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# Do Anxiety Scores of Pregnant Women Correlate with Doppler Indices of Uterine and Umbilical Arteries?

**Mega E[1*], Mega F[2], Tekelioglu M[3], Eser GY[3] and Tug N[3]**

[1]Specialist, Istanbul Health Sciences University Fatih Sultan Mehmet Education and Research Hospital, Istanbul, Turkey

[2]Clinical Psychologist, Turkey Ministry of Health Istanbul Provincial Health Directorate Ministry of Health Istanbul Medeniyet University Goztepe Education and Research Hospital, Istanbul, Turkey

[3]Specialist, Department of Obstetrics and Gynecology, Istanbul Health Sciences University Ilhan Varank Education and Research Hospital, Istanbul, Turkey

[4]Department of Obstetrics and Gynecology, Istanbul Health Sciences University Ilhan Varank Education and Research Hospital, Istanbul, Turkey

**[*]Corresponding author:**
Ertunc Mega,
Specialist, Istanbul Health Sciences University Fatih Sultan Mehmet Education and Research Hospital, Hastane Sokak no: 1/8
Icerenkoy- Atasehir 34752, Istanbul, Turkey

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## 1. Introduction

In The Diagnostic and Statistical Manual of Mental Disorders (DSM-V), a stressor is defined as any emotional, physical, social, economic, or otherwise unclassified factor that disrupts the normal physiological, cognitive, emotional, or behavioural balance of an individual [1]. Thus, as pregnancy alters the normal physiological balance of pregnant women, it can be regarded as a stress factor or stressor for all individuals who experience it. Stressors serve as promoters of physiological and psychological adaptations and are, therefore, beneficial and desirable. Stressors are not always or necessarily unpleasant, and stressors can occur in situations unrelated to stress [2]. In DSM-V, a psychological stressor is defined as any event or change in life that can be associated temporally (and perhaps causally) with the onset, occurrence, or exacerbation of a mental disorder [1]. Therefore, pregnancy itself is not a psychological stressor, unless it can be associated with the onset, occurrence, or exacerbation of a mental disorder defined in DSM-V.

Stress denotes a real or perceived perturbation to an organism's physiological homeostasis or psychological well-being [2]. In DSM-V, stress is defined as the pattern of specific and nonspecific responses a person makes to stimulus events that disturb his or her equilibrium and tax or exceed his or her ability to cope [1]. Tailoring this broader statement to better suit pregnancy; if a woman makes specific and nonspecific responses to her ongoing pregnancy, which disturbs her equilibrium and taxes or exceeds her ability to cope, then this woman shows a stress pattern or is in distress.

Prenatal environmental exposures, which include the maternal psychological state, can have sudden or sustained effects across the lifespan of the offspring, yet, this process is not well understood [3]. In their review, Van den Bergh et al. proposed two mechanisms for the transmission of anxiety/stress from mother to foetus in humans. One of these mechanisms works through the maternal stress hormones, glucocorticoids in particular, which are transmitted across the placenta [4] and the other mechanism works as a result of a change in uterine artery blood flow [5,6]. Most of the studies [7] emphasise that this relationship is based on the sympathomedullary pathway or the hypothalamic-pituitary-adrenal axis of the autonomic nervous system, the former via the sympathetic and parasympathetic neural system and the latter via the neuroendocrine system [7,8].

Anxiety is defined as the apprehensive anticipation of future danger or misfortune accompanied by a feeling of worry, distress, and/

or somatic symptoms of tension. The focus of anticipated danger may be internal or external [1]. Anxiety is defined by the American Psychiatric Association (APA) as an emotion characterised by feelings of tension, worried thoughts, and physical changes like increased blood pressure [9]. The results of a 12-month prevalence study indicate that anxiety disorders are by far the most common mental disorders in adults (18.1%, standard error 0.4) , but only 22.8% (standard error 1.5) presented serious cases [10]. Currently, anxiety is the most common psychiatric disorder worldwide [11]. According to different studies, the prevalence of anxiety in pregnant women should lie somewhere between 10-30% [12-17]. In a Bayesian multivariate meta-analysis, the prevalence of maternal anxiety disorders during the antenatal period was found to be 20.7% [18].

In a systematic review and meta-analysis focusing on the relationship between adverse perinatal outcomes and pregnant women's anxiety during pregnancy, antenatal anxiety was found to be associated with preterm birth, spontaneous preterm birth, and lower mean birth weight. According to the study, the association between the mode of delivery and APGAR scores of neonates were nonsignificant [19].

As we have emphasised earlier, anxiety is characterised by feelings of tension and worried thoughts, as well as physical changes like increased blood pressure [9]. There is a number of research focusing on pregnant women's anxiety status and the preplacental [6,20-25] and postplacental [21,22,24-26] arterial Doppler indices. Some of these studies have highlighted certain correlations between the indices and the psychological inventories and scales, while the rest of them could not find any correlations. We are of the opinion that the studies which suggest a correlation exists between maternal anxiety levels and Doppler indices fail to consider the homeostasis factor, both in state and trait anxiety situations.

In this cross-sectional study, our aim is to evaluate whether a correlation exists between the anxiety status of pregnant women and obstetrical Doppler indices for umbilical and uterine arteries. We hypothesise that, considering the stable and maximum diameter of arteries between 34–37 weeks' gestation, Doppler indices of the uterine arteries will not differ according to anxiety status, as long as the blood pressure and heart rate remains stable. Our research questions are as follows: a. Is there a difference between the Doppler indices of preplacental & postplacental arteries of participants who showed high state anxiety status and those who showed low anxiety status? b. Is there a difference between the Doppler indices of preplacental & postplacental arteries of participants who showed high trait anxiety status and those who showed low anxiety status? Another objective of our study was to create a correlation matrix for the emphasised arteries and The State-Trait Anxiety Inventory (STAI) total scores. As to our knowledge, this is the first study of its kind where the aforementioned gestational age was used for all Doppler assessments and the first where all pregnant women attended antenatal classes.

## 2. Materials and Methods

We conducted this cross-sectional study at an education and research hospital in Istanbul, Turkey, between 01.01.2019 and 01.02.2020. The exclusion criteria were as follows: level of reading lower than that of 8th grade, smoking, alcohol consumption, multigestational pregnancy, maternal congenital uterine anomaly, umbilical artery anomaly, placental anomaly, foetal anomaly, obstetrical complications, use of any medication apart from routine pregnancy supplements, and diagnosed maternal physical or psychological disorders. For all pregnant women, control visits and antenatal classes took place at the same hospital where the study was conducted. Women who did not attend antenatal classes and monthly pregnancy control visits were also excluded from the sample group. All participants' blood pressure and heart rate were normal, both before filling out the inventory and before receiving Doppler ultrasonography. The patients gave birth at the same hospital where the study was conducted and at other hospitals. We accessed the delivery reports of women who chose other hospitals via Gebe, Lohusa, Bebek, Çocuk İzlem Sistemi (GEBLIZ), which is a data processing system designed for pregnancy follow-up in Turkey. The descriptive statistics for continuous variables are presented in Table 1.

We have informed the participants that the information they provide will solely be used for scientific research, and their personal data will not be processed or shared outside disclosed scientific purposes. We have obtained all participants' explicit consent and received approval from the ethics committee of the Istanbul Health Sciences University Fatih Sultan Mehmet Education and Research Hospital, Istanbul, Turkey.

The pregnant women have completed the State-Trait Anxiety Inventory Turkish questionnaire (STAI-Tr) during hospital visits between 34–37 weeks' gestation and afterward received Doppler assessment.

All Doppler evaluations were performed by two experienced research sonographers. We have strictly adhered to the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) guide, both for the uterine arteries and the umbilical artery [27].

The State-Trait Anxiety Inventory is a commonly used measure of trait and state anxiety [28]. This psychological inventory can be used in clinical settings for diagnosing anxiety and distinguishing it from depressive syndromes [29]. STAI is a self-report questionnaire based on the methodology of Cattell and Scheier [30], originally developed by Spielberger, Gorsuch & Lushene [31]. Öner & Le Compte [32], translated the inventory into Turkish, and validated it. The inventory has two subscales: (a) state & (b) trait. The scale is a 4-point scale and it consists of 40 self-reported items, twenty per (a) & (b). The state anxiety items include:

"I am tense; I am worried" and "I feel calm; I feel secure." The trait anxiety items include: "I worry too much over something that really doesn't matter" and "I am content; I am a steady person." Responses for the S-Anxiety scale assess the intensity of current feelings "at this moment": 1) not at all, 2) somewhat, 3) moderately so, and 4) very much so. Responses for the T-Anxiety scale assess the frequency of feelings "in general": 1) almost never, 2) sometimes, 3) often, and 4) almost always [28].

Internal consistency coefficients for the scale have ranged from 0.86 to 0.95; test-retest reliability coefficients have ranged from 0.70 to 0.94 for state scale, and 0.79 to 0.90 for trait scale [33]. Proven validity, namely sensitivity and specificity are 0.82 and 0.88, respectively [34].

The range of scores for each subtest is 20–80, with higher scores indicating greater anxiety. Since STAI is not a diagnostic test, there are no absolute cut-off values for it. Some research suggests 39 to be the cut point [35-39], where others recommend 44 [40,41]. We preferred using 39, as more studies and textbooks recommend it as the cut-off value [42].

To reduce bias, the anxiety scale scores were calculated by a clinical psychologist who was blind for the Doppler measurement results. The respondent researcher received the results separately and transferred the variables for statistical analysis.

IBM SPSS Statistics 22 for statistical analysis (SPSS IBM, Turkey) program was used to perform the statistical analyses. Kolmogorov–Smirnov and Shapiro-Wilk tests used for checking normality. All variables were assessed to be distributed normally, both for low and high anxiety scores, except for RI right uterine artery. If the data were normally distributed, parametric testing was applied. If not, corresponding non-parametric tests were used. Also, Levene's test was used to assess the equality of variances, and the t-value was determined. All tests were two tailed.

The reliability of the scales in the study was assessed using Cronbach's alpha, and the internal consistency coefficient was calculated. According to the calculations, the internal consistency coefficient of the 20 items in the State Anxiety scale was 0.713, and the internal consistency coefficient of the 20 items in the Trait Anxiety scale was 0.657.

We used the between groups t-test for comparing the groups. Non-parametric versions of the t-test were also analysed since it was determined that the dependent variables did not show a normal distribution. Pearson correlation coefficient was calculated to reveal the relationship between variables.

**Table 1:** Descriptive statistics for continous variables.

| Variables | *N* | Mean | *SD* |
|---|---|---|---|
| Age of pregnant woman | 205 | 27.04 | 5.06 |
| BMI | 205 | 27.17 | 4.18 |
| Gestational day of Doppler USG | 205 | 253 | 5 |
| PI right uterine artery | 205 | 0.84 | 0.4 |
| RI right uterine artery | 205 | 0.83 | 0.38 |
| PI left uterine artery | 205 | 0.51 | 0.17 |
| RI left uterine artery | 205 | 0.48 | 0.18 |
| PI umbilical artery | 205 | 0.91 | 0.3 |
| RI umbilical artery | 205 | 0.6 | 0.26 |
| Gestational day of delivery | 205 | 271 | 10 |
| Weight of newborn | 205 | 3264.76 | 451.14 |
| State anxiety total score | 205 | 37.09 | 9.57 |
| Trait anxiety total score | 205 | 43.52 | 7.82 |

## 3. Results

In this cross-sectional study, our sample group comprised 350 pregnant women aged 18-40. After the exclusions took place, the sample group comprised 215 participants. Afterward, 10 additional participants did not give consent to having their information used in our study. The sample group was finalised at 205 pregnant women.80% of the patients gave birth at the same hospital where the study was conducted, and 20% opted for another hospital. Concerning the descriptive variables of the participants, the occupational situation and pregnancy history were as follows: 91.2 of the pregnant women were homemakers; 41% were primigravid; 87.8% had no abortus history. 75.6% of the pregnant women had a vaginal delivery, and 93.7% of foetuses were in vertex presentation. Four neonates' 5-minute Apgar score was lower than 8,while all neonates' 10-minute score, including the four we mentioned earlier, was either 9 or 10.92. 7% of the placentas examined after delivery were grade 2, and 7.3% were grade 3. Neonatal ICU was needed for only one neonate. 54.1% of the neonates were female. In the anxiety test, 112 (54.6%) and 56 (27.3%) participants exhibited low scores for the state and trait status, respectively.

In our study, we observed no specific correlation between the Doppler indices of all three arteries and the anxiety scores ($p>0.05$).

This was true for both state and trait anxiety scores. There was a significant moderate positive correlation between state and trait anxiety scores (r=0.521, p<0.01). There was a moderate positive correlation between pulsatility indices of contralateral uterine arteries (r=0.365, p<0.01). There was a moderate positive correlation between resistance indices of contralateral uterine arteries (r=0.442, p<0.01). The correlation matrix is shown in Table 2.

The descriptive statistics for state and trait anxiety are shown in Table 3.

In our research, we divided the participants into two groups: one group showed low anxiety status, and the other group showed high anxiety status. We performed this grouping for both state and trait anxiety groups. We analysed the correlation between the STAI total scores and the preplacental & postplacental Doppler indices, and investigated whether a significant statistical difference exists between the low and high anxiety groups. In our study, we observed no statistically significant differences for any Doppler indices among anxious and non-anxious groups (p>0.05). This was true for both t-tests and non-parametric Mann–Whitney U tests.

The between groups t-test results, with a cut point of 39, is shown in Table 4.

**Table 2:** Correlation matrix of variables.

| *Variable* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| PI right uterine artery | - | | | | | | | |
| RI right uterine artery | .705** | - | | | | | | |
| PI left uterine artery | .365** | .379** | - | | | | | |
| RI left uterine artery | .330** | .442** | .732** | - | | | | |
| PI umbilical artery | 0.109 | -0.011 | -0.03 | -0.068 | - | | | |
| RI umbilical artery | 0.109 | 0.081 | -0.009 | -0.043 | .598** | - | | |
| State anxiety total score | -0.049 | -0.009 | -0.074 | -0.089 | -0.066 | -0.046 | - | |
| Trait anxiety total score | 0.079 | 0.039 | -0.043 | 0.017 | 0.005 | 0.085 | .598** | - |

** p< 0.01

**Table 3:** Descriptive statistics for state and trait anxiety.

| | | *N* | Mean | *SD* | Std. error of mean |
|---|---|---|---|---|---|
| STATE ANXIETY GROUP | | | | | |
| PI RUtA | Low | 56 | 0.84 | 0.43 | 0.05 |
| | High | 149 | 0.84 | 0.39 | 0.03 |
| RI RUtA | Low | 56 | 0.5 | 0.16 | 0.02 |
| | High | 149 | 0.51 | 0.17 | 0.01 |
| PI LUtA | Low | 56 | 0.85 | 0.43 | 0.05 |
| | High | 149 | 0.82 | 0.35 | 0.02 |
| RI LUtA | Low | 56 | 0.48 | 0.15 | 0.02 |
| | High | 149 | 0.49 | 0.18 | 0.01 |
| PI UmA | Low | 56 | 0.93 | 0.36 | 0.04 |
| | High | 149 | 0.89 | 0.28 | 0.02 |
| RI UmA | Low | 56 | 0.58 | 0.19 | 0.02 |
| | High | 149 | 0.6 | 0.28 | 0.02 |
| TRAIT ANXIETY GROUP | | | | | |
| PI RUtA | Low | 112 | 0.88 | 0.44 | 0.04 |
| | High | 93 | 0.79 | 0.34 | 0.03 |
| RI RUtA | Low | 112 | 0.52 | 0.18 | 0.01 |
| | High | 93 | 0.49 | 0.15 | 0.01 |
| PI LUtA | Low | 112 | 0.85 | 0.41 | 0.03 |
| | High | 93 | 0.8 | 0.32 | 0.03 |
| RI LUtA | Low | 112 | 0.5 | 0.19 | 0.01 |
| | High | 93 | 0.47 | 0.15 | 0.01 |
| PI UmA | Low | 112 | 0.93 | 0.33 | 0.03 |
| | High | 93 | 0.88 | 0.26 | 0.02 |
| RI UmA | Low | 112 | 0.61 | 0.22 | 0.02 |
| | High | 93 | 0.58 | 0.3 | 0.03 |

RUtA stands for right uterine artery, LUtA stands for right uterine artery, UmA stands for umbilical artery.

**Table 4:** Between group's t-test results.

| | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|---|
| **STATE** ANXIETY GROUP | | | | | | | |
| | | | | | | **Lower** | **Upper** |
| PI RUtA | -0.047 | 203 | 0.962 | -0.00301 | 0.0634 | -0.128 | 0.12199 |
| RI RUtA | -0.155 | 203 | 0.877 | -0.004182 | 0.026931 | -0.057283 | 0.048919 |
| PI LUtA | 0.455 | 203 | 0.65 | 0.02718 | 0.05975 | -0.09063 | 0.14499 |
| RI LUtA | -0.301 | 203 | 0.763 | -0.00857 | 0.02844 | -0.06465 | 0.04751 |
| PI UmA | 0.799 | 203 | 0.425 | 0.03846 | 0.04814 | -0.05646 | 0.13339 |
| RI UmA | -0.372 | 203 | 0.71 | -0.01548 | 0.04159 | -0.09749 | 0.06653 |
| **TRAIT** ANXIETY GROUP | | | | | | | |
| | | | | | | **Lower** | **Upper** |
| PI RUtA | 1.615 | 203 | 0.108 | 0.09103 | 0.05638 | -0.02013 | 0.2022 |
| RI RUtA | 1.576 | 202.967 | 0.117 | 0.037071 | 0.023529 | -0.009322 | 0.083464 |
| PI LUtA | 0.876 | 202.24 | 0.382 | 0.04571 | 0.05221 | -0.05724 | 0.14866 |
| RI LUtA | 1.286 | 202.634 | 0.2 | 0.03193 | 0.02484 | -0.01704 | 0.0809 |
| PI UmA | 1.121 | 203 | 0.264 | 0.04824 | 0.04302 | -0.03659 | 0.13307 |
| RI UmA | 0.741 | 203 | 0.46 | 0.02755 | 0.03719 | -0.04577 | 0.10088 |

With a cut-off point 39. p> 0,05

## 4. Discussion

In our study, we found no correlation between the Doppler indices of umbilical arteries and anxiety scores of pregnant women. One of the first studies regarding Doppler indices and anxiety scores of pregnant women was done by Sjöström et al., who analysed the relationship between umbilical artery PI and maternal anxiety levels during 37-40 weeks of gestation. Our findings are in concordance with this study [5]. In other studies focusing on different gestational ages, Helbig et al., Monk et al, and Mendelson et al., also found no association between anxiety status and PI and RI values of umbilical arteries [24,25,43]. Our study differs from Helbig et al.'s study in the methods of psychological screening that were used and the gestational age in which the participants were [43]. In their study, Monk et al. did not use psychological screening, instead, the participants were pregnant women with histories of mental disorders [25]. Mendelson et al. used STAI, as we did in our study. However, the participants in their study were between 38–39 weeks' gestation [24].

In our study, we found no correlation between Doppler indices of uterine arteries and anxiety scores of pregnant women. Our findings are in concordance with Helbig et al.'s, Monk et al's, and Kent et al.'s studies [20,25,43]. Our study differs from that of Kent et al. in terms of the methods of psychological screening that were used, and the gestational age in which the participants were.

Our findings for umbilical artery Doppler indices and anxiety scores of pregnant women are not in concordance with Mendelson et al.'s study, who found a correlation between the anxiety scores and uterine artery Doppler indices [24]. Our study differs from their study in several elements. Firstly, there is no statement in their study regarding the BP and heart rate of pregnant women. On the other hand and up to our opinion, the measurement of anxiety with weekly intervals must be a question of concern for the familiarness to the items. Our findings are not in concordance with Teixeira et al.'s [6] and Vythilingum et al's. [23] studies. Our study differs from Teixeria et al.'s study, in which the PI of uterine arteries were measured. Firstly, in their study, the mean of contralateral arteries was analysed. Secondly, the cut-off values we used for assessing the anxiety status differed from theirs (39 vs 40). Vythilingum et al's. study, at first glance, suggests a weak positive correlation exists between trait anxiety and uterine artery PI. However, when adjusted for alcohol and nicotine consumption, the association was not observed to be significant.

## 5. Limitations of the Study

Our study, in which we found no correlation between Doppler indices and state and trait anxiety of pregnant women during 34-37 weeks of gestation, has certain limitations. Firstly, our research was limited by a small sample size. Secondly, the cut point, particularly for the trait subscale of STAI, is not well defined; and this proves itself to be a limitation not only for our study but also for general scientific research.

One potential strength of our study is the gestational age during which the Doppler indices were measured. The diameter of uterine arteries between 34–37 weeks' gestation exhibits a standard diameter (4.5 mm) [44]. Another strength of our study is that all participants attended antenatal care classes, which may play an important role in separating state anxiety status from pregnancy-induced stressors.

## 6. Conclusion

In conclusion, the age-old nature versus nurture debate, which centres on the question of whether human capabilities are inborn or acquired through experience, have evolved alongside scientific research. Today, the lingering question is not whether it is nature or nurture that shapes human psychology, but rather, how these two factors combine together to do so. There is good evidence suggesting a relationship exists between the anxiety status of pregnant women and the well-being of foetuses and neonates. In our opinion, instead of the sympathomedullary pathway, this relationship should be further investigated on the hypothalamic-pituitary-adrenal axis via neuroendocrinological biochemistry, genetics, and epigenetics.

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