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NEUROPLASTICITY, BEHAVIOR AND SOCIAL INTERACTION: HOW SCREEN TIME AFFECTS CHILD AND ADOLESCENT DEVELOPMENT

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Abstract: The digital revolution has exposed children at an increasingly early age to the use of electronic devices, raising concerns about their effects on neurological, behavioral and social development. This article, through an integrative literature review of the last 12 years (2013-2025), analyzed 18 scientific studies investigating the repercussions of excessive screen time during childhood, with an emphasis on neuroplasticity, cognition, language, social interaction and emotional health. The findings indicate that prolonged use of devices is associated with structural changes in children's brains, including a reduction in frontal white matter and functional connectivity, as well as impairments in executive functions such as attention, memory and emotional regulation. Children with more than two hours of daily exposure showed up to a 15% reduction in vocabulary and 8.3% in working memory, as well as an increase in behavioral and emotional disorders, such as aggression, impulsivity and depressive symptoms. In the social field, a decrease of up to 28% in family interaction time was observed in homes with high screen use. On the other hand, protective practices such as shared reading and active supervision have been shown to significantly reduce the negative impacts of digital exposure, highlighting the role of parental mediation and the quality of the content accessed. The study concludes that although moderate and supervised use of technology can bring benefits, early and excessive use poses significant risks to child development. In view of this, it is recommended that public policies, family guidelines and evidence-based educational strategies be strengthened in order to promote the conscious, healthy and balanced use of digital technologies during childhood.
Keywords: neuroplasticity, child development, screen time, cognition, public policies.

INTRODUCTION

The expansion of digital technologies has significantly altered the dynamics of social interaction, which are increasingly dependent on electronic devices. This reality, present in various socio-economic contexts, has a direct impact on child development (KABALI et al., 2015). A study carried out in the United States found that 86% of children under the age of two already have daily contact with screens (KABALI et al., 2015), which raises concerns about the effects of this exposure on brain and behavioral development. In Brazil, the Fernandes Figueira Institute (FIOCRUZ, 2019) points out that the first years of life are marked by high neural plasticity - a critical period for the acquisition of cognitive and socio-emotional skills - and are therefore particularly sensitive to the quality and quantity of stimuli received (HUANG et al., 2024; TAKEUCHI et al., 2013).

Recent evidence shows significant correlations between excessive screen use and changes in neurocognitive and psychosocial development (COSTA et al., 2025; MADIGAN et al., 2020). Meta-analyses show that children exposed to screens for more than two hours a day have an 8.3% deficit in working memory (COSTA et al., 2025) and a reduction of up to 15% in receptive vocabulary (MADIGAN et al., 2020), compared to peers with moderate use. In addition, neuroimaging studies have shown structural changes in the frontal white matter in children with prolonged use of digital devices (HUANG et al., 2024), a key region for executive functions such as attention, planning and emotional regulation.

In the behavioral domain, large-scale longitudinal studies have identified consistent associations between excessive screen time and a 23% increase in externalizing problems (TWENGE; CAMPBELL, 2018), a 2.5 times greater risk of depressive symptoms (NAGATA et al., 2024) and a 32% reduction in sleep

quality (KRACHT et al., 2023). In Brazil, a study of preschoolers showed that 70% of children exceeded the recommendations for time of use established by the Brazilian Society of Pediatrics (SBP, 2023), which recommends limiting or avoiding exposure according to age group (Table 1) (LIMA et al., 2024).

Age Group	Recommended Daily Time	Observations
Under 2 years old	None	Stimuli should come exclusively from direct human interactions
2 to 5 years	Maximum 1 hour	Active supervision; prioritize quality content
6 to 10 years	1 to 2 hours	Maintain balance with other activities
11 to 18 years	2 to 3 hours	Provide guidance on risks and promote healthy digital habits

Table 1. Recommendations of the Brazilian Society of Pediatrics on screen exposure time by age group.

Source: SBP, 2023

In the social sphere, studies point to a reduction of up to 28% in family interaction time in homes with high device use (VASCONCELOS et al., 2023). On the other hand, mediating practices such as daily shared reading (>30 min) have the potential to reduce the negative impacts of screen time on language acquisition by up to 45% (HUANG et al., 2024), highlighting the protective role of active parental mediation.

Systematic reviews with children aged 0 to 36 months have identified significant correlations between greater digital exposure time and: (1) increased body mass index; (2) reduced cognitive stimulation in the family environment; and (3) compromised quality of caregiver-child interactions (DUCH et al., 2013; KRACHT et al., 2023). These findings suggest that the progressive replacement of human interactions with audiovisual stimuli can damage the formation of neural networks responsible for attention, language and emotional self-regulation - fundamental processes that reach their developmental peak in the first years of life.

On a neurobiological level, chronic and unregulated exposure to screens has a direct impact on the maturation of the prefrontal cortex, the structure responsible for executive functions such as planning, inhibitory control and emotional regulation. Advances in functional neuroimaging reveal that excessive screen time is associated with reduced cortical thickness and less connectivity between frontal and parietal regions, compromising essential cognitive processes such as sustained attention, working memory and behavioral control (TAKEUCHI et al., 2015; HUTTON et al., 2020).

Another critical mechanism involves exposure to blue light emitted by screens, particularly at night, which interferes with melatonin production and compromises natural sleep-wake cycles. This dysregulation directly affects fundamental neurocognitive processes, including memory consolidation, attention regulation and emotional balance (CHANG et al., 2015; HUTTON et al., 2020).

Given this multifactorial scenario, it is essential to gain an integrated understanding of the effects of early and prolonged exposure to digital devices on child development. This study, through an integrative review, analyzes the repercussions on neuroplasticity, executive functions, behavior and social interaction, in addition to identifying protective factors and parental mediation strategies that can mitigate potential damage.

OBJECTIVES

The central aim of this article is to analyze the impacts of early and prolonged exposure to electronic devices during childhood, with an emphasis on their repercussions on brain neuroplasticity, cognitive development and social interaction skills. Considering the high sensitivity of children's brains to environmen-

tal stimuli, the aim is to understand how factors such as the length of exposure, the age at which use begins and the nature of the content accessed influence the functional organization of neural circuits - especially in areas related to language, attention, memory and emotional regulation.

The aim is also to investigate possible correlations between excessive use of digital technologies and damage to children's development, including delays in language acquisition, difficulties in school performance and compromises in socioemotional skills. Behavioral symptoms frequently associated with unregulated exposure to screens, such as aggression, impulsivity, irritability, anxiety and depressive symptoms, observed in different age groups of the pediatric population, will also be analyzed.

Another key objective is to identify the factors that can moderate the effects of digital exposure. In this sense, the role of appropriate parenting practices will be assessed, with emphasis on active mediation of technology use and the quality of family interactions. The difference between merely recreational content and material with educational value will also be considered, with the aim of establishing parameters to guide a more qualified use of digital technologies.

Finally, the study aims to propose intervention strategies based on current scientific evidence in order to minimize the adverse effects of excessive digital exposure on child development. These strategies include recommendations for parental mediation, delimiting screen time by age group and encouraging interactive practices such as shared reading and supervised educational use of technologies. In this way, we hope to contribute to the promotion of a conscious and balanced use of electronic devices in the context of childhood, favoring the integral well-being and healthy development of children.

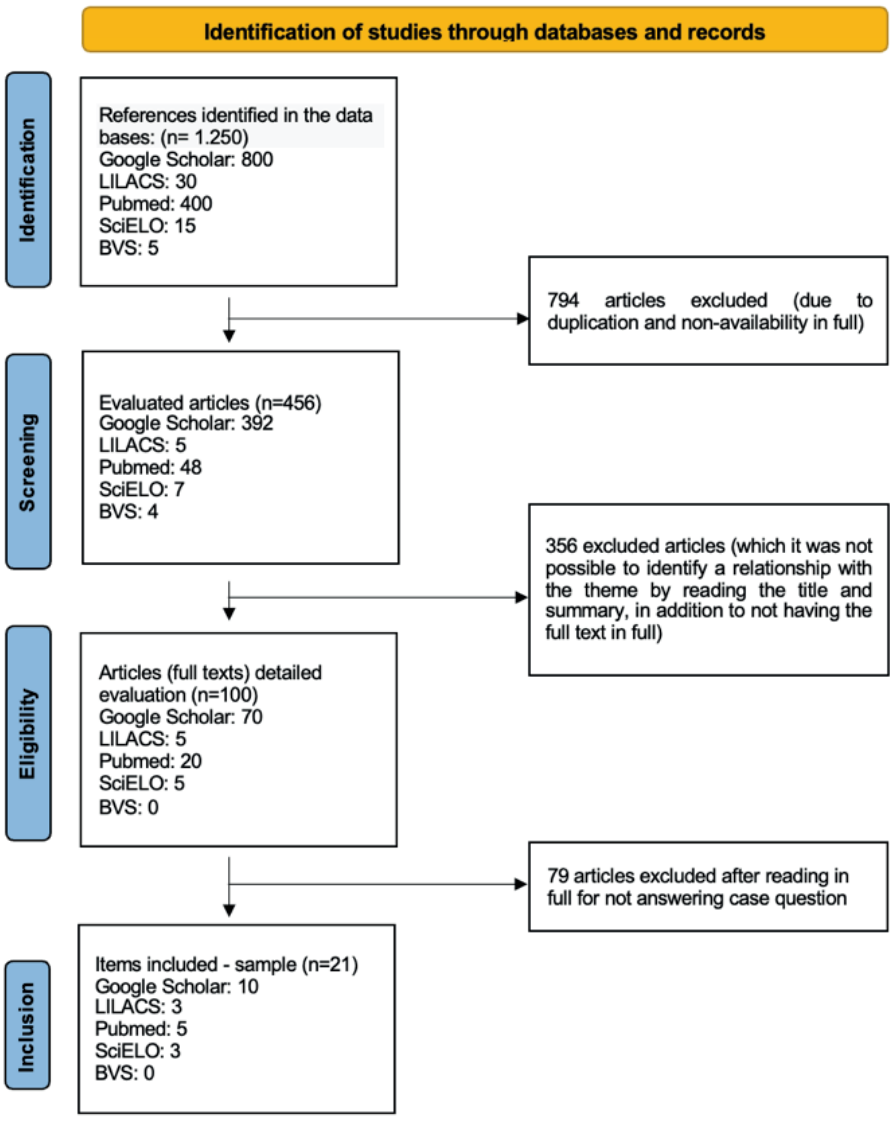
METHODOLOGY

This study is configured as an integrative literature review, with a qualitative approach and exploratory-descriptive character, whose main objective was to identify and analyze scientific publications on the impacts of excessive use of screens on brain neuroplasticity, behavior and social interaction during child development. For this study, excessive use was considered to be daily exposure to digital devices above the recommendations of the Brazilian Society of Pediatrics (SBP, 2023) or the equivalent international guidelines for each age group.

To build the search strategy, we used the Health Sciences Descriptors (DeCS) and their equivalents in the Medical Subject Headings (MeSH), covering Portuguese, English and Spanish. The main terms used were: "neuroplasticity", "screen time", "electronic devices", "child development" and "social behavior". The descriptors were combined using Boolean operators such as AND and OR, allowing for greater comprehensiveness and specificity in the results. An example of the strategy applied was: ("screen time" AND "neuroplasticity" AND "child development") OR ("electronic devices" AND "social behavior").

The searches were carried out in the LILACS, Virtual Health Library (VHL), MEDLINE and PubMed databases. We included studies published between 2013 and 2025, written in any of the three languages mentioned, which directly addressed the effects of the use of electronic devices on brain function, behavioral changes and social consequences at different stages of human development. Articles from before 2013 were excluded, as well as duplicates, incomplete papers, papers unrelated to the central theme or papers that did not provide access to the full text.

The selection process was conducted in three stages: screening titles, reading abstracts and full analysis of eligible texts. After applying



VHL: Virtual Health Library; PubMed: U.S. National Library of Medicine; SciELO: Scientific Electronic Library Online; n: sample number.

Figure 1 - PRISMA flowchart of the search and selection process for the included studies

Authors / Year	Article Title	Main Results	Conclusions
REDDY & REDDY (2025)	Impact of screen time on language development and sleep patterns in children: an observational cohort study	>4h of screen time/day: worse language development and reduced sleep duration; educational content = positive impact.	Excessive screen time impairs language and sleep in children, especially young and low-income children. Supervision and educational content are essential.
HUANG et al. (2024)	Screen brain network development and socio-emotion competence childhood: moderation associations parent-child reading	Early screen time alters brain connectivity and reduces socioemotional competence. reading mitigated the negative effects screen time.	Parental intervention emerges as a significant protective factor. Daily shared reading (>30 minutes) reduces the negative impact of screen time on language acquisition by 45%. Active mediation is a protective factor.

HUTTON et al. (2024)	Digital media and developing brains: concerns and opportunities	Excessive use associated with impairments in language, attention and emotional regulation, as well as poorer academic performance. Adolescence: higher risk of depression.	Moderate use can be positive; excessive use compromises cognition and mental health.
KRACHT et al. (2023)	Association between maternal and infant screentime with child growth and development: a longitudinal study	Screen time increased significantly between 12 and 24 months in both sexes. Early screen time increased BMI in boys and impaired motor skills in girls.	Different effects between the sexes; early reduction is essential for healthy growth.
DE SOUZA et al. (2025)	Screen use in children - two sides of the coin: a critical narrative review	Educational use with mediation: cognitive benefits. Passive and excessive use: linguistic, emotional and physical damage.	Quality of content and supervision are crucial. Public policies and family guidance are urgently needed to promote balanced and healthy use of digital technologies.
COSTA et al. (2025)	Association between early digital exposure and cognitive function in children under six: a meta- analysis	>2h/day: 8.3% impairment in working memory.	Early exposure impairs executive functions. Limiting use improves cognition.
MADIGAN et al. (2020)	Associations between screen use and child language skills: a systematic review and metaanalysis	Heavy use at <3 years: 15% reduction in receptive vocabulary.	Screen time directly affects language development.
TWENGE & CAMPBELL (2018)	Associations between screen time and lower psychological well--being among children and adolescents: evidence from a population-based study	>4h/day: +23% externalizing problems in children.	Excessive exposure affects behavior and psychological wellbeing.
NAGATA et al. (2024)	Screen time and mental health: a prospective analysis of the Adolescent Brain Cognitive Development (ABCD) Study	≥7h/day in adolescents: 2.5x higher risk of depression.	High screen times are associated with a higher prevalence of mental disorders.
LIMA et al. (2024)	Impact of screen time on the cognitive and behavioral development of preschool children	70% of preschool children exceed the recommended time. Associated with sleep, attention and emotional regulation disorders.	High digital exposure compromises overall development at preschool age.
DUCH et al. (2013)	Screen time use in children under 3 years old: a systematic review of correlates	Children with <1h/day showed 17% more social skills.	Low digital exposure favors positive social interaction.
VASCONCELO S et al. (2023)	The impact of excessive screen use on children's neuropsychomot or development: a systematic review	Excessive use reduced family interaction time by up to 28%.	Excessive screen use harms coexistence and family bonds.
KABALI et al. (2015)	Exposure and use of mobile media by young children	86% of children <3 years old use devices daily; average of 1h/day.	Widespread early use requires attention from caregivers.
BARRETO et al. (2023)	The impacts of screen time on child development	Excessive screen use in children aged 0-6 is associated with impaired cognitive, motor, social and emotional development, as well as promoting sleep disorders, irregular eating, sedentary lifestyles and increased risk of chronic diseases; parental supervision is key to healthy child development.	Excessive exposure harmful, moderate use with supervision can be beneficial.
ALVES et al. (2025)	The impact of screen use on child development: a literature review	Reported motor, cognitive and social impairments with prolonged screen time.	Excessive use compromises multiple areas of development.

Table 2. Summary of the main studies on the effects of screen time on child development

Source: prepared by the authors

the inclusion and exclusion criteria, 21 articles were selected to make up the final corpus of the analysis; however, only 15 of the 21 articles selected were explored further as they presented the most significant results for the study. The search and selection process is represented in the PRISMA flowchart (Figure 1).

Although the study adopted a qualitative approach, data analysis followed the principles of thematic analysis, allowing the findings to be categorized into three main axes: neuropsychological impacts (involving memory, attention, language and emotional regulation), behavioural and socio-emotional changes (such as aggression, impulsivity, anxiety and socialization difficulties), and moderating factors (including parental mediation, type of content consumed and family context). Although no formal methodological quality assessment tool was used, such as the GRADE or Jadad score, the scientific relevance, theoretical coherence and methodological clarity of each study included were taken into account.

This approach allowed for the construction of a critical and comprehensive synthesis, capable of deepening the understanding of the effects of excessive digital exposure in childhood and adolescence, especially with regard to neuroplasticity, behavior and social interaction skills.

RESULTS

A systematic analysis of recent studies on the effects of screen time on child development reveals consistent patterns that deserve special attention. As shown in the research compiled in Table 2, the impacts of digital exposure vary significantly according to the duration of use, the age group and the quality of the content consumed. The findings converge in pointing out that excessive use of electronic devices is associated with damage in multiple areas of development, from neurocognitive alterations to compromises in social and emotional skills. However, it is important to note that the studies also identified moderating factors that can mitigate these effects, particularly active parental mediation and careful selection of educational content.

The findings converge in indicating that excessive use of electronic devices is associated with damage in multiple areas of child development. In the neurocognitive field, exposure of more than 2 hours a day is correlated with impaired executive functions (COSTA et al., 2025), delayed language development (MADIGAN et al., 2020) and changes in the organization of neural networks (HUANG et al., 2024). These effects seem to be more pronounced in children under the age of three, a crucial period for brain plasticity (KABALI et al., 2015; DUCH et al., 2013).

In the psychosocial domain, excessive screen time is related to behavioral problems, such as an increase in externalizing symptoms (TWENGE & CAMPBELL, 2018), a higher risk of mental disorders in adolescence (NAGATA et al., 2024), as well as compromising the quality of interaction and family ties (VASCONCELOS et al., 2023). The negative impact on sleep, evidenced by Reddy & Reddy (2025), and the association with sedentary lifestyles and obesity (KRACHT et al., 2023; BARRETO et al., 2023) reinforce the multifactorial nature of the consequences of inappropriate screen use.

A relevant aspect that emerges from the analysis is the crucial role of parental mediation. As demonstrated by Huang et al. (2024) and Barreto et al. (2023), practices such as shared reading and active supervision can significantly reduce the negative impacts of screen time. Furthermore, the distinction between educational and recreational uses (DE SOUZA et al., 2025) suggests that the quality of the content consumed is just as important as the amount of time spent with digital devices.

These findings have important implications for parents, educators and public policy makers. The finding that 70% of pre-school children already exceed screen time recommendations (LIMA et al., 2024) reinforces the urgent need for effective strategies to promote a more balanced use of digital technologies in childhood. At the same time, the positive results associated with moderate and supervised use suggest that, when properly employed, digital technologies can be incorporated in a beneficial way into children's development.

DISCUSSION

The results of this study show a multifaceted reality regarding the effects of digital exposure on child development, highlighting three central axes: neuropsychological impacts, behavioral and socio-emotional changes, and moderating factors that influence these effects. Despite the complexity of child and adolescent development, which is marked by multiple biopsychosocial interactions, the data analyzed indicates consistent associations between excessive screen use and damage in various areas that are essential for a child's healthy growth.

In the neurobiological field, robust evidence points to structural and functional changes induced by prolonged exposure to digital devices. Huang et al. (2024) and Costa et al. (2025) show that use of screens for more than two hours a day is associated with a significant decrease in frontal white matter density and a reduction in working memory of approximately 8.3%, suggesting interference in neuroplasticity during critical periods of brain development. These observations are supported by the Fernandes Figueira Institute (2019), which highlights the sensitive window of plasticity in the first years of life. In addition, the fact that 86% of children under the age of three already use digital devices on a daily basis (KABALI et al., 2015) reinforces the magnitude and urgency of the issue, especially given the vulnerability of the developing brain and the need for diverse and rich stimuli for healthy neural organization.

At the behavioral and emotional level, the literature reviewed supports a doseresponse relationship between screen time and an increase in behavioral problems, including aggression, impulsivity, anxiety and externalizing symptoms (TWENGE & CAMPBELL, 2018; NAGATA et al., 2024). The increased prevalence of mental disorders in adolescents exposed to more than seven hours of screen time a day (NAGATA et al., 2024) reinforces the potential negative impact in the medium and long term. The finding that 70% of pre-school children already exceed screen time recommendations (LIMA et al., 2024) configures this issue as a public health emergency. The mechanisms underlying these negative effects may include both sleep dysregulation (KRACHT et al., 2023; REDDY & REDDY, 2025), a factor known to affect mood and attention, and overstimulation of the brain's reward system, possibly aggravating addictive and impulsive behaviors (KARAKOSE et al., 2022).

The social dimension cannot be neglected. Although digital technologies are often promoted as facilitators of socialization, the findings of Duch et al. (2013) and Vasconcelos et al. (2023) point to a paradox: excessive use is related to a reduction in face-to-face interactions and impaired development of fundamental social skills, such as empathy, communication and emotional self-regulation. In a world increasingly mediated by screens, this data draws attention to the need to balance access to technology with real opportunities for direct human interaction, which is essential for healthy socio-emotional development.

It is important to emphasize that the problem does not lie in the technology itself, but in the way and context in which it is used.

Studies indicate that active parental mediation and the use of educational content can substantially mitigate the negative impacts of screen time. Huang et al. (2024) showed that daily shared reading reduces language impairment by up to 45%, demonstrating the power of quality human interactions. De Souza et al. (2025) reinforce that passive and decontextualized use is linked to damage, while intentional and supervised use can promote cognitive benefits. These guidelines are in line with the recommendations of the Brazilian Society of Pediatrics (2023), which emphasize the importance of supervision and family mediation for balanced and healthy use.

It is important to highlight the inherent limitations of the studies reviewed, such as the predominance of correlational designs, which restrict direct causal inference, and methodological heterogeneity, especially in terms of measuring the time and quality of screen use. These aspects indicate the urgent need for longitudinal research with standardized protocols, capable of clarifying the causal mechanisms and longterm effects of digital use in childhood.

In view of the evidence gathered, we recommend the development of public policies that promote the conscious and responsible use of digital technologies, aligned with educational programs for families, emphasizing parental mediation and the importance of appropriate content. In addition, there is room for initiatives that encourage fundamental complementary activities, such as outdoor play, shared reading and face-to-face social interactions.

In summary, the findings of this study reinforce the need to seek a balance between the benefits and risks of digital technologies in childhood. Moderate, supervised and intentional use can be an ally in child development, while excessive and unmediated exposure poses substantial risks, especially in the most sensitive periods of brain plasticity. It is therefore up to families, educators, health professionals and public policymakers to act in a coordinated way to enhance the educational potential of technologies, without neglecting the irreplaceable role of concrete experiences and human interactions in the child's growth and learning process.

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