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Article

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Abstract: Background/Objectives: The growth of the digital landscape has surely outpaced the research on the effects of screen media on children's health, learning, and development. The potential risk-to-benefit ratio of screen media exposure for education. and entertainment purposes warrant further exploration. Therefore, we aimed to investigate the relationship between screen time and academic performance, anxiety, and outdoor playing among school children in India **Methods:** 537 parents responded to this online survey and reported about 537 Indian schoolchildren (mean age 10.9 years) from 5 schools. The e-questionnaire contained demographic profile information, self-reported height and weight, academic performance, and screen time-related data. The anxiety and behavioral status of the children were assessed using the Spencer Children Anxiety Scale (SCAS) and the Pediatric Symptom Checklist (Parent Version) instruments, respectively. **Results:** The mean screen time was 3.06 ±1.22 hours/day, average outdoor playing per week was 11.23 ± 4.1 hours per week, and the mean BMI was 18.2±3.2. The screen time (hours) in a typical week was positively correlated with BMI, SCAS anxiety score, behavioral problems, and academic performance in the linear regression analysis. **Conclusions:** We conclude that screen time was associated with increased BMI, behavioral problems, and poor academic performance. Further research is necessary to rule out the influence of other intricate factors, such as sleep and parental involvement. The careful use of digital media must serve as a positive force in children's educational and developmental trajectories.

Keywords: screen time; anxiety; behavior pattern health risk; schoolchildren; academic performance

1. Introduction

Digital learning is already an essential part of Indian schools. The digital India education program (Prime Minister E-Vidya) aims to improve digital infrastructure by providing schoolchildren with digital content(Kumar & Selva Ganesh, 2022; V. A. & Panakaje, 2022). The National Council of Education Research and Training (NCERT, India) offers schoolchildren interactive learning, textbooks, audio, and video content(Singh & Agarwal, 2023). Although few rural areas in India lack affordable internet and digital infrastructure, the digital divide persists. The Union Education Ministry (UDISE, 2021-22) found that 0.54 million of 1.48 million schools used digital learning systems(Deb, 2024). Digital education is a government initiative and the future for many Asian countries. Digital education offers interactive learning, local language content, different formats, customized classes, inclusivity, and flexibility(Li et al., 2020). The health concerns of children must be explored more if we are to safely transition to technology-based education. According to Happinetz, Indian children spend 2–4 hours per day on screens for entertainment and digital games. Screen time exposure harms children's physical, mental, social, and academic health, so researchers recommend limiting it(Moitra & Madan, 2022; Varadarajan et al., 2021). Screen time exposure is reported as early as infancy in most countries and excess screen time prevalence ranged from 10% to 93.7% across high-income countries, 21% to 98% in middle-income countries, and 1.0 to 3.1 hours/day among school-aged children in several countries(Carson & Janssen, 2012; Domingues-Montanari, 2017; Hale & Guan, 2015; Id et al., 2020). Studies conducted in India reported that the median age of first screen exposure at 10 months and most school-aged children use smartphones (96%) followed by television (89%). A systematic review of Indian studies found that 39% to 44% of adolescents suffer from smartphone addiction and the most probable root cause being excess screen time during childhood. The Indian Academy of Paediatrics (IAP) advises that children aged 5 or younger should have less than one hour of screen time, while older children should balance screen time with physical activity, sleep, meals, academic responsibilities, social interactions, and hobbies. If screen time appears to supplant these activities, it can be classified as excessive screen(Gupta et al., 2022; M. Sharma et al., 2022). In addition, there is significant variation in the definition of excess screen time across studies, ranging from 1 hour to over 3 hours(Muppalla et al., 2023; Pandya & Lodha, 2021; Tezol et al., 2022). In 2021, the Indian Academy of Pediatrics (IAP) released parental guidelines regarding screen time, cautioning against the detrimental effects of excessive usage and providing recommendations on digital hygiene, appropriate usage, the initiation of social media for children, and related subjects(M. Sharma et al., 2022).The recent surge in digital usage and associated health concerns like sleep disturbances, shortened sleep duration, adverse weight gain, poor academic performance, attention deficits, emotional dysregulation, less prosocial behavior, reduced physical activity, and outdoor play among children has drawn the attention of the researchers in the recent times(Menon et al., 2021; Presta et al., 2024). Conversely, some researchers argue that screen time is associated with better academic performance. Hence, given the governmental plan to expand digital technology in Indian schools and the reports of digital gluing among children, this study aimed to explore the relationship between screen time to academic performance, anxiety, and outdoor playing among school children in India..

2. Materials and Methods

Study design and participants

The current study was conducted during Jan to April 2024 using an online survey method. The study was approved by the Departmental Research Committee, School of Allied Health Sciences, Galgotias University, under reference to DEC/FEA/PT/06/23, and the study was registered with the Indian Council of Medical Research India (CTRI/2023/10/058965). This study adhered to the General Data Protection Regulation (GDPR) and Digital Personal Data Protection Act, India(M & C, 2020).

The school authorities in Greater Noida city were approached and the importance of the study was explained. The counselors of five private schools consented and the school distributed the online survey questionnaire to the parents of children studying grade 3 to grade 9. The parents confirmed their participation by giving informed consent at the beginning of the online survey. The consent form and information sheet emphasized the right to withdraw from the study without consequences. The anonymized dataset were obtained from the school counselors. We designed a self-administered online questionnaire with 95 items, which was compatible with mobiles, and tablets employing user-friendly interface, to facilitate easy response, we used brief instructions, simple choices, big fonts, and mostly select options. Different links were created for each grade of study to allow multiple responses if the parent had more than one child studying in the five schools selected.

Survey

The questionnaire gathered information regarding the demographic profile of the child. Anthropometric measures like height and weight of the children were asked, in addition the average screen time in hours per day, and all subject average academic performance score of the current year were asked. The screen related questions like screen media available, frequency of use by the child, and use time were used. The other measures contained are described below; The Spencer Children Anxiety Scale (SCAS - Child): The scale consists of 45 items, 38 of which assess specific anxiety symptoms, and the remaining 7 are filters used to reduce response bias. It is rated on a 4-point Likert scale where 0 is "never", 1 is "sometimes", 2 is "often" and 3 is "always". The total score is calculated from 6 subscales (panic/agoraphobia, separation anxiety, social phobia, obsessive compulsive disorder and physical injury fears). The total score ranges from 0 to 114. A higher score indicates greater severity. The average for each subscale is calculated to estimate the severity of anxiety-related symptoms(Glod et al., 2017). Pediatric Symptom Checklist (PSC - Parent Version): this scale was used to identify emotional and behavioral problems(Muzzolon et al., 2013). It consists of 35 items where parents rate a child's behavior as "Never", "Sometimes" or "Often". The total score is calculated from 0 to 20, where a higher score indicates a greater likelihood of emotional or behavioral problems. The school counselors were requested to send a reminder to the parent's to fill the questionnaire after 7 days and 537 responses were collected after 15 days. The study is reported in accordance with the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) recommendations(Elm et al., 2007).

3. Data Analysis

Data was analyzed using SPSS version 26.0 for Windows (IBM Corp., Armonk, NY, USA). The assumptions for normal distribution of the continuous variables were tested using Kolmogrov-Smirnov test and the data is presented as means ±standard deviations (SD). The categorical variables are presented as frequencies (percentages). Descriptive statistics was used to describe the children's demographic characteristics, parents-reported screen time, play time, academic performance, pediatric symptoms score, and children anxiety score. Pearson correlation analysis was used to assess the direct correlation between screen time and other variables with the level of significance at < 0.05. Linear regression analysis was used to explore if the parent-reported screen time of school children predicts variables like BMI, play time, academic performance,SCAS-Child score and PSC- Parent score secured in the examination was 81.13 (range 50 – 100 %). The average play time in a typical week was 11.23±4.1 hours and the total screen time across all digital displays was 21.45±8.54 hours per week (Table 1). The average PSC (parent completed version) score for pediatric symptoms was 38.4±12.4, with the sub-domain of externalizing problems observed with higher score (7.2±2.7) and the average SCAS children version score was 46.1±14.7, with sub-domain of panic agoraphobia observed with higher score   (9.1±3.3).

Table 1. Basic characteristics of all participants.

N =537

Sex	Boys (n, %)	291, 54.2%
	Girls (n, %)	246, 45.8%
Age, mean (SD)		10.98±2.01
BMI, mean (SD)		18.1±3.2
Screen time (hours)/week, mean (SD)		21.45±8.54
Play time (hours/week), mean (SD)		11.23±4.1
Academic performance %, mean (SD)		81.1±9.6
Pediatric Symptom Checklist mean (SD)	Attention Problem PSC	5.04±1.8
	Internalizing Problem PSC	5.1±1.9
	Externalizing Problems PSC	7.2±2.7
	PSC total	38.4±12.4
Spencer's Children Anxiety Scale mean (SD)	Separation Anxiety Score	6.1±2.3
	Social Phobia Score	6.2±2.2
	Obsessive Compulsive Score	6.3±2.2
	Panic Agoraphobia Score	9.1±3.3
	Physical Injury Fears Score	5.1±2.1
	Generalized Anxiety Score	6.0±2.4
	SCAS-Child total	46.1±14.7

Note: Pediatric Symptom Checklist (PCS- parent completed version): 74 maximum score from 37 items with 3 domains (Attention Problem PSC, Internalizing Problem PSC, Externalizing Problems PSC); Spencer Children Anxiety Scale: 135 domains of the scale were calculated separately (the separation anxiety score, social phobia score, obsessive compulsive score, panic agoraphobia score, physical injury fear score, and generalized anxiety score).

3.1. Baseline Characteristics

A total of 537 parents responded to the e-questionnaire, comprising 291 boys (54.2%) and 246 girls (45.8%). The age of the children ranged from 8 to 14 years, with a mean age of 10.98±2.01 years. The mean BMI of school children computed based on the parents reported height and weight was 18.1±3.2 kg/m² and the academic performance measured as the overall percentage of

3.2. Correlation Analysis

The correlation between screen time, age, BMI, play time, PSC score, and SCAS score are shown in Table 2. Screen time per week had no relationship with age and play time (p > 0.05). Screen time had a positive correlation with the children BMI (r 0.522, p < 0.001), academic performance (r 0.371, p < 0.001), PSC version of pediatric symptoms scale total score (r 0.504, p < 0.001) and subscales (attention problem (r 0.434, p < 0.001), internalizing problem (r 0.398, p < 0.001), externalizing problems (r 0.455, p < 0.001)). The screen time was also observed to have positive correlation with the SCAS total score for anxiety (r 0.526, p < 0.001) and all its subscales. There was a wide range of positive correlations among the total and subscales of PSC version of pediatric symptoms scale and SCAS scores (Table 2). No correlation was observed between age, play time and BMI (p > 0.05), whereas age and BMI demonstrated moderate positive correlation with PSC version of pediatric symptoms scale and SCAS scores respectively.

Table 2. Correlation Matrix of the sample (n-537).

| | Age | BMI | PA | AcP | PSC | | | | SCAS-Child version | | | | | | |
					AP	IP	EP	Total	SAS	SPS	OCS	PAS	PIFS	GAS	Total
Screen-time	0.026	0.522**	0.028	-0.37**	0.434**	0.398**	0.455**	0.504**	0.481**	0.430*	0.414**	0.451**	0.412*	0.451**	0.526**
Age	1	0.01	0.035	-0.021	-0.049	0.071	-0.014	-0.041	0.001	-0.025	-0.051	-0.009	0.041	-0.011	-0.018
BMI	0.01	1	0.085	-.429**	.777**	.771**	.847**	.960**	.805**	.804**	.771**	.851**	.795**	.807**	.967**
PA	0.035	0.085	1	-0.057	0.067	0.048	0.082	.093*	.096*	0.073	0.060	0.071	0.051	0.061	0.081
AcP	0.371*	-0.429**	-0.057	1	-.334**	-.349**	-.390**	-.413**	-.381**	-.332*	-.338*	-.389**	-.346**	-.348**	-.431**
PSC-AP	0.434**	0.77**	0.067	-.334**	1	.593**	.637**	.814**	.634**	.599**	.626**	.610**	.643**	.611**	.743**
PSC-IP	0.398**	.771**	0.048	-.349**	.593**	1	.645**	.737**	.572**	.621**	.740**	.697**	.594**	.687**	.790**

PSC-EP	0.455**	.847**	0.082	-.390**	.637**	.645**	1	.816**	.729**	.781**	.675**	.780**	.741**	.698**	.880**
PSC-total	0.504**	.960**	.093	-.413**	.814**	.737**	.816**	1	.779**	.770**	.736**	.812**	.750**	.781**	.928**
SCAS-SAS	0.481**	.805**	.096	-.381**	.634**	.572**	.729**	.779**	1	.665**	.593**	.679**	.651**	.633**	.825**
SCAS-SPS	0.430**	.804**	0.073	-.332**	.599**	.621**	.781**	.770**	.665**	1	.611**	.690**	.619**	.677**	.842**
SCAS-OCS	0.414**	.771**	0.060	-.338**	.626**	.740**	.675**	.736**	.593**	.611**	1	.623**	.616**	.626**	.793**
SCAS-PAS	0.451**	.851**	0.071	-.389**	.610**	.697**	.780**	.812**	.679**	.690**	.623**	1	.681**	.682**	.878**
SCAS-PIFS	0.412**	.795**	0.051	-.346**	.643**	.594**	.741**	.750**	.651**	.619**	.616**	.681**	1	.627**	.818**
SCAS-GAS	0.451**	.807**	0.061	-.348**	.611**	.687**	.698**	.781**	.633**	.677**	.626**	.682**	.627**	1	.842**
SCAS-Total	0.526**	.967**	0.081	-.431**	.743**	.790**	.880**	.928**	.825**	.842**	.793**	.878**	.818**	.842**	1

*P * p < 0.05, ** p < 0.001,   BMI –Body Mass Index, PA –Play activity, AcP – Academic performance, PSC - Pediatric Symptom Checklist ((PCS- parent completed version)): with 3 domains (AP- Attention Problem PSC, IP- Internalizing Problem PSC, EP- Externalizing Problems PSC); Spencer Children Anxiety Scale: with six domains (SAS - separation anxiety score, SPS - social phobia score, OCS - obsessive compulsive score, PAS - panic agoraphobia score, PIFS - physical injury fear score, and GAS - generalized anxiety score).

3.3. Linear regression Analysis

The statistically significant variables in the correlation analysis were incorporated into the linear regression model (Table 3). The linear regression model indicated that screen time is associated with children BMI (β 0.98, t = 5.8, p < 0.001), academic performance (β – 0.12, t = -2.96, p < 0.001), and pediatric symptoms scale (β – 0.178, t = 4.33, p < 0.001).

Table 3. Multiple linear regression analysis.

Model	Unstandardized coefficients β (SE)	Standardized coefficients β	t	Sig	95% CI	R²
BMI	0.989 (0.17)	0.352	5.84	<0.001	0.66, 1.32	
Academic performance	-0.120 (0.034)	-0.134	-2.96	0.003	-0.16, -0.03	0.641

Pediatric Symptom total score	0.178 (0.04)	0.259	4.33	< 0.001	0.09, 0.26

4. Discussion

This study assessed the association between screen time and the academic performance, anxiety, behavioral problems of school-aged children in India. Children spending more time on screens possible tend to have poorer academic performance and higher levels of anxiety, alongside an increased body mass index (BMI). Modifiable factors, such as limiting screen time and prompting physical activity, are needed to support children's mental and physical health.. Future research directions may also be highlighted

Discussion

This study observed that children are engaged in excess screen time as reported by the parents, exceeding 3 hours per day, among relatively young children aged 4--14 years. These figures are three times greater than the recommended 1–2 hours per day (Saunders & Vallance, 2017). There are studies reporting serious health issues with more than the recommended amount of screen time(Dahlgren et al., 2021; Domingues-Montanari, 2017; Zhang et al., 2022).

Cognitive and Psychological Implications

We found a higher score (35.7) of psychosocial distress among children assessed by the Pediatric Symptom Checklist (clinical cutoff of 28). The mean score of the internalizing problems domain of the scale assessing anxiety and depression (5.1) was marginally above the cutoff (5.0 A study conducted in the UK involving 14,665 participants revealed that adolescents who used computers for more than 3 hours on weekdays had a 30% increased risk of anxiety and depression compared with those with less than 1 hour of use(J. N. Khouja et al., 2019). In our study, the mean score of the externalizing problems domain of the scale assessing aggression and hyperactivity (7.2) was also marginally above the cutoff (7.0). In line with our findings, a systematic review and meta-analysis published in JAMA recently reported a small but significant association between greater screen time and both externalizing (e.g., aggression, inattention) and internalizing (e.g., anxiety, depression) behavior issues in children aged 12 years or younger(Eirich et al., 2022). In contrast, the mean score for attention problems was 5.05 (SD = 1.9), below the cutoff of 7, indicating that these issues are less prominent. Contradictory evidence is available on the effect of screen time on attention. A systematic review suggested that attention decreases with increasing screen time. However, one included study in the same review suggested improvement in attention with increasing screen time among children(Santos et al., 2022). Another recently published study reported no relationship between screen time and attention subdomains among children aged between 6 and 10 years(Liebherr et al., 2022). The authors also suggest future research investigating the effect of socioeconomic status and a longitudinal study. Other studies have reported that sleep mediates the relationship between attention and screen time(Guerrero et al., 2019).

Body mass index (BMI), academic performance, screen time, and anxiety symptoms

The children in our study population fell into the normal weight category. However, an increase in BMI is strongly correlated with anxiety domains. The panic agoraphobia score (PAS) is a severe form of anxiety in certain situations. There was a strong correlation between increased BMI and panic agoraphobia score (r = 0.851), generalized anxiety score (GAS) (r = 0.807), separation anxiety score (SAS) (r = 0.805), social phobia score (SPS) (r = 0.804), physical injury fear score (PIFS) (r = 0.795) and obsessive–compulsive score (OCS) (r = 0.771). These results suggest that children who engage in excessive screen time tend to have higher BMIs and reduced social interaction, which may lead to this severe form of anxiety. A review article reported the physical and psychological side effects of screen time and the development of anxiety (Priftis & Panagiotakos, 2023). Many other studies have

reported the psychological effects of excessive screen time, ranging from sleep disturbance to severe psychological syndromes(J. Khouja et al., 2017; Leung & Torres, 2021; Lissak, 2018; Mougharbel et al., 2023; Santiago et al., 2022). Conversely, our findings strongly indicate that physical activity serves as a protective factor against the adverse effects of excessive screen time. Engaging in outdoor play is correlated with lower levels of anxiety and improved behavioral outcomes. This finding is consistent with the literature that advocates for the mental health benefits of physical activity, including enhanced mood and reduced stress levels(Carter et al., 2021; Dale et al., 2019; Romero-Pérez et al., 2020). We observe a similar protective effect on academic performance, where higher academic performance negatively correlates with the SAS, SPS, and externalizing problems from the Pediatric Symptom Checklist (EP-PSC), suggesting that better academic outcomes are associated with lower levels of anxiety and behavioral difficulties. These findings underscore the importance of balancing screen time with outdoor activities and academic engagement to support healthier psychological outcomes in children. Collectively, these findings advocate for multifaceted interventions that focus on reducing BMI, increasing physical activity, increasing academic performance, and managing screen time to address and improve children's behavioral health effectively.

Limitations

This study had many limitations. There are other factors that could affect a child's academic performance at school. Individual factors such as intellectual ability, learning styles, motivation, and overall health significantly impact students' learning outcomes. Parental involvement, socioeconomic status, family structure, parental education levels, and the resources available to children are examples of family factors(Farooq et al., 2011; Habibullah & Ashraf, 2013; Pinquart & Ebeling, 2020). This study did not assess these factors, thereby limiting our understanding of their potential impact on academic performance. Future research should explore these additional influences to provide a more comprehensive view of what affects children's performance in school and also report the utility purpose of screen by children, categorizing entertainment time and education screen time

Strategies for managing Screen Time

Addressing the challenges posed by excessive screen time among children necessitates a collaborative approach involving educational systems, parents, and public health initiatives. On the basis of our findings, some detailed strategies for managing screen time effectively are as follows:

1. **Educational Policy and Curriculum Design**
   a. Integrate Technology Constructively: Develop curricula that use technology to enhance learning rather than replace traditional methods. This includes the use of interactive tools that promote engagement and understanding (Calderón et al., 2020).
   b. Train Educators: Teachers are equipped with the skills to use digital tools effectively in the classroom, ensuring that they can guide students in balanced technology use(Rodrigues, 2020).
   c. Scheduled Tech-Free Times: Implement designated periods during the school day that are free from digital devices to encourage face–face interaction and physical activity (A. K. Sharma & Sharma, 2024).

2. **Parental Guidelines and Home Management**
   a. Establish clear screen time rules: Specific daily or weekly screen time limits for children should be set, especially to reduce screen use before bedtime to help improve sleep quality.
   b. Encouraging Engaging Alternatives: Promotion activities that can replace screen time, such as reading, sports, and the arts, to provide diverse experiences that support cognitive and physical development.
   c. Be a role model: parents should also moderate their screen use to set a behavioral standard, showing children that there is a time and place for technology.

3. **Public Health initiatives**
   a. Awareness Campaigns: Launch educational campaigns that inform parents and children about the risks of excessive screen use, such as increased anxiety and behavioral issues, as well as the benefits of alternative activities.

    b.   Community Programs: Support or introduce community initiatives that provide children with opportunities for outdoor play and physical activities, which have been shown to reduce anxiety and improve academic performance.

    c.   Screen Time Recommendations: Publicize guidelines on the optimal screen time for different age groups to help parents and educators make informed decisions (Whiting et al., 2021).

4. **Observation and feedback**

    a.   Regular Screen Time Audits: Encourage families to regularly review and discuss screen time habits and make adjustments as needed. Apps that track usage and provide reports can facilitate this.

    b.   Feedback Mechanisms in Schools: Schools can offer feedback to students and parents about screen time usage and its impacts, helping them understand the consequences of their screen habits.

5. **Legislation and policy enhancement:**

    a.   Supportive Legislation: Advocates for policies that encourage reduced screen time in educational institutions and promote physical activity in school curricula(Woods et al., 2021).

5. Conclusions

In summary, this study contributes important insights into the impact of screen time on child development, emphasizing the need for careful management of digital engagements to safeguard and promote children's mental and academic growth. As technology continues to pervade every aspect of daily life, on-going research and adaptive interventions will be essential to ensure that is digital media as a positive force in children's educational and development trajectories.

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