

Impact of screen exposure during pediatric ages including multifaceted aggravating factors: a literature review

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Technological devices with screens—such as computers, smartphones, tablets, video game consoles, and televisions—have become essential in daily life, especially among the pediatric population. This widespread use has significant effects on their physical and mental health, prompting the development of guidelines for appropriate screen use based on age group. In this context, we conducted a narrative review to assess the impact of screen devices on this population, exploring how specific genes and their polymorphisms may act as risk factors for these effects. A systematic literature search was performed to evaluate the clinical and genetic impact of screen exposure, focusing on outcomes such as obesity and overweight, sedentary behavior, depression and anxiety, myopia, behavioral disorders, and sleep and memory disturbances. The findings indicate that screen exposure exceeding 2 hours per day is associated with these outcomes, with the strongest evidence supporting links to obesity and sedentary behavior. Additionally, polymorphisms in genes such as *FTO*, *CACNAID*, and *DRD2* were found to influence these outcomes. Overall, the evidence suggests that excessive screen use during childhood is associated with numerous adverse physical and mental health conditions. There is a significant relationship between screen time and increased risk of overweight and obesity, as well as sleep disturbances due to reduced resting hours. Strategies are urgently needed to mitigate these impacts in the pediatric population.

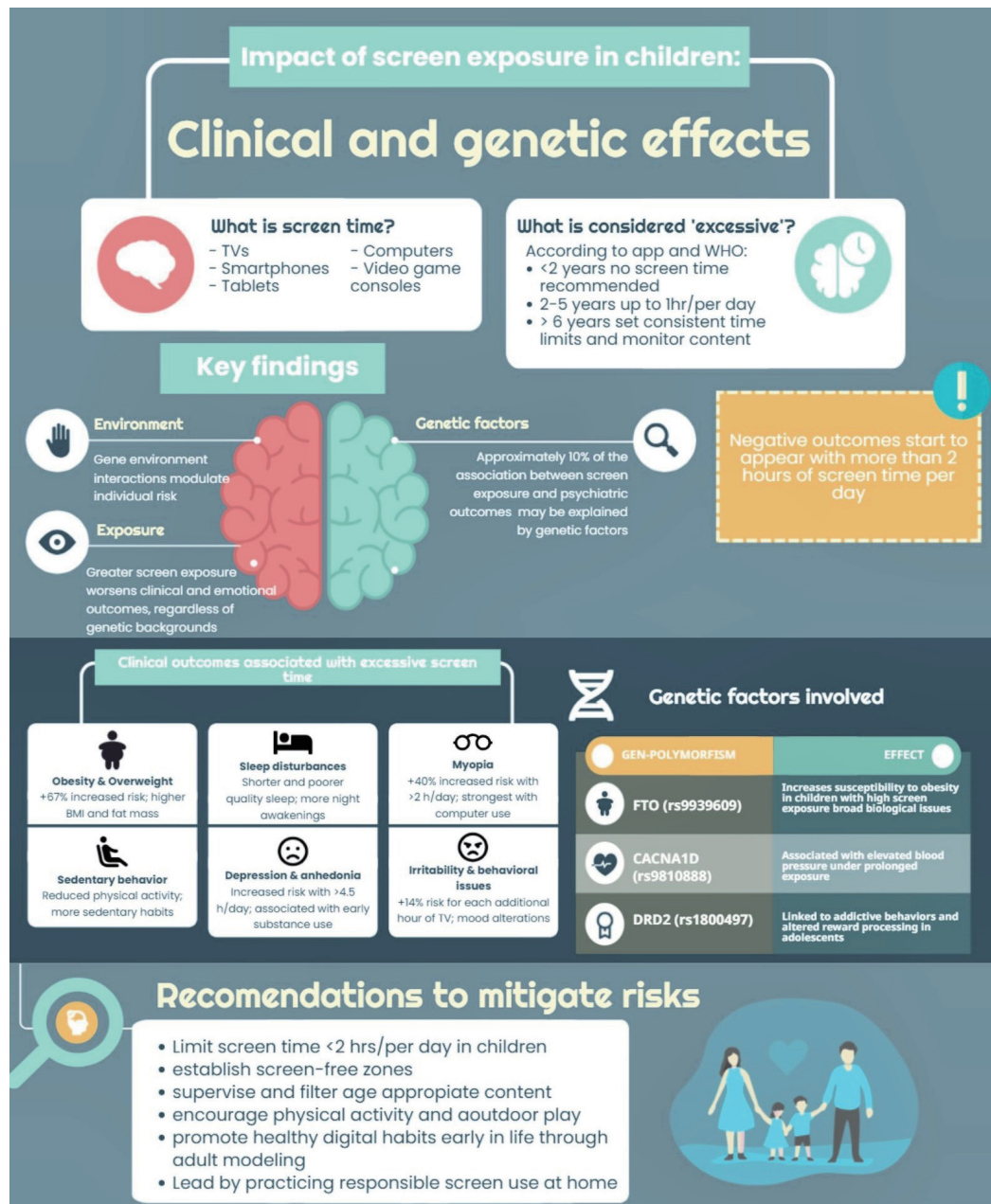
Key words: Screen time, Pediatrics, Clinical effects, Genetic effects

Key message

Excessive screen time in children is linked to obesity, overweight, sedentary behavior, depression and mood disorders, myopia, behavioral changes, sleep disturbances, attention deficit hyperactivity disorder, among others. Polymorphisms in genes like *FTO*, *CACNAID*, and *DRD2* could further increase these risks. Implementing strategies such as limiting screen use, creating screen-free zones, and monitoring content is essential to mitigate adverse physical and mental health effects in the pediatric population.

Introduction

Screen time refers to all electronic devices, including computers, smartphones, tablets, video game consoles, and televisions. Over the past decade, technological advancements have exponentially increased screen time worldwide. One of the most deeply affected groups is the pediatric population, which includes individuals from 0 to 18 years of age.¹⁾ Consequently, research on the effects of screen exposure on this population has intensified, particularly regarding its short-, medium-, and long-term impacts, classifying it as a public health concern.²⁾ The American Academy of Pediatrics (AAP) recommends creating a family media consumption plan that considers the health, educational, and entertainment needs of all family members. Specifically, the AAP advises limiting screen exposure based on age groups: for children under 18 months, screen time should be avoided; for those aged 2 to 5 years, it should be limited to 1 hour per day; and for children over 6 years, setting boundaries on both the duration and



Graphical abstract

type of content is essential.³⁾ Following these guidelines is crucial because technology, when used appropriately and responsibly, can promote healthy psychosocial and educational development in pediatric populations. However, there is no clear consensus in the literature, and the AAP does not provide a specific definition of what constitutes prolonged screen exposure. Therefore, for this review, any screen time that exceeds the limits outlined in the AAP's recommendations is considered prolonged. To mitigate the adverse effects of prolonged screen exposure, the World Health Organization adds further recommendations: establishing screen-free zones (e.g., bedrooms), creating screen-free times (such as upon waking), monitoring commonly used content like video games

or apps, and implementing supervision programs for social media content and contacts.⁴⁾ These measures aim to foster responsible technology use.⁵⁾ This paper aims to review the literature on the clinical impacts and genetic factors associated with prolonged screen exposure in the pediatric population.

Materials and methods

A systematic literature search focused on the impact of prolonged screen exposure in the pediatric population. The research question was formulated using the PICO strategy (Problem, Intervention, Comparison, and Out

come): *In the pediatric population, what are the clinical and genetic effects of prolonged screen exposure compared to populations without such exposure?* For this review, screen time encompassed electronic devices such as computers, smartphones, tablets, video game consoles, and televisions. Digital research databases, including PubMed, MEDLINE, and LILACS, were consulted. The inclusion criteria were as follows: (1) studies involving pediatric populations aged 18 years or younger, (2) screen time measured in hours per day, (3) studies including both boys and girls, (4) publications with both unrestricted (open access) and restricted (paywalled) availability, (5) meta-analyses, systematic reviews, clinical trials, and analytical studies (cohort, case-control), (6) articles published in English or Spanish, (7) publications between January 2014 and August 2024. On the other hand, the exclusion criteria were as follows: (1) case reports, case series, letters to the editor, conference posters, and review articles due to their observational nature, (2) studies involving populations with pre-existing conditions, (3) articles focusing on coronavirus disease 2019 as a study variable, (4) articles not addressing the impact of prolonged screen exposure on pediatric populations or its relationship with clinical and genetic characteristics. The search terms were: ((“Obesity”[MeSH] OR “Overweight”[MeSH]) OR (“Sedentary Behavior”[MeSH] OR “Exercise”[MeSH]) OR (“Depression”[MeSH] OR (“Myopia”[MeSH] OR (“Irritability Mood Symptoms”[MeSH] OR (“Sleep”[MeSH] OR (“Anxiety”[MeSH] OR (“Memory”[MeSH] OR (“Behavior, Addictive”[MeSH] OR (“Bullying”[MeSH] OR (“Attention Deficit Disorder with Hyperactivity”[MeSH] OR (“Neurodevelopmental Disorders”[MeSH] OR (“Headache”[MeSH] OR (“polymorphism”[MeSH] OR (“genetic

factors”[MeSH]) AND (“Screen time”[MeSH]) AND (allchild [Filter]) AND (systematicreview [Filter] OR meta-analysis [Filter] OR randomizedcontrolledtrial [Filter]) AND (y_10 [Filter]) AND (ffrft [Filter])). The search yielded a total of 7,283 articles. Titles and abstracts were reviewed, leading to the exclusion of 5,876 publications and 931 duplicates, resulting in 476 articles. Subsequently, 2 reviewers assessed the full texts, identifying a total of 31 articles, as shown in Fig. 1.

Discussion

The outcomes with the most evidence were organized from the highest to the lowest number of publications based on the harmful effects of screen exposure over time in the pediatric population. These outcomes include: obesity and overweight, sedentary behavior, depression and anxiety, myopia, behavioral disturbances, and sleep disturbances. The relationship between each of these outcomes and screen exposure is presented in Table 1. The analysis and discussion of the effects are presented in order of frequency, from most to least, based on the literature found, as described in the materials and methods.

1. Obesity and overweight

A systematic review analyzing 40 articles found that a significant number of the studies reviewed indicated an 11% increased risk (odds ratio [OR], 1.766; 95% confidence interval [CI], 1.104–2.562, $P=0.0001$) between screen time and increased adiposity, body mass index (BMI), abdominal circumference, and body fat percentage.⁶⁾ Another

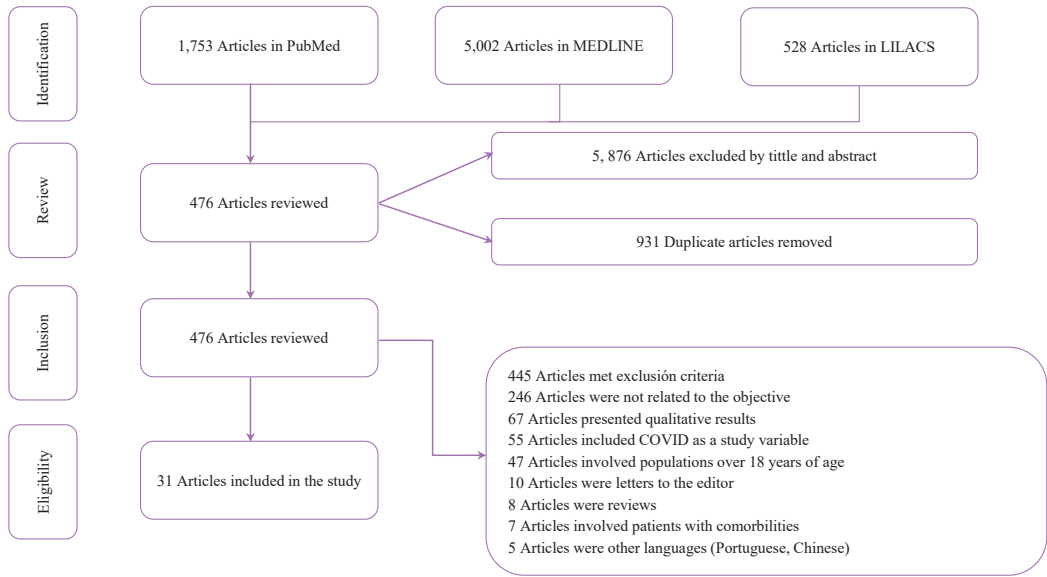


Fig. 1. Search strategy flowchart. COVID, coronavirus disease.

Table 1. Outcomes associated with screen time. The studies found and the variables analyzed are shown

Outcome	Author	Year	Total population	No. of studies	Value of the association measure	Confidence interval	P value
Obesity	Miguel-Berges et al. ⁽⁶⁾	2023	718	-	OR=2.515	1.171–3.021	<0.05
	Zhang et al. ⁽¹⁷⁾	2022	Not specified	89	OR=1.67	1.48–1.88	<0.05
					OR=1.47	1.33–1.62	
	Li et al. ⁽²⁾	2020	Not specified	6	OR=1.872	1.678–2.088	<0.001
				10	OR=1.262	1.155–1.379	
				6	OR=1.988	1.445–2.735	
	Fang et al. ⁽⁷⁾	2019	Not specified	16	OR=1.67	1.48–1.88	<0.0001
	Stiglic and Viner ⁽¹⁾	2018	Not specified	13	OR=2.05	1.13–3.73	0.02
Sedentarism (or sedentary lifestyle)	Sequi-Domínguez et al. ⁽⁸⁾	2024	2.840	20	SD=-26.2	-31.06 to -21.34	-
	Feng et al. ⁽¹⁰⁾	2024	147	-	OR=3.41	0.07–6.76	0.05
	Jiang et al. ⁽⁹⁾	2023	349	-	β =-2.07	-3.94 to -0.19	0.04
	Saunders et al. ⁽¹¹⁾	2022	239.267	42	β =-0.04	-0.05 to -0.12	<0.05
Depression	Christodoulou et al.	2020	709	-	β = .161	not specified	<0.05
	Lin et al. ⁽²¹⁾	2020	11.875	-	SD=0.02	0–1	<0.001
	Liu et al. ⁽²¹⁾	2015	127.714	16	OR=1.12	1.03–1.22	<0.05
Myopia	Zong et al. ⁽¹⁶⁾	2024	90.415	19	OR=2.24	1.47–3.42	<0.05
					OR=2.39	2.07–2.76	
					OR=1.15	0.97–1.37	
					OR=1.07	1.01–1.13	
	Zhang et al. ⁽¹⁷⁾	2022	Not specified	252	OR=1.40	1.31–1.50	<0.001
	Enthoven et al. ⁽¹⁵⁾	2021	525	-	β =-0.07	-0.13 to 0.01	0.05
	Wu et al. ⁽¹⁴⁾	2020	1.2–1.9 million	-	OR=50%	49.9–50.1	<0.001
Irritability	Lin et al. ⁽²¹⁾	2020	11.875	-	SD=0.03	0–1	<0.001
	Faridizad et al. ⁽¹⁹⁾	2019	14.274	-	OR=1.14	1.09–1.18	<0.05
					OR=1.12	1.04–1.19	
Sleep disturbances	Saunders et al. ⁽¹¹⁾	2022	239.267	44	β =-0.10	-0.18 to -0.2	0.01
					β =-0.04	-0.05 to -0.12	<0.05
	Lin et al. ⁽²¹⁾	2020	11.875	-	SD=0.02	0–1	<0.001
	Faridizad et al. ⁽¹⁹⁾	2019	14.274	-	OR=1.07	1.037–1.10	<0.001
	Janssen et al. ⁽²²⁾	2019	60.445	31	OR=-0.07	-0.12 to -0.03	0.002
					OR=-0.13	-0.21 to -0.04	0.004
					OR=0.10	-0.25 to 0.05	0.203
Addiction	Lindenberg et al. ⁽²⁴⁾	2022	422	-	T=22.592	11.58–13.93	<0.001
Anxiety	Paulich et al. ⁽²⁵⁾	2021	11.875	21	T=0.002, β =0.000	-	0.999
					T=1.97, β =0.028		0.049
Memory	Huber et al. ⁽²⁶⁾	2018	31	-	SD=4.81	0–12	<0.001
			17		SD=4.54	0–12	
			29		SD=3.04	0–12	
Genetics	Liu et al. ⁽¹³⁾	2024	Not specified	-	OR=1.006	1.003–1.01	<0.01
					OR=1.005	0.983–1.028	0.648
					OR=0.989	0.974–1.004	0.145
	Meng et al. ⁽³⁰⁾	2024	225.534	-	OR=1.848	1.336–2.555	<0.001
					OR=2.104	1.395–3.170	0.105
	Zhang et al. ⁽²⁹⁾	2023	4.262	-	β =0.10	0.07–0.13	<0.05
					β =0.03	0.03–0.06	
					β =0.13	0.10–0.16	
	Brand et al. ⁽²⁷⁾	2022	1.338	-	β =-0.013	-0.023 to 0.004	0.005
					β =0.011	0.003–0.019	0.007
	Restrepo et al. ⁽³²⁾	2021	460	-	Rho=0.8	-	0.002
	Yang et al. ⁽²⁸⁾	2019	2.021	-	β =5.49, SE:2.18	-	0.012
					β =4.80, SE:1.70		0.017

OR, odds ratio; SD, standard deviation; deviation; SE, standard error.

meta-analysis found that screen time exceeding 2 hours/day was positively associated with the risk of overweight and obesity (OR, 1.67; 95% CI, 1.48–1.88, $P<0.0001$), indicating that the pediatric population exposed to more than 2 hours/day of screen time has a 67% higher risk of developing overweight/obesity compared to those with less exposure.⁷⁾ On the other hand, a meta-analysis that included 4 clinical trials showed that reducing TV time was associated with a decrease in BMI of -0.89 kg/m^2 (95% CI, -1.467 to 0.11 ; $P=0.01$), showing a significant association between screen exposure and BMI.²⁾ According to the evidence found, excessive screen time is associated with a higher risk of overweight and obesity in children and adolescents.

2. Sedentarism

The use of screens in childhood, especially at early ages, has been shown to have a negative impact on physical activity by promoting sedentary routines, defined as time during which children remain seated or engage in no significant physical activity for more than 15 consecutive minutes.⁸⁾ These are activities that should elevate the heart rate to 70%–85% of the maximum heart rate and increase the respiratory rate.^{9,10)} A retrospective cohort study conducted in 2023 in Family Care Homes in the United States with 120 caregivers and 349 children, mostly Hispanic, analyzed the relationship between physical activity practices and screen time using questionnaires and accelerometers to measure the children's activity.¹¹⁾ The authors found that 68.2% of children who spent more than 6 hours a day in front of screens showed more sedentary behavior, compared to 31.8% of children who spent 5 hours or less in front of electronic devices. A reduction in screen time was observed ($\beta=-8.50$; 95% CI, -11.50 to -5.51 ; $P<0.001$) while increasing moderate to vigorous physical activity time ($\beta=3.16$; 95% CI, 1.00 – 5.31 ; $P=0.004$), indicating the importance of limiting screen time.⁸⁾

3. Depression and mood disorders

The literature has observed that as screen time increases with activities such as watching television, using computers, and playing video games for more than 2 hours, there is an increase in depressive symptoms. This was highlighted by a 2020 study conducted by the University of Southern California, which evaluated 709 students from 4th to 6th grade to determine the relationship between depression (assessed using 4 questions selected from the Center for Epidemiologic Studies Depression Scale) and screen time (measured through computer use outside the school context, television, and video games). In particular, it was identified that boys spent more time on screens ($M=2.954$; standard deviation [SD]= 0.75) compared

to girls ($M=2.171$; $SD=0.046$; $P<0.001$).¹²⁾ Additionally, a critical threshold was found with more than 4.5 hours of screen time per day, where the risk of depression through depressive symptoms increased ($\beta=0.161$, $P<0.05$).¹²⁾ The most frequent symptom was anhedonia, which is defined as the inability to feel pleasure.¹³⁾ It was also noted that higher levels of anhedonia made children more prone to engaging in risky behaviors, as assessed through the use of substances at early ages.¹²⁾

4. Myopia

Visual disturbances are a common issue in pediatric consultations, and evidence shows a positive association with screen use. One study showed the association of mobile device use with refractive errors in adolescents aged 12 to 16 years. It included 512 individuals, where an application was used to assess myopia development by measuring smartphone use and face-to-screen distance objectively.¹⁴⁾ The study found that continuous use, defined as 20-minute episodes without interruptions, had a significant association with refractive error ($\beta=-0.07$; 95% CI, -0.13 to -0.01) and with axial length ($\beta=0.004$; 95% CI, 0.001 – 0.008).¹⁵⁾ Another meta-analysis evaluated the relationship between screen time and myopia, finding a significant association with more than 2 hours/day of screen exposure (OR, 2.24; 95% CI, 1.47–3.42).¹⁶⁾ Regarding cohort studies, it was found that continuous exposure to screens ($>1 \text{ hr/day}$) is positively associated with the onset of myopia (OR, 1.07; 95% CI, 1.01–1.13).¹⁶⁾ Subgroup analyses (by device type, study quality, and geographical region) showed that computer screens have a stronger impact on myopia (OR, 8.19; 95% CI, 4.78–14.04).¹⁶⁾ Finally, a systematic review and meta-analysis of 268 studies, 59.2% of which showed a positive relationship between screen time and myopia, found that children and adolescents who spend more time on screens (more than 2 hr/day) have a 40% higher risk of developing myopia compared to those who spend less time (OR, 1.40; 95% CI, 1.31–1.50).¹⁷⁾

5. Behavioral alterations

The literature on behavioral changes has found evidence linking screen exposure with changes in emotional states, such as irritability, physical complaints, and mood in preadolescents. Irritability is defined as an emotional state in which a child experiences a low threshold for anger in response to negative emotional events.¹⁸⁾ In a multicenter study (CASPIAN-V) conducted on an Iranian population, the association between screen time and physical health complaints was investigated in 14,274 students aged 7–18 years. The results showed an average television use of 1.97 hr/day and computer use of 0.57 hr/day. Each additional hour of television use increased the risk of irritability by

14% (OR, 1.14; 95% CI, 1.07-1.22).¹⁹⁾ On the other hand, each additional hour of computer use increased the risk of irritability by 12% (OR, 1.12; 95% CI, 1.04-1.19). The study also compared incidence rates in urban and rural populations, where it was found that children living in urban areas reported higher frequencies of symptoms such as irritability and sleep difficulties.^{19,20)} Additionally, a study by Lin et al.²¹⁾ in 2020, which examined 9,987 families with children aged 9-10 years, investigated the relationship between screen time and mood in preadolescents. They found that children who spent more time on screens, especially playing video games or watching restricted movies, showed increased irritability ($P<0.001$).

6. Sleep disturbances

One of the aspects that has gained attention regarding screen exposure in children is its impact on sleep patterns. A study conducted on children aged 0-7 years in China found a positive relationship between screen exposure time and sleep duration disturbances. This study showed that more than 1 hr/day of screen time was associated with a higher risk of shorter sleep duration (OR, 1.42; 95% CI, 1.392-1.449; $P\leq0.009$). Similarly, it was observed that children exposed to screens for more than 2 hours/day had a significantly higher risk of reduced sleep duration (OR, 2.283; 95% CI, 2.132-2.445; $P<0.001$) compared to those exposed for only 1 hr/day. On the other hand, a systematic review found a negative association in 39 of 43 studies between screen time and sleep duration, with more night awakenings, longer sleep latency, and poorer sleep quality in children aged 1 to 5 years. In the same study, a meta-analysis with 7 studies found a negative correlation ($r=-0.07$; 95% CI, -0.12 to -0.03, $I^2=0\%$, $P=0.002$) in infants (0 to 1 years) and children aged 1 to 2 years ($r=-0.13$; 95% CI, -0.21 to -0.04; $I^2=NA$, $P=0.004$). However, in preschool children (3 to 4 years), no relationship was found between screen exposure time and sleep duration ($r=0.10$; 95% CI, -0.25 to 0.05; $I^2=93.5\%$; $P=0.203$). Overall, an inverse relationship was shown between screen time and sleep quality/duration in children under 5 years.²²⁾

7. Other findings

In the search for other outcomes, which were less frequently reported but still supported by analytical evidence, conditions such as attention deficit hyperactivity disorder (ADHD), impulsivity, neurodevelopmental disorders, bullying,²³⁾ low levels of physical activity, sleep problems, poor eating habits, headaches, and cancer were included. Meta-analyses have shown reciprocal associations between digital media use and ADHD symptoms, especially with problematic use rather than screen time alone.²⁴⁾ Children with ADHD symptoms may be more vulnerable

to high media use, while digital media may in turn worsen symptoms through effects on sleep, impulsivity, and social functioning.²⁵⁾ Huber et al.²⁶⁾ conducted a study with 96 children aged 2 to 3 years to assess the impact of screen use on working memory. The children were exposed to an educational app, an educational TV program, or a cartoon, and their ability to delay gratification was assessed. The results indicated that by controlling screen activity, the likelihood of not touching a candy for 3 minutes increased by 19% on average for each additional month of age (95% CI, 7%-32%; $\chi^2(1)=10.49$, $P=0.001$). Furthermore, when comparing screen conditions, it was observed that the probability of not touching the candy was, on average, 8% higher in the educational app condition compared to the cartoon, controlling for age (95% CI, 1.69-40.92; $\chi^2(1)=6.80$, $P=0.009$). The success percentages for delaying gratification were 84% for the educational app, 63% for the educational TV program, and 61% for the cartoon.²⁶⁾

8. Genetic correlation

Studies regarding genetic predisposition and its association with various outcomes related to screen exposure in children are very limited. However, a relationship between single nucleotide polymorphisms (SNPs) and screen exposure outcomes such as obesity, hypertension, and ADHD was found (Table 2), the table shows the function, location, and variants of the genes. In 2007, an SNP, rs9939609 in the *FTO* gene (Alphaketoglutarate-dependent dioxygenase), was first described, with its role in obesity and its association with some phenotypes. A cross-sectional study conducted with children and adolescents aged 6 to 17 years in a city in Brazil found an inverse association between screen time and waist circumference (WC) ($\beta=$

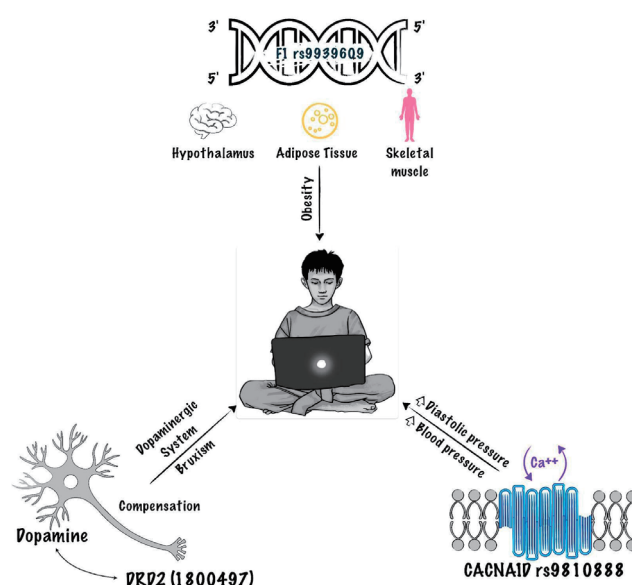


Fig. 2. Genetic risk factors in diseases associated with screen exposure.

-0.013; CI, -0.023 to -0.004; $P=0.005$). Furthermore, a significant association was found between screen time and the presence of the rs9939609 polymorphism (allele A) ($\beta=0.011$; CI, 0.003 to 0.019; $P=0.007$).²⁷⁾ Additionally, a significant association was found between the AA genotype of the *FTO* polymorphism and WC in individuals who spent more than 3.8 hr/day on screens. However, no association was found in those who spent between 1 and 3 hr/day in front of screens. It was concluded that lifestyle modulates genetic predisposition to greater WC, acting as a moderating factor in the relationship between the *FTO* gene polymorphism and WC. It was also observed that an increase in sedentary behavior, especially in children and adolescents, was related to adverse health consequences such as body fat accumulation.²⁷⁾

Yang et al.²⁸⁾ conducted a case-control study to evaluate the association between the rs9810888 variant of the *CACNA1D* gene and blood pressure in 2,030 Chinese children aged 7 to 18 years, as well as its possible interaction with lifestyle factors. The *CACNA1D* gene encodes the α -1 subunit of voltage-dependent calcium channels expressed in neuroendocrine cells and electrically excitable cells, such as smooth and cardiac muscle. This variant (rs9810888) has been associated with the activation of voltage-dependent channels, leading to membrane hyperpolarization and increased calcium influx. In this study, it was found that children with screen exposure exceeding 2 hours per day and carrying the GG genotype had higher diastolic blood pressure ($\beta=5.49$, standard error [SE]=2.18, $P=0.012$) as well as higher mean arterial pressure ($\beta=4.80$, SE=1.70, $P=0.017$).²⁸⁾ In a cohort study with data collected between 2016 and 2019 as part of the Adolescent Brain Cognitive Development Study in the United States, researchers evaluated how genetic factors influence the associations between screen time and attention problems or internalizing behaviors in preadolescents aged 9 to 11 years. A polygenic risk score analysis, capable of indicating whether certain events are due to specific genetic variants,

was performed. It was reported that screen time was associated with attention problems ($\beta=0.10$ SD; 95% CI, 0.07–0.13 SD) and internalizing problems ($\beta=0.03$ SD; 95% CI, 0.003–0.06 SD). Additionally, sensitivity analysis established that approximately 10% of the phenotypic association between exposure and outcome could be attributed to the presence of genetic factors.²⁹⁾ Meanwhile, Meng et al.³⁰⁾ conducted a Mendelian randomization study involving 225,534 children (186,843 healthy controls and 38,691 children with ADHD) to confirm the causal relationship between screen time and ADHD, using a set of SNP data previously linked to ADHD. The study found that prolonged mobile phone use (OR, 1.848; 95% CI, 1.336–2.555; $P=2.07\text{e-}4$) and time spent watching television (OR, 2.104; 95% CI, 1.395–3.170; $P=3.8\text{e-}4$) significantly increased the risk of pediatric ADHD, regardless of the presence of specific SNP variants.³⁰⁾ The polymorphism of the *DRD2* gene has been extensively studied in addiction disorders. The variation in this gene at the Taq1A1 locus (rs1800497) has been associated with reduced D2 receptor density in brain regions such as the caudate nucleus, thalamus, and hippocampus, making carriers more susceptible to impulsive-addictive-compulsive behaviors. A case-control study investigating reward dependence in adolescents with excessive internet video game use found that adolescents carrying this allele may use video games as a compensatory mechanism for deficiencies in the dopaminergic system.³¹⁾ In 2021, a hospital in Medellín, Colombia, conducted a cross-sectional study in children aged 4 to 8 years to examine the possible relationship between sleep bruxism and screen exposure time in pediatric populations. The study identified a statistically significant association ($\text{Rho}=0.8$; $P=0.002$). Furthermore, the *DRD2* gene polymorphism was suggested to have an etiological relationship with certain bruxism phenotypes in children. The researchers proposed that future studies should investigate the presence of this polymorphism in these patients.³²⁾ Although these findings suggest that screen

Table 2. Published studies regarding the gene and screen exposure outcomes such as obesity, hypertension and attention deficit hyperactivity disorder

Gene	Function	Polymorphism	Polymorphism effect
FTO (fat mass and obesity-associated)	Gene located in the chromosomal region 16q12.2, encoding the FTO enzyme, which belongs to the family of alpha-ketoglutarate-dependent dioxygenase proteins; these perform functions such as nucleic acid demethylation. ³³⁾	rs9939609	Susceptibility to obesity is determined by an interaction between this genetic factor and environmental factors. ²⁷⁾
CACNA1D (voltage-dependent calcium channel subunit alpha 1D)	Gene located in the chromosomal region 3p21.1, encoding the protein that acts as a voltage-dependent channel allowing calcium ions to enter cells. It is involved in processes such as muscle contraction, hormone or neurotransmitter release, and gene expression. ³⁴⁾	rs9810888	Predisposition to hypertension, the polymorphism causes increased ion influx, leading to cellular hyperpolarization. ²⁸⁾
DRD2 (dopamine receptor D2)	Gene located in the chromosomal region 11q23.2, encoding the D2 subtype of the dopamine receptor. This is a G-protein coupled receptor that inhibits the activity of adenylylate cyclase. ³⁵⁾	rs1800497	Associated with addiction disorders, it reduces the density of dopamine receptors in certain brain areas. ³¹⁾

exposure may interact with specific genetic variants to influence behavioral or physiological outcomes Fig. 2 is cited, it is important to note that these variants are not currently integrated into routine clinical diagnostics due to their nonspecific nature and the complexity of polygenic traits. Additionally, current clinical methodologies may not be able to capture the nuanced effects of such polymorphisms, particularly in the absence of clearly defined disease phenotypes. Therefore, the interpretation of these associations should remain within the scope of exploratory research and hypothesis generation, while their application to individualized clinical care remains premature at this time.

Conclusions

The results shown in the scientific literature suggest that excessive screen use in childhood is associated with numerous adverse physical and mental health conditions. A significant relationship was identified between screen time and an increased risk of overweight and obesity, as well as sleep disturbances due to a reduction in rest hours. Additionally, prolonged use of digital devices is linked to a higher risk of developing visual problems, such as myopia, especially with exposure to computers, where a stronger association was found compared to other devices. In the emotional domain, increased screen time is associated with an increase in depressive symptoms, such as anhedonia, as well as behavioral changes like irritability. At the genetic level, studies conclude that there are genetic variants related to different clinical outcomes, but exposure to screens can also increase ADHD symptoms in children, regardless of the presence of certain genetic variants related to ADHD. The polymorphisms with the strongest evidence are those located in the *FTO*, *CACNA1D*, and *DRD2* genes. The rs9939609 variant in the *FTO* gene makes children with higher screen exposure more susceptible to increased WC. Additionally, genetic variants in the *CACNA1D* gene are associated with alterations in blood pressure, and the *DRD2* gene is linked to addiction disorders and reward dependence in adolescents. Although these genetic variants are not currently used in clinical practice nor routinely analyzed across all populations, they represent a key piece of evidence supporting the impact of genetic susceptibility on the various outcomes associated with screen exposure in the pediatric population. Further studies are needed to validate these associations, explore their underlying mechanisms, and assess their potential relevance across diverse demographic and clinical contexts.

Given this context, it is crucial to implement an educa-

tional strategy for parents, caregivers, and healthcare professionals about the effects of screen time in childhood, promoting moderate and age-appropriate use. Adults should serve as role models, also limiting their own screen time to foster healthy practices in children and adolescents.

Footnotes

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