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The Relationship Between Maternal Experience of Depression Symptoms and Intense Stress During Pregnancy and Child Development Disorders – a narrative review

Authors:

Alicja Sołtan (AS)

ORCID: https://orcid.org/0009-0006-8750-0797

E-mail: soltan.alicja@gmail.com

Central Clinical Hospital of the Medical University of Warsaw, ul. Banacha 1A, 02-097 Warsaw, Poland

Małgorzata Witaszczyk (MW)

ORCID: https://orcid.org/0009-0004-0197-5480

E-mail: malgosiawitaszczyk@gmail.com

University Clinical Center of the Medical University of Silesia in Katowice, ul. Medyków 18, 40-752 Katowice

Natalia Wiktorzak (NW)

ORCID: https://orcid.org/0009-0004-8601-3087

E-mail: natalia.wiktorzak@onet.pl , wiktorzaknatalia1@gmail.com

Cardinal Stefan Wyszyński Voivodeship Hospital in Łomża, Marszałka Józefa Piłsudskiego 11, 18-400 Łomża, Poland

Julia Lipska (JL)

ORCID: https://orcid.org/0009-0009-4093-2543

E-mail: Julka98712@gmail.com

Medical University of Lublin, al. Racławickie 1, 20-059 Lublin, Poland

Jagoda Prządka (JP)

ORCID: https://orcid.org/0009-0001-7921-919X

E-mail: jagodaprzadka45@gmail.com

Nicolaus Copernicus University in Toruń Ludwik Rydygier Collegium Medicum in Bydgoszcz, ul. Jagiellońska 15, 85-067 Bydgoszcz

Dominika Kochan-Olszewska (DKO)

ORCID: https://orcid.org/0009-0002-0001-7809

E-mail: dominikakochan98@gmail.com

Holycross Cancer Center in Kielce, ul. Artwińskiego 3, 25-734 Kielce, Poland

Longin Rudnicki (LR)

ORCID: https://orcid.org/0009-0003-8980-8718

E-mail: longinr@op.pl

Gdańsk Medical University: Gdansk, Poland

Jakub Pawlicki (JP)

ORCID: https://orcid.org/0009-0007-3888-4672

E-mail: jakub.pawlicki96@gmail.com

Specialist Hospital. St. Wojciech based in Gdansk, Aleja Jana Pawła II 50, 80-462 Gdańsk, Polska

Gracjan Koźma (GK)

ORCID: https://orcid.org/0009-0002-8812-6427

E-mail: gracjan.kozma@gmail.com

Military Institute of Aviation Medicine, 54/56 Krasińskiego Street, 01-755 Warsaw, Poland

Justyna Laskus (JL)

ORCID: https://orcid.org/0009-0004-8065-0464

E-mail: jlaskus@poczta.onet.pl

Bielański Hospital, ul. Cegłowska 80, 01-809 Warsaw, Poland

Paweł Klimas (PK)

ORCID: https://orcid.org/0009-0002-8803-0476

E-mail: klimas.pawel42@gmail.com

Św. Wincentego a Paulo Hospital, 1 Wójta Radtkego St., 81-348 Gdynia, Poland

Bartosz Gawior (BG)

ORCID: https://orcid.org/0009-0003-0935-5414

E-mail: bartosz.gawior@gmail.com

Mazovian Bródno Hospital, ul. Ludwika Kondratowicza 8, 03-242 Warsaw, Poland

Olga Stasiak (OS)

ORCID: https://orcid.org/0009-0008-3013-8015

E-mail: stasiak.olga1@gmail.com

Międzylesie Specialist Hospital in Warsaw, ul. Bursztynowa 2, 04-749 Warsaw, Poland

Marta Borkowska (MB)

ORCID: https://orcid.org/0009-0002-8105-3384

E-mail: marborkk@gmail.com

Military Institute of Medicine - National Research Institute, ul. Szaserów 128 Warszawa, 04-141 Polska

Corresponding Author:
Alicja Sołtan, E-mail: soltan.alicja@gmail.com

Abstract

Background. Human development begins at the moment two sex cells combine into a single zygote in the mother's womb, where the genetic material passed onto the child by both parents determines the organism's traits. However, during pregnancy, the child's body takes many necessary substances from the mother, and harmful factors can also pass through the placenta. There is great scientific interest focused on the impact of stress and emotions experienced by the mother during pregnancy on her child's development.

Aim. This review paper presents studies examining the relationship between the mental state of expectant mothers and the developmental rate of their children. The aim is to verify the thesis that children of mothers who were more stressed during pregnancy developed slower.

Material and methods. A narrative review of empirical studies concerning the relationship between maternal prenatal stress, depression, and anxiety, and the cognitive, psychomotor, and neurological development of their children.

Results. The reviewed studies report mixed outcomes regarding the impact of maternal mental state on child development. While some studies demonstrate that symptoms of prenatal depression and anxiety are associated with a decrease in cognitive and socio-emotional development, other findings suggest that mild, non-pregnancy-related stress and anxiety may have a slight positive impact on early psychomotor and mental development.

Conclusions. The research results do not unequivocally demonstrate an exclusively negative impact of maternal stress and mental disorders on child development. Mild stress can sometimes stimulate maturation, whereas severe stress and negative attitudes towards pregnancy may be among the numerous factors negatively shaping the child's later life. Further research using objective hormonal measurements is recommended to obtain more conclusive results.

Key words: pregnancy, stress, depression, anxiety, cognitive development, psychomotor development, mental development.

Introduction

The main factor determining the formation of the phenotype of every organism is its genotype, i.e., the set of all its genes. Genetic material determines the appearance of specific physical and behavioral traits, and its mutations lead to the development of many diseases that can be passed down from generation to generation. However, for gene expression to occur correctly, appropriate conditions must be provided. The greatest number of changes in the structure and functioning of the human body occurs during fetal life, where over the course of 40 weeks, all tissues forming the organism develop from a single-cell zygote. The proper development of the fetus is possible thanks to the provision of necessary conditions by the mother's body. The child, through the placenta, takes from the mother essential nutrients, oxygen, and vitamins, while also getting rid of harmful metabolic products. Many harmful substances produced or ingested

by the mother during pregnancy also pass through the placenta and can negatively impact the child's health. The awareness of expectant mothers regarding which lifestyle choices negatively affect the course of pregnancy will allow for the elimination of harmful factors, thereby ensuring optimal conditions for the child's development. Therefore, this is an extremely important topic in the work of psychologists providing therapy to pregnant women, who, unaware of the risks, might significantly deteriorate the future quality of life of their children.

Many factors influence child development and physical and mental health, with the psychological state of the mother during pregnancy playing a significant role. Information about the emotions experienced by the mother is received by the fetus already in the early stages of pregnancy. The significance of the impact of prenatal environmental factors on development is described by the fetal programming hypothesis. According to this hypothesis, the environment in the uterus can alter fetal development. Numerous physiological changes occur in the fetus's body to adapt to the specific conditions prevailing in its early living environment. Pathological changes occurring in response to harmful factors can have tragic consequences and become the cause of many diseases manifesting later in life [1]. The main factors negatively affecting the course of pregnancy are: the mother's age, lifestyle, number of previous pregnancies [2], and the use of stimulants [3]. However, few people are aware that experiencing negative emotions and stress by a pregnant woman can also harm the health of the developing child [4].

Various stressful situations are present in everyone's life. In 1967, Holmes and Rahe [5] created a list of stressful situations most commonly occurring in people's lives. They organized life events in order from the least to the most stressful and assigned each situation a point value corresponding to the level of stress. Even everyday life events, such as the need to arrive on time for a meeting, household chores, or arguments with loved ones trigger a stress response in the body. The more intense the stressor is, the stronger the body's reaction [5]. Severe or chronic stress, as well as associated negative emotions, negatively affect the mother's body, and when they reach the organism of the developing fetus, they have even more harmful consequences. Negative emotions disrupt the functioning of the mother's immune system, and the resulting changes alter the concentration of interleukins (IL-6, IL-8, IL-10, IL-13, and IL-18) in the maternal and umbilical cord blood. This leads to the occurrence of fetal inflammatory response syndrome (FIRS) [6] and can be a cause of premature birth or even miscarriage [7].

In response to a stressor, the entire stress regulation system is activated in the body, activating the hypothalamic-pituitary-adrenal (HPA) axis as well as the sympathetic nervous system. The hypothalamus releases corticotropin-releasing hormone (CRH), which stimulates the pituitary

gland to release adrenocorticotropic hormone (ACTH), which in turn initiates the production of cortisol in the adrenal glands. These hormones are released into the blood, together with noradrenaline produced by the sympathetic nervous system. The HPA axis and the reproductive system mutually regulate their functions in both pregnant and non-pregnant women. Hormones secreted by the HPA axis stimulate the hypothalamic-pituitary-gonadal (HPG) axis, and the endometrium, myometrium (the muscular layer of the uterus), and ovaries are rich in receptors for CRH and cortisol, making them very sensitive to fluctuations in the levels of these hormones [8].

Studies show a direct link between maternal prenatal stress and numerous pregnancy complications. Stress, anxiety, and depressive states in the first trimester of pregnancy are associated with an increased risk of preeclampsia in the later stages of pregnancy [9, 10], and also result in lower birth weight in children [11]. Stress caused by psychosocial problems, particularly bad situations in a relationship or family, contributes to the emergence of numerous abnormalities in the child's body structure [12].

Excessive stress in the first trimester of pregnancy is especially harmful to the developing nervous system. Children of stressed mothers have a smaller head circumference, which indicates poorer brain development, and they also score lower in neonatal neurological examinations [13]. In a retrospective study conducted by Stott and Latchford [14], it was demonstrated that children of mothers who experienced stressful situations during pregnancy have more problems during childhood, exhibit delayed motor development, and have many behavioral and cognitive problems. In another study [15], 70 mother-child pairs were gathered and monitored from the first trimester of pregnancy for the next 10 years. It was observed that children of stressed mothers exhibited greater mobility during an ultrasound examination at 36 weeks of pregnancy; these same children cried more often during the first 7 months after birth, displayed a difficult temperament, higher mobility, and irregularity in biological functions. After 9 years, the children were assessed independently by their parents, teachers, and researchers, all of whom concluded that the children of stressed mothers had more difficulty concentrating, were more aggressive, and overactive. This increased excitability mainly applied to boys. Other studies conducted in 2002 by British researchers [16] demonstrated a link between prenatal stress and an increased risk of ADHD symptoms in 4-year-old boys.

Cortisol secreted in response to stress by the HPA axis enters the mother's bloodstream; in the placenta, 50-90% of maternal cortisol is converted by 11β-hydroxysteroid dehydrogenase into biologically inactive cortisone. Under normal conditions, this is entirely sufficient; however,

when the cortisol concentration in the blood is too high, it passes through the placenta into the fetal body in excessive amounts [17]. When cortisol enters the developing brain, it can negatively affect synaptogenesis and dendrite proliferation [18]. This is particularly harmful to the hippocampus, whose nerve cells are extremely sensitive, and an excessive concentration of glucocorticoids causes their damage, prevents their regeneration [19], and in the case of pyramidal cells, can even lead to their death [20], which leads to a reduction in the volume of the hippocampus, especially its gray matter. These changes have a significant impact on the subsequent quality of life of the child, as the hippocampus is responsible for the consolidation of memory pathways, and its damage impairs learning abilities. Another exceptionally sensitive area of the brain is the amygdala, which is responsible for emotions and emotional memory. A higher level of maternal cortisol in the early stages of pregnancy is associated with a larger amygdala volume in 7-year-old girls, but this correlation is not observed in boys. Increased amygdala volume is observed in affective disorders such as depression, schizophrenia, bipolar disorders, and anxiety. This suggests that affective disorders may have their roots in very early development [21].

Research materials and methods

This theoretical paper constitutes a narrative review of empirical studies concerning the relationship between stress experienced by pregnant women and the cognitive, psychomotor, and neurological development of their children. The cited studies aim to verify the thesis that there is a correlation between the occurrence of depression and periods of intense stress during pregnancy, and child development disorders.

Research results

Interested in data showing that depression affects 10-20% of pregnant women, Ibanez et al. [22] decided to investigate the impact of depression and anxiety during pregnancy on early cognitive development in children. Their study was conducted on a group of 1,380 two-year-olds and 1,227 three-year-olds, as well as their mothers. The researchers gathered pregnant women who visited two prenatal care centers in France (Nancy and Poitiers) between 2003 and 2006, before the 24th week of pregnancy. Between the 24th and 28th weeks of pregnancy, the occurrence of depression symptoms was assessed using the Center for Epidemiological Studies Depression Scale (CES-D) [23], and the level of anxiety using the State-Trait Anxiety Inventory (STAI) authored by Spielberger [24]. Based on the results of these tests, the women were divided into

4 subgroups according to the presence of these traits. Subsequent measurements of depression and anxiety levels were taken at 4, 8, and 12 months postpartum using the Edinburgh Postnatal Depression Scale (EPDS) [25], providing information about the mother's mental state during the first year after giving birth. Three years after delivery, maternal depressive symptoms were reassessed using the CES-D [23]. All questionnaires were translated into French. In addition to the tests, between the 24th and 28th weeks of pregnancy, interviews were conducted with each expectant mother to collect information regarding their age, education level, income, and family situation. When their children were 2 and 3 years old, information was collected concerning child-rearing practices and the amount of time devoted to the child each week. At the age of 24 months ± 2 months, the children's language abilities were assessed using the MacArthur Communicative Development Inventory (CDI) [26]. Parents received a list of 100 words and were asked to select those spontaneously used by their child. Similar tests were performed a year later. Parents received the Ages and Stages Questionnaire (ASQ) [27] in which they had to answer 30 questions, 5 from each of the six categories: communication, gross and fine motor skills, problem-solving, and social skills. For each question, they indicated whether their child possessed the given skill.

The authors of the study demonstrated a significant correlation between the occurrence of maternal prenatal anxiety and poorer development in 2- and 3-year-old children. However, they found no link between pregnancy depression and child development disorders. The researchers also proved the positive impact of parental stimulation in the first years of life on the child's cognitive development. They observed that the time devoted by parents without symptoms of depression was longer than in those who exhibited such symptoms, which contributed to delayed child development.

In 2013, Koutra et al. [28] investigated the impact of pre- and postnatal maternal mental state, as well as her personality, on the development of an 18-month-old child. To do this, they examined a group of 470 mothers and their children, reflecting the population in a given region. All women were over 17 years of age and spoke Greek. The first meeting took place before the 15th week of pregnancy when the women visited one of four clinics in Heraklion for their first ultrasound scan. At that time, researchers conducted an interview with each woman, collecting their medical history and lifestyle data. Between the 28th and 32nd weeks of pregnancy, the women's mental state was assessed using the STAI scale [24], and their character was determined using the Eysenck Personality Questionnaire-Revised (EPQ-R) [29], analyzing their responses across 3 main personality dimensions. Eight weeks after giving birth, a

telephone interview was conducted with each woman, based on which researchers determined their level of postpartum depression using the EPDS scale [25]. At the age of 18 months, the level of mental and psychomotor development was assessed using the Bayley Scales of Infant and Toddler Development (Bayley-III) [30]; the tests were performed by qualified psychologists in the mother's presence.

The researchers demonstrated that symptoms of prenatal depression were associated with a decline in cognitive development, independently of postpartum depression. A high level of anxiety caused a decline in socio-emotional development, whereas extroverted mothers had children who were more developed in this domain. High levels of anxiety and neuroticism had a positive impact on expressive communication in infants. Children of mothers who experienced symptoms of postpartum depression showed a noticeable decline in cognitive development and fine motor skills.

Di Pietro, Novak, Costigan, Atella, and Reusing [31] conducted a study on 94 pregnant women and their children. The researchers wanted to test the validity of the common belief that stress and negative emotions experienced by the mother during pregnancy have lasting negative consequences on early child development. To this end, they measured the level of stress and anxiety in the gathered women, as well as the presence of depression symptoms. All women were non-smokers, over 20 years old, and were not carrying twin pregnancies. The first measurements began in the 24th week of pregnancy; expectant mothers were asked to fill out 2 questionnaires regarding their mental state. Anxiety and depression levels were measured using the shortened version of the McNair, Lorr, and Droppleman [32] questionnaire – the Profile of Mood States (POMS) [33]. The level of stress experienced by the women over the previous 24 hours was determined using the Daily Stress Inventory [34]. Subsequent measurements of stress and anxiety levels were conducted in the 28th week of pregnancy. To measure stress levels, women completed the Perceived Stress Scale (PSS) [35], and to determine anxiety levels, the STAI questionnaire [24] was used. In the 32nd week of pregnancy, depression levels were measured again, this time using the Center for Epidemiological Studies Depression Scale (CES-D) [23]. The level of stress related to pregnancy was also measured, where respondents specified their attitude towards pregnancy using the Pregnancy Experience Scale [36]. Later on, the continued course of the women's pregnancies was observed, so that shortly after their children's 2nd birthdays, final tests could be conducted. At the 24th month of the children's lives, their neurobehavioral development level was assessed using the Bayley Scales of Infant Development II (BSID), which is the most widely used scale for early childhood development.

Observations of fine and gross motor skills as well as children's mental development were made by a clinical psychologist. To more accurately assess the children's behavior, an additional BSID scale was used – the Infant Behavior Record (IBR), based on which the children's attitude toward performing tasks, as well as their contact with the examiner, was determined. Before meeting the psychologist, the children's heart rates were measured. At around the same time, the mothers' anxiety levels were assessed using STAI [24], stress levels using the PSS scale [35], and the presence of depression symptoms via the CES-D scale [23].

The research results showed that the widespread belief in society regarding the harmful impact of maternal stress on child development is not entirely accurate. Moreover, a slight but significant positive impact of mild stress on early childhood development was demonstrated. A higher level of maternal anxiety, non-pregnancy-related stress, and the presence of depression symptoms were associated with a more advanced level of motor development. The presence of anxiety and depression also significantly positively influenced the pace of mental development. However, the study revealed that children of mothers with a negative attitude towards pregnancy experienced a significantly slower pace of psychomotor development, and also had problems with emotional control and attention focus. These results lead to the conclusion that stress, but exclusively that which is unrelated to pregnancy and occurs in the woman in normal amounts, does not have a negative impact and may even stimulate fetal maturation.

Discussion

The studies cited in this paper aimed to verify the validity of the thesis that there is a correlation between the stress experienced by pregnant women and the cognitive and neurological development of their children. The answer to this question is not unequivocal. In the works cited above, researchers investigated relationships between multiple factors, checking, among other things, how the occurrence of maternal depression symptoms affects early childhood development. In the study by Koutra et al. [28], researchers demonstrated that symptoms of both pre- and postnatal depression were independently associated with a decline in cognitive development. Ibanez et al. [22] did not find a significant correlation between these two specific factors; conversely, according to Di Pietro et al. [31], higher levels of maternal anxiety, non-pregnancy-related stress, and the occurrence of depression symptoms are associated with more advanced motor and mental development.

The first two studies indicated a negative impact of maternal prenatal anxiety on socio-emotional and mental development, whereas the study by Di Pietro et al. [31] showed a positive

impact. Based on the studies described above, it can be stated that the occurrence of stress during pregnancy is just one of many factors influencing a child's development. As demonstrated by Ibanez et al. [22], parental stimulation of children in the first years of life plays a very crucial role, while a negative attitude towards pregnancy can strongly negatively impact development [31]. The divergence of the results presented by Di Pietro et al. [31] might stem from the small sample size, which consisted of only 94 women. However, to draw definitive conclusions regarding the truthfulness of the thesis, a larger number of studies would need to be considered. The issue discussed is also difficult to examine, as all assessments of stress, anxiety, and depression levels rely heavily on the subjective self-assessment of the women's mental states, and the survey responses may not always perfectly mirror reality. To better investigate stress levels, it would be necessary to monitor the levels of stress hormones, such as cortisol, throughout the entire pregnancy; however, such a study would be very costly and burdensome for the women. Thus, this is challenging with current methods of hormone measurement, but the application of novel examination techniques would allow for a more precise investigation of this topic.

Conclusions

The research results do not unequivocally demonstrate an exclusively negative impact of maternal stress and mental disorders on child development. Mild stress can sometimes stimulate maturation, whereas severe stress and negative attitudes towards pregnancy may be among the numerous factors negatively shaping the child's later life. Given the diverse findings across different studies, it highlights the complex nature of prenatal maternal psychological states and their varying effects on neurodevelopment. Further research, utilizing objective physiological measurements such as cortisol levels, is recommended to clarify these interactions and draw definitive conclusions.

Disclosure:

Author’s Contribution:

Conceptualization: Alicja Sołtan, Małgorzata Witaszczyk, Natalia Wiktorzak

Methodology: Julia Lipska, Dominika Kochan-Olszewska, Longin Rudnicki, Marta Borkowska

Investigation: Jagoda Prządka, Longin Rudnicki, Gracjan Koźma, Olga Stasiak

Data curation: Alicja Sołtan, Jakub Pawlicki, Dominika Kochan-Olszewska, Marta Borkowska
Writing – rough preparation: Alicja Sołtan, Gracjan Koźma, Justyna Laskus, Jagoda Prządka
Writing – review and editing: Alicja Sołtan, Paweł Klimas, Julia Lipska, Bartosz Gawior
Visualisation: Bartosz Gawior, Natalia Wiktorzak, Jakub Pawlicki, Paweł Klimas
Supervision: Alicja Sołtan, Olga Stasiak, Małgorzata Witaszczyk, Justyna Laskus

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