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THE NEGATIVE IMPACT OF DIGITAL GADGETS ON THE HEALTH OF SCHOOL-AGE CHILDREN: A COMPREHENSIVE REVIEW OF PHYSICAL, PSYCHOLOGICAL, AND NEUROLOGICAL CONSEQUENCES

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ABSTRACT: Background: The proliferation of digital devices — smartphones, tablets, computers, and gaming consoles — among school-age children and adolescents has transformed childhood environments, with associated health consequences that are increasingly recognized as significant public health concerns. Objective: This article systematically reviews evidence on the negative health impacts of excessive gadget use among school children, including musculoskeletal, ophthalmological, neurological, psychological, and sleep-related consequences. Methods: Narrative review of peer-reviewed literature, systematic reviews, and international health organization reports published between 2010 and 2024. Results: Excessive screen time is associated with myopia progression, musculoskeletal disorders, sleep disruption, attention deficits, anxiety, depression, and social developmental delays. The Andijon region of Uzbekistan and similar Central Asian school-age populations are at elevated risk due to rapidly increasing device penetration without commensurate health literacy. Conclusion: Evidence-based digital health guidelines, school health programs, and parental education campaigns are critical to mitigate the adverse health effects of unregulated gadget use in children.

1. INTRODUCTION

The digital revolution has irrevocably altered the landscape of childhood. In 2023, a global survey by UNICEF found that approximately 71% of youth aged 15–24 years were internet users, and device ownership among younger children — often as young as 6–8 years — is rising rapidly across both high-income and middle-income countries. In Uzbekistan, smartphone penetration reached 72% of the population by 2023, with a significant proportion of users being school-age children and adolescents. The rapid diffusion of gadgets has been further accelerated by the COVID-19 pandemic, which necessitated remote learning through digital devices, substantially increasing children's daily screen exposure.

While digital technologies offer undeniable educational and social benefits, unregulated and excessive use has been linked to a spectrum of health consequences affecting multiple physiological and psychological systems. Concerned by these trends, the WHO issued its first guidelines on physical activity, sedentary behavior, and sleep for children under 5 in 2019, and the American Academy of Pediatrics (AAP) has published evolving screen time recommendations limiting recreational screen time to one hour per day for children aged 2–5 and providing structured guidance for older children.

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Among school-age children in upper grades (grades 7–11, ages 13–17), gadget use tends to be heaviest and least supervised. This age group simultaneously undergoes critical neurological development, hormonal changes of puberty, and the formation of cognitive habits and social identities — rendering them particularly susceptible to the adverse effects of excessive digital engagement. Research linking gadget use to myopia, musculoskeletal disorders, sleep impairment, attention deficits, anxiety, and depression in this demographic has accumulated substantially over the past decade.

This review synthesizes current evidence on the health consequences of excessive gadget use in school children, with particular attention to the upper-grade adolescent population, discusses underlying mechanisms, and proposes evidence-based recommendations for clinicians, educators, and policymakers.

2. METHODS

A narrative review was conducted using PubMed, PsycINFO, Scopus, and Google Scholar. Search terms included: 'screen time children health effects,' 'smartphone adolescents,' 'gadget use school children,' 'myopia screen time,' 'musculoskeletal smartphone,' 'digital device sleep adolescents,' 'social media mental health youth,' 'gaming disorder children,' 'digital addiction youth,' and 'sedentary behavior children.' Studies published between 2010 and 2024, including original research, meta-analyses, systematic reviews, and national health guidelines, were included. Priority was given to studies with samples of school-age children (6–18 years) and quantitative exposure-outcome measurements. Studies examining preschool children exclusively or adults without adolescent subgroup analysis were excluded.

3. RESULTS

3.1 Ophthalmological Effects: Myopia Epidemic

Among the most robustly established health consequences of gadget use in children is the acceleration of myopia (nearsightedness) development and progression. Myopia prevalence has risen dramatically over the past three decades, prompting researchers to describe a global 'myopia epidemic.' In East Asia, where screen time is highest among children, myopia prevalence reaches 80–90% among university-age populations. A meta-analysis of 145 studies across 2.1 million participants confirmed a strong association between near-work activities — including smartphone and tablet use — and myopia onset and progression.

The mechanisms involve sustained ciliary muscle contraction during near-work tasks, creating myopigenic retinal signals that promote axial elongation of the eyeball. Crucially, outdoor time appears protective through the dopamine-releasing effects of bright light on the retina, which inhibits axial elongation. With increased indoor gadget use displacing outdoor activity, children lose this protective exposure. Computer vision syndrome — a cluster of symptoms including eye strain, dry eyes, blurred vision, headaches, and neck pain — is reported by 50–90% of heavy screen users. Blue light emitted by device screens contributes to photoreceptor stress and circadian rhythm disruption.

3.2 Musculoskeletal Effects

Prolonged gadget use enforces postures that stress the cervical and lumbar spine. 'Text neck' — a term describing the forward head posture adopted during smartphone use — places up to five times the normal cervical load on the neck when the head is flexed at 60 degrees. A cross-sectional study of 749 high school students found that those using smartphones more than 4 hours per day had a 6-fold higher prevalence of neck pain compared to minimal users.

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Adolescents in grades 7–11, who may spend 6–10 hours daily on devices for combined academic and recreational purposes, are at substantial risk.

Additionally, repetitive thumb movements during touchscreen typing are associated with de Quervain's tenosynovitis and trigger finger in adolescents — conditions previously rare in this age group. Prolonged sitting during device use contributes to weakened core musculature, poor posture, and low back pain. Studies in school populations across South Korea, Germany, and India have consistently documented higher rates of musculoskeletal complaints in heavy gadget users.

3.3 Sleep Disruption

Digital gadget use, particularly in the evening and nighttime hours, significantly disrupts sleep quality and quantity in school children through multiple mechanisms. Blue-spectrum light suppresses melatonin secretion by the pineal gland, delaying sleep onset. Social media and gaming content triggers cortisol and dopamine release, maintaining arousal incompatible with sleep initiation. Notification alerts fragment sleep. A systematic review of 67 studies found that device presence in the bedroom was associated with a 31-minute reduction in sleep duration and a 2.04-fold increase in excessive daytime sleepiness.

Adequate sleep (8–10 hours for adolescents) is essential for synaptic consolidation, immune function, hormonal regulation, and emotional regulation. Chronic sleep restriction is independently associated with obesity, impaired academic performance, depressive symptomatology, and increased injury risk. The co-occurrence of sleep deprivation and excessive screen time creates a reinforcing cycle, as fatigued children often turn to stimulating digital content for arousal maintenance.

3.4 Mental Health Consequences

Anxiety and depression: A substantial body of evidence links heavy social media and smartphone use to heightened anxiety and depressive symptoms in adolescents, with effect sizes that have strengthened as usage has intensified. A longitudinal study of over 6,000 adolescents in the United States demonstrated that daily social media use exceeding 3 hours was associated with a significantly higher risk of depression and anxiety compared to peers using less than 1 hour per day. Mechanisms include social comparison, cyberbullying victimization, fear of missing out (FOMO), disrupted sleep, and displacement of protective offline social interactions.

Attention and academic performance: Neuroimaging studies have demonstrated structural and functional differences in prefrontal cortical regions implicated in executive function — including impulse control, attention regulation, and working memory — in adolescents with problematic internet use compared to controls. The high-stimulation, reward-delivering nature of social media and gaming may downregulate dopaminergic motivation pathways, reducing capacity for sustained attention in lower-stimulation learning environments. Meta-analyses link heavy recreational screen time to lower academic achievement scores in mathematics, reading, and sciences.

Gaming disorder and digital addiction: The WHO included gaming disorder in ICD-11 (2022), defining it as impaired control over gaming behavior with increasing priority given to gaming over other activities, despite negative consequences. Prevalence estimates among adolescents range from 1–9%, with higher rates in male adolescents. Internet gaming disorder activates the same neural reward circuits as substance addiction, with functional MRI studies revealing hyper-reactivity of the nucleus accumbens to gaming cues.

3.5 Physical Inactivity and Obesity

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Gadget use is among the strongest displacers of physical activity in children. Each additional hour of recreational screen time is associated with reduced vigorous physical activity, decreased cardiorespiratory fitness, and higher adiposity indices. The obesogenic effect of screens extends beyond activity displacement to include reduced sleep (promoting appetite-stimulating hormones ghrelin and cortisol) and exposure to food advertising, which is disproportionately for energy-dense products. In school populations, screen-induced physical inactivity is a primary driver of the declining physical fitness trends documented across Central Asian countries since the 1990s.

4. DISCUSSION

The convergence of evidence from ophthalmology, orthopedics, sleep medicine, neuropsychology, and public health paints a consistent picture: excessive, unregulated gadget use during childhood and adolescence is harmful across multiple health domains. The effect sizes reported are clinically meaningful — a doubling of depression risk, 6-fold increase in neck pain, 30+ minutes of lost sleep nightly — representing substantial individual and population-level burden.

It is critical to note that gadgets per se are not inherently harmful; educational and communicative uses provide genuine value, and blanket prohibition is neither feasible nor desirable in the modern era. Rather, the goal is optimizing the quality, context, and quantity of digital engagement. Evidence-based screen time recommendations — no more than 2 hours of recreational screen time for school-age children, device-free bedrooms, outdoor time targets — provide practical guidance for families and schools.

In Uzbekistan and the Andijon region specifically, rapidly rising smartphone and internet penetration has outpaced the development of digital health literacy among parents, teachers, and health workers. School hygiene curricula should integrate digital health education, covering ergonomics, blue light protection, safe social media practices, and self-regulation strategies. School physicians and pediatricians should routinely screen for problematic device use, myopia progression, musculoskeletal complaints, and sleep difficulties in adolescent patients.

Policy interventions — including regulations on digital device use in schools, restrictions on smartphone-based game advertising targeting minors, and mandatory ergonomic standards for student device use — represent system-level levers that can support healthier digital engagement environments without eliminating the educational benefits of technology.

5. CONCLUSION

Digital gadgets exert significant, evidence-based negative health effects on school-age children when used excessively and without appropriate guidance. These effects encompass vision (myopia), musculoskeletal health (text neck, repetitive strain), sleep (melatonin suppression, fragmentation), mental health (depression, anxiety, gaming disorder), cognitive function (attention, academic performance), and physical fitness (inactivity, obesity). The adolescent population in Uzbekistan, including upper-grade students in the Andijon region, is at increasing risk as device penetration rises rapidly.

A coordinated response engaging schools, healthcare providers, parents, and policymakers is needed to promote healthy digital habits, establish evidence-based screen time guidance, and integrate digital health literacy into the standard hygiene and health education curriculum. Future research should generate regionally specific prevalence data and evaluate the effectiveness of culturally adapted digital health interventions in Central Asian school populations.

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