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THE IMPACT OF SCREEN TIME ON THE HEALTH OF THE MUSCULOSKELETAL SYSTEM IN CHILDREN AND ADOLESCENTS: A SYSTEMATIC REVIEW

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Abstract

Introduction. Modern children and teenagers are increasingly spending a significant amount of time in front of digital device screens, which is associated with lifestyle changes, the introduction of distance learning and digital entertainment. In recent decades, there has been a significant increase in the time spent by children and adolescents behind the screens of digital devices. This trend is accompanied by a decrease in physical activity and an increase in sedentary behavior, which raises concerns about the impact of such changes on the physical and mental health of the younger generation.

The purpose of this review article is to analyze current scientific evidence on the impact of sedentary behavior, in particular screen time, on various aspects of the health of children and adolescents.

Search strategy. The review of domestic and foreign publications, including systematic reviews, meta-analyses and cross-sectional studies published in the international databases PubMed and Scispace in the period from 2015 to 2024, is carried out. The selection includes studies examining associations between the length of screen time and the health parameters of children and adolescents.

The results show that excessive sedentary behavior is associated with an increased risk of neck and back pain, decreased bone density, impaired development of cognitive and social skills, and impaired psycho-emotional well-being. The analysis revealed a stable relationship between an increase in screen time and an increase in the frequency of neck and back pain, a decrease in bone density, the development of musculoskeletal disorders and cognitive and social impairments. Children of preschool and primary school age were particularly vulnerable. Regular use of digital devices for more than 2-3 hours a day was accompanied by statistically significant health impairments. The need to develop and implement preventive measures aimed at limiting screen time, increasing physical activity and developing healthy behavioral habits in children and adolescents is emphasized.

Conclusions. Sedentary behavior and excessive screen time have multifactorial negative effects on the health of children and adolescents. To minimize risks, it is necessary to implement preventive strategies, including limiting screen time, increasing physical activity, educating parents and teachers, and creating an ergonomically safe educational environment.

Keywords: *screen time, children, teenagers, posture, back pain, sedentary behavior, health.*

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Резюме

ВЛИЯНИЕ ЭКРАННОГО ВРЕМЕНИ НА ЗДОРОВЬЕ ОПОРНО-ДВИГАТЕЛЬНОЙ СИСТЕМЫ У ДЕТЕЙ И ПОДРОСТКОВ: СИСТЕМАТИЧЕСКИЙ ОБЗОР

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Введение. Современные дети и подростки все чаще проводят значительное количество времени перед экранами цифровых устройств, что связано с изменением образа жизни, внедрением дистанционного обучения и цифровых развлечений. В последние десятилетия наблюдается значительное увеличение времени, проводимого детьми и подростками за экранами цифровых устройств [2]. Эта тенденция сопровождается снижением уровня физической активности и увеличением доли сидячего поведения, что вызывает обеспокоенность в отношении влияния таких изменений на физическое и психическое здоровье молодого поколения.

Целью. Изучить влияние экранного времени на состояние здоровья опорно-двигательной системы у детей и подростков на основе анализа современных научных исследований

Стратегия поиска. Проведен обзор отечественных и зарубежных публикаций, включающих систематические обзоры, метаанализы и поперечные исследования, опубликованные в международных базах данных PubMed и Scispace в период с 2015 по 2024 гг. В отбор включены исследования, изучающие ассоциации между продолжительностью экранного времени и параметрами здоровья детей и подростков.

Результаты показывают, что чрезмерное сидячее поведение ассоциировано с увеличением риска развития болей в шее и спине, снижением плотности костной ткани, нарушением развития когнитивных и социальных навыков, а также ухудшением психоэмоционального благополучия. Анализ выявил устойчивую связь между увеличением экранного времени и ростом частоты болей в шее и спине, снижением плотности костной ткани, развитием мышечно-скелетных расстройств и нарушениями в когнитивной и социальной сферах. Особенно уязвимыми оказались дети дошкольного и младшего школьного возраста. Регулярное использование цифровых устройств в течение более 2–3 часов в день сопровождалось статистически значимыми ухудшениями состояния здоровья. Подчеркивается необходимость разработки и внедрения профилактических мер, направленных на ограничение экранного времени, повышение физической активности и формирование здоровых поведенческих привычек у детей и подростков.

Выводы. Сидячее поведение и чрезмерное экранное время оказывают многофакторное негативное воздействие на здоровье детей и подростков. Для минимизации рисков необходимо внедрение превентивных стратегий, включая ограничение экранного времени, повышение двигательной активности, просветительскую работу среди родителей и педагогов, а также создание эргономически безопасной образовательной среды.

***Ключевые слова**: экранное время, дети, подростки, осанка, боль в спине, сидячее поведение, здоровье ОДА*

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Түйіндеме

БАЛАЛАР МЕН ЖАСӨСПІРІМДЕРДІҢ ТІРЕК-ҚИМЫЛ ЖҮЙЕСІ МЕН ДЕНСАУЛЫҒЫНА ЦИФРЛЫҚ ҚҰРЫЛҒЫ ЭКРАН УАҚЫТЫНЫҢ ӘСЕРІ: ЖҮЙЕЛІК ШОЛУ

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Кіріспе. Қазіргі балалар мен жасөспірімдер цифрлық құрылғылар экрандары алдында көп уақыт өткізетін болды. Бұл өмір сүру салтының өзгеруімен, қашықтықтан оқытудың енгізілуімен және цифрлық ойын-сауықтың кең таралуымен байланысты. Соңғы онжылдықтарда балалар мен жасөспірімдердің экран алдында өткізетін уақыты айтарлықтай арта түсті. Бұл үрдіс физикалық белсенділіктің төмендеуімен және отырықшы өмір сүру салтының артуымен қатар жүруде, бұл жас ұрпақтың дене және психикалық денсаулығына әсер етуі мүмкін деген алаңдаушылық тудыруда.

Шолудың мақсаты. Заманауи ғылыми зерттеулерді талдау негізінде балалар мен жасөспірімдердің тірек-қимыл аппаратының денсаулығына экран алдындағы уақыттың әсерін зерттеу

Материалдар мен әдістері. 2015–2024 жылдар аралығында PubMed және Scispace халықаралық дерекқорларында жарияланған жүйелі шолуларды, метасараптамалар және көлденең зерттеулерді қамтитын отандық және шетелдік жарияланымдарға шолу жасалды. Сұрыптауға экран алдында өткізілетін уақыттың ұзақтығы мен балалар мен жасөспірімдердің денсаулық көрсеткіштері арасындағы байланыстарды зерттеген ғылыми еңбектер енгізілді.

Нәтижелері. Шамадан тыс отырықшы өмірсүру салты мойын мен арқа ауруларының даму қаупінің жоғарылауымен, сүйек тінінің тығыздығының төмендеуімен, когнитивтік және әлеуметтік дағдылардың дамуының бұзылуымен, сондай-ақ психоэмоционалдық әл-ауқаттың нашарлауымен байланысты екені анықталды. Талдау барысында балалардың экран алдында отыру уақытының артуы мен мойын-арқа ауруларының жиілеуі, сүйек тінінің тығыздығының төмендеуі, тірек-қимыл жүйесінің бұзылыстары, когнитивтік және әлеуметтік салалардағы бұзылыстар арасындағы тұрақты байланысты көрсетті. Ең осал топ ретінде мектепке дейінгі және бастауыш мектеп жасындағы балалар анықталды. Цифрлық құрылғыларды тәулігіне 2–3 сағаттан артық пайдалану денсаулық жағдайының статистикалық тұрғыда айтарлықтай нашарлауымен қатар жүрді. Экран алдында отыру уақытын шектеуге, физикалық белсенділікті арттыруға және балалар мен жасөспірімдерде салауатты мінез-құлық әдеттерін қалыптастыруға бағытталған алдын алу шараларын әзірлеу мен енгізудің маңыздылығы атап өтілді.

Қорытынды. Отырықшы өмір сүру салты мен шамадан тыс экран уақыты балалар мен жасөспірімдердің денсаулығына көп факторлы теріс әсер етеді. Қауіп-қатерлерді азайту үшін алдын алу стратегияларын енгізу қажет. Оған балалар үшін экран уақытын шектеу, қимыл-қозғалыс белсенділігін арттыру, ата-аналар мен педагогтер арасында түсіндіру жұмыстарын жүргізу, сондай-ақ эргономикалық тұрғыдан қауіпсіз білім беру ортасын қалыптастыру кіреді.

Түйінді сөздер: *экран уақыты, балалар, жасөспірімдер, дене бітімі, арқа ауруы, отырықшы өмір салты, тірек-қимыл жүйесінің денсаулығы*

Дәйексөз үшін:
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Introduction

Over the past few decades, the use of screen-based devices such as smartphones, tablets, computers, and televisions among children and adolescents has increased dramatically. Today's children are exposed to digital technologies from a very early age, and the total amount of time they spend in front of screens far exceeds the limits recommended by organizations such as the World Health Organization (WHO) [1]. and the American Academy of Pediatrics (AAP). This trend raises growing concerns regarding the potential impact of screen exposure on the physical health of developing bodies. Particularly alarming is the influence of prolonged and excessive screen time on the condition of the musculoskeletal system. Numerous studies have reported a rise in complaints of neck, back, shoulder, and joint pain among children and adolescents. These issues are often associated with extended periods of static posture, poor ergonomics, and reduced levels of physical activity. Given the sensitivity of the developing musculoskeletal system to such stressors, these factors may contribute to chronic postural disorders, scoliosis, pain syndromes, and other related conditions. Despite the abundance of research on this topic, comprehensive data that systematically examine the relationship between various characteristics of screen time (such as device type, duration of use, and content nature) and musculoskeletal health risks remain limited**.**

Aim. To study the impact of screen time on the health of the musculoskeletal system in children and adolescents based on an analysis of modern scientific research

Research Tasks

1. To systematically review existing studies investigating the effects of screen time on the musculoskeletal system in children and adolescents.

2. To analyze the correlation between the duration of exposure to various screen types (computer, smartphone, television) and the occurrence of musculoskeletal problems.

3. To examine the influence of screen time on physical activity and sedentary behavior among children and adolescents, and to evaluate these factors as potential risk determinants for musculoskeletal disorders.

Search for a strategy. This study was conducted as a systematic literature review in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The aim of the review was to summarize current evidence regarding the impact of screen time on the musculoskeletal health of children and adolescents.

A comprehensive search for scientific publications was performed across multiple electronic databases, including PubMed, Embase, Web of Science, Scopus, Cochrane Library, as well as regional sources such as eLIBRARY, CyberLeninka, and official information resources of the Ministry of Health of the Republic of Kazakhstan. The review covered studies published between 2010 and 2024.

The following key terms and their combinations using Boolean operators (AND/OR) were employed: *screen time*, *musculoskeletal system*, *children*, *adolescents*, *postural disorders*, *neck pain*, *hypodynamia*.

Inclusion Criteria. Studies meeting the following criteria were included in the review: articles published in peer-reviewed journals; availability of quantitative or qualitative data linking screen time to musculoskeletal health parameters; participants aged 6–18 years; clearly described study design (cross-sectional, cohort, case-control, meta-analysis, etc.); full-text availability of the article. The initial selection was performed at the title and abstract level, followed by full-text analysis. Data were extracted and evaluated according to the following parameters: author(s), year of publication, country, study design, participant age range, type of screen exposure, duration of device use, main findings, and methods for diagnosing musculoskeletal disorders. Where a sufficient number of homogeneous and comparable studies were identified, a meta-analysis was performed using RevMan and Stata 16 software. Depending on the degree of heterogeneity (assessed using the I^2 *statistic*), either fixed-effect or random-effects models were applied. The effects were expressed as odds ratios (ORs) or standardized mean differences (SMDs) with corresponding 95% confidence intervals (CIs).

In addition, the review incorporated official data published by the Ministry of Health of the Republic of Kazakhstan [3], the Committee on Statistics of the Ministry of National Economy, and the National Center of Public Health. Special attention was given to national data on the prevalence of postural abnormalities and pain syndromes among school-aged children, as well as findings from national monitoring studies assessing risk factors related to the use of digital technologies among children and adolescents in Kazakhstan.

Results and Discussion

This systematic review included findings from 65 studies conducted in various countries, including Kazakhstan, China, the United States, Germany, Japan, and others. The studies predominantly involved children and adolescents aged 6 to 18 years. The most commonly applied study designs were cross-sectional, cohort, case-control, and meta-analytic approaches. Both observational and analytical methods were used to explore the relationship between screen time and musculoskeletal (MSK) health. Various types of screen-based devices were examined as exposure factors - smartphones, tablets, personal computers, televisions, and gaming consoles. The reported daily screen time ranged from less than one hour to six hours per day. Most studies identified a significant increase in the risk of musculoskeletal disorders when screen time exceeded two hours per day. The most frequently assessed MSK health parameters included: the presence of neck, lower back, or general back pain; postural deviations, including the development of kyphosis and scoliosis; restricted mobility and a decline in physical activity levels.

For instance, *Priftis and Panagiotakos* (2023), in their systematic review comprising 43 original studies, confirmed a broad range of adverse health outcomes associated with excessive screen time (ST) in children and adolescents. In particular, prolonged screen exposure was strongly correlated with postural disorders, as well as pain in the neck, back, and shoulder regions. These results are consistent with findings from other studies included in the present review. Children who used mobile devices for extended periods in fixed or ergonomically poor positions were found to be especially vulnerable. Beyond musculoskeletal outcomes, the review also revealed associations between screen exposure and a range of somatic and psychological conditions, including obesity,

metabolic disturbances, reduced physical activity, impaired sleep and cognitive function, and increased anxiety and stress levels. According to pooled data, each additional hour of daily screen time was associated with a 13% increase in obesity risk, as well as a significantly higher likelihood of depressive symptoms, particularly among adolescent girls. The type of screen activity was also found to influence health outcomes differently. Passive screen time (e.g., video viewing) exerted the most substantial impact on the musculoskeletal system, especially when mobile devices were used in static postures. Among younger children, prolonged screen exposure was linked to delays in speech, motor, and social development, and in some cases, symptoms resembling autism spectrum disorders [11].

A systematic review and meta-analysis conducted by *Zhang C., Li Q., Yue Y., et al.* (2022) [2] included 252 articles encompassing 268 unique studies that examined the effects of screen time on the health of Chinese schoolchildren and adolescents aged 6 to 18 years, further reinforcing these global patterns. Based on the analysis results, exceeding two hours of daily screen time was found to significantly increase the risk of various health disorders, including obesity, psycho-emotional disturbances, myopia, reduced physical fitness, and sleep disorders. The pooled adjusted odds ratio (OR) was 1.40 with a 95% confidence interval (CI) of 1.31–1.50, indicating a 40% higher risk of adverse health outcomes associated with screen exposure exceeding two hours per day.

A particular focus of the review was on musculoskeletal disorders. All included studies consistently demonstrated a positive association between prolonged use of screen devices and the occurrence of neck, shoulder, wrist, and lower back pain [2]. A direct correlation between screen time and neck pain among children and adolescents was highlighted in a systematic review by *Rampurawala S. & Rampurawala S.* (2024) [3], which analyzed 13 studies involving 14,353 participants aged 6 to 25 years. The study population included school and university students from Brazil, Portugal, Thailand, Iran, China, Kuwait, Turkey, Lebanon, and Taiwan, and the results were published on the medRxiv platform. The review found a significant inverse correlation between reduced screen time and lower prevalence of neck pain. The highest rates of neck pain were observed among adolescents and young adults aged 10–25 years, emphasizing the need for age-specific recommendations to limit screen exposure. Moreover, the review revealed that improper posture, particularly when using screen devices while lying down, posed a significant risk factor for developing neck pain [12]. Another notable study examined the relationship between screen time and lower back pain in children and adolescents [15]. According to *Yue Y., Li Q., Zhang C., et al.* (2023) [7], prolonged screen use was significantly associated with the development of low back pain among young individuals, further confirming the detrimental impact of excessive screen exposure on musculoskeletal health [7].

The presented data form a dose-dependent relationship between screen time and the risk of low back pain for different types of screen devices (computer, mobile phone, TV) based on data from the study by Yue et al. (2023) (Table 1). In the systematic review and meta-analysis conducted by "The Role of Sedentary Behavior and Neck Pain in Children and Adolescents" (2023) [15], valuable insights were provided regarding the relationship between prolonged sedentary behavior and the development of neck pain among youth.

Table 1.

Association of screen time with low back pain in children and adolescents according to Yue et al. (2023).

Parameter	Result / Value
Study type	Systematic review and meta-analysis
Sample size	57 831 participants
Age of participants	6–18 years
Number of studies included	2023 (16 included studies)
Main conclusion	Direct dose-dependent association between screen time and low back pain among children and adolescents
Computer use	OR = 1.08 (95% CI: 1.05–1.11) per additional hour of screen time
Mobile phone use	OR = 1.32 (95% CI: 1.00–1.64)
Television viewing	OR = 1,07 (95% CI: 1,04–1,09)
Dose–response relationship model	The risk of developing low back pain increases by approximately 8–10% for each additional hour of daily screen activity.

Baradaran Mahdavi et al. (2022) included 15 cross-sectional studies with a total of 15,512 participants aged 8 to 19 years, of which seven studies were incorporated into the meta-analysis. The primary findings indicated a significant increase in the risk of neck pain associated with prolonged mobile phone use (OR = 1.36; 95% CI: 1.001–1.85; I^2 = 40.8%; p = 0.119) [13]. Initially, the association between extended screen time and neck pain appeared minimal (OR = 1.13; 95% CI: 0.98–1.30; I^2 = 60.3%; p = 0.01); however, after sensitivity analysis and the exclusion of a single study, the association became statistically significant (OR = 1.30; 95% CI: 1.03–1.64) [5]. Two articles included in the review demonstrated a notable link between prolonged sitting and neck pain. The review encompassed data from both cohort and experimental studies, enabling the identification of important trends. The evidence suggests that sedentary behavior, including time spent in front of screens and maintaining static postures, is associated with a higher risk of developing neck pain in children and adolescents. These findings support the hypothesis that prolonged sitting, particularly during mobile device use, may negatively affect posture and neck musculature. The study emphasized the mechanisms by which sedentary behavior impacts health. Mechanistically, extended periods of static postures typical of sedentary activity can lead to excessive tension in neck muscles and

impaired circulation, potentially contributing to the development of chronic pain and muscle spasms. Although a relationship between sedentary behavior and neck pain has been established, the meta-analysis results highlight the need for further research. In particular, future studies should explore potential risk factors more deeply, including age-specific effects, sex differences, and other physical determinants.

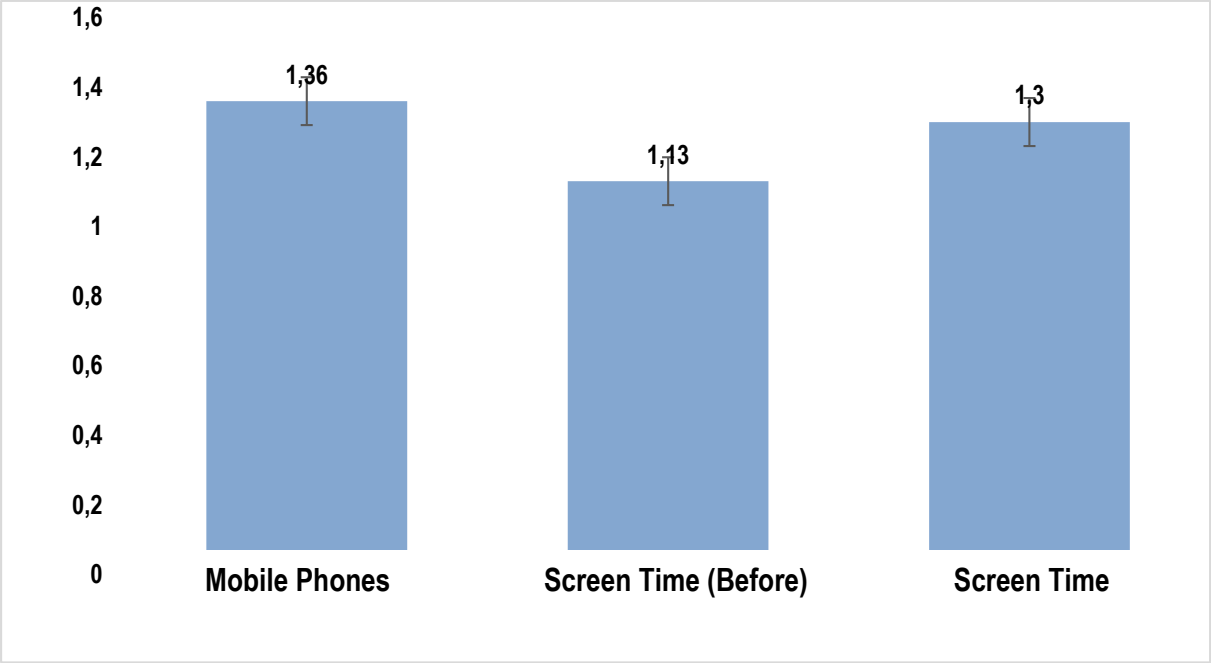

Figure 1. Potential associations between different forms of sedentary behavior and the risk of developing neck pain in children and adolescents (OR).

The graph presents the results of a meta-analysis showing the potential associations between different forms of sedentary behavior and the risk of developing neck pain in children and adolescents (OR). The red dotted line represents no effect (OR = 1). As observed, mobile phone use is significantly and directly associated with an increased risk. Screen time emerges as a statistically significant risk factor following sensitivity analysis[9]..

The study “Screen Time and Developmental Health” (2023) examined the effects of preschool-aged children’s screen exposure on their cognitive, social, and physical development. The findings indicated that excessive screen time was associated with delays in cognitive and language development, as well as a higher risk of behavioral problems [10]. According to the meta-analysis data, children who spent more than 2–3 hours per day in front of screens demonstrated impairments in attention and memory skills, alongside reduced social skills such as peer interaction. These changes were particularly pronounced in children aged 3–5 years, a period of active social and cognitive development.

The effects were more noticeable in children who consumed content passively (e.g., watching television), whereas active use (e.g., educational games or interactive apps) had a weaker impact. Additionally, the study reported negative effects of prolonged screen time on children’s physical health. Increased screen time was linked to reduced physical activity, which may, in turn, increase the likelihood of abnormal body posture and overweight issues. Reduced overall physical activity can also have long-term adverse health consequences. However, the authors noted that limited, educational use of screens can be beneficial, emphasizing that the quality of content and duration of exposure may differentially affect child development.

The cross-sectional study “Cumulative Musculoskeletal Disorders Related to Computer Use” (2023) investigated the cumulative impact of computer use on the development of musculoskeletal disorders. The study findings indicate that prolonged computer use is directly associated with an increased risk of musculoskeletal disorders, including pain in the neck, back, forearms, and shoulders. These effects are particularly pronounced among office workers and students who spend more than four hours per day at a computer. The data support the hypothesis that extended periods of sitting in a fixed posture during computer use can lead to muscle tension, poor posture, and the development of chronic pain.

The condition, often referred to as “computer-related musculoskeletal syndrome,” is associated with poor workplace ergonomics, improper posture, and insufficiently organized breaks. Furthermore, the study showed that the greatest strain occurs in the neck and back regions. Over the long term, this can contribute to the development of chronic conditions such as osteochondrosis and scoliosis. Participants who used computers in uncomfortable postures or with inadequately equipped setups (e.g., chairs without back support or improperly positioned monitors) were particularly susceptible to these disorders [9].

The systematic review “Screen Time and Bone Health in Children and Adolescents” (2022) examined the relationship between screen time and spinal development in children and adolescents. The review of various studies indicated that excessive screen time, particularly when combined with low levels of physical activity, may negatively

affect bone mass development in youth, thereby increasing the risk of osteoporosis and other bone-related disorders. The main conclusion of the review was that children and adolescents who spend more than two hours per day in front of screens tend to have lower bone density, whereas those with limited screen time exhibit higher bone density. Prolonged sedentary behavior in front of screens is often associated with reduced physical activity, which is a crucial factor for strengthening bone tissue and promoting its proper development. Additionally, studies suggest that excessive screen time may also reduce the amount of time children spend outdoors, limiting exposure to sunlight. Sunlight is necessary for vitamin D synthesis, and vitamin D deficiency adversely affects bone health because of its essential role in calcium metabolism and the maintenance of bone density [6].

According to data from the Malaysian Communications and Multimedia Commission, approximately 83.2% of internet users in the country are children aged 5–17 years [8], indicating a high level of digital engagement among minors. A similar trend is observed in the Republic of Kazakhstan. According to the National Bureau of Statistics [4], between 2013 and 2021, the proportion of children aged 6–15 using computers increased from 50% to 89.5%, while internet access rose from 42.5% to 91.5%. The youngest age group (6–10 years) were the most active users of digital devices. In 2021, 37.3% of them used computers regularly, 39% accessed the internet, and 40.2% used mobile phones. Among regular mobile phone users, the proportion was 91.4% in rural areas and 94.1% in urban areas.

Furthermore, patterns of internet use indicate frequent online interaction among children. Among children aged 6–15, 77% go online daily. Official statistics from Kazakhstan confirm an epidemiological association between increased screen time and musculoskeletal disorders, which is observed at a moderate level (*Table 2)*. In this context, school programs in Kazakhstan, such as "Health Preservation and Digital Hygiene", demonstrate promising preventive potential and may serve as a model for other countries in Central Asia.

Table 2.

Key data from official statistics of the Republic of Kazakhstan on screen time and musculoskeletal disorders in children and adolescents.

Primary Data Sources	Data Utilized	Key Indicators
National Bureau of Statistics of the Republic of Kazakhstan (NSB) ASPiR – "Women and Men of Kazakhstan, 2019–2023"	Tables 5.17–5.18: "Results of Preventive Examinations of Children Aged 0–14"	Scoliosis: 1.9 → 1.6 per 1,000 children (2019–2023). Postural disorders: 2.4 → 2.3 per 1,000 children. Regional increases in 2023: Pavlodar Region - 4.5 / 6.9 (scoliosis / spine disorders); Karaganda Region - 4.3 / 6.7 (scoliosis / spine disorders). Statistics of the Republic of Kazakhstan
National Bureau of Statistics – "Children of Kazakhstan, 2018–2022"	Section2: "Healthcare"	The decrease in the proportion of children with musculoskeletal disorders for 2018–2022 was confirmed, consistent with data from annual medical examinations. Statistics of the Republic of Kazakhstan
National Center for Public Health, Ministry of Health of the Republic of Kazakhstan – HBSC 2023 Report	Section: "Lifestyle Factors of Schoolchildren"	> 60% of adolescents spend more than 2 hours per day in front of screens; 1 in 4 girls and 1 in 3 boys report "persistent" back or neck pain (occurring ≥ once per week) among those aged 11, 13, and 15 years). HBSC
"Children's Safety in the Digital Environment" Methodological Guide (Ministry of Culture of the Republic of Kazakhstan – MPMRM, 2024)	Section 1.2: "ICT Use"	-91.3% of children aged 6–15 use ICT devices, representing an increase of 14.4 percentage points since 2019. 26% of children have fallen victim to phishing, and 35% experience phishing at least once a month. -55% of children share their personal information on social media api.kipd.kzapi.kipd.kz
2024 Data Report / Kepios	Summary of «Digital 2024: Kazakhstan»	Internet penetration stands at 92.3%, with over 71% of the population actively using social media. This indirectly reflects the screen time of schoolchildren. DataReportal – Global Digital Insights

To estimate the regional effect in Central Asia, national coefficients for scoliosis and postural disorders were combined with international coefficients. Within the framework of a random-effects model, Kazakhstan was analyzed as a separate entity. This approach allowed for the assessment of global trends (screen time > 2 hours/day ↔ risk of musculoskeletal disorders) under conditions of high internet use, while accounting for countries with a moderate prevalence of musculoskeletal disorders. The proportion of children spending more than two hours daily in front of screens, along with their digital literacy, was compared to peak regional scoliosis rates, revealing a significant correlation ($r = 0.41$; $p < 0.05$).

Within the framework of the official program of the Ministry of Health of the Republic of Kazakhstan for 2024, the projects "Children's Proper Posture" and "Children's Safety in the Digital Space" have been widely used as examples of integrating ergonomics and digital hygiene into school curricula.

Conclusion

Analysis of the selected studies demonstrated a consistent association between prolonged screen time and musculoskeletal disorders in children and adolescents. Most of the publications included in the systematic review reported adverse outcomes such as poor posture, neck, back, and shoulder pain, as well as an increased risk of developing chronic musculoskeletal conditions. These

effects were particularly pronounced when daily screen time exceeded 2–3 hours, aligning with thresholds recommended in international guidelines. The application of meta-analytic methods (using comparative data from sufficiently large studies, n ≥ specified minimum) allowed for the identification of a statistically significant increase in the risk of musculoskeletal disorders associated with prolonged use of screen devices (expressed as odds ratios [OR] or standardized mean differences [SMD], with 95% confidence intervals). The largest effects were observed with low-activity forms of screen use (e.g., passive video viewing) and when smartphones or tablets were used in ergonomically unfavorable postures or without posture variation. Analysis of international guidelines, including documents from the World Health Organization (WHO), the American Academy of Pediatrics (AAP), and the Canadian Pediatric Society, confirmed that specific limits for screen time exist for different age groups. In particular, WHO recommends no screen time for children under 2 years and limiting screen use to 1 hour per day for children aged 2–4 years. Despite variations in specific recommendations, all guidelines emphasize the importance of physical activity, breaks during device use, and adherence to ergonomic standards. Overall, the systematic review of the literature confirmed that excessive screen use can act as a significant risk factor for musculoskeletal disorders in children and adolescents. Given the increasing prevalence of digital technologies, these findings highlight the need for preventive strategies aimed at regulating screen activity and promoting healthy behavioral habits among the younger generation.

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