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ARTICLE REVIEW

Maternal stress and its influence on embryonic and fetal development: a literature review

El estrés materno y su influencia en el desarrollo embrionario y fetal: una revisión de la literatura

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ABSTRACT

Introduction: stress is a physiological reaction of the body to threatening situations, whether social, physical or psychological.
Objective: to determine the influence of maternal stress on embryonic and fetal development.
Methods: a literature review was carried out, through a search of information in databases such as Scopus, Dialnet, SciELO and Redalyc. Other elements of the gray literature were included due to their importance for the subject matter.
Results: the body exerts stress as a physiological response when a human being is under physical, mental or emotional tension, that is, in circumstances that are considered dangerous or threatening to the person. Maternal stress situations trigger physiological processes that end in the production of hormones and neurotransmitters such as cortisol, catecholamines, reactive oxygen species, cytokines and serotonin, which influence the health status of the fetus.
Conclusions: maternal stress causes the baby to have neurological, morphological and other types of affectations, secondary to the affectation of the development of structures and processes. Among these affectations are the occurrence of autism spectrum disorders, susceptibility to psychiatric disorders, premature delivery, low birth weight and bronchial asthma.

Keywords: Embryonic and Fetal Development; Disease Susceptibility; Health Status; Neurotransmitters.

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RESUMEN

Introducción: el estrés es una reacción fisiológica del cuerpo ante situaciones amenazantes, ya sea sociales, físicas o psicológicas.
Objetivo: determinar la influencia del estrés materno sobre el desarrollo embrionario y fetal.
Métodos: se realizó una revisión de la literatura, mediante una búsqueda de información en bases de datos como Scopus, Dialnet, SciELO y Redalyc. Se incluyeron otros elementos de la literatura gris por la importancia para la temática.
Resultados: el cuerpo ejerce estrés como respuesta fisiológica cuando un ser humano se encuentra bajo tensión física, mental o emocional, es decir, en circunstancias que se consideran peligrosas o amenazantes para la persona. Las situaciones de estrés materno desencadenan procesos fisiológicos que terminan en la producción de hormonas y neurotransmisores como cortisol, catecolaminas, especies reactivas de oxígeno, citocinas y serotonina, las cuales influyen en el estado de salud del feto.
Conclusiones: el estrés materno ocasiona que él bebé tenga afectaciones a nivel neurológico, morfológicas y de otros tipos, secundario a la afectación del desarrollo de estructuras y procesos. Entre estas afectaciones se encuentran la ocurrencia de trastornos del espectro autista, susceptibilidad a trastornos psiquiátricos, parto prematuro, bajo peso al nacer y asma bronquial

Palabras clave: Desarrollo Embrionario y Fetal; Susceptibilidad a Enfermedades; Estado de Salud; Neurotransmisores.

INTRODUCTION

Stress is a physiological reaction exerted by the body to situations of physical, mental or emotional pressure, i.e. situations perceived as threatening or harmful to the person. This mechanism produces bodily changes such as cortisol production, elevation of blood pressure, heart rate, blood glucose, among others. When there are high levels of stress in the body for a certain period of time, problems can occur in both the physical and mental health of the individual, giving way to the predisposition of the person to develop diseases and psychological disorders. It is worth mentioning that this is a natural and extremely necessary response in every person.[1]

Cortisol is a steroid hormone produced by the adrenal gland specifically in the fasicular zone being the widest. This hormone has several biological actions, involving the whole organism and several homeostatic mechanisms. The main function is metabolic, but there are physiological actions that include renal function and regulation of ion transport, cardiovascular systems and maintenance of vascular tone and permeability, immune function and actions in the central nervous system.[2]

During acute stress, a "fight or flight" process occurs, and the stress response causes various hormones, including cortisol, to be released into the bloodstream. The hormones increase concentration, reflexes and strength. On the other hand, heartbeat and blood pressure increase, while the immune system and memory are sharpened. After coping with short-term stress, the body returns to normal. However, chronic stress can cause problems at the digestive, immune, nervous and cardiovascular systems. If a person faces constant challenges and his or her body continues to produce higher levels of hormones, the body will not have time to recover.[3]

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Stress has three phases: alarm phase, adaptation or resistance phase and exhaustion phase.[4,5]

It should be taken into account that stress is not the same as anxiety, while stress is psychologically referred to as a process of adaptation to the environment, anxiety is an emotional reaction of general alertness to situations that seem threatening or even stressful. It is important to know how to identify and differentiate when stress and anxiety occur respectively.[6]

At present, the importance given to this and other health problems is deficient, especially in susceptible stages and groups such as pregnancy. This translates into an insufficient approach in strategic areas such as prenatal care. If we take into account that gestation is a critical period for the mother, due to the various physical and psychological changes that imply a mental restructuring for the development of the maternal identity; and for the fetus, which undergoes morphological and functional changes that occur as a result of the interaction between the fetal genome and the external environment, we understand the importance of studying stress in this situation.[5,7]

The stress experienced by a mother during her gestational period may have an impact on the health status of the fetus. This is justified by the lipophilic nature of cortisol, which makes it easier for it to cross the transplacental barrier and affect the fetus. However, this process is not mediated by cortisol alone, but rather requires the synergistic action of other mediators such as catecholamines, reactive oxygen species (ROS), cytokines and serotonin/tryptophan that help transfer maternal stress to the fetus either directly or indirectly. In addition, this excess cortisol produced by the mother may cause persistent developmental impairment of the hypothalamic-pituitary-adrenal axis.[8,9,10]

METHODS

A review of the literature concerning the impact of maternal stress on embryonic and fetal development was performed. For this purpose, a search for information was conducted in the period April - May 2023 at the Autonomous Regional University of Los Andes.

The information search was carried out in the databases Scopus, Dialnet, SciELO and Redalyc. An advanced search formula was structured by combining terms by Boolean operators. The terms "Stress", "Gestation" and "Fetus" were used, as well as their English translations. After the selection of the information in the databases, we proceeded to analyze elements of the gray literature (Thesis) of importance for the development of the present study.

DEVELOPMENT

There are a series of factors that contribute to the appearance of stress in pregnant women; such is the case of maternal anxiety and depression. The social environment also constitutes a stress trigger, where the occurrence of couple arguments, problems in the family environment or domestic violence intervene. Similarly, other situations such as the occurrence of natural or man-made disasters such as war are triggers of maternal-fetal stress.[11]

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There are numerous alterations that affect the development of the embryo and fetus produced mainly by maternal exposure to stress. These effects can be classified into three groups:

Neurological effects

During critical periods of early development, very high cortisol levels put the nervous system of the fetus at risk. This can produce functional abnormalities in the neurotransmitter system, cause abnormal glial cell functions, as well as alterations in migratory events or abnormal neuronal growth.[12,13]

As consequences of neurodevelopmental alterations, the product of conception may present a number of entities, including autism spectrum disorders, communication problems, delayed language development, an increased risk of schizophrenia in adulthood, as well as altered basic defense and conservation functions. All these alterations are an impediment in the correct development of the child in his environment, both in the short and long term.[14,15]

One article,[16] states that the children of women exposed to moderately severe stress during pregnancy may suffer consequences in their intellectual development, including hyperactivity and attention deficit.

Morphological effects

Low birth weight is established when the newborn has a birth weight of less than 2500g. According to studies carried out at the Hospital San Juan de Lurigancho,[5] stress related to insufficient financial situations, labor instability, family problems and environments that can generate stressful environments for the mother are a fundamental risk factor for low birth weight in the newborn. In fact, this event can increase up to 5,6 times the probability of the newborn to be born with this complication. Currently, low birth weight in newborns is considered a public health problem due to the complications it can generate in the individual in the short term in organs and systems, and in the long term in the course of development.

On the other hand, the risk of asthma is noted. Mothers who are exposed to high levels of stress together with environmental air pollution have a higher risk of their babies developing asthma; it also affects pulmonary development.[17]

Other effects

Preterm delivery is a delivery that occurs after 22 weeks but before 37 weeks. In this type of delivery, the product of conception has not achieved adequate maturation.[18]

Based on the pathophysiology of stress, it is understood that it acts in two ways, the first is when the stressor is examined by the central nervous system and in this way there is a response that is alert where the hypothalamic-pituitary-adrenal axis is responsible for secreting catecholamines through the adrenal medulla resulting in the known symptoms of stress.[19]

The second response occurs with the increase in the synthesis of corticosteroids to maintain the flow of glucose to the organs and thus preserve the state of alertness. This stage is the most important since corticosteroids cause an increase in the production of uterotonic receptors and a decrease in tocolytic receptors, resulting in the mother going into labor due to the stress levels present.[19]

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It is worth mentioning that not all newborns that have been exposed to maternal stress will have neurological, morphological or other effects that can be caused by this agent.

Experimental models

An article published by the University of Buenos Aires in the area of Biological Chemistry entitled "Susceptibility to the development of insulin resistance in a model of fetal programming by gestational stress" analyzed mice, exposing them to prenatal and postnatal stress. In addition, they were fed a high-fat diet. The results showed offspring more susceptible to develop metabolic alterations.[20]

This article suggests that maternal stress can cause alterations not only at birth, but also increase the predisposition to develop others in the future, and therefore have a future impact on adult life.

A research article published by the University of Oviedo entitled "Effect of stress on the success in the different stages of assisted reproduction treatment" states that there is a moderate to high degree of stress in the case of women who have infertility problems and go to assisted reproduction programs.[21]

Another article published by the Spanish Journal of Public Health entitled "Protocol of the GESTASTRESS cohort study on the effects of stress during pregnancy through the measurement of cortisol in the hair of the woman and the newborn" mentions that prenatal stress is related to psychopathological disorders, cardiovascular and immunological diseases.[14]

It is important to emphasize the need for multidisciplinary care during gestation to prevent maternal stress and its repercussions on the development of the product of conception. Stress requires a treatment that crosses medical specialties and the psychologist, guaranteeing a healthy gestation.

CONCLUSIONS

Maternal stress situations trigger physiological processes that result in the production of hormones and neurotransmitters such as cortisol, catecholamines, reactive oxygen species, cytokines and serotonin, which influence the health status of the fetus. Maternal stress causes the baby to have neurological, morphological and other types of affectations, secondary to the affectation of the development of structures and processes. Among these affectations are the occurrence of autism spectrum disorders, susceptibility to psychiatric disorders, premature delivery, low birth weight and bronchial asthma.

Conflict of interest
The authors declare that there is no conflict of interest.

Authors' contribution
All authors participated in conceptualization, formal analysis, project management, writing - original draft, writing - revision, editing and approval of the final manuscript.

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