Práticas e Cuidado: Revista de Saúde Coletiva
ISSN: 2675-7591

LITERATURE REVIEW

# THE IMPACT OF MATERNAL CARE ON CHILDREN'S NEURODEVELOPMENT AND PSYCHOLOGICAL DEVELOPMENT

## EL IMPACTO DE LOS CUIDADOS MATERNOS EN EL NEURODESARROLLO Y EL DESARROLLO PSICOLÓGICO DE LOS NIÑOS

## OS IMPACTOS DO CUIDADO MATERNO NO NEURODESENVOLVIMENTO E DESENVOLVIMENTO PSÍQUICO INFANTIL

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**Manuscript received on:** February 23, 2023.
**Approved on:** December 28, 2023.
**Published on:** July 22, 2024.

**Abstract**
**Introduction:** The scenario of child abuse in Brazil is a worrying reality. There is strong evidence from studies carried out over the last few decades that early childhood experiences are fundamental in building the integral health of individuals. Maternal care becomes the "environment" that can significantly interfere with the foundation that underpins child development. **Objectives:** This study sought to understand how the environment, in terms of maternal care, can impact on children's neurophysiological and psychological development, bringing together the theory of pediatrician and psychoanalyst Donald W. Winnicott (1896 - 1971) with the findings of neuroscience, especially epigenetics**. Method:** Narrative literature review based on PubMed, Scielo, Google Scholar, books and reports from international organizations. The keywords epigenetics, neurodevelopment and maternal care were used as descriptors. **Results:** People with a history of maltreatment, abuse or neglect in childhood showed structural alterations such as reduced volume of the hippocampus, corpus callosum and prefrontal cortex, and increased activity and volume of the amygdala. These factors can have a decisive influence on brain development, leading to significant changes in physiological regulatory systems, enabling the development of mental illnesses and disorders throughout life. **Conclusions:** The results of neuroscience research point to the possible impairment of the physical, mental and psychological health of individuals who suffer abuse and neglect during childhood. Therefore, this study considers the scientific basis of Donald W. Winnicott's theory, which emphasizes the importance of providing children with a caring, stimulating and welcoming environment in early childhood.

**Keywords:** Epigenetics; Neurodevelopment; Maternal care.

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Práticas e Cuidado:
Revista de Saúde Coletiva
ISSN: 2675-7591



**Resumen**
**Introducción:** El escenario del maltrato infantil en Brasil es una realidad preocupante. Existen fuertes evidencias provenientes de estudios realizados en las últimas décadas de que las experiencias de la primera infancia son fundamentales en la construcción de la salud integral de los individuos. El cuidado materno se convierte en el "ambiente" que puede interferir significativamente en las bases que sustentan el desarrollo infantil. **Objetivos:** Este estudio buscó entender cómo el ambiente, en términos de cuidado materno, puede impactar en el desarrollo neurofisiológico y psicológico de los niños, uniendo la teoría del pediatra y psicoanalista Donald W. Winnicott (1896 - 1971) con los hallazgos de la neurociencia, especialmente la epigenética. **Método:** Revisión bibliográfica narrativa basada en PubMed, Scielo, Google Scholar, libros e informes de organizaciones internacionales. Se utilizaron como descriptores las palabras clave epigenética, neurodesarrollo y cuidados maternos. **Resultados:** Las personas con antecedentes de malos tratos, abuso o negligencia en la infancia mostraron alteraciones estructurales como la reducción del volumen del hipocampo, el cuerpo calloso y la corteza prefrontal y el aumento de la actividad y el volumen de la amígdala. Estos factores pueden influir decisivamente en el desarrollo del cerebro, provocando cambios significativos en los sistemas de regulación fisiológica, lo que posibilita el desarrollo de enfermedades y trastornos mentales a lo largo de la vida. **Conclusiones:** Los resultados de las investigaciones neurocientíficas apuntan a la posible alteración de la salud física, mental y psicológica de los individuos que sufren maltrato y abandono en la infancia. Por lo tanto, este estudio considera la base científica de la teoría de Donald W. Winnicott, que hace hincapié en la importancia de proporcionar a los niños un entorno afectuoso, estimulante y acogedor en la primera infancia.

**Palabras clave:** Epigenética; Neurodesarrollo; Atención materna.

**Resumo**
**Introdução:** O cenário de maus tratos infantis no Brasil é uma realidade preocupante. Há fortes evidências em estudos realizados nas últimas décadas sobre o quanto as experiências vivenciadas na primeira infância são fundamentais na construção da saúde integral dos indivíduos. Os cuidados maternos se convertem no “ambiente” que pode interferir de forma significativa no alicerce que embasa o desenvolvimento infantil. **Objetivos:** Este trabalho buscou compreender como o ambiente, em termos de cuidado materno, pode impactar o desenvolvimento neurofisiológico e psíquico infantil, reunindo-se a teoria do pediatra e psicanalista Donald W. Winnicott (1896 - 1971) aos achados da neurociência, em especial, da epigenética. **Método:** Revisão narrativa da literatura, tendo como bases PubMed, Scielo, Google Acadêmico, livros e relatórios de Organizações Internacionais. Utilizou-se como descritores as palavras-chave epigenética, neurodesenvolvimento e cuidado materno. **Resultados:** Pessoas com histórico de maus tratos, abuso ou negligência na infância apresentaram alterações estruturais como volume do hipocampo, corpo caloso e córtex pré-frontal reduzidos, atividade e volume da amígdala aumentados. Esses fatores podem influenciar de modo decisivo o desenvolvimento cerebral, levando a alterações significativas nos sistemas regulatórios fisiológicos, possibilitando o desenvolvimento de doenças e transtornos mentais ao longo da vida. **Conclusões:** Os resultados das pesquisas realizadas pelas neurociências apontam para o possível comprometimento da saúde física, mental e psíquica dos indivíduos que sofrem maus-tratos e negligência na infância. Portanto, este estudo considera a fundamentação científica da teoria de Donald W. Winnicott, que enfatiza a importância de se fornecer às crianças um ambiente de cuidados, estímulos e acolhimento na primeira infância.

**Palavras-chave:** Epigenética; Neurodesenvolvimento; Cuidado materno.

## INTRODUCTION

In recent decades, scientific research in the fields of neuroscience and psychology has shown that the fundamental foundations for health and behavior throughout life are laid very early on.[1-8]

Early childhood is essential for the development of the nervous system, including the development of sensory areas, motor skills, language, learning, as well as psychological development, emotional and behavioral skills. Therefore, this period is fundamental to guaranteeing the foundations for the realization of the individual's potential throughout life.[6, 9] The neural connections formed in early childhood are strengthened through stimuli received from the external environment.[10,11] In this sense, maternal care aimed at guaranteeing the child's safety, physical and emotional well-being can significantly interfere with the foundation that underpins development.[4,12,13]

According to epigenetics, brain structure can also be shaped by the environment. From the complex interrelationship between genetic baggage and environmental stimuli, the encephalic, biological and psychological architectures would be shaped. Therefore, the quality of the child's experiences in their environment, especially with regard to maternal care, would have a significant and lasting impact on child development, not only in the biological dimension, but also in the psychological and social spheres.[3,14]

In this sense, Donald Woods Winnicott (1896-1971), an English psychoanalyst and pediatrician, states in his theory that only through a welcoming and facilitating environment can children develop all the potential they bring at birth, structuring a psyche that allows them to live a full and healthy life. Otherwise, according to him, development can be compromised leading to behavioral changes and various pathologies.[4,5,8]

Understanding the relevance of this issue for science and society, we ask ourselves what are the consequences of the various experiences to which children are subjected in their development process? This study is justified by this question and, above all, by the current statistics on child abuse in Brazil and

around the world. Neuroscience brings relevant results through its research on this subject. It is believed that linking these studies to a theory of child psychic development is important in this scenario. We hope to contribute to future studies, general clarification and, in particular, to raising parents' awareness of their participation in building their children's health and quality of life. In this way, this narrative review aims to understand the extent to which the environment, in terms of maternal care, can interfere in the child's psychic and neurophysiological development, associating the results of neuroscience research with the theory of psychoanalyst Donald Winnicott (1896 - 1971).

## METHOD

PubMed, Scielo and Google Scholar were used as search bases, as well as books and reports from international organizations. The keywords epigenetics, neurodevelopment and maternal care were used as descriptors for the search. We opted for the criterion of proximity to the chosen theme to search for the selected material, which underpins this study.

## LITERATURE REVIEW

- Donald Woods Winnicott

The theory of the English pediatrician and psychoanalyst Donald Woods Winnicott (1896 - 1971) was based on his clinical practice of around forty years at Paddington Green Children's Hospital in London. His work monitoring children evacuated from London due to bombing during the Second World War was decisive for the foundations of his work, which is still present today among professionals working with child development.

- The importance and effects of maternal care

The theory proposed by Winnicott emphasizes the issue of the child's maturation and their readiness to build their psychic apparatus. According to him, the maturing process that begins in the first few months of life lays the foundations for the psychic construction of the being, making this first stage decisive for the direction that the individual's personality will take, since this foundation underpins the view of oneself, of others and the way in which the individual will act and react to the world.[4,5,8]

For Winnicott, although human beings are born with an innate potential to mature and develop, this process will depend on a facilitating environment offered to the baby so that it can realize all its innate potential. This environment is represented primarily by the maternal figure. As each human being is very unique in terms of how they respond to the environment, their needs and potential will be different and, therefore, the mother's ability to identify these needs will also be an important factor in this process.[4- 6, 8, 16]

- The main concepts of Winnicott's theory

The initial process that structures the child to mature starts from an inherited physical organization that, at birth, begins to interact with the environment and, at first, is totally dependent on it. In his theory, Winnicott proposes that the construction of personality begins with experiences that allow the organization of the physical body to be integrated, in other words, it is based on somatic aspects and an intense relationship with the environment.[4, 6 - 8]

"The good enough mother" or "environment"

A concept proposed by Winnicott in his theory, the "good enough mother", also known as the "environment", is not the perfect mother, but the one who manages to identify and promote the meeting of the child's needs, allowing the child to adapt in a way that gradually, to the extent of its readiness, prepares the child to achieve autonomy and experience the external world by responding to it in a full and healthy way.[4, 5, 8]

The author emphasizes that it is not enough for the mother figure to provide the child with basic care such as food, sleep and hygiene, but also to nurture them, know how to stimulate them, give them attention, pay attention to them and know how to recognize their particular needs. For Winnicott, the quality of this interaction underpins the child's emotional and affective development.[4 - 6, 8]

Support or holding

The "support" or "holding" involves all the care offered by the mother to the child, which contributes to its emotional development and allows it to identify itself as a unique, whole being.

At birth, the child does not yet have a sense of itself as an individual, and the distinct "psychic spaces" between it and its mother have not yet been built. The favorable environment offered by the mother creates the conditions for the formation of the baby's identity as a unique being, distinct from the mother. It is through holding and handling that the mother enables the child to identify with itself or its own "self", allowing it to build body awareness.[4, 8, 17]

Handling

The mother's interaction with the baby, through touch, cuddling, gazing and talking, helps to promote an arrangement between body and psyche that is fundamental for building this important physical-psychic integration which, if poorly carried out, can lead to psychosomatic damage and other pathologies for the child's future.[4, 7, 8]

Integration

The child experiences "me", "not me", "internal world", "external world", "good", "bad", among others, which are gradually integrated, made conscious, thus beginning the construction of the psychic instance known as "ego" or "me".[4, 5, 7]

Personification

This involves the process of physical-psychic integration that occurs through the "holding" or support offered by the mother, through care and attention to the child. At this stage, the child begins to perceive itself as a unique individual, distinct from its mother, as well as perceiving its own "soma", developing a vision of "itself" or "self".[4, 5,17]

The beginning of "object relations"

Through well-executed work on integration and embodiment, the child begins to perceive the "other", to see the world around them more clearly and to understand that the mother, not being an extension of them, cannot satisfy them or be with them all the time. Through small experiences of frustration and maternal absence, the child elaborates on this lack, through the memories of motherhood which, if experienced positively, help the child in the process of tolerating frustration, a fundamental learning for later coping with life.[4, 5, 8]

Winnicott states that creative processes also arise at this stage, when the child perceives the mother as being independent of them and uses resources to withstand frustrations and the absence of the one, they believed would be at their disposal all the time.[4, 7, 18]

Transitional object

At this stage, children adopt what Winnicott called a "transitional object". This concept refers to the object that the child chooses to "replace" the mother figure in her absence: pillows, stuffed animals and so on. Children also use songs, manipulating objects and other resources to make up for this lack. These alternatives awaken children's creative potential and make it easier for them to see the need to adapt to their environment.[4, 7, 18]

Therefore, the perception that the mother is a separate being from the child generates frustrations and it is this process that allows the child to move towards autonomy and continue to develop their personality.

The perception of the "other" in inter-relationships and the formation of bonds become important, as they will provide the child with an empathetic attitude in the future, as well as the ability to respond to the environment in a spontaneous and creative way to develop their potential and to develop their own personality.

The perception of the "other" in inter-relationships and the formation of bonds become important, as they will provide the child with an empathetic attitude in the future, as well as the ability to respond to the environment spontaneously and creatively, to develop their potential, considering that they live among other beings who are different from them.

According to Winnicott, it is up to the maternal figure to promote this transition by presenting the world to the child gradually and in such a way that they can assimilate it, providing welcomeness, stimulation and security. For the author, although everyone goes through this stage, it is the facilitating environment of the "good enough mother" that will help shape the child's psychic construction towards full development. When this doesn't happen, the child develops by trying to respond to the environment not in such a way as to express their potential, but to mask it, blunting the spontaneous and creative being that should emerge and, in this way, potentially developing a series of compromises for their future, such as affective, psychosomatic and learning problems, psychopathologies, among others.[4, 5, 6]

## EPIGENETICS

Unlike genetics, epigenetics aims to study the information contained in DNA relating to changes that are not caused by alterations in the DNA sequence, but by environmental conditions. Thus, an organism can adjust gene expression by activating or deactivating certain genes according to the environment in which it lives without altering its genome or DNA nucleotide sequence.[15, 19]

- DNA and the environment

The environment, which begins to exert its influence from the mother's womb, becomes fundamental after birth and environmental experiences can influence behavior by altering gene expression.[20]

All cells in the body have the same DNA sequence, but each type uses only parts of the information contained in this sequence. Some regions of the DNA, the genes, contain information for the production of proteins, which are the molecules that carry out most of the cell's functions. The information contained in genes is copied in the form of messenger RNA (mRNA) which is then translated into proteins. This information can be activated or silenced, depending on the organism's needs.[21-23] Thus, since all the cells in the organism have the same genetic information, what guarantees differentiation between them, enabling the formation of various tissues, is the fact that certain genes are expressed or not expressed. This regulation is carried out by epigenetic mechanisms (around genes, caused by environmental stimuli), such as DNA methylation and changes in chromatin.

Molecular epigenetic mechanisms that activate and silence genes

The expression or repression of genes is established through epigenetic modifications such as DNA methylation and changes to histones and chromatin structure, as well as the functions of non-coding RNA. These mechanisms act by modifying access to chromatin for the regulation of gene transcription and can modify gene expression in a transmissible or heritable way, thus causing genetic plasticity. DNA methylation is considered the most durable of the epigenetic modifications. It is a modification that occurs after DNA replication and is mainly, but not always, aimed at silencing or repressing the transcriptional gene.[24, 25]

DNA methylation occurs when a nitrogenous base in DNA, cytosine-guanine, binds to a methyl group (CH3) in certain regions of DNA called promoters, whose role is to control the function of genes.

Currently, DNA methylation has been the most studied of the epigenetic factors, since deregulated DNA methylation can be an important driver of pathological conditions, including neurological, mental, autoimmune and cancer diseases.[25] It is important to stress that gene silencing or repression is not always problematic. Often, these processes are necessary. In order to develop during pregnancy, the human fetus undergoes a series of methylation and demethylation events. After this initial programming of the epigenome, this pattern of DNA methylation is relatively stable, but also remains vulnerable to alteration by environmental exposures over specific periods in the gestation and later life of the individual. These methylation processes are important for early infant neurodevelopment, as well as in protecting the genome from invasion by viral DNA sequences or neoplastic processes, for example.[26] However, stressful environmental exposures in-utero or early in life affect DNA methylation patterns which, in turn, can affect infant development and predispose individuals to diseases and the development of psychopathologies.[27, 28]

Exposure to intense stress can trigger the methylation process, involving segments of DNA and preventing gene expression. In contrast, in a developmentally appropriate environment, there will be less methylation and greater production of neurotrophins, resulting in greater neuroplasticity.[29]

There is evidence that epigenetic mechanisms are associated with complex behaviors and mental disorders.[3, 19, 28] Epigenetics has therefore been considered extremely important for understanding the origin of various pathologies.

## Child development and the Brazilian reality

The World Health Organization (WHO) defines child abuse and child maltreatment as "all forms of physical and/or emotional maltreatment, sexual abuse, neglect or negligent or commercial treatment, resulting in actual or potential harm to the child's health, survival, development or dignity, in the context of a relationship of responsibility, trust or power".[30] A child is considered

neglected or abused when their physical, mental or emotional condition has been harmed or is in imminent danger of being harmed as a result of the failure of their parents or legally responsible person to exercise a minimum degree of care in terms of adequate food, clothing, shelter or education, medical, dental, surgical care, if necessary for the child.[13]

According to the Brazilian Society of Pediatrics (SBP), between 2010 and August 2020, around 2,000 fatal victims of aggression were under the age of 4.[31]

"Of the total number of cases reported by health services, 71% (62,537) were due to physical violence, 27% (23,693) to psychological violence and 3% (2,342) to episodes of torture. This survey did not take into account variations such as sexual violence and harassment, child labor, among other types of aggression that will be addressed by the SBP in a later publication." Although the number of records is significant, experts warn of underreporting, inferring that the scenario could be much worse, as many cases do not reach medical attention or the attention of the authorities.

According to SINAN data, the 25,000 cases reported in public and private health units over the last decade concerned babies under the age of one. The remaining 51,300 cases involved children aged between one and four.[32]

According to data provided by UNICEF and the Brazilian Public Safety Forum, there has been an increase in the zero to four age group, which is worrying because these are violent deaths in early childhood. In the 18 states for which complete data is available for the historical series, violent deaths of children under 4 increased by 27% from 2016 to 2020 - from 112 in 2016 to 142 in 2020."[33]

With regard to sexual violence, UNICEF reports that "The vast majority of victims of sexual violence are girls - almost 80%. For girls, a very high number of cases involve victims between the ages of 10 and 14, with 13 being the most frequent age. For boys, the crime is concentrated in childhood, especially between the ages of 3 and 9. The majority of cases of sexual violence against girls and boys take place in the victim's home and in the cases where there is information about the perpetrator, 86% of the perpetrators were known".[33]

According to a publication by the International Society for the Prevention of Child Abuse and Neglect, linked to the United Nations (UN) and the World Health Organization (WHO), "Brazil is the country with the highest estimates of child abuse in the world. The data recorded refers to sexual, physical and emotional abuse and physical and emotional neglect in 30 countries". According to PUCRS researcher Rodrigo Grassi Oliveira, the consequences for the health of these children may involve the risk of mental illness, drug addiction or diseases such as diabetes and obesity.[34]

Child development and epigenetics

Studies show that stressful environments involving abuse and neglect in childhood can produce a cascade of neurobiological events that are capable of causing lasting changes in brain development.[35, 36] In this sense, maternal care, being the first and most intense social interaction experienced by the child, becomes an environmental condition potentially capable of interfering in the construction of significant structures for neurodevelopment in general, as well as for the individual's psychological development.[4, 13, 14]

In recent years, several studies have focused on understanding how maternal care can influence the development of specialized brain structures and functions.[12, 37]

A significant part of the basic structure that provides support for the structural and functional organization of the brain is consolidated until the first two years of life. After this period, until the individual matures, there is a slower and more gradual adjustment and reorganization of the main circuits and neural networks.[10] This intense development of the brain in the first two years of life is very important for the establishment of cognitive skills and behaviors throughout life and may be linked to neurodevelopmental disorders and the risk of neuropsychiatric disorders.[27, 28] From gestation, the environment experienced by the mother, her diet, habits, addictions, infections, stress, all these factors influence the fetus and the way genes are expressed and how the architecture and functioning of the brain will be defined.[2, 11 ,39]

In the process of child development, various structures and functions are differentiated in the interaction between genes and the environment in response to reactions both internal and external to the individual. Biological responses to stress are inherent to human beings and are important for adapting to the environment and, consequently, for survival. However, when experienced intensely and over a long period of time, they increase the risk of physical and mental health complications, especially in childhood.[36]

Recent studies have shown that exposure to stressful stimuli of long duration and intensity can lead to changes in sensitivity to stress and in brain mechanisms, functions and structures. This is due to the changes that stress promotes in neurotransmission and synaptic plasticity in regions related to the functioning of the hypothalamic-pituitary-adrenal (HPA) axis, as well as in the prefrontal cortex, hippocampus and amygdala. These changes have a substantial impact on the central nervous system and, consequently, on the body as a whole.[40, 41]

The hypothalamic-pituitary-adrenal (HPA) axis

The hypothalamic-pituitary-adrenal axis (HPA axis) is the circuit responsible for the stress response. The activity of the HPA axis is governed by the secretion of corticotropin-releasing hormone (CRH) and vasopressin (VPA) by the hypothalamus. This, in turn, activates the secretion of adrenocorticotropic hormone (ACTH) by the pituitary gland, which finally stimulates the secretion of glucocorticoids by the adrenal cortex. Glucocorticoids adjust the functions of almost all the body's tissues; however, the most well-known physiological effect is the regulation of energy metabolism. The development of the HPA axis and the brain regions involved in its regulation begins in the intrauterine period and continues after birth, being protected by various mechanisms in the maturing brain. However, exposure to stress in early life has been reported in several studies to have numerous consequences for the function of the HPA axis in adulthood.[37, 42]

Experiences of intense stress in early childhood are related to changes in gene expression in genes related to the stress response (hypothalamic-pituitary-adrenal axis) associated with hyperactivity of the autonomic nervous system and cortical and subcortical processes of neuroplasticity and neurodegeneration, and can therefore have serious consequences for the individual's physical and mental health.[28]

Stress comprises a series of responses by the body to situations that represent a threat to its equilibrium, whether physical, psychological or otherwise. Environmental stressors reach the hypothalamus, which releases CRH (corticotropin-releasing hormone) or CRF (corticotropin-releasing factor) into the adenohypophysis or anterior pituitary gland. This releases ACTH (corticotropin) which, in turn, acts on the adrenal glands, stimulating them to produce and secrete cortisol. Cortisol will increase free fatty acids and blood glucose, providing energy to cope with the stressful situation.[43]

When stress lasts, chronic stress can develop and, therefore, excessive activation of the HPA axis. Consequently, this leads to a greater chance of developing numerous physical pathologies, such as diabetes, hypertension, cardiovascular problems, eating and sleeping disorders, among others, as well as anxiety conditions that can lead to various psychological disorders, such as generalized anxiety disorder, panic disorder, obsessive-compulsive disorder, major depression and other pathologies that have anxiety as a basic factor in their constitution.[28, 42, 44]

Stressful environments, poor nutrition and mistreatment can activate epigenetic markers, chemical substances that activate or deactivate certain genes, affecting their expression and impacting on child development itself and genetic transmission to the next generation, in other words, having transgenerational implications.[1, 45]

The environment: a shaper of development

Considering the environment from the intrauterine period onwards, research results evaluating the interrelationship between the environment and neurodevelopment point to a correlation between maternal anxiety and the development of babies' brains, from gestation and continuing into the first months of life. According to these studies, high concentrations of maternal cortisol interfere with the growth of babies' brains.[46, 47]

Exposure to chronic stress in the infant development period can induce significant alterations in the structural and functional development of the HPA axis and its main external regulators, the amygdala, hippocampus and prefrontal cortex, and can have serious long-term consequences, increasing the risk of developing psychopathologies.[42]

A reduction in the hippocampus, a region of the brain important for memory and stress modulation, has been associated with psychopathologies such as depression and post-traumatic stress, among others. According to these studies, children with a history of abuse had a reduction in the hippocampus, a neuroanatomical structure that is related to anxiety disorders.[48, 49]

Studies have also drawn attention to the transgenerational issue, since the intense stress experienced in childhood can modify chromatin, altering the expression of genes that regulate the nucleus accumbens, as well as the hippocampus. Such alterations could result in changes to the physiological and behavioral characteristics of individuals, and could be transmitted both in systemic cell duplication and in transmission to future generations.[50]

If, however, the stress of maternal deprivation or mistreatment has been shown to have negative effects on these structures [51], on the other hand, maternal care would help to promote an adaptation to the stress response carried out by the HPA axis and the healthy development of the hippocampus and other subcortical structures.[37]

Researchers seeking to investigate transgenerational effects used mice genetically modified for memory disorders and raised them in an environment enriched with toys, activity wheels and social interaction. According to the authors, the mice programmed for memory disorders acquired normal memory and the mice of the next generation also inherited a normal memory, despite having the genetic information for the disorder and not having been raised in an environment enriched with stimuli like those of the first generation.[52]

Traumas suffered in childhood were also associated with lower levels of brain-derived neurotrophic factor, BDNF, which plays an important role in neurogenesis and the survival of neurons.[5, 18, 58]

Therefore, the epigenetic processes generated from interaction with the environment can affect child development in a positive or negative way, depending on the context of care experienced by the child.[26]

## RESULTS AND DISCUSSION

Brazil is currently considered a world leader in terms of child abuse, neglect and maltreatment. Data provided by the Society for the Prevention of Child Abuse and Neglect, an institution linked to the United Nations (UN) and the World Health Organization (WHO), show alarming statistics.

This study sought to understand the impact of maternal care on the child's neurophysiological and psychological development. The proposal was based on Donald W. Winnicott's (1896 - 1971) theory, which emphasizes the importance of maternal care for children's physical and psychological development, with the findings of neuroscience, especially epigenetics, portrayed in the literature review presented here.

In his theory, Winnicott emphasizes maternal care, which he calls "environment" and which goes beyond basic survival issues. According to the author, this care, which does not have to be perfect, must be sufficient to provide a nurturing, welcoming and stimulating environment for the child's full developmental potential in physiological terms and in the construction of their personality. In the absence of this development-facilitating environment, the implications for the individual's all-round health would be compromised.[4, 5, 6, 8]

Likewise, neuroscience in the field of epigenetics have sought to understand how much an environment can shape the development of individuals, emphasizing through the results of their research that mistreatment, neglect or abuse in childhood would be a compromising factor, insofar as they make the environment toxic and therefore unsuitable for the development of the physical and psychological potential of the being.[12, 36, 37]

The results of this review show a strong correlation between chronic stressful environments and serious implications for the structural and functional development of the brain in early childhood, with multiple consequences for the physical and mental health of developing individuals.[40, 41, 46]

According to epigenetics, chronic stressful environments involving abuse and neglect activate epigenetic markers or chemical substances capable of activating or deactivating certain genes, affecting their expression and, as a consequence, causing significant changes in the structural and functional development of the HPA axis, amygdala, hippocampus and prefrontal cortex.[1, 45]

Epigenetic alterations, in turn, are directly related to the HPA (pituitary-adrenal) axis, which is linked to physiological responses to stressful situations. Responsible for the neuroendocrine regulation of physiological processes, the compromised HPA axis would have consequences for the balance of various systems in the body and could lead to a wide range of pathologies in adulthood, including cardiovascular problems, diabetes and cancer, among others.[19, 41, 53]

Thus, early stress could have beneficial or disadvantageous effects depending on the environment in which the child develops.[26, 28] This is due to the importance of the adaptive aspect of stress, since natural exposure to stress generally prepares an organism for adversity throughout life.[42, 54]

In other words, when considering development in an appropriate care environment, as proposed by Winnicott [5, 8], the natural experience of stress has the potential to promote resilience and strength, thus becoming a positive element.[37]

However, in an environment where exposure to stress is intense, there is an increased possibility of developing illnesses in general, as well as psychopathologies.[25, 48, 55] This is because, according to epigenetic studies, stressful environments induce atrophy in important areas of the brain, such as the hippocampus. The reduction of the hippocampus is related to anxiety disorders, which can induce the development of depression, post-traumatic stress and generalized anxiety.[49] Another important aspect related to the HPA axis is the action of glucocorticoids in imbalance, which would lead to negative

feedback inhibition of the HPA axis with a significant increase in corticotropin-releasing hormone (CRH), leading to resistance to glucocorticoids which, in turn, would lead to an increase in inflammatory markers resulting in diseases throughout life, and hypercortisolemia could also lead to mental disorders.[56]

Thus, while early stress due to abuse and neglect has been shown to have negative consequences for cortical and subcortical structures, maternal care would help promote adaptation to the stress response by the hypothalamic-pituitary-adrenal axis (HPA axis) and the healthy development of the hippocampus and other subcortical structures.[57]

In addition, traumas suffered in childhood have also been associated with lower levels of brain-derived neurotrophic factor (BDNF), which plays an important role in the neurogenesis and survival of neurons, as well as in brain plasticity. It is worth remembering how important the issue of brain plasticity becomes in creative processes and responses to life situations for development.[5, 18, 58]

Another important factor pointed out in research is the transgenerational issue.[52,59] Chronic stress, which can alter chromatin, modifies the expression of genes that regulate brain regions such as the nucleus accumbens, as well as the hippocampus.[50] As a consequence, individuals' physiological and behavioral characteristics would be compromised, which could be transmitted both in the systemic duplication of cells and in the transmission to the next generations, multiplying the compromise of future generations.[1, 9, 45]

There is, therefore, strong evidence in studies carried out over the last few decades of how fundamental early childhood experiences are in building the integral health of individuals.[3,13] The correlation between chronic stress experienced in early childhood due to mistreatment, abuse or neglect of care and the development of physical and mental disorders throughout life, as evidenced by scientific studies, is in line with the theory postulated by Winnicott throughout his work. These studies associate inadequate environmental conditions with lasting alterations in the frontal and subcortical brain circuits, as well as alterations in the individual's physiological, cognitive and psychological balance that are difficult to reverse [10, 27], especially in terms of brain structures with compromised development in early childhood.[44, 53, 54]

However, epigenetic effects, unlike genetic mutations, can be reversible in some cases, albeit slowly and with difficulty.[26, 60] The question that arises is the means, the tools that would have to be used for such a reversal, such as therapies, social support programs, parental awareness and support for victims. It is important to remember that, once the disease has been established, the path to a cure is laborious and depends on the response of each individual, as well as having a very expensive social cost.[41] In this sense, this review infers that prevention would be an excellent way forward.

Despite the numerous limitations of this study, including the sample size of articles analyzed in this narrative review, and the difficulties inherent in analyzing children in situations of mistreatment, neglect and abuse, we emphasize the extreme importance of continuing research in this direction, since every child has the right to fully develop all their potential. In addition, it is recommended that these results and those to come encourage the development of awareness programs for parents and caregivers as a way of preventing and remedying the problem, as well as the training of professionals and therapeutic interventions to support children who are victims of this condition. Individuals, families and society can only gain from this.

## CONCLUSIONS

Various studies, carried out on both animals and humans, have shown the substantial impact that exposure to chronically stressful situations and environments during early childhood can have on neurophysiological and psychological systems. This exposure results in notable changes in neuroendocrine, autonomic and behavioral aspects. Individuals with a history of maltreatment, abuse or neglect in childhood showed significant structural alterations such as reduced hippocampal volume, reduced prefrontal cortex, reduced corpus callosum volume, increased amygdala activity and volume. These factors would have a determining impact on brain development and could therefore trigger substantial changes in physiological regulatory systems. This, in

turn, could contribute to the emergence of diseases, somatic and cognitive imbalances and potential mental disorders. Thus, based on the results obtained in the research analyzed, this study supports the scientific foundation of Donald Winnicott's theory, which emphasizes the crucial importance of providing children with a caring, stimulating and welcoming environment during early childhood. As the author points out, children need to be given a good start that gives them the opportunity to develop physically and psychologically as full and healthy individuals.

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