

Review Article

EFFECTS OF EXCESSIVE SCREEN TIME EXPOSURE ON NEUROPSYCHOMOTOR DEVELOPMENT: A SCOPING REVIEW

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ABSTRACT

Modernity and the technological advance present in the 21st century, are characterized by the constant kids' use of screens, through smartphones, tablets, televisions or computers, a situation that increases the infants' exposure to these digital media. Therefore, the objective of the present study is comprehending the effect of the use of screens in the childhood and the impacts caused on the child neuropsychomotor development. Regarding the methodology, it is an integrative literature review, elaborated through researches in May 2022, utilizing the virtual database U.S National Library of Medicine (PUBMED), with the following keywords: "screen time" AND "child performance" AND "development", in the time range from 2010 to 2022. From 371 found articles, 42 were relevant for the present study and were selected according to the title, authorship/ publishing year, publishing journal and method utilized in the study. Literature review was executed regarding the association between screen exposure and the damage of the language, communication skills, sleep disturbances, cognitive deficits, higher risk of obesity, sedentary lifestyle and psychological difficulties. It was verified that not every child is influenced in the same way by the time spent in front of screens, since the social and the family context have great relevance in this aspect. It is of extreme importance that the recommendations about the adequate time of screen use by the children are followed and that this usage is, predominantly, executed with interactive and supervised content, to guarantee that the accessed content is compatible with the age group of the child in question.

Keywords: Screen Time, Neurodevelopment, Child Development.

INTRODUCTION

The pandemic declared in March, 11 2020 by the World Health Organization (WHO), due to the SARS-CoV-2 virus, which causes COVID-19, spread in a very fast pattern around the globe and caused numerous changes in the life of the world's population, highlighting the necessary and abrupt adaptation to the social distancing (1). This distancing of every convivial sphere, necessary tool to control the contagion rates of the new coronavirus (SARS-CoV-2), affected in a significant way the interpersonal relationships, fact that induced the population to search, aiming to get rid of the feeling of loneliness, distraction alternatives (2). Certainly, due to the experienced pandemic circumstances, the use of digital devices increased globally 266% (3), becoming indispensable before the use of social media, executing online classes and virtual medical consultations (4). Therefore, the present scenario prolongs the individuals' contact with the direct light of screens, a fact that can have multiple negative repercussions in the physical and mental health of the infants (5). In particular, the experiences experienced by children are important, vulnerable beings that need active and constant stimuli for the complete formation of their cognitive and motor development that, inevitably, were affected with the interruption of the presential school life, deprivation of circulating places and the decrease of the convivial

cycle (6). The constant technological evolution, responsible for eliminating physical barriers so that social connections happen through digital means, mainly during the social isolation period, reflect a dichotomy between the commodity brought by the technologic means in the school, leisure and entertainment areas and the difficulty to impose usage limits for those that are still in child development phases and that need to practice and dominate interpersonal, motor and communication abilities outside the screens (7). However, the lack of control of the children's exposition to screens, leads to some damages, mainly because it reduces interactions between the infant and its parents, family and caregivers, making this bond fragile due to the increased exposition to digital content, situation observed when problems in the development of language, attention and capacity of dealing with boundaries are described, limiting the diversity of stimuli and feelings (8). Furthermore, besides the direct damages to the health, the association between excessive screen time with the neurodevelopment reflects a tendency related to the content to which the infants are exposed, such as contents that lead to triggers regarding food, sleep, suicide, use of drugs, offensive messages (cyberbullying) and access to photos or videos with sexual content (7), which can lead to mental disorders, such as anxiety, depression and psychic suffering (9). Through the combination of the pandemic context and the technological advances, the progressive increase of children's exposure to screens is evident, incorporated as a life habit in different age groups and social contexts (41). One of the propellant factors of such change is, for example, the deprivation of stimuli and games in the open air for children, giving them more time in the domestic environment and exposed to computers, tablets,

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Smartphone's and televisions screens (5). Furthermore, such exposition, when excessive, leads to the infants' internet dependance, which damages study strategies and neuropsychomotor development (10). However, the number of children and adolescents that develop obesity is increasing with the excessive use of online content (11,12,45). The child development happens faster in the first 5 (five) years of life and, during this growth and maturation period, the screen time accessed by children influences their neuropsychomotor development, affecting the ability of developing ideally, since important opportunities to practice and master interpersonal, motor and communication abilities can be lost (13). In the United States, 2017, about 45% of the children, between 0 (zero) and 8 (eight) years old, had their own smart phone, having this percentage increased exponentially since 2011 (14). Furthermore, as presented by the researchers, there is not a difference between the screen time spent by girls and boys of the same age. However, differences regarding race, social class and parents' schooling are reported, demonstrating that white children of higher social class and with parents that have good schooling spend less time in front of screens and in families that are deficient in functional terms, for example, families with low income or father/mother without a partner, are prone to increased media use (15,16). Therefore, the development of children associated with the screen time is connected to numerous personal and contextual factors, including family income, maternal depression, child sleep, reading regularly for the kid and the sex (17). Furthermore, not all children are equally influenced by screen time, which highlights the possibility that there are factors that soften the negative effects of this exposition on the infant's development (18). Thus, this literature

review aims to discuss and contribute for a better comprehension of the association between the children's exposure to screens and their neuropsychomotor development, describing the impacts of the prolonged use of these devices.

METHODS

This article presents a descriptive literature review based on the analysis of scientific articles published between 2010 and 2022 in PubMed. The used keywords were "child neurodevelopment" "pandemic" "Covid-19" "screen use" "neuropsychomotor delay" "interactive media" "screen time" "child development" " digital devices" "infant delay of interpersonal abilities" "electronic device dependence". The utilized terminologies are in agreement with the system Health Science Descriptors (DeCS). The data research was executed from September 2022 to August 2023 through journals online. Later on, the materials were selected utilizing the following inclusion criteria: subject approach, publishing data between 2010 and 2022, articles fully available and/or abstract, and studies in humans. We restricted our search to studies written in English. To guarantee the saturation of the content, the authors reviewed the references from the included studies and relevant reviews about the theme to identify absent publications. The authors participated in each phase of the revision (Eligibility, Triage and Inclusion), selecting the articles that matched the criteria of selection cited above. The studies' results are summed up in a narrative way in each section of this review.

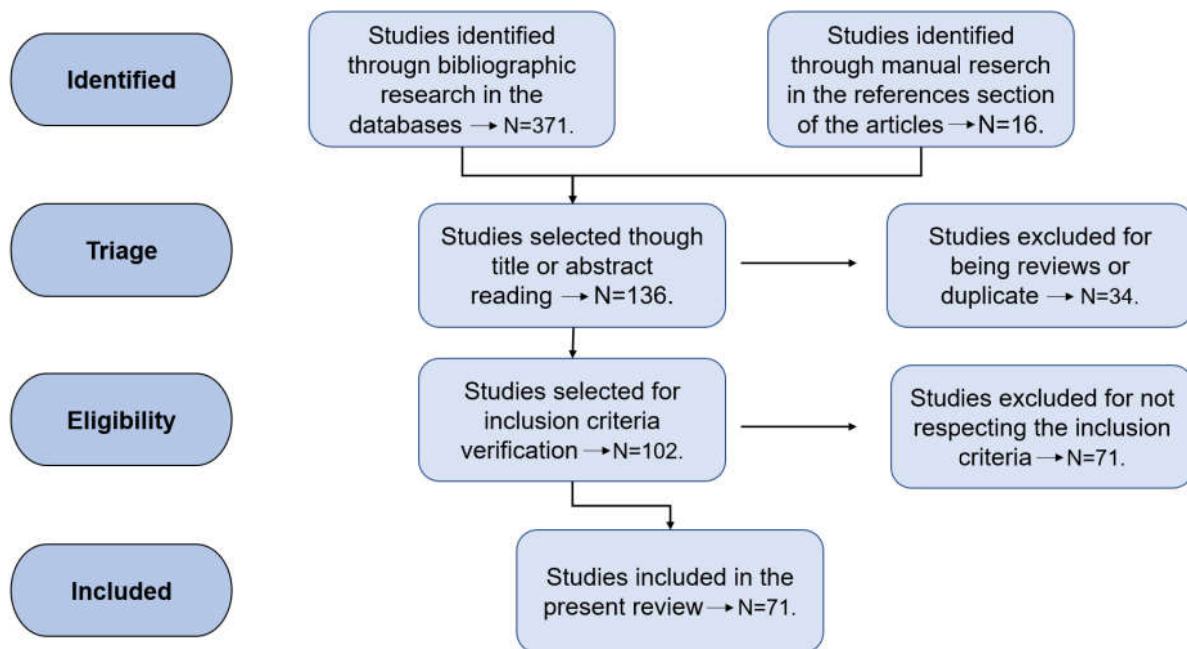


Figure 1. Articles addressing screen time exposure and neuropsychomotor development delay.

NEURODEVELOPMENTAL EFFECTS OF EXCESSIVE SCREEN TIME EXPOSURE

Evidence suggests that the chronic sensorial stimulation through excessive exposure to screen time can affect the brain development in a negative way. The excessive use of smartphones can increase the risk of cognitive, behavioral and emotional disorders in adolescents and young adults, which also has the potential of increasing the risk of premature dementia in late adulthood. The general increase of screen time is associated with negative results, such as low self-esteem, increase in the incidence and severity of

mental health problems and addictions, slow apprenticeship and acquisition of knowledge, and an increased risk of premature cognitive decline (19). Besides, studies prove that the autism spectrum disorder (AED) is associated with congenital factors, such as genomic mutations and prenatal, perinatal and neonatal risk factors. Furthermore, abnormalities in the morphology and in brain function have been observed in children with autism since the first childhood. In studies executed in 2019 and 2020, it was reported that, as a postnatal environment factor, the duration of screen time can be associated with characteristics of AED (43). However, studies demonstrate that the increase of audiovisual materials disponibility

and the visualization practices of babies are parallel to the period of growth in the prevalence of autism spectrum disorder (AED). An association between AED and the increase of exposure to the cable/TC screen in the childhood is demonstrated, suggesting that the exposure to audiovisual materials in the childhood is a possible contributing cause of AED (44). In 2019, the World Health Organization published guidelines about healthy physical activity, sedentary behavior and sleep in children younger than 5 years old, claiming that children should not be exposed to screens when they are 1 year old or younger. The American Academy of Pediatrics also recommended that children are not exposed to screens until 18 months of age; alerts about the adverse effects of screen exposure about children's health were issued (20). Furthermore, the precocious and prolonged exposure to violent content is also linked to the risk of antisocial behavior and the decrease of the prosocial behavior. Psychoneurological effects: the addicting screen time use diminishes the social confrontation and involves desire behavior that is similar to the substance dependent behavior (21). Thus, it is possible to notice that the excessive time of access to these contents can, also, present risks to the children's mental health, leading to mental and behavioral

disorders, such as depression, anxiety and psychic suffering (22). Brain structural changes related to cognitive control and emotional regulation are associated with the addictive behavior to social media. A case study about a treatment of a 9 year old boy diagnosed with attention deficit hyperactivity disorder (ADHD) implies that the behavior associated with ADHD influenced by the screen time can be incorrectly diagnosed as ADHD. The reduction of the screen time is efficient in the decrease of the behavior associated with the disorder in question (21). The attention deficit hyperactivity disorder (ADHD) is a disorder of the neurodevelopment characterized by symptoms of lack of attention and hyperactivity/ impulsiveness beginning prematurely in childhood and adolescence. Children in the general population can present numerous symptoms of ADHD (attention problems, hyperactivity and impulsiveness) continuously. Such behavior is referred to as behavior related to ADHD and is associated with screen time (21). Lastly, researches constantly executed come to conclusions in common, associating, indeed, the excessive screen time with problems in fulfilling development milestones for motor abilities, space-time abilities, resolution of problems and language acquisition (12).

Association of factors that evidence the relation between the excessive screen time and the development	Study	Authors	Year	Relevance
Exacerbated screen use and obesity	Screen Media Exposure and Obesity in Children and Adolescents	Thomas N Robinson, Jorge A Banda, Lauren Hale, Amy Shirong Lu, Frances Fleming-Milici, Sandra L Calvert, Ellen Wartella	2017	The exposure to screen media leads to obesity through the increase in the intake of food during the visualization and exposure to the marketing of food and beverages high in calories and low in nutrients.
Exacerbated screen use and sleep impacts	Digital Media and Sleep in Childhood and Adolescence. Pediatrics.	Monique K LeBourgeois, Lauren Hale, Anne-Marie Chang, Lameese D Akacem, Hawley E Montgomery-Downs, Orfeu M Buxton	2017	The wear in screens replaces the time spent sleeping. That said, the effects of the light emitted by devices in the circadian time are factors that associate the consumption of digital devices and the sleep health.
Exacerbated screen use and Attention Deficit Hyperactivity Disorder (ADHD).	Adverse physiological effects of screen time on children and adolescents: Literature review and case study	Gadi Lissak	2018	The excessive use of digital media by children and adolescents appears as an important factor that can complicate the formation of the audio psychophysiological resilience, that being, the non wandering mind, typical in the behavior associated with ADHD.
Exacerbated screen use and language development	Associations Between Children's Media Use and Language and Literacy Skills	Rebecca A Dore, Jessica Logan , Tzu-Jung Lin,, Kelly M Purtell, Laura M Justice	2020	The use of media can replace other literacy activities, such as shared reading, and lessen the quantity and the quality of the interaction between children and caregivers.
Exacerbated screen use and autism	Causation of autism: Audiovisual brain specialization in infancy competes with social brain networks	Karen Frankel Haffler, , Leonard M Oestriche	2016	The increase in the availability of audiovisual materials and the visualization practices of babies are parallel to the period of increased prevalence of autism spectrum disorder (ASD).

SCREEN TIME EFFECTS ON SOCIAL COMMUNICATION SKILLS

Scientific evidence demonstrates that the frequent use of digital technology has a significant impact on the brain's function and behavior. The potential harmful effects of the prolonged use of screens and technology include increase in the symptoms of attention deficit, damaged emotional and social intelligence, technology addiction, social isolation, damaged brain development and interrupted sleep (23). There is evidence that the screen exposure to children of 12, 18 and 36 months are related to non-social behavioral characteristics at 54 months. Screen time in early childhood has negative influences in social abilities (24). The recent increase in the use of digital devices by children raised concerns that the screen time will substitute face-to-face interaction and, therefore, damage the development of the emotions' comprehension by children. A study performed with Norwegian children revealed that an increased screen time at 4 years old predicted lower levels of emotional comprehension at 6 years old. Besides, the television in the children's room at 6 years old predicted lower levels of emotional comprehension at 8 years old (25). Otherwise, the excessive screen time or the precocious exposure to screens is associated with lack of attention, lack of behavioral control, delay in the language and executive function deficit (26).

ASSOCIATION BETWEEN SCREEN USE AND CHILDREN'S LANGUAGE SKILLS

The development of the language abilities in children is greatly influenced by the immediate environment in which they are inserted, this being the domestic environment, usually habited by parents, brothers and relatives. In that regard, with the growing technological revolution, screens became a part of this domestic environment, playing an important role in the time spent by infants, especially in front of television devices (27). Studies show evidence that this precocious and/or exceeding exposure to screens can lead to a child cognitive development below the expected for the age gap in question, and the effects can vary according to the digital content and family context that the child is exposed to (12). As an example, research has shown that interactive and quality content, as well as the company of an adult to share the experience when exposing the infant to screens, can benefit the child, mainly when it comes to language development (28). The exponential growth of screen time use by children, strongly influenced by the technological adhesion present in the 21st century, plays an important role in the child neuropsychomotor development, specially when it comes to the language process and literacy, revealing a damaging aspect in the evolution of such competences, since the exposure to screens can consume the time that should be spent in activities as shared reading, replacing the quality and interpersonal interaction time of stimuli between the caregiver and the child (29). There are reports, based on studies performed in the United States, in a sample comparing 4-year-old children, which quantify the fact that the greater the time spent watching television by children is associated with a decreased time dedicated to reading books amongst parents and children, which can lead to occasional language deficit (30). The daily exposure to screens is frequently associated with a delay in the language development in children, being this factor related to the used screen size, the type of screen, time spent and language variations (27). Otherwise, although it has a certain type of stimulus to language development through the consumed content via screens, such as dialogues in animations and digital texts, researches have shown that the infant exposition to verbal interaction, through questioning and dialogue, is strongly associated with the improvement of the necessary subsides so these can transmit important information and express in the most unequivocal way, suggesting that with the

decrease of this kind of interaction, children will lack a certain type of language (5,6). In any case it is necessary to highlight that studies also indicate that the moderate use of media that allow the screen touch and the child's interaction with its content and, also, those content that are watched with an adult beside, as a mediator, can positively contribute to the child's language development (7). There is still research that states that children's language can be equally well stimulated by well projected e-books. However, digital books that have sounds, animations and games, can cause distractions and reduce the expected learning (8). That being said, studies report that the exposure time to screens should be limited, following the recommendation that children below 2 years old do not use digital devices and that children from 2 to 5 years old use screens for, at most, an hour a day, with educative content that is age compatible, besides, the supervision of an adult is important (42).

SCREEN TIME AND SLEEP

The health risks associated with the excessive use of digital devices (computers, Smartphone, tablets, consoles etc) are negatively associated with the daily performance and the sleep quality, essential factors in the development of young people. The sleep becomes irregular, shortened and delayed in relation to its late beginning and the precocious awakening due to the school activities in the weekdays, which results in rhythm desynchronization and sleep privation. Evidence points that the excessive use of screens in the night time changes the nocturnal chronotype and experiences a misalignment between the social and biological rhythms, which, along with the sleep deprivations, results in fatigue, daytime sleepiness, behavioral problems and low academic performance (35). Besides, studies show that in children with epilepsy, the daily exposure to screen time is higher and the sleep duration is lesser than the recommended quantity, with greater exposure to screen time associated with sleep disturbances (36). In the last few years, screen time has become a more complicated concept, with an increasing variety of electronic media devices available in the whole world. Television continues to be the predominant type of screen based activity amongst children. However, the use of computers, video games and the ownership of devices, such as tablets and smartphones, has been happening since a progressively younger age (12). The children are becoming less physically active as the opportunities to play secure active games, recreational activities and active transport diminish. At the same time, sedentary activities based on screens, during school and leisure, are increasing, which reflects in the night period, when they should be prepared to sleep (37). Furthermore, the time dislocation, in other words, the time spent on screens replaces the time spent sleeping and in other activities, the psychological stimulation based on media content, the effects of the light emitted by devices in the circadian time, are factors that associate the digital device consumption and the sleep health, mainly through the delay in sleep time and the reduction of the total duration of sleep (38). Therefore, the increase in screen time was associated with later sleeping time and lesser time duration. Adverse associations were found associating the sleep quality with the excessive exposure to screens. Attention should be given to the promotion of balanced screen usage and regular sleeping habits in children (39). There are still present studies that describe the need of parents, doctors and educators to incentivize behaviors of sleep promotion in minors, although the physical activity and the games in open air, in particular, have been favorably associated with most of the sleep results in small children and preschoolers (40).

CONCLUSION

In that sense, although there are benefits attached to the use of screens, when utilized excessively, numerous negative effects are verified in children, such as sedentary lifestyle, obesity, depression, anxiety, metabolic and cardiovascular diseases, language and communication deficit and deregulation of the sleep circadian cycle. Furthermore, not every children is influenced the same way by the time spent in front of screens, because the social and family context have great repercussion in this analysis, besides aggregated factors, such as the child's sex, family income, parents' civil state, maternal depression, amongst others. However, the use of screens is not completely doomed, since perspectives that reduce the negative consequences were reported, when orientating the use of screens in a controlled and interactive way. Therefore, it is concluded that the excessive screen time usage has negative perspectives, evidenced since the exposure to improper content, until the decrease of social interactions, and that is the reason why the use of screens should be controlled and limited.

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Conflict of interest

The authors declare that they have no conflicts of interest. All authors read and approved the final manuscript.

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