



International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
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ARTICLE TITLE	SCREEN TIME AND SOMATIC HEALTH IN CHILDREN AND ADOLESCENTS: A NARRATIVE LITERATURE REVIEW
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DOI	https://doi.org/10.31435/ijitss.3(51).2026.6678
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RECEIVED	13 June 2026
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ACCEPTED	06 September 2026
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PUBLISHED	15 September 2026
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SCREEN TIME AND SOMATIC HEALTH IN CHILDREN AND ADOLESCENTS: A NARRATIVE LITERATURE REVIEW

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ABSTRACT

Background: Digital screen exposure has become an integral part of childhood and adolescence, raising increasing concerns regarding its potential effects on physical health. Although screen use offers substantial educational, social, and recreational benefits, prolonged or poorly timed exposure may coexist with behaviours associated with adverse somatic outcomes.

Objective: This narrative review examines the current evidence concerning associations between screen exposure and major domains of somatic health in children and adolescents, with particular emphasis on obesity and metabolic health, sleep and circadian function, ocular health, musculoskeletal symptoms, headache, physical activity, and fitness.

Methods: Relevant systematic reviews, meta-analyses, longitudinal studies, and randomized controlled trials examining screen exposure and physical health outcomes in children and adolescents were reviewed. Particular attention was given to potential mechanisms, differences between types of screen use, and methodological limitations affecting causal interpretation.

Results: Higher screen exposure is consistently associated with several adverse health outcomes, including greater adiposity, shorter and poorer-quality sleep, digital eye strain, and an increased risk of myopia. Associations with musculoskeletal pain and headache have also been reported, although evidence is more heterogeneous. Screen exposure may additionally contribute to lower physical activity through displacement of movement and outdoor time. Potential mechanisms include behavioural displacement, sedentary behaviour, dietary changes, sleep and circadian disruption, prolonged near work, and sustained non-ergonomic postures. However, most available evidence remains observational, with substantial heterogeneity and potential confounding, reverse causation, and measurement bias.

Conclusions: Screen exposure should not be considered an isolated or universally harmful determinant of health. Its effects are likely to depend on duration, timing, content, context, and the behaviours it replaces. Future research should prioritize objective exposure measures, longitudinal and experimental designs, and within-person analyses. Clinical and public health strategies should focus on maintaining a healthy balance between digital media use, sleep, physical activity, outdoor exposure, and other essential health behaviours.

KEYWORDS

Screen Time, Digital Media Use, Children and Adolescents, Somatic Health, Physical Health, Sedentary Behavior, Obesity, Sleep, Myopia, Musculoskeletal Health

CITATION

Zmysłowska, K., Stadnik, K. A., Szatkowska, A., Kwaśniewska, M., Hajdaniak, A., Kiersztyn, J. M., Grabowska, A., & Seńcio, N. (2026). Screen time and somatic health in children and adolescents: A narrative literature review. *International Journal of Innovative Technologies in Social Science*, 3(51). [https://doi.org/10.31435/ijitss.3\(51\).2026.6678](https://doi.org/10.31435/ijitss.3(51).2026.6678)

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1. Introduction

Digital media have become an integral part of everyday life among children and adolescents. Smartphones, tablets, computers, televisions, gaming devices, and other screen-based technologies are increasingly used for communication, entertainment, education, and social interaction. Consequently, exposure to digital screens now represents a substantial component of young people's daily routines. Although public and scientific debate has frequently focused on the psychological consequences of excessive screen use, particularly its potential associations with depression, anxiety, problematic social media use, and impaired well-being, growing evidence suggests that prolonged screen exposure may also have important implications for physical health [1,2].

The relationship between screen use and health is complex. Screen time is not a uniform exposure but encompasses activities that differ considerably in their purpose, timing, intensity, and behavioural context. Passive television viewing, smartphone-based social media use, computer gaming, and educational activities may involve substantially different patterns of cognitive stimulation, posture, visual demand, and associated behaviours. Moreover, screen use may occur alongside other lifestyle factors, including prolonged sedentary behaviour, reduced physical activity and outdoor exposure, unhealthy eating patterns, and delayed sleep. Therefore, total daily screen time alone may provide only a limited representation of the ways in which digital technology interacts with physical health [1,2].

Nevertheless, a growing body of epidemiological evidence has identified associations between greater screen exposure and a range of somatic outcomes in children and adolescents. A large umbrella review comprising 102 meta-analyses, 2,451 primary studies, and almost 1.94 million participants demonstrated associations between electronic screen use and multiple health and behavioural outcomes, although effect sizes were generally small to moderate and substantial heterogeneity and risk of bias were observed across the available evidence [1]. Reported physical health consequences include increased adiposity and cardiometabolic risk, disturbances of sleep duration and timing, ocular symptoms and myopia, headache, and musculoskeletal complaints. Recent European recommendations similarly emphasise that the potential consequences of screen exposure extend across physical, psychological, and social domains and should therefore be considered within the broader context of child and adolescent health [2].

Sleep appears to represent one of the most consistently investigated somatic domains. A recent meta-analysis of 21 cohort studies involving more than 548,000 participants found that greater daily screen exposure was associated with shorter sleep duration, an increased likelihood of insufficient sleep, delayed bedtime, and difficulties initiating sleep [3]. However, emerging evidence also illustrates the importance of distinguishing between population-level associations and within-person effects. A 2026 meta-analysis examining day-to-day variations in screen use found only a small association with later sleep onset and no significant associations with several other measures of sleep duration, efficiency, or quality [4]. Such findings highlight the possibility that some observed relationships between screen time and health may partly reflect differences in lifestyle, family environment, or behavioural patterns rather than direct biological effects of screen exposure itself.

Similar interpretative challenges are present in other somatic domains. For example, increasing screen exposure has been associated with myopia, yet prolonged near work and reduced outdoor activity may contribute substantially to this relationship. Likewise, associations between screen use, obesity, and metabolic abnormalities may reflect not only lower energy expenditure but also dietary behaviours, eating while using screens, sleep disruption, and the displacement of physical activity. Musculoskeletal symptoms may be related to sustained posture and prolonged sitting rather than screen exposure per se.

These considerations underscore a fundamental challenge in contemporary screen-time research: **association should not automatically be interpreted as causation**. Many available studies remain observational, exposure is frequently assessed through self- or parent-reported estimates, and definitions of screen time differ considerably between studies [1]. In addition, rapidly changing patterns of digital technology use may limit the applicability of evidence derived primarily from television or computer use to contemporary smartphone-based behaviours.

The aim of this narrative review is therefore to examine current evidence regarding the relationship between screen exposure and somatic health in children and adolescents, with particular emphasis on obesity and metabolic health, sleep, ocular health, musculoskeletal symptoms, headache, and physical activity. In addition to summarising reported associations, the review considers potential biological and behavioural mechanisms, methodological limitations, and the extent to which existing evidence supports causal relationships. By moving beyond screen duration as a single exposure metric, this review also highlights the importance of the **type, timing, context, and purpose of screen use** in understanding its potential implications for the physical health of young people.

2. Screen Time as a Changing Exposure

Screen exposure in children and adolescents has undergone substantial changes over the past two decades. Earlier research on screen time was largely focused on television viewing, whereas contemporary exposure increasingly involves smartphones, tablets, computers, gaming consoles, and other connected devices. These technologies are used across multiple domains of daily life, including entertainment, communication, education, and social interaction. As a result, the concept of “screen time” increasingly encompasses behaviours that may differ substantially in their cognitive, visual, physical, and social demands [1,2].

Importantly, screen time should not be regarded as a homogeneous exposure. Total daily duration does not capture the type of activity performed, the content consumed, the degree of user engagement, or the context in which screen use occurs. Recreational activities such as passive video viewing, social media use, and gaming may have different implications from educational computer use. Similarly, screen exposure during the daytime may have different consequences from use immediately before or during bedtime. The distinction between active and passive screen use may also be relevant, as interactive activities can involve different cognitive and behavioural demands than prolonged passive viewing [1,2].

The device itself may also influence the nature of exposure. Smartphone use typically involves a smaller viewing distance and may be associated with prolonged near work, whereas television viewing is generally performed at a greater distance. Computer use may involve sustained sitting and fixed posture, while gaming can involve either highly sedentary or relatively interactive behaviours depending on the technology used. Consequently, the biological and behavioural pathways linking screen exposure with health outcomes are unlikely to depend exclusively on the number of hours spent in front of a screen.

Furthermore, screen time frequently interacts with other components of daily behaviour. Prolonged screen use may displace sleep, physical activity, outdoor exposure, or family meals, while eating during screen-based activities may influence dietary intake. These displacement and behavioural pathways may therefore mediate some of the observed associations between screen exposure and somatic health outcomes [1,2].

This increasing heterogeneity creates an important methodological challenge. Studies relying on a single estimate of total daily screen time may obscure potentially meaningful differences between devices, activities, timing, and contexts of use. The current literature consequently increasingly supports moving beyond a simple quantitative measure of screen duration towards a more multidimensional assessment incorporating **what young people do on screens, when they do it, for how long, and what behaviours screen use replaces** [1,2].

3. Obesity and Metabolic Health

Among the somatic outcomes associated with screen exposure, obesity and metabolic health have been among the most extensively studied. The proposed relationship is biologically and behaviourally plausible, as prolonged screen use may contribute to energy imbalance through several interconnected pathways. Screen-based activities are frequently sedentary and may displace physical activity, while screen use can also coincide with snacking, consumption of energy-dense foods, and prolonged eating episodes. In addition, exposure to food advertising and other forms of digital marketing may influence food preferences and dietary choices. Consequently, the association between screen time and adiposity is unlikely to be explained by reduced energy expenditure alone [1,2].

Several meta-analyses have reported a positive association between greater screen exposure and overweight or obesity in children and adolescents. Wu et al. found that individuals in the highest screen-time category had a mean BMI approximately 0.70 kg/m² higher than those in the lowest category. Similarly, a systematic review and dose-response meta-analysis including 44 studies and more than 112,000 adolescents reported that those in the highest screen-time category had approximately 27% higher odds of overweight or obesity compared with those in the lowest category (OR = 1.27, 95% CI [1.17, 1.39]) [5]. However, the substantial heterogeneity between studies and the absence of a clear nonlinear dose-response relationship suggest that the association should not be interpreted as evidence of a simple threshold effect. Differences in the type of screen exposure, population characteristics, dietary behaviours, and methods used to assess screen time may contribute to the variability of the findings [5].

The type of screen activity may be particularly relevant. In the meta-analysis by Haghjoo et al., television viewing appeared to show a stronger association with overweight and obesity than some other forms of screen use, whereas associations involving video gaming or computer use were less consistent [5]. This observation supports the concept that the health consequences of screen exposure depend not only on duration but also on the behavioural context accompanying the activity. Passive television viewing, for example, may be particularly conducive to prolonged uninterrupted sitting and eating, whereas some forms of gaming may involve greater physical engagement. Therefore, treating all screen-based behaviours as a single exposure may obscure clinically relevant differences.

Evidence concerning central adiposity is somewhat less consistent. A systematic review and meta-analysis of nine studies found no statistically significant association between high screen time and the odds of central obesity (OR = 1.14, 95% CI [0.97, 1.34]); nevertheless, participants with the highest screen exposure had a mean waist circumference approximately 1.23 cm greater than those in the lowest exposure category [6]. These findings suggest that screen exposure may be associated with markers of adiposity even when categorical definitions of central obesity do not demonstrate a statistically significant relationship.

Beyond body weight, increasing screen exposure has also been associated with broader cardiometabolic risk. A systematic review and dose-response meta-analysis including seven studies found that children and adolescents with the highest levels of screen time had significantly higher odds of metabolic syndrome than those with the lowest exposure (OR = 1.64, 95% CI [1.32, 2.03]). The dose-response analysis estimated a 29% increase in the odds of metabolic syndrome for every additional two hours of screen time per day [7]. Potential

mechanisms include increased adiposity, reduced physical activity, prolonged sedentary behaviour, adverse dietary patterns, and sleep disruption. However, the relatively small number of studies included in this analysis and the predominantly observational nature of the available evidence limit causal interpretation.

Importantly, experimental evidence provides a more cautious perspective. A meta-analysis of 14 randomized controlled trials involving 1,894 children and adolescents found that interventions successfully reduced total screen exposure by approximately 6.9 hours per week, but did not produce a significant reduction in BMI or BMI z-score [8]. This discrepancy between observational and intervention studies suggests that screen time may function partly as a marker of a broader lifestyle pattern rather than as an isolated causal determinant of obesity. Reducing screen exposure without simultaneously addressing physical activity, diet, sleep, and other environmental factors may therefore be insufficient to produce measurable changes in body composition.

Overall, current evidence supports an association between higher screen exposure and greater adiposity and cardiometabolic risk in children and adolescents, but the strength of evidence varies across outcomes. The relationship is likely multidimensional and mediated by a combination of sedentary behaviour, dietary intake, sleep, and displacement of healthier activities. Further longitudinal and experimental research using objective measures of screen exposure and detailed assessment of accompanying behaviours is required to determine whether screen time itself contributes directly to obesity and metabolic dysfunction or primarily represents one component of a broader obesogenic lifestyle.

4. Sleep and Circadian Health

Sleep is one of the most consistently investigated somatic outcomes associated with screen exposure in children and adolescents. Adequate and appropriately timed sleep is essential for physical growth, metabolic regulation, cognitive functioning, and overall health during childhood and adolescence. At the same time, young people increasingly use smartphones, tablets, computers, and other digital devices during the evening and close to bedtime. Consequently, the potential relationship between screen exposure and sleep has attracted considerable attention, with research suggesting that greater screen use may be associated with shorter sleep duration, later bedtimes, increased sleep latency, and poorer sleep quality [1,2].

Recent longitudinal evidence supports an association between increasing screen exposure and several adverse sleep outcomes. A systematic review and meta-analysis of 21 cohort studies involving 548,338 participants found that each additional hour of daily screen time was associated with approximately 3–5 minutes less total sleep duration and a 25% higher odds of short sleep (OR = 1.25, 95% CI [1.08, 1.40]) [3]. Greater screen exposure was also associated with insomnia symptoms, delayed bedtime, and difficulty initiating sleep. Notably, bedtime was delayed by approximately 13 minutes for every additional hour of daily screen use [3]. These findings are particularly relevant during adolescence, when biological changes already contribute to a tendency toward later sleep timing.

An umbrella review published in 2026 provides a broader assessment of the available evidence. Brozatus et al. included 84 systematic reviews covering 475 original studies involving children and adolescents aged 0–18 years [9]. Overall, screen time was associated with poorer sleep, although the strength of evidence varied considerably between outcomes. Importantly, the authors noted that the field remains dominated by reviews of relatively low methodological quality and by primary studies using cross-sectional designs and subjective measures of both media exposure and sleep [9]. This observation is important because the apparent consistency of an association does not necessarily indicate that screen exposure directly causes sleep disturbance.

The timing and context of screen use may be particularly important. Evening and bedtime exposure may interfere with sleep through several complementary mechanisms. First, screen-based activities can produce **time displacement**, whereby time spent using devices directly reduces the amount of time available for sleep. Second, engaging content, social interaction, gaming, or emotionally stimulating material may increase cognitive and physiological arousal and make it more difficult to transition into sleep. Third, exposure to light emitted by digital screens may influence circadian physiology, particularly when devices are used close to bedtime. These mechanisms may operate simultaneously, making it difficult to attribute sleep disruption to any single component of screen exposure [9,10].

The type of device and activity may also modify the relationship. An umbrella review focusing specifically on adolescents found that smartphones and computers were more consistently associated with adverse sleep outcomes than television, while social media and internet use were particularly associated with delayed bedtimes, shorter sleep duration, and increased sleep onset latency [10]. This may reflect differences

in how these devices are used rather than an intrinsic effect of the technology itself. Smartphones, for example, can be used continuously throughout the evening and are frequently kept within reach during the night, allowing notifications and social interactions to interrupt established bedtime routines.

However, recent research challenges a straightforward interpretation of these associations. A 2026 systematic review and meta-analysis examined **within-person** relationships between day-to-day variation in screen use and sleep, thereby reducing the influence of stable individual differences between participants [4]. The findings suggested only a small association between greater screen use and later sleep onset, while several other sleep parameters showed no clear relationship. This approach is important because children who generally use screens more may differ from those who use them less in numerous characteristics that also influence sleep, including family routines, physical activity, mental health, socioeconomic circumstances, and pre-existing sleep patterns.

Reverse causation may also contribute to the observed associations. Adolescents experiencing insomnia, boredom, or difficulty falling asleep may turn to smartphones or other devices during periods when they would otherwise be sleeping. Thus, greater nighttime screen use may sometimes represent a consequence of poor sleep rather than its primary cause. Longitudinal and experimental studies are therefore particularly valuable for clarifying the direction of the relationship.

Overall, the available evidence supports an association between greater screen exposure, particularly evening and bedtime use, and several adverse sleep outcomes. Nevertheless, the magnitude and causality of these relationships remain uncertain. Future studies should distinguish between daytime and nighttime exposure, device type, and specific screen-based activities, while incorporating objective measures such as device-recorded screen use, actigraphy, and polysomnography where appropriate. Such approaches may help determine whether reducing screen exposure itself improves sleep or whether the observed relationship primarily reflects broader behavioural and environmental patterns surrounding digital media use.

5. Ocular Health

Ocular health represents one of the most rapidly developing areas of research concerning the physical consequences of digital screen exposure in children and adolescents. The widespread adoption of smartphones, tablets, and computers has substantially increased the amount of time young people spend performing visually demanding near-work activities. Prolonged screen use has been associated with both short-term ocular symptoms, commonly described as digital eye strain, and longer-term refractive outcomes, particularly myopia. However, these outcomes should be considered separately, as the mechanisms and strength of evidence differ considerably between transient symptoms and structural changes in refractive development [1,2].

Digital eye strain, also referred to as computer vision syndrome, encompasses a heterogeneous group of ocular and visual symptoms that may develop during or after prolonged digital device use. Common complaints include eye fatigue, dryness, burning or irritation, blurred vision, difficulty focusing, and headache. A systematic review of studies involving young screen users found that digital eye strain was common and was associated with longer durations of screen exposure [11]. Several mechanisms may contribute to these symptoms. Sustained near fixation places continuous demands on accommodation and vergence, while prolonged concentration on a screen may reduce spontaneous blink frequency and increase tear-film instability. Glare, inappropriate viewing distance, poor lighting, small font size, and inadequate ergonomic conditions may further increase visual discomfort. Importantly, digital eye strain is generally considered a functional and reversible condition rather than evidence of permanent ocular damage.

The relationship between screen exposure and myopia is potentially more clinically significant. Myopia has become increasingly prevalent worldwide, particularly among children and adolescents, and is associated with an increased lifetime risk of ocular complications such as retinal detachment, myopic maculopathy, and glaucoma. Digital screen use has emerged as one of several environmental factors potentially contributing to this trend. A 2025 systematic review and dose-response meta-analysis published in *JAMA Network Open* included 45 studies involving 335,524 participants and found that digital screen exposure was significantly associated with myopia. Each additional hour of daily screen exposure was associated with approximately a 21% increase in the odds of myopia (OR = 1.21, 95% CI [1.13, 1.29]) [12]. The dose-response analysis suggested that the increase in risk was particularly evident between approximately one and four hours of daily exposure, although the relationship became less clearly linear at higher levels of exposure [12].

These findings are supported by other recent evidence. A 2024 meta-analysis examining the relationship between screen exposure and myopia reported a significant association between higher screen exposure and

increased odds of myopia, with stronger associations observed in several cohort and case-control analyses [13]. Nevertheless, interpreting this relationship as a direct effect of digital screens requires caution. Screen use frequently involves prolonged near work, and near-work duration itself is an established risk factor for myopia. Consequently, screen exposure may represent one modern form of near work rather than an independent causal factor. This distinction is particularly important because reading printed books, studying, and other close-up activities may produce similar visual demands.

Outdoor exposure provides another potentially important explanatory pathway. Time spent outdoors appears to have a protective association with the development of myopia, and children with greater screen exposure may simultaneously spend less time outside. A recent systematic review examining physical activity, sedentary behaviour, sleep, near work, screen time, and myopia emphasised the complex interplay between these behaviours [14]. Thus, the observed relationship between screen use and myopia may partly reflect the displacement of outdoor activity rather than exposure to screens alone. Differences in parental myopia, age, educational demands, urbanisation, and socioeconomic circumstances may provide additional confounding.

The distinction between short-term symptoms and long-term ocular outcomes is therefore important. Digital eye strain may arise relatively quickly during prolonged screen use and is likely to be strongly influenced by viewing conditions, blinking behaviour, and ergonomics. Myopia, in contrast, develops through longer-term interactions between genetic susceptibility and environmental exposures. Consequently, evidence demonstrating that prolonged screen use causes transient visual discomfort cannot automatically be extrapolated to permanent refractive changes.

Preventive strategies should therefore address the broader visual environment rather than focusing exclusively on screen duration. Appropriate viewing distance, regular visual breaks, adequate lighting, ergonomic positioning, and sufficient time outdoors may all be relevant. The available evidence does not support the assumption that blue-light-blocking filters prevent digital eye strain; systematic review evidence has not demonstrated a clear protective effect [15]. Similarly, reducing screen time alone may not adequately address myopia risk if prolonged near work and insufficient outdoor exposure remain unchanged.

Overall, current evidence indicates that digital screen exposure is associated with both digital eye strain and myopia among children and adolescents, with particularly substantial evidence emerging for the latter. However, screen exposure should be understood as one component of a broader visual and behavioural environment. Future research should distinguish between device use, total near-work exposure, outdoor time, and other established risk factors for myopia, while using objective measures of digital exposure wherever possible. Such an approach is necessary to determine whether digital screens independently contribute to myopia or primarily represent a rapidly expanding form of near-work exposure within an increasingly indoor lifestyle.

6. Musculoskeletal Health

Musculoskeletal symptoms represent another potential somatic consequence of prolonged screen exposure among children and adolescents. The rapid increase in smartphone, tablet, computer, and gaming-device use has raised concerns about prolonged static postures, repetitive movements, and insufficient variation in body position. Unlike obesity or sleep disturbances, however, the evidence linking screen exposure with musculoskeletal health remains less consistent and is based predominantly on observational studies. The most frequently reported symptoms involve the neck, shoulders, upper back, and lower back [1,2].

A systematic review and meta-analysis examining sedentary behaviour and neck pain in children and adolescents found a significant association between prolonged mobile phone use and neck pain (OR = 1.36, 95% CI [1.001, 1.85]) [15]. The association between prolonged total screen time and neck pain was initially marginally non-significant, but became statistically significant after sensitivity analysis (OR = 1.30, 95% CI [1.03, 1.64]) [15]. These findings suggest that the relationship may be particularly relevant for handheld-device use, although the relatively modest effect sizes and the cross-sectional design of most included studies limit conclusions regarding causality.

The cervical region may be particularly vulnerable because smartphone and tablet use frequently involves sustained neck flexion. When a device is positioned below eye level, users may maintain a forward-head posture for prolonged periods, increasing the mechanical demands placed on cervical and shoulder musculature. Repetitive thumb movements and prolonged static positioning of the upper limbs may additionally contribute to discomfort in the wrists, hands, and forearms. A systematic review of mobile handheld device use identified neck complaints as the most frequently reported musculoskeletal symptom,

with reported prevalence ranging from 17.3% to 67.8% across studies [16]. Evidence concerning specific risk factors was strongest for neck flexion and certain patterns of texting, gaming, and phone use, whereas the relationship with total duration of use was less consistent [16].

Low back pain is another relevant outcome during adolescence, when the prevalence of spinal pain begins to increase. A dose-response meta-analysis including 57,831 children and adolescents found positive associations between low back pain and daily computer use (OR = 1.32, 95% CI [1.05, 1.60]), mobile phone use (OR = 1.32, 95% CI [1.00, 1.64]), and television viewing (OR = 1.07, 95% CI [1.04, 1.09]) [17]. These findings suggest that different forms of screen exposure may contribute to musculoskeletal discomfort, although the mechanisms are likely to involve prolonged sitting and static posture rather than an intrinsic effect of the screen itself.

An important distinction should therefore be made between screen exposure and sedentary behaviour. Screen-based activities are often performed while sitting, but not all sedentary behaviours involve screens, and not all screen use is necessarily sedentary. Consequently, screen time may partly act as a proxy for prolonged sitting and reduced postural variation. This is particularly relevant when interpreting associations with back pain, as physical inactivity, overall sedentary time, physical fitness, school-related sitting, backpack load, and previous musculoskeletal symptoms may all influence pain risk [15,17].

The quality of the evidence also warrants caution. A systematic review specifically examining personal electronic device use and musculoskeletal pain in children and adolescents identified 24 eligible studies, of which 21 were cross-sectional and only two were longitudinal [18]. Such a predominance of cross-sectional research makes temporal relationships difficult to establish. Reverse causation is also possible: young people experiencing neck or back pain may alter their activity patterns or spend more time using devices while resting. Furthermore, subjective estimates of screen duration and pain are susceptible to recall and reporting bias.

Overall, current evidence suggests that prolonged use of smartphones, tablets, computers, and other screen-based devices is associated particularly with neck and, to a lesser extent, back pain in children and adolescents. The most plausible mechanisms involve sustained static postures, neck flexion, repetitive upper-limb movements, and prolonged sedentary behaviour. However, evidence remains insufficient to conclude that screen exposure independently causes musculoskeletal pathology. Preventive strategies should therefore focus not only on reducing screen duration but also on improving ergonomics, encouraging regular movement and postural variation, and reducing prolonged uninterrupted sitting. Future longitudinal studies using objective measures of device use and physical activity are needed to clarify whether screen exposure represents an independent risk factor or primarily one component of a broader sedentary lifestyle.

7. Headache and Migraine

Headache is a common neurological complaint during childhood and adolescence and may represent another potential health outcome associated with prolonged screen exposure. Digital devices are frequently reported by young people as headache triggers, particularly when used continuously for extended periods. However, unlike the evidence concerning sleep or obesity, the relationship between screen exposure and headache remains less clearly established. Current research is characterized by substantial heterogeneity in definitions of screen time, headache diagnoses, and outcome measures, with most available studies relying on cross-sectional designs [1,2].

A 2024 scoping review specifically examining screen time and pediatric headache identified 48 studies. The strongest association reported across the literature was between longer duration of screen use and headache, while computer use was the device most frequently associated with headache symptoms [19]. Migraine appeared to be associated with screen exposure more consistently than some other headache diagnoses, although the available evidence was insufficient to determine whether screen use affects headache frequency or headache-related disability [19]. These findings suggest a possible relationship but do not establish that prolonged screen exposure directly causes primary headache disorders.

Several mechanisms may plausibly explain an association. Prolonged screen use can contribute to visual discomfort and digital eye strain, including accommodative fatigue, ocular dryness, and blurred vision, which may be accompanied by headache. Sustained neck flexion and static posture may additionally contribute to cervicogenic or tension-type headache through musculoskeletal strain. Screen exposure may also indirectly influence headache susceptibility through sleep restriction, delayed sleep timing, reduced physical activity, and prolonged sedentary behaviour [2,19]. In individuals with migraine, bright light, visual stimulation,

prolonged concentration, and irregular sleep may act as potential triggers rather than screen exposure itself being a specific cause.

Evidence from clinical populations is similarly mixed. In a cross-sectional study of 139 children and adolescents attending a specialist headache clinic, total screen time did not differ significantly between participants with migraine, tension-type headache, mixed headache, or unclassified headache. However, among children with migraine with aura, greater screen exposure was associated with higher headache frequency [20]. Another study of adolescents attending a headache clinic found no significant correlation between screen type or duration and monthly headache frequency or school functioning, despite many participants reporting that prolonged screen use or increased screen brightness worsened their headaches [21]. These findings illustrate the difference between perceived triggering effects and objectively demonstrated increases in headache burden.

Reverse causation is also particularly relevant in this context. Young people experiencing headaches may spend more time using digital devices while resting at home or may report screen exposure more readily because they perceive it as a trigger. Conversely, headaches may lead to reduced participation in outdoor activities and increased sedentary behaviour, creating an apparent association with screen use. Furthermore, sleep deprivation, stress, dehydration, and irregular meals are established headache-related factors that may cluster with intensive digital media use [19].

Overall, available evidence suggests that prolonged screen exposure may be associated with headache in children and adolescents, with migraine potentially representing a particularly susceptible subgroup. Nevertheless, the current evidence does not establish screen time as an independent causal risk factor for headache or migraine. Future research should incorporate objective device-based measures of exposure, prospective headache diaries, standardized diagnostic criteria, and assessment of important coexisting factors such as sleep, hydration, physical activity, visual strain, and psychological stress. Such approaches may help determine whether screen exposure represents a direct trigger, an indirect contributor, or simply a correlate of other modifiable headache-related behaviours.

8. Physical Activity, Fitness and the Displacement Hypothesis

One of the most widely proposed mechanisms linking screen exposure with adverse somatic health outcomes is the **displacement hypothesis**. According to this model, time spent engaging with screens may replace activities that are beneficial for health, particularly moderate-to-vigorous physical activity, outdoor time, and active forms of recreation. Because children and adolescents have a finite amount of time available within a 24-hour day, prolonged sedentary screen use may therefore influence health not only through direct effects but also by reducing opportunities for movement [1,2].

Physical activity is particularly relevant during childhood and adolescence because it contributes to cardiorespiratory fitness, healthy body composition, musculoskeletal development, and cardiometabolic health. At the population level, however, many young people do not achieve recommended levels of physical activity, and activity tends to decline during adolescence [22]. Screen-based leisure may contribute to this pattern by providing an easily accessible alternative to physically active recreation. Nevertheless, the relationship is not necessarily reciprocal or deterministic: physically active adolescents may also use screens extensively, while screen-based activities can occasionally facilitate physical activity through exercise applications, online training, or active video games.

Evidence concerning the relationship between screen exposure and physical fitness has historically been mixed. Earlier systematic reviews generally reported an inverse association between higher screen time and cardiorespiratory fitness, although the strength and consistency of evidence varied between studies [1]. More recent research has increasingly emphasized that total sedentary time, physical activity, and screen time are related but distinct constructs. A 2024 systematic review examining determinants of objectively measured physical activity and sedentary behaviour in adolescents highlighted substantial heterogeneity in the factors influencing movement behaviours, reinforcing the difficulty of attributing inactivity specifically to digital media use [22].

Intervention evidence provides an important test of the displacement hypothesis. A 2024 systematic review and meta-analysis of 102 randomized controlled trials involving almost 46,000 children and adolescents examined whether changing one movement behaviour affected other behaviours. Increasing physical activity produced a small reduction in sedentary behaviour, whereas interventions specifically targeting screen time did not produce significant changes in physical activity or sleep [23]. Similarly, a recent systematic review of

randomized trials found that interventions incorporating physical activity promotion could reduce screen-based sedentary behaviour, suggesting that increasing opportunities for movement may sometimes be more effective than focusing exclusively on screen reduction [24].

These findings suggest that displacement may operate in both directions. Screen use can displace physical activity, but simply removing screen time does not guarantee that the newly available time will be spent being physically active. Children may instead engage in other sedentary activities. Consequently, interventions aimed at improving physical fitness should probably focus on **what replaces screen time**, rather than screen reduction as an isolated target.

Overall, current evidence supports the plausibility of the displacement hypothesis but does not establish that screen exposure independently causes physical inactivity or poor fitness. The relationship is likely bidirectional and embedded within broader behavioural patterns involving family environment, school schedules, access to recreational facilities, sleep, and individual preferences. Future research should therefore examine the full 24-hour movement behaviour composition rather than treating screen time as an isolated exposure.

9. Mechanisms Connecting Screen Exposure With Somatic Health

The potential relationship between screen exposure and somatic health is unlikely to be explained by a single biological mechanism. Rather, digital media use may influence health through several interconnected behavioural, physiological, and environmental pathways. Importantly, these mechanisms may operate simultaneously and may amplify one another. Consequently, the health consequences attributed to screen time may reflect the broader behavioural context in which screen use occurs rather than a direct physiological effect of exposure to digital devices [1,2].

One of the most prominent mechanisms is **behavioural displacement**. Prolonged screen use may replace physical activity, outdoor exposure, sleep, or other health-promoting behaviours. This may contribute to lower energy expenditure and poorer cardiorespiratory fitness while simultaneously increasing sedentary time. However, displacement is not necessarily complete: reducing screen time does not automatically result in increased physical activity, suggesting that the relationship between screen exposure and movement behaviours is more complex than a simple substitution model.

A second pathway involves dietary and metabolic behaviours. Screen-based activities, particularly television viewing and recreational digital media use, may facilitate eating without attention to satiety cues, increase exposure to food advertising, and encourage consumption of energy-dense snacks. Screen use may therefore influence body weight through both increased energy intake and reduced energy expenditure. These effects may be further reinforced by sleep disruption, as insufficient or irregular sleep is itself associated with metabolic dysregulation and obesity [2].

Sleep and circadian disruption represent another interconnected mechanism. Evening screen use may delay bedtime by directly displacing sleep, while stimulating content may increase cognitive or emotional arousal. Light exposure from screens may additionally interact with circadian timing. Sleep restriction can subsequently affect appetite regulation, metabolic function, daytime activity, and headache susceptibility, creating a pathway through which screen exposure may influence several somatic outcomes simultaneously. Recent evidence suggests that screen use, sleep, and adiposity may share common behavioural determinants rather than representing entirely independent relationships [25].

Digital devices may also produce more direct sensory and biomechanical effects. Prolonged near viewing can increase visual demands and is associated with digital eye strain, while repeated near work and reduced outdoor exposure may contribute to myopia risk. The available evidence also suggests that screen-related behaviours interact with near work, physical activity, and outdoor time in determining myopia risk [18]. Similarly, prolonged static postures, neck flexion, and repetitive upper-limb movements during smartphone or computer use may contribute to musculoskeletal discomfort.

Finally, these mechanisms are embedded within a broader 24-hour behavioural system. Screen use does not occur independently of sleep, diet, physical activity, school demands, family routines, or socioeconomic circumstances. The same number of hours of screen exposure may therefore have very different implications depending on what activity it replaces, when it occurs, and how it is performed. This multidimensional perspective is essential when interpreting associations between screen exposure and somatic health and supports moving beyond total daily screen duration as the primary measure of exposure.

10. The Problem of Causality

Although a substantial body of literature has identified associations between screen exposure and adverse somatic outcomes in children and adolescents, determining whether screen time itself causes these outcomes remains challenging. Most available evidence is observational, and therefore vulnerable to confounding, reverse causation, measurement error, and selection bias. The distinction between an exposure that directly contributes to disease and a behavioural marker associated with other risk factors is particularly important when interpreting the health effects of digital media.

One of the major methodological challenges is **confounding**. Children and adolescents who spend more time using screens may differ systematically from those with lower exposure in physical activity, dietary habits, sleep patterns, socioeconomic circumstances, parental behaviours, family routines, and mental health. These factors may independently influence obesity, sleep, headache, musculoskeletal symptoms, or other somatic outcomes. Consequently, an observed association between screen time and a health outcome may partly reflect differences in the broader environment rather than a direct effect of screen exposure. The large umbrella review by Sanders et al. found that 95 of 102 included meta-analyses had medium-to-high risk of bias, while heterogeneity was high in most health-related analyses, illustrating the methodological limitations of the current evidence base [1].

Reverse causation represents another important concern. Health problems may themselves influence screen use. Adolescents experiencing insomnia may use smartphones at night because they are unable to sleep, while those with headaches, fatigue, or musculoskeletal pain may spend more time using devices while resting at home. Similarly, children with overweight or lower physical fitness may be less likely to participate in active recreation and consequently spend more time in sedentary screen-based activities. In such situations, screen exposure may be partly a consequence or correlate of poor health rather than its primary cause.

The concept of **displacement** further complicates causal interpretation. Screen use may replace sleep, physical activity, outdoor exposure, or other health-promoting behaviours. If these displaced behaviours are responsible for part of the observed health effect, reducing screen time without modifying what replaces it may have limited benefits. This distinction is supported by intervention evidence: randomized trials targeting screen reduction have not consistently demonstrated corresponding improvements in BMI or other health outcomes [8]. Therefore, the causal pathway may involve the entire pattern of behaviours occurring within a fixed 24-hour period rather than screen exposure alone.

Another limitation concerns the measurement of the exposure itself. Many studies rely on self-reported or parent-reported estimates of daily screen time, which may be affected by recall error and may not accurately capture short, frequent episodes of smartphone use. Furthermore, total duration provides little information about the content, purpose, timing, device, or context of screen use. Consequently, two individuals with the same reported screen duration may have substantially different exposures and health implications. This heterogeneity can both obscure genuine associations and produce apparently inconsistent findings across studies.

The evidence is also affected by differences in study design. Cross-sectional studies can identify correlations but cannot reliably establish temporal sequence. Longitudinal studies provide stronger evidence, but residual confounding remains possible. Randomized controlled trials provide the strongest basis for causal inference, yet screen-time interventions are difficult to design and may not isolate the effect of screen exposure from simultaneous changes in physical activity, family routines, diet, or sleep. Moreover, interventions that successfully reduce screen time do not necessarily reproduce the natural variation in screen exposure observed in everyday life.

Taken together, the available literature supports the existence of **associations** between greater screen exposure and several adverse somatic outcomes, but the strength of causal evidence differs substantially between health domains. Evidence is relatively convincing for some relationships, particularly when biologically plausible mechanisms and longitudinal findings converge, whereas other associations remain uncertain. Future research should prioritize prospective designs, objective device-based measures of exposure, repeated assessment of health outcomes, and methods capable of addressing time-varying confounding and within-person variation. Importantly, research should move beyond the question of whether screen time is “harmful” and instead examine **which types of screen exposure, under which circumstances, and through which pathways influence physical health**.

11. Clinical and Public Health Implications

The available evidence has several implications for clinical practice and public health. Although the causal relationship between screen exposure and individual somatic outcomes remains incompletely established, the consistency of associations across several health domains supports addressing digital media use as part of routine health promotion in children and adolescents. Importantly, clinical counselling should focus not only on reducing screen duration but also on identifying patterns of use that interfere with sleep, physical activity, healthy eating, outdoor exposure, and other health-promoting behaviours [1,2].

In clinical practice, assessment of screen exposure may be incorporated into routine history taking, particularly in children presenting with obesity, sleep difficulties, recurrent headaches, visual symptoms, or musculoskeletal pain. Rather than asking only “How many hours does your child spend on screens?”, clinicians should consider when screens are used, for what purpose, which devices are involved, and whether use occurs during meals, before bedtime, or in the bedroom. This contextual approach is consistent with contemporary paediatric recommendations, which increasingly emphasize the quality and context of digital media use rather than a single universal time threshold for all children and adolescents [2,26].

Preventive counselling should prioritize protecting essential health behaviours. Screen-free periods around bedtime, regular opportunities for physical activity and outdoor time, appropriate viewing distance and posture, and avoiding devices during meals may be more clinically meaningful than pursuing an arbitrary daily screen-time target. The American Academy of Pediatrics currently recommends individualized family media plans for children and adolescents aged six years and older, emphasizing that digital media should not displace sleep, physical activity, family interaction, or other developmentally important activities [26]. Recent European recommendations similarly emphasize age-appropriate limits and the importance of content, context, and displacement rather than duration alone [27].

At the public health level, interventions should extend beyond individual families. Schools, healthcare systems, policymakers, and technology developers all influence the environments in which young people use digital media. Public health strategies may therefore include digital health education, promotion of active and outdoor lifestyles, school policies supporting healthy movement and sleep routines, and efforts to improve the design of digital environments for children. A socioecological approach is particularly appropriate because children's screen behaviours are shaped by family circumstances, educational requirements, socioeconomic factors, and commercial digital environments [26].

Overall, the current evidence does not justify framing screens as inherently harmful or recommending universal elimination of digital media. Digital technologies have important educational, social, and recreational functions. Instead, clinical and public health approaches should aim to create a **healthy digital balance**, in which screen exposure is compatible with adequate sleep, physical activity, outdoor time, healthy nutrition, and appropriate development. This approach acknowledges both the potential risks of excessive or poorly timed screen use and the limitations of the current causal evidence.

12. Conclusions

Screen exposure has become a fundamental component of modern childhood and adolescence, making complete avoidance neither realistic nor necessarily desirable. The evidence reviewed in this article indicates that greater or poorly timed screen exposure is associated with several domains of somatic health, including obesity and metabolic risk, sleep and circadian disturbances, ocular problems, musculoskeletal symptoms, headache, and reduced opportunities for physical activity. However, the strength and consistency of these associations vary considerably between outcomes.

A central finding of this review is that **screen time should not be interpreted as a uniform exposure**. The health implications of one hour of educational computer use, late-night smartphone use, active gaming, and prolonged passive video viewing may differ substantially. Timing, content, device, posture, and the activities displaced by screen use are therefore likely to be at least as important as total duration.

Importantly, the predominance of observational evidence prevents strong conclusions about causality. Confounding, reverse causation, exposure misclassification, and the displacement of other behaviours complicate interpretation. Large-scale evidence syntheses have identified associations across multiple health domains while simultaneously highlighting substantial heterogeneity and methodological limitations in the underlying literature [1].

Future research should therefore move beyond the question of whether “screen time is harmful” and investigate **which forms of screen exposure, in which contexts, and through which mechanisms influence**

health. Objective measures of device use, longitudinal follow-up, randomized interventions, and within-person analyses may substantially improve causal inference.

From a clinical and public health perspective, the most appropriate goal is not the elimination of digital media but the promotion of a **healthy digital balance**. Protecting adequate sleep, regular physical activity, outdoor exposure, healthy nutrition, and appropriate visual and musculoskeletal habits should remain the central priority when evaluating screen use in young people.

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