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The intersection of stress, childhood adversities, and oral health: implications for pediatric care

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Aim: The physiological stress response is shaped in childhood and the intensity, frequency, and duration of stressful stimuli determine it. Adverse emotions experienced in early childhood can have profound and lasting physiological and psychological consequences. Therefore, it is important to understand how dental treatment can be a significant stressful in a child's life and recognize the potential lifelong impact. It is also crucial to comprehend how chronic stress can negatively affect oral health over time. **Methods:** In the present study, a critical review was conducted by analyzing scientific articles related to stress, salivary cortisol levels, child neurodevelopment, and the association of these factors during pediatric dental care, from 1981 to 2024, in databases such as PubMed and SciElo. **Results:** Across 69 studies, the review emphasizes the connections between adverse childhood experiences (ACEs), dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, and their cumulative effect on pediatric oral health. The findings illustrate how ACEs can disrupt normal brain functioning, leading to chronic stress, poor oral health outcomes, and altered behavior during dental care. **Conclusion:** Dental professionals must approach pediatric care with a deep understanding of the child's emotional and psychological state. By doing so, they can contribute to healthier oral outcomes and help mitigate the long-term impact of childhood adversities on oral health.

Keywords: Adverse childhood experience. Dentists. Stress, physiological.

Introduction

Understanding the biological, physical, and social events of children's neuropsychomotor and social development is crucial for their integral care. Dental professionals should recognize that their role extends beyond physical, clinical, and complementary examination, they must be aware of the possible adversities that surround that child. After all, the adversities present in childhood are responsible for delineating the future adults they will become.

The first 1000 days of the baby encompass the 270 days of the gestational period and the first two years of the baby's life. During these moments, children are vulnerable to genetic, epigenetic, and environmental factors which is a decisive period, that has a great influence and can be determining factors in their future life, regarding their personality, behavior, and general health[1-2].

Given that many children undergo dental care during this period, it is essential to understand how these experiences can impact their lives, as they can be significant stressors. Furthermore, it is crucial to consider the potential long-term consequences for the child, particularly on oral health and stress response, underscoring the importance of professional expertise in this area.

Materials and Methods

In the present study, a critical review was conducted to evaluate studies that relate stress in childhood and its effect throughout life, and the relation with dental treatment, using the PubMed and SciELO databases, employing the keywords "Pediatric Dentistry", "Dental Care", "Child Development," "Adverse Childhood Experiences," "Toxic Stress," "Hypothalamus-Pituitary System," and "Brain Development," in both Portuguese and English languages, from 1981 to 2024.

Sixty-five duplicate studies were excluded from the articles retrieved. The search results were reviewed, the titles and abstracts were screened to remove studies outside the scope of this review, and three hundred ninety-seven articles were excluded. Then, the full text of all potentially eligible studies was obtained and further examined to exclude those that did not fulfill the inclusion criteria. In this step, 85 citations were removed. Ultimately, sixty-nine scientific articles were analyzed and included in this review, focusing on toxic stress, salivary cortisol levels, brain development, and the association of these changes with dental care. A flow diagram of the literature is presented in Figure 1.

The inclusion criteria for the selection of articles were clinical case studies, review articles, and original articles with experimental studies. Papers on perspectives and opinions, commentary articles, and book reviews were excluded.

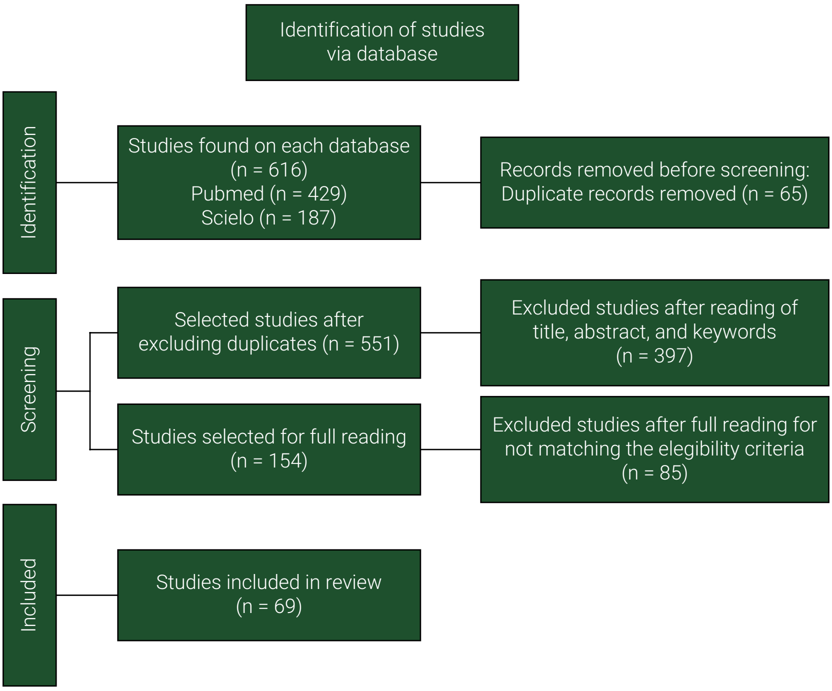

Figure 1. Flow diagram of the literature search and included studies.

Results

Children's Neurodevelopment

Children's neurodevelopment, spanning birth to early school age, involves physical, emotional, social, and cognitive aspects. The study of neurodevelopment reveals that experiences in various environments and relationships shape the brain's architecture from an early age[1-3].

In early childhood, children develop across three dimensions: biological, psychical, and social. Biologically, ensuring proper nutrition and a hygienic environment is essential for fostering healthy physical growth. Physiologically, tactile experiences, affectionate interactions, and exposure to visual, olfactory, and auditory stimuli from caregivers play a pivotal in shaping motor, cognitive, emotional, and sensory skills. Lastly, the social dimension emphasizes the significance of a nurturing environment that supports appropriate social interventions for the overall well-being of the child[1-3].

During the first years of life, the various stimuli that the child is exposed sees enable and increase dendrites and synaptic connections, as well as cerebral myelinization, crucial for efficient nerve conduction. This period and adolescence are critical for brain development, starting from the third week of pregnancy, where the development of neural structures begins, starting with the formation of the neural tube[4], as well as the stress response, occurring from the 20th week of the intrauterine life of the baby[5].

Some of these stimuli may come from adverse childhood situations, by external stimuli performed by parents, caregivers, and prepared professionals, which are related to negative experiences in a short or long time, impacting physiological, cognitive, behavioral, and psychological functions throughout life[6-7].

Neuroscience studies confirm that events during pregnancy and childhood influence a lifetime[1,7-11]. Analyses the function, structure, and brain development of pre-term babies compared to term-born babies, especially those births between the 27th and 32nd weeks, show functional disorganization and heightened stress response, compared to term-born children, from the 38th week birth[12]. Stressful factors in neonatal intensive care, like exposure to strong lights, loud noises, and frequent invasive interventions, may be associated with this outcome[13].

Corroborating these results[12-13], another research revealed that perinatal stress induces behavioral changes, including heightened and prolonged stress response, increased anxiety, difficulties in learning and memory, and an intensified desire and preference for alcoholic beverages[14]. On the other hand, in childhood, a period of active brain development and highly responsive to lived experiences, there is a remarkable capacity for plastic changes, which influences behavioral, epigenetic, and neural outcomes throughout life[14].

Research suggests[14-16] a stress response mechanism, known as resilience, that enables the body to adapt to adversity. This capacity varies among individuals, influenced by factors such as the presence of a support network to overcome adversities and early coping mechanisms developed since childhood, because of brain plasticity[16]. Also known as neural plasticity, the brain's constant remodeling capacity, extends throughout life, peaking during childhood, allowing for adaptation to new stimuli and events[14].

Stress Response and Childhood Stressors

A study involving rodents, where offspring separated from their mothers shortly after birth for a prolonged period displayed increased vulnerability to stressors in adulthood. This supports the idea that adversities faced in childhood and adolescence can significantly influence later life[17-18].

These stress-inducing situations potentially activate two interconnected systems, the hypothalamic-pituitary-adrenal axis (HPA) and the sympathetic nervous system (SNS), triggering responses in the body[6,19-21]. These responses are linked to an activation of the sympathetic nervous system (SNS) stimulates the adrenal medulla, leading to the release of adrenaline and noradrenaline into the bloodstream. This influences the functioning of peripheral organs, resulting in changes in hepatic, cardiovascular, respiratory, and other systems[6,16-21].

Activation of the HPA axis in response to stress involves the hypothalamus producing and realizing corticotropin-releasing hormone (CRH), and the pituitary gland generating adrenocorticotropin hormone (ACTH). This stimulates the adrenal cortex to release cortisol into the blood plasma[15-22]. The peak in blood occurs 15 to 20 minutes post-release, and after 2-3 minutes, there is a peak of cortisol in saliva. This cortisol diffuses across salivary gland membranes, reflecting concentrations of free cortisol in plasma[23].

The stressor stimulus can trigger two mechanisms: allostasis or allostatic load. Allostasis, which aims to adapt the body and achieve homeostasis, is considered a normal reactive response to stress known as resilience. Homeostasis functions as negative feedback through catecholamines' secretion and action, controlling the release of these substances and preventing a harmful response[24,25].

When this activation and release of hormones become persistent over the long term, the response to adverse situations can be compromised [25], so, the mechanisms of allostatic load are triggered, resulting from cumulative adaptations and the failure to control these systems. Allostatic load occurs when the individual inadequately responds to stress, leading to stressor overload[16,24,25].

Stress can be classified into three forms based on the analysis of intensity, frequency, and duration, along with the individual's reaction: positive, tolerable, and toxic stress[6,24]. Positive stress involves low-intensity and short-duration stress, modulated by protective mechanisms that swiftly restore homeostasis. It fosters resilience skills, stimulates neural synapses, and contributes to adaptive responses[24].

Tolerable stress arises when it persists over a period that could potentially impact brain architecture. However, the presence of a supportive network and strong relationships creates a welcoming environment for the child, helping maintain physiological homeostasis and preventing stress from reaching toxic levels[24].

On the other hand, toxic stress is characterized by chronic, intense adverse experiences that exceed the child's coping abilities, lacking a support network to navigate through them. In such cases, disturbances in neuropsychomotor development and an increased risk of organic diseases throughout life, such as diabetes mellitus, systemic arterial hypertension, pulmonary, cardiovascular, and autoimmune diseases, in addition to poor oral health, can be observed as consequences[20,21,24]. These risks include issues, such as cigarette use, alcohol and drug abuse and obesity[6].

Stress Response in Dental Setting

Dental treatment is widely recognized as a stressor for individuals who undergo it. Among children and adolescents, approximately 9% of them experience fear, anxiety, and behavior management challenges in dental settings, a negative experience they had[26]. Studies[27,28] reveal that anxious patients, in retrospect, perceive the procedure as more distressing and painful weeks after the treatment, contrary to the opinion of non-anxious patients who report reduced pain over time[29].

A study supporting this idea observed that patients with fear, anxiety, and dentist phobia had previous negative experiences, reliving these emotions. However, the study, involving adults aged 44 to 51, focused on experiences in adulthood around 25 years old, excluding childhood and adolescent memories, requiring additional research validation[30].

During dental appointments, stress can be measured through cortisol levels in saliva[31], with its collection and analysis regarded as a non-invasive, simple, and pain-less method. Many studies are conducted to identify which dental procedures and situations are considered more stressful in the dental environment[23,32-44].

Some studies indicate that even in simple procedures like dental prophylaxis, changes in cortisol levels can be observed, with increased reports[23,32-35]. Even before the first consultation, during the examination, non-cooperative patients exhibited elevated cortisol levels[36]. Slightly more invasive treatments involving anesthesia have also been studied, revealing higher cortisol levels after extraction procedures[37,38] and post-anesthesia for restoration procedures[39].

Moreover, studies have found a correlation between higher stress levels in children with cavities[40,41]. Another study showed that less cooperative children presented higher cortisol levels than cooperative ones[42], enabling professionals to identify moments and children more sensitive to stress through behavior.

Furthermore, additional research has been conducted on dental care and stress. It was possible to identify that procedures incorporating aromatherapy as a means to manage anxiety and stress yielded positive results, with lower levels of salivary cortisol reported[43,44].

Discussion

Dental care in children, even a less invasive procedure, can be a stressor, especially for those who have experienced more frequent adversities during childhood[23]. The ability to cope with stressful situations is mediated by interconnected brain and hormonal systems, promoting adaptability to life circumstances. The proper and balanced functioning of these systems is essential for healthy development[45].

The response to stress occurs from intrauterine life, around the 20th week[5], but the stability of the stress regulatory system (HPA) takes place only after a few months or years[46]. Thus, adversities experienced during childhood may alter the functioning of this system, leading to pathological responses to stress throughout life[47].

Continuous, intense, and uncontrollable stress, known as toxic stress, has the potential to affect the brain structure[48]. With this, the response of the stress regulatory system is likely to be altered in the presence of adverse situations, resulting in a lowered stress threshold. This makes even simple stimuli capable of activating this system, and stress becomes more common and frequent, which reduces resilience and increases impulsivity in the face of these events[24].

Adults who reported experiencing adversities during childhood exhibited higher cortisol levels[49]. These findings support the arguments that changes occurring in childhood can affect the functioning of the stress regulatory system throughout life. Research suggests that psychosocial interventions during childhood especially in vulnerable groups can be effective. This reinforces that the nervous system responsible for stress (HPA) is more malleable during this period, offering the potential for resilience[50-52].

Dysregulation of the HPA system significantly affects neural function, leading to changes in brain regions responsible for learning and memory, as well as alterations in the immune system[53,54]. Specifically, high cortisol levels can suppress the immune system, affecting the inflammatory response and increasing susceptibility to infections[21]. Additionally, some studies have indicated that exposure to stress during childhood is associated with delays in cognitive development, increased susceptibility to infections, somatic diseases, alterations in sleep patterns, and poor oral health[10,55].

Studies[56-58] have also sought to explain the relationship between adverse childhood experiences (ACEs) and poor oral health. These studies demonstrate that chronic stress results in allostatic load, which is the hyperactivation of the stressor response system. This cumulative physiological impact of stress directly affects oral health by promoting inflammatory responses and contributing to poor oral health maintenance, thereby increasing the risk of periodontal disease and caries. This is consistent with other research showing that children who experience stressful situations are more likely to have poor oral health, with ACEs acting as a predictor[55,59].

Furthermore, the presence of childhood adversities often means that children receive less preventive care, which can lead to greater development of caries disease and other oral health deficiencies[60]. Other studies have observed that children whose parents were more careful from pregnancy through the early years of life demonstrated better development and lower rates of caries due to less exposure to adverse events and the provision of necessary care by the mother[61]. In this context, premature and low birth weight children also had a higher prevalence of caries in early childhood[62], and are more prone to stressful experiences compared to those born at term[12,13].

Moreover, children with untreated decayed teeth are more likely to be bullied compared to those who have had caries treated or those who are caries-free[55,63,64], indicating a stressful and often chronic situation in a child's life. This association may help explain the link between caries and ACEs[24]. Additionally, it has been observed that children born to parents who smoke are at greater risk of developing caries[65], which may further explain the connection between stress and poor oral health, as stressful situations can lead to increased tobacco and drug use[14]. Lastly, the long-term effects of parents who experienced chronic adversity during childhood can manifest in the oral health condition of their children, increasing the likelihood of caries disease in early childhood[62,66].

These findings support the argument that adversities in childhood can impact brain development and various bodily systems, giving rise to consequences that persist throughout life[9]. Among these factors associated with the oral health and adverse situations is dental care itself, which can also function as a stressful moment in a person's life, where higher levels of cortisol, the stress hormone, can be observed after care[33,34,67]. Stress can be measured quantitatively through salivary collection and analysis, using salivary biomarkers, specifically cortisol[68]. Although dental treatment reduced cortisol levels in children with early childhood caries after the end of treatment, the presence of cortisol was higher in children requiring dental treatment and who had caries compared to those without the disease[41].

A previous negative experience related to dental treatment can be significantly associated with uncooperative behavior[29,69]. Corroborating this, studies indicate that patients with fear, anxiety, and dentist phobia, who had previously undergone negative experiences, often report feeling as if they are reliving those past situations[30]. However, one of these studies involved adult patients, aged between 45 and 51 years old, and the reported negative experiences occurred in adulthood, around 25 years old, which does not encompass memories from childhood and adolescence, requiring further studies to substantiate it[30].

Taking into consideration all of that, mental disorders mostly develop in childhood and negative dental experiences in this period of life trigger the development of dental fear and anxiety. Furthermore, the reaction and behavior of children during dental treatment do not necessarily correspond to the psychological stress of children once uncooperative behavior does not always reflect the anxiety state. So, it is essential to understand the emotional changes and mental stress in children who underwent dental procedures as well as to be apt to evaluate the exact level of a child's development, attitudes, and temperament to predict their reaction in front of a stressful stimulus. So, professional who deals with children as dentists must be aware of making good memories on children for them become healthy and free of traumas adults.

In conclusion:

1. Awareness of Risk Factors: pediatric dentists should be aware of the risk factors contributing to stress in young patients;
2. Understanding the Impact of Dental Care: recognize how dental care can influence their stress response for mitigating these effects;
3. Knowledge of Children's Neurodevelopment: health professionals must know children's neurodevelopment to apply behavior management techniques according to individual cognitive development stages;
4. Understanding the Impact of Stress on Oral Health: it is crucial to comprehend how chronic stress can negatively affect oral health, leading to long-term consequences if not properly managed.

By incorporating these considerations into their practice, they can create a more positive and supportive dental experience for children, potentially reducing stress, and fostering long-term oral health habits.

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Data Availability

Datasets related to this article will be available upon request to the corresponding author.

Conflicts of interest

None.

Author Contribution

Maria Eugênia Domingueti Rabelo Ribeiro actively participated in the construction of the manuscript, her responsibility was to conceptualize, investigate, and find the data curation, writing-original draft preparation, and after the supervision, review, edit, and approve the final version of the manuscript. **Lara Evangelista Orlandi** actively participated in the construction of the manuscript, her responsibility was to conceptualize, investigate and find the data curation, review, edit, and approve the final version of the manuscript. **Rodrigo Rodrigues** and **Leandro Araújo Fernandes** actively participated in the construction of the manuscript, their responsibility was to do the formal analysis, make the data curation, review, edit, and approve the final version of the manuscript. **Daniela Coelho de Lima** and **Heloisa de Sousa Gomes** actively participated in the construction of the manuscript, their responsibility was to do the formal analysis and review, editing, supervision, and approve the final version of the manuscript.

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