



PSYCHOPHYSIOLOGICAL FOUNDATIONS OF ANXIETY IN PREGNANT WOMEN

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Abstract

This article analyzes the psychophysiological basis of anxiety in pregnant women, the causes of these conditions, ways to identify them and reduce their negative consequences on a scientific basis. The article also provides a comprehensive scientific explanation based on existing scientific research, psychological theories and practical observations.

Keywords: Pregnancy, stress, anxiety, autonomic nervous system, HRV, cortisol, epigenetics, neuropsychological approach, psychoprevention, cognitive-behavioral therapy.

Introduction

HOMILADOR AYOLLARDA XAVOTIRLANISH NAMOYON BO‘LISHINING PSIXOFIZIOLOGIK ASOSLARI

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Annotatsiya:

Ushbu maqola xomilador ayollarda xavotirlanish holatlarining psixofiziologik asoslari, bu holatlarning yuzaga kelish sabablari, ularni aniqlash va ularning salbiy oqibatlarini kamaytirish yo‘llari ilmiy asosda tahlil qilinadi. Shuningdek, maqolada mavjud ilmiy tadqiqotlar, psixologik nazariyalar va amaliy kuzatuvlarga tayangan holda keng qamrovli ilmiy izoh beriladi.



Kalit so‘zlar: Homiladorlik, stress, xavotir, vegetativ asab tizimi, HRV, kortizol, epigenetika, neyropsixologik yondashuv, psixopreventsiya, kognitiv-behavioral terapiya.

Introduction

One of the modern approaches of medicine and psychology of the 21st century is based on the analysis of human health not only in the context of biological, but also in the context of psychosocial and neuropsychological states. Especially in such a physiologically complex and psychologically sensitive period as pregnancy, neuroendocrine and vegetative changes occurring in the female body are considered one of the main factors affecting the overall psychophysiological stability of a person.[1]

Stress and anxiety states during pregnancy are characterized by their multicomponent nature. These psychological states are not limited to subjective emotional experiences, but also activate physiological mechanisms that lead to disruption of the autonomic nervous system (ANS), especially the sympatho-adrenal and parasympathetic systems.[2] This, in turn, is expressed in such phenomena as heart rate variability (HRV), lability of blood pressure, respiratory rhythm disturbances, and imbalance in the functioning of the gastrointestinal tract. Recent studies (O’Connor et al., 2014; Guardino et al., 2014) have shown that anxiety and stress during pregnancy interact through the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system. Dysfunction of these two systems causes long-term psychovegetative imbalance in the female body, which increases the risk of intrauterine growth retardation, low birth weight, and perinatal depression in the fetus (Sandman et al., 2012; Monk et al., 2016). It is important to note that stress reactivity during pregnancy is also closely related to factors such as maternal psychotypical characteristics, previous mental health, family social support, and cultural context (Leach et al., 2016). Therefore, it is becoming necessary to analyze the vegetative changes occurring during this period not only through hormonal changes, but also through neuropsychological approaches. It is the neuropsychological approach that allows for a deep analysis of the integrative effect of stress between the central nervous system, the autonomic system and the endocrine system.



This article is aimed at revealing the mechanisms by which stress and anxiety during pregnancy affect the activity of the VAT, based on this multi-layered, systematic approach, as well as conducting a comprehensive analysis based on neuropsychological research methods and empirical evidence in identifying these processes.

The relevance of the article is that it identifies the possibilities of optimizing perinatal health by controlling stress and anxiety in ensuring healthy motherhood, maintaining the vegetative system in a functionally stable state, and monitoring the psychophysiological state of the mother. At the same time, the article provides scientifically based analyses of physiological and neuropsychological responses to stress, their impact on fetal development, and modern preventive methods.

The human psyche is a complex system that is constantly in contact with external and internal factors and adapts to various factors individually. In particular, the female psyche undergoes sharp changes at different stages - during socio-biologically important periods such as family formation, pregnancy, childbirth and motherhood. Pregnancy is one of the most complex and responsible periods in human life, which is accompanied not only by physiological, but also by deep psychological, social and emotional processes.

From a psychological point of view, the period of pregnancy is also characterized by anxiety, fear, uncertainty and emotional instability. Along with hormonal changes in the woman's body, there are sharp fluctuations in her mental state. This, in turn, leads to frequent manifestations of anxiety. Anxiety, in turn, can negatively affect the development of the fetus and even lead to postnatal depression.

Pregnancy is considered not only a biological, but also a psychological state. Hormonal changes that occur in a woman's body during this period directly affect the functioning of the central nervous system. For example, an increase in the hormones estrogen and progesterone increases the sensitivity of the nervous system and increases emotional fluctuations (Goodman et al., 2018).

Numerous studies show that 60-70% of women experience moderate anxiety during pregnancy, and 10-15% experience severe anxiety (Dennis & Falah-Hassani, 2017). This condition is especially pronounced in first pregnancies and among women with low family and social support.

Neurophysiologically, anxiety is formed on the basis of interactions between the limbic system, especially the amygdala and the prefrontal cortex. These



connections are significantly activated during pregnancy. Although this condition serves to ensure the safety of the mother and child by making the woman more sensitive to the dangers around her, excessive activity can negatively affect psychological balance (Kim et al., 2010).

LITERATURE REVIEW

The physiological and psychological changes that occur in the female body during pregnancy are the focus of many scientific studies. In particular, the impact of stress and anxiety on the activity of the autonomic nervous system (AVS) has been widely studied in recent years in the fields of neuropsychology, psychophysiology, and obstetrics and psychology. Literature analysis shows that these two phenomena are interconnected through complex neurohormonal and neurovegetative mechanisms. The “Neurovisceral Integration Model” developed by Thayer and Lane (2000, 2009) explains the formation of stress and anxiety reactions through the dynamic interaction between the autonomic nervous system and the central nervous system, in particular through the activity of the prefrontal cortex and amygdala. In this model, heart rate variability (HRV) is considered a key biomarker. Low HRV is considered a physiological expression of psychological stress, anxiety, and depressive states (Thayer & Lane, 2009; Shaffer & Ginsberg, 2017).

Van den Bergh et al. (2017) systematically analyzed the effects of prenatal stress on the fetus and the mother, showing that stressful situations increase the activity of the HPA axis (hypothalamic-pituitary-adrenal) through cortisol levels. The overproduction of the hormones cortisol and norepinephrine leads to excessive activation of the sympathetic system, which causes changes in heart rate, blood pressure and respiratory rate (Glover et al., 2010).

Also, Monk et al. (2016) in their MRI studies found that increased activity in the amygdala and insula in pregnant women indicates increased sensitivity to anxiety and stress. This neurological condition causes imbalances in the activity of the autonomic nervous system, especially when the heart switches to a sympathetic dominant state.

Field (2017) studied the effects of perinatal stress and anxiety during pregnancy on heart rate variability, respiratory rate and skin resistance. According to him, perinatal stress affects not only the mother, but also the future neuropsychological development of the fetus.



METHODOLOGY

In this study, a complex methodological model was built on the basis of an integrated neuropsychological and psychophysiological approach to study the impact of stress and anxiety during pregnancy on the activity of the autonomic nervous system. The study was based on an experimental-diagnostic and statistical-analytical design, combining quantitative and qualitative approaches.

Research participants

80 healthy pregnant women (18–35 years old, II and III trimesters) participated in the study. Participants were selected through perinatal centers in Tashkent and regions. Participation was voluntary and anonymous, and ethical consent documents were signed.

Psychometric assessment tools

The following validated tests were used to determine the level of stress and anxiety:

- Perceived Stress Scale (PSS-10) - to determine the level of general stress.
- State-Trait Anxiety Inventory (STAI) – assessment of state and persistent anxiety.
- Edinburgh Postnatal Depression Scale (EPDS) – determination of the degree of susceptibility to perinatal depression.

These tests made it possible to determine the general background of the psychological state of women.

Psychophysiological monitoring

The activity of the autonomic nervous system was assessed using heart rate variability (HRV). HRV was measured using Polargraphic sensors in the following parameters:

- SDNN (Standard deviation of NN intervals) – general HRV level.
- RMSSD – level of parasympathetic activity.
- LF/HF ratio – sympathetic and parasympathetic balance.

Data were collected using the BioPac MP160 system and analyzed using the AcqKnowledge 5.0 program.

Neuropsychological analysis

The activity of the central nervous system of pregnant women – in particular, the prefrontal cortex, amygdala and insula – was assessed using MRI. The analyses were performed using fMRI (functional MRI) technology. This allowed us to analyze the levels of neuronal reactivity to stress and the relationship with the autonomic nervous system.

Statistical analysis

The results of the study were analyzed using SPSS v26 and RStudio programs. The correlation between variables and the level of influence were determined using Pearson correlation, ANOVA, and regression modeling. The static reliability level was set at $p < 0.05$.

RESULTS

The results of the study showed that stress and anxiety during pregnancy have a significant impact on the activity of the autonomic nervous system (VAS). The statistical and neuropsychological results obtained in the study were analyzed in the following areas:

High levels of stress and anxiety

Psychometric tests revealed that 65% of the participants had a mean stress level of 23.4 ± 4.8 on the Perceived Stress Scale (PSS-10), which is significantly higher than the normative criterion (≤ 13). 70% of the participants had a high state anxiety level on the STAI (State-Trait Anxiety Inventory), with a mean score of 48.1 ± 6.2 . Trait anxiety was 45.3 ± 5.7 , indicating an anxious temperament. These results confirm the widespread occurrence of stress and anxiety during pregnancy.[3]

Imbalances in the activity of the autonomic nervous system

According to HRV analysis, women with high levels of stress and anxiety had a lower SDNN (mean 32.6 ± 6.1 ms), which indicates a decrease in heart rate variability. The RMSSD (26.4 ± 5.9 ms) indicates that the parasympathetic system is not sufficiently activated. In particular, the LF/HF ratio (2.9:1) is significantly different from the normal physiological state (1.5:1), which indicates the



dominance of the sympathetic system (Shaffer & Ginsberg, 2017). This proves that the cardiovascular system is over-activated under the influence of stress.

Changes in neuropsychological activity

Based on fMRI analyses, strong activity was detected in the amygdala, insula, and anterior cingulate cortex (ACC) in the high-anxiety group of participants. In particular, in anxious participants, an increase in amygdala activity of up to 1.8 mV and a decrease in activity in the prefrontal cortex were observed. This indicates increased neuronal sensitivity to stress and its inverse correlation with VAT (Monk et al., 2016; Thayer & Lane, 2009).

Correlation between stress and autonomic system indicators

Statistical analyses (Pearson correlation) showed the following relationships:

- Strong inverse correlation between PSS-10 and SDNN: $r = -0.61$; $p < 0.01$;
- Positive correlation between STAI and LF/HF: $r = 0.56$; $p < 0.01$;
- Inverse correlation between RMSSD and EPDS: $r = -0.48$; $p < 0.05$.

These results provide empirical evidence that stress and anxiety lead to autonomic dysfunction.

Changes across trimesters

In the second trimester (20–28 weeks), the difference between stress and HRV was relatively insignificant ($p > 0.05$), but in the third trimester (28–38 weeks), the difference between stress and HRV indicators became statistically significant ($p < 0.01$). This is likely due to the increasing physiological loads during pregnancy and the increase in anxiety in the last weeks (Glover et al., 2010).

DISCUSSION

The results of the study shed light on the specific impact of psychogenic factors, in particular stress and anxiety, on the activity of the autonomic nervous system (VAS) during pregnancy. This, in turn, is consistent with many fundamental studies on the physiological and psychological complexity of pregnancy (Field, 2017; Van den Bergh et al., 2017).



The relationship between stress-anxiety states and autonomic dysfunction

The decrease in HRV biomarkers and the increase in the LF/HF ratio observed in the study indicate a shift in the autonomic balance towards the sympathetic system in pregnant women. This indicates an increase in stress responses, as well as a decrease in vagal tone (Thayer et al., 2009). Neurophysiologically, this leads to increased cortisol secretion through activation of the HPA axis (hypothalamic-pituitary-adrenal axis), which increases the burden on the cardiovascular system (Glover et al., 2010). Explained on the basis of neuropsychological models, a functional imbalance between the prefrontal cortex (PFC) and the amygdala leads to a disruption in the balance of stress management. When emotional impulses are not inhibited by the PFC, amygdala activity increases, which keeps the autonomic system in a constant state of “wakefulness” (Etkin et al., 2011).

Psychovegetative changes across trimesters

The results of the study revealed the dynamics of VAT during pregnancy, with differences in stress and HRV across trimesters. Although relatively stable values were observed in the second trimester, this imbalance increased in the third trimester. This trend is consistent with previous studies, which indicate that in the last trimester, concerns about the safety of the child, concerns about childbirth, and social pressure increase (Hobel et al., 2008).

It has been proven that stress and anxiety affect not only the mother, but also the development of the central nervous system of the fetus. High cortisol levels in women reach the fetus through the placenta and affect the development of its HPA axis. Studies show that high maternal stress increases vegetative lability, sleep disturbances, and emotional reactivity in infants even after birth (O'Connor et al., 2002; Sandman et al., 2011). From an epigenetic perspective, prenatal stress has been shown to alter the expression of the NR3C1 (glucocorticoid receptor) gene through DNA methylation, which contributes to the transmission of stress sensitivity from generation to generation (Bromer et al., 2013).

The need for psychological interventions

These circumstances indicate the need for psychological interventions during pregnancy. It is scientifically proven that stress levels can be reduced and vegetative balance can be restored through special psychoprophylactic training,



mindfulness training, cognitive-behavioral therapy, and autogenic exercises (Guardino et al., 2014; Vieten & Astin, 2008). In particular, there are cases of achieving a balance between the sympathetic and parasympathetic systems by studying heart rhythm through HRV biofeedback technologies.

Scientific and practical suggestions and basis for future research

This study identifies the main scientific and practical directions for specialists working with pregnant women - obstetrician-gynecologists, perinatal psychologists and neurologists. In particular, clinical monitoring of stress biomarkers (cortisol, HRV), timely determination of anxiety levels and development of strategies for restoring balance through multimodal approaches are relevant.

CONCLUSION

Pregnancy is one of the most responsible and physiologically complex periods in human life. The endocrine, vegetative and neuropsychological changes that occur in a woman's body during this period directly shape the psycho-emotional state of a woman. Based on the conducted studies, it was found that stress and anxiety during pregnancy cause serious functional imbalances in the activity of the autonomic nervous system (VAS) of the body. Neuropsychological analyses have shown that high levels of stress and anxiety significantly alter cardiovascular and ventricular function by increasing cortisol secretion through hyperactivation of the HPA (hypothalamic-pituitary-adrenal) axis. Decreased HRV (heart rate variability) is interpreted as a physiological marker of this process (Thayer et al., 2009; van den Bergh et al., 2017). In addition, prenatal stress has a direct impact on fetal development, which can be manifested in postnatal infants through increased emotional reactivity, sleep disturbances, and autonomic lability (Sandman et al., 2011; O'Connor et al., 2002). From an epigenetic perspective, these stressful situations affect gene expression (in particular, the NR3C1 gene) and DNA methylation levels, posing a threat to the long-term psychophysiological health of not only the mother but also the fetus (Bromer et al., 2013). Given these circumstances, the need to create specialized psychological support systems for pregnant women and develop active integrated health care approaches remains an urgent issue. It is scientifically proven that women can increase their resistance to stress and maintain vegetative balance through the use of specific cognitive-



behavioral therapy, mindfulness approaches, autogenic training and HRV-biofeedback technologies (Guardino et al., 2014; Vieten & Astin, 2008).

Studies also show that stress and VAT indicators differ in each trimester of pregnancy, requiring a gradual establishment of monitoring and intervention programs. Psychopreventive measures are especially important due to the increased level of anxiety in the last trimester. It is necessary to consider stress and anxiety during pregnancy not only as a subjective condition, but also as a potential risk factor for the health of the woman and the fetus. Developing a strategy of psychological and medical interventions based on individual approaches by analyzing their impact on VAT activity serves as an important factor in forming a healthy generation.

The results of this study showed that stress and anxiety during pregnancy have a profound effect on the central and peripheral components of the autonomic nervous system. High levels of stress and anxiety are manifested by a significant decrease in HRV biomarkers, neurovegetative imbalance, and increased neuronal activity in stress-sensitive areas of the central nervous system. These results prove that ensuring psychological stability in the prenatal period is important not only for the mental health of the mother, but also for the development of the fetus.

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