the nonpregnant women or referral to tertiary center clinic. Almost all patients that apply to our clinic came from centers at periphery by the referrals. During this referral procedure, pregnant women may concern with wellbeing of their babies so anxiety level of patients might be increased. However, studies including high number of cases with different gestational weeks are needed to explain this better.

This study has some limitations.Firstly, as we have mentioned before, our center was a referral hospital for high risk pregnancies. That issue may also increase the risk of selection bias. The women probably have a high anxiety level due to the referral. So results of our study should be confirmed with multicenter studies. Secondly, limitation of our study was that, the BAI gives no indication of a woman's underlying 'trait' anxiety. So, we have tried to minimize the confounding influence of trait anxiety on our observation by excluding women with previous histories of anxiety and depression, as we have not determined trait anxiety in our cohort of pregnant women. For future research, the recently developed Beck Anxiety Inventory-Trait (BAIT) may be a useful survey instrument.

In conclusion, anxiety in pregnancy had great impact on NST parameters such as number of FHR accelerations, decelerations, fetal movements, variability scores and NICHD NST scores which were basic, useful, reliable markers of

fetal well-being. It is also important to emphasize that, not minimal, mild or moderate, but especially severe forms of anxiety significantly affects NST parameters. Therefore, obstetricians should emphasis on therapies reducing severity of anxiety in pregnancy that seem to be important issues for fetal well-being.

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