

Original article

Effect of screen time on physical fitness among children aged 9–12 years in Mumbai, India: A cross-sectional study

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Abstract

Background: The COVID-19 pandemic increased children's reliance on screens for learning and recreation, potentially affecting physical fitness. This study evaluated associations between screen time and physical fitness among 9–12-year-old school children in Mumbai, India.

Methods: In this cross-sectional study, 425 children (219 boys, 206 girls) from seven schools were assessed. Screen time was measured using the parent-administered ScreenQ questionnaire. Anthropometry and fitness tests (partial curl-ups, push-ups, sit-and-reach, 600m run, and 50m dash) were conducted. Body mass index was calculated. Pearson's correlation and independent t-tests were used ($P < 0.05$ significant).

Results: Mean screen time was higher in boys 4.1 (± 2.5) hours /day than girls 1.8 (± 0.4) hours/day; $P < 0.001$). Overall, 330 children (77.6%) exceeded the Indian Academy of Paediatrics guideline of < 2 h/day. In boys, screen time showed a weak positive correlation with Body mass index ($r = 0.2$, $P = 0.01$) and a weak negative correlation with cardiovascular endurance ($r = -0.10$, $P = 0.02$); no such associations were observed in girls. No significant correlations were found with flexibility, muscular endurance, or speed. Boys performed better than girls in core strength, cardiovascular endurance, and speed ($P < 0.05$).

Conclusion: In 9–12-year-old children, higher screen time was weakly associated with Body mass index and cardiovascular endurance in boys, but no associations were found for other fitness parameters. These findings should be interpreted cautiously, as correlations were weak and not

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generalizable across sexes. The findings highlight the importance of promoting active lifestyles and monitoring screen time among school-aged children in Mumbai, India.

Keywords: Screen Time; Physical Fitness; Motor Activity; Child; Exercise Test

Background

Physical fitness is a state of health, well-being and ability to perform aspects of sports, occupation and daily activities that is achieved through proper nutrition [1], physical exercise and sufficient rest. The major contributing factors of physical fitness are the levels of physical activity and sedentary behavior [2].

Physical activity, as defined by World Health Organization (WHO), is any bodily movement produced by skeletal muscles that requires energy expenditure. According to Physical Activity Guidelines by WHO in 2020, children and adolescents aged 5 to 17 years are recommended to perform at least 60 minutes of moderate to vigorous intensity physical activity daily that includes aerobic and strength training [3]. According to the India's 2018 Report Card on Physical Activity for Children and Youth, approximately 25% of children and youth accumulate > 60 minutes of moderate and vigorous physical activity (MVPA) daily; an average of 49% of children and youth spend at least 1 hour playing outdoors per day, 37% spend at least 1 hour in active play per day, and approximately 15% of children and youth meet recommended standards for minimum fitness. Along with this, the report states, less than half of the Indian children and youth are meeting screen time-based sedentary behavior guidelines (<2 hours/day) [4].

The recommended physical activity levels are met by the children from their active play participation with the friends in the playgrounds and parks, and from the school based physical activities, but due to the recent COVID-19 pandemic, India closed down the schools and shifted to e-learning as an emergency measure. There was a great transition from physical mode to virtual platform of schooling [5]. Due to closure of schools, playgrounds, public parks and recreational facilities, the mobility of children and youth was affected [6]. The access to school-based physical activities, physical education and sports sessions, recess or breaktime games and walking to reach school and back to home from school was no longer available. Thus, the physical activity levels in the children were reduced below the normal recommendation [7].

Schools were resumed on virtual platform with help of electronic devices and Internet facility. Regular schedule included extensive use of electronic devices [8], increasing the screen time. According to Indian Academy of Pediatrics (IAP), "Screen time is the total time spent per day in viewing screens such as mobile phone, television (TV), computer, tablet, or any hand-held or visual device." According to IAP, children aged 5 to 17 years should

have a limit of 2 hours of recreational screen time per day [9]

Due to the lockdown conditions, children's work and creational activities were shifted to virtual sources that led to increased usage of various gadgets, devices, applications, and software, and increased gadget screen time for formal and informal purposes. Studies suggest that, during the COVID 19 pandemic, the closure of schools had tremendous negative impact on the health habits of children, including less of physical activity, increased screen time exposure, and irregular sleep pattern [10].

There has been a tremendous change in the educational sector of India post COVID-19 outbreak. Initially, with the lockdown, closure of the schools was implemented. Later, to ensure that the students do not remain inactive and their academic progress is maintained, the schooling was resumed on a virtual platform. Thus, India too adopted the concept of E-learning for the betterment [5].

Sedentary lifestyle and physical fitness are negatively correlated among children and adults. Increased gadget screen time is one of the major factors of having a sedentary lifestyle among adults. The use of the internet and gadgets is inversely associated with the physical activity. Although IAP recommends limiting screen time for children aged 5–17 years, this study focused on the 9–12-year group as it represents a transitional stage from childhood to adolescence. Children with this age start gain-

ing independence in recreational choices and greater access to personal gadgets. Physical activity levels also begin to decline, making it a critical window for study. Unlike younger children, they can reliably self-report screen use and actively participate in fitness assessments. Studying this group enables early identification of patterns before sedentary behaviors become more entrenched in adolescence enabling timely interventions to promote active lifestyles [6]. Hence, there is a need to explore the effect of screen time on physical fitness among children. The aim of this study is to determine the effect of screen time on physical fitness in children aged group 9 to 12 years.

Methods:

Study design and population: This was a school-based cross-sectional analytical study assessing the relationship between screen time and physical fitness parameters in school attending children's aged 9–12 years from selected schools in Mumbai Metropolitan Region.

Sampling: Seven schools in Mumbai were identified, and permission was obtained from school authorities. All Seven schools were selected through convenience sampling. All the selected schools were Brihanmumbai Municipal Corporation (BMC) government schools, chosen based on feasibility, accessibility, and administrative permissions for conducting the study.

Sampling procedures: The Inclusion Criteria of the study was Children aged 9–12 years, all gender, enrolled in selected schools in Mumbai and Willing to participate, with parental consent and Exclusion Criteria were Children with any musculoskeletal, neurological, cardiovascular or chronic medical conditions or any recent surgery that can interfere with the test.

Sample size: A total of 430 participants were screened, and 425 met the inclusion criteria. (>80% power ($r = 0.20$, $\alpha = 0.05$))

Outcome variables: Physical fitness parameters: abdominal/core strength (Partial Curl-Up test), muscular endurance (Push-Up test), flexibility (Sit and Reach test), cardiovascular endurance (600 m run test), speed (50 m dash run test) and Screen time (SCREENS-Q questionnaire).

Explanatory variables: Age, gender, BMI, and demographic characteristics.

Data collection: The study purpose was explained to school authorities, class teachers, physical education educators, parents, and children. Written informed consent was obtained from parents. Participants and parents received instructions on clothing, footwear, hydration,

and nutrition prior to assessments. Demographics information such as Name, age, gender, standard, parents' names, class-in-charge, and contact details were recorded. Anthropometry measurement was carried out like: Weight measured using a digital scale (0.1 kg precision) and height with a measuring tape (m). Body mass index (BMI) calculated followed by Fitness Tests: *Partial Curl-Up Test*: Number of curl-ups in 30 seconds, *Push-Up Test*: Standard push-ups for boys, modified for girls; repetitions until exhaustion or loss of rhythm, *Sit and Reach Test*: Flexibility measured in cm and mm, *600 m Run*: Cardiovascular endurance measured by completion time, *50 m Dash*: Speed assessed by time to completion. The selected tests (partial curl-up, push-ups, sit-and-reach, 600m run, 50m dash) are validated components of the 'Fitnessgram' battery and are also recommended in the Fit India Movement protocols for school fitness assessment. and lastly Screen Time Assessment using ScreenQ covered domains including media environment, use context, early exposure, parental perceptions, and parental media use.

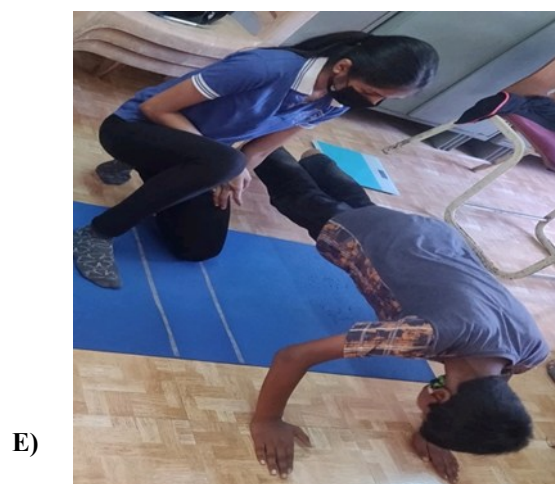
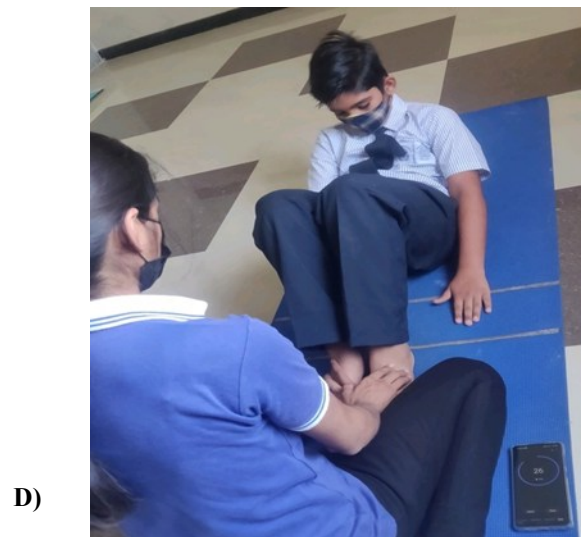
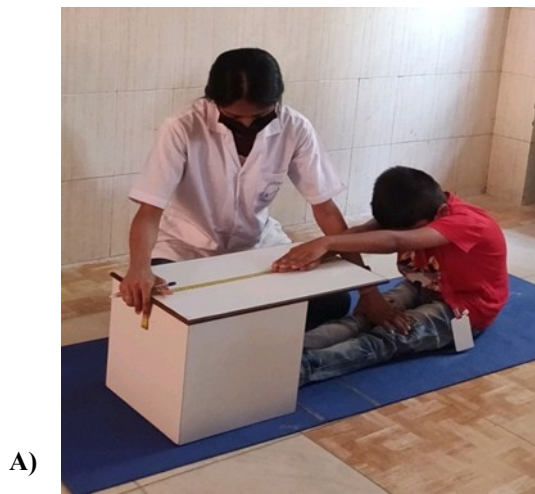


Figure 1. Fitness testing of participants a) and b) shows sit and reach test, c) and d) shows partial curl-up test and e) and f) shows push-up and modified push-up test.

Data processing and analysis: Data were recorded, coded, and entered into a database for statistical analysis to examine associations between screen time and physical fitness parameters.

Ethical considerations: Ethical approval was obtained from the Institutional Ethical Committee (MGMIHS/IEC/04/2022 dated 07/02/2022). Participation was voluntary, with informed consent obtained from parents. Confidentiality and anonymity of all participants were maintained throughout the study.

Results: Data from a total of 425 children were obtained, and their sex distribution by age and screen time is given in Table 1. The age of the males ranged from 52-64, while that the females ranged from 45-55 years. Ninety-five children used screen time for less than 2 hours, of which 45 were males and 50 were females. A majority (330) of the children used screen time for more than 2 hours, of which 172 were males and 158 were females. Mean (SD) Screen time for males was 4.1 (± 2.5), whereas for females it was 1.8 (± 0.42) hours/day.

Table 1: Distribution of participants sex by age and screen time (N-425)

Characteristics		Male n (%)	Female n (%)	Total
Age (years)	9	48	54	102
	10	64	55	119
	11	53	54	107
	12	52	45	97
Screen time	Less than 2 hours	45	50	95
	More than 2 hours	172	158	330
	Mean (\pm SD*) (hours)	4.1 (± 2.5)	1.8 (± 0.42)	4.1 (± 2.48)

* Standard deviation

On comparison between males and females there was statistically significant difference in fitness measured by the partial curl up of abdomen (Mean Rank =229.6 vs 196.2, $P = 0.006$), in 600 meters run in minutes (Mean Rank =197.2 vs 229.8, $P = 0.007$) and in 50 meters dash run

test in seconds (Mean Rank =181.2 vs 246.2, $P < 0.001$). This indicates that males outperformed the females in partial curl-up test, 600 meters run test and 50 meters dash run test [Table 2]

Table 2: Comparison of fitness parameters between males and females (N=425)

Fitness parameters	Male (Mean Rank)	Female (Mean Rank)	P-value
Body mass index (kg/m ²)	218.2	207.4	.357
Partial Curl-Up test (number)	229.2	196.2	.006
Push-Up/Modified Push-Up test (number)	205.5	220.8	.199
Sit and Reach test (cm)	209.6	216.5	.560
600 meters run test (minutes)	197.2	229.8	.007
50 meters dash run test (seconds)	181.2	246.2	<.001
Screen time (hours)	213.6	212.2	.920

Statistically significant weak correlation with R value of 0.176 and a P-value of 0.01 was found between BMI and Screen time in males as shown in Table 3.

Table 3: Correlation and regression analysis of physical fitness parameters and screen time among male participants aged 9-12 years (N=222).

Physical fitness parameters	Mean ±SD)	R	P	R Square	P
Body mass index (kg/m ²)	17.8 (4.75)	.176	.010	-	-
Partial Curl-Up test (number)	11.5 (3.52)	.071	.295	.002	.478
Push-Up /Modified Push-Up test (number)	13.4 (9.47)	.058	.395	.006	.273
Sit and Reach test (cm)	15.9 (5.98)	.042	.543	.006	.274
600 meters run test (minutes)	267.6 (45.49)	.118	.084	.015	.075
50 meters dash run test (seconds)	10.6 (1.68)	.120	.079	.022	.027

No statistically significant correlation was found between the abdominal/core strength, flexibility, muscular endurance, CVE and Screen time. Whereas no statistically significant correlation was found between abdominal/core strength, muscular endurance, flexibility, CVE, speed and ST in females (Table 4).

Table 4: Correlation and regression analysis of physical fitness parameters and screen time among females aged 9-12 years (N=208).

Physical fitness parameters	Mean (\pm SD)	R	P	R Square	P
Body mass index (kg/m ²)	17.1 (+ 3.63)	.089	.203		
Partial Curl-Up test (number)	10.9 (+ 3.44)	.053	.446	.006	.284
Push-Up /Modified Push-Up test (number)	14.6 (+ 9.67)	.001	.986	.001	.604
Sit and Reach test (cm)	15.9 (+ 6.01)	-.065	.353	.004	.365
600 meters run test (minutes)	279.2 (+ 48.87)	.086	.219	.009	.166
50 meters dash run test (seconds)	11.6 (+ 1.89)	-.065	.349	.002	.479

Statistically significant weak correlation was found between BMI, CVE and ST between BMI and ST (R= .166, P=.001), and between CVE and ST (R=0.113, P=.02) with statistically significant variance in the association between 600 meters run test and ST (variance= .01, P=.043).

Table 5: Correlation and regression analysis of physical fitness parameters and screen time among the participants aged 9-12 yrs (N=430).

Physical fitness parameters	Mean + SD	R	p	R Square	p
Body mass index (kg/m ²)	17.5 (4.25)	.166**	.001		
Partial Curl-Up test (number)	11.0 (3.52)	-.049	.310	.011	.029
Push-Up /Modified Push-Up test (number)	14.0 (9.58)	-.034	.482	.000	.969
Sit and Reach test (cm)	15.8 (5.99)	.015	.750	.000	.750
600 meters run test (minutes)	273.3 (47.47)	.113*	.020	.010	.043
50 meters dash run test (seconds)	11.1 (1.85)	.058	.231	.001	.462

Discussion

The aim of the present study was to determine the effect of screen time on physical fitness among children age 9-12 yrs. The results showed that most of the children spent around 4 hours per day on screens which is almost double the screen time recommended by the IAP. Of this, 0.5- 2 hours is spent on school-based screen time per day and about 0.5 to 4 hours is spent on leisure screen time. Of the total population of 425, 330 children exceeded

the IAP ST guidelines i.e. of 2 hours/day. Males had more screen time 4.1 + 2.5 hrs/day than females 1.76 + 0.43 hrs/day. This increase in ST can be explained by the lockdown imposed during COVID19 which reduced outdoor activities and promoted screen-based games and activities. This led to the shifting of offline teaching to e-learning, which is supported by findings from various recent studies [8,11,13,14]

On comparison between males and females, there was a significant difference found in the partial curl up test, 600 meters run test and 50 meters dash run test i.e. the boys outperformed the girls core strength, CVE and speed. The difference in the abdominal/core strength between the males and females might be related with the higher muscle mass and high hemoglobin concentration in the males which is supported by Bar-Or et.al. and Rowland et.al. in their respective studies [15,16]. The CVE is determined mostly on the level of physical activity on daily basis which in Indian society is less in females as compared to males because the females are more involved in domestic household sedentary work while the males play and involve themselves in various outdoor physical activity [17]. Girls showed lower physical activity levels due to intersecting sociocultural and environmental barriers. Traditional gender roles and domestic responsibilities limit their leisure time, while safety concerns and the lack of accessible playgrounds restrict outdoor activity. Academic pressure and entrenched stereotypes further discourage participation in sports or active play, steering girls toward sedentary indoor routines. These combined factors create a significant gender gap in physical activity. Addressing these barriers requires gender-sensitive school programs and safer community spaces led to less participation of females in sports activities in the school associated with the deeply-rooted set gender expectations in the Indian families, there is decrease in the CVE [18].

In our study, we also found that there was a weak correlation between the screen time and the BMI and CVE of the individual. The relationship between TV viewing and body composition can be explained as the displacement of more active behaviors resulting in a reduction of total energy expenditure, the increase of snacking, the influence of programming and TV commercials in acquiring unhealthy dietary patterns or the interference of TV time in sleep patterns as supported by Rey-Lopez et al. [19]. Screen time also promotes sedentary behavior [20] and reduces physical activity which in turn increases the weight leading to the high BMI.

Regarding CVE it is already known that CVE is positively associated with MVPA [21,22,23] which was reduced during the COVID19 pandemic because of the increased screen time as reported by Chawla et al.[24] and Bahl et al.[25]. Due to reduced physical activity and increased sedentary time over a long period of lockdown there was decreased maximal oxygen uptake, blood volume and stroke volume during exercise, maximal cardiac output, maximal ventilatory volume and endurance performance along with increased maximal heart rate, recovery heart rate and mean blood pressure leading to poor CVE performance as stated by Mujika I et. al. These effects start after 4 weeks of no physical activity [26,27].

The results of our study also showed that

is no correlation found between screen time and the flexibility, muscular and core strength of the individual. As strength and flexibility do not require daily periodized program as a non-periodized program affects the strength and flexibility to a similar extent as stated by Moraes et al. [27], thus during the lockdown the physical activity reduced but it wasn't completely eliminated which was enough to maintain the strength and flexibility of the individual [28-31].

Limitations

The ScreenQ questionnaire, originally developed and validated in Western populations, was used to assess children's screen media use. Although not formally validated in India, it was considered appropriate as urban lifestyles in Mumbai increasingly mirror those of the Western world. The tool was selected for its comprehensive domains (screen environment, usage patterns, parental perceptions) and prior application in pediatric populations. To enhance cultural appropriateness, parents were briefed in the local language, and clarifications were provided during administration. The study included only government schools in Mumbai, restricting generalizability to children from other socioeconomic and educational backgrounds. Additionally, the cross-sectional design limits causal inference. Screen time was parent-reported, making it vulnerable to recall bias. Children's physical activity levels, dietary intake, sleep habits, and extracurricular sports

participation outside school were not recorded, which may act as potential confounders. Seasonal variation in activity was also not considered. Finally, observed associations—particularly those evident only in boys highlight sex-specific differences and caution against broad generalization.

Conclusion

In this study, we observed a weak correlation of screen time with BMI and CVE among children aged 9–12 years, while no correlation was found with flexibility, core strength, muscular endurance, or speed. Notably, the association between screen time and BMI was evident only in males, and therefore cannot be generalized to females. Additionally, sex-based differences were observed in core strength, cardiovascular endurance, and speed. These findings should be interpreted cautiously as they apply only to the 9–12-year age group and highlight the need for larger studies before drawing broader public health implications.

Recommendation

Schools should plan and incorporate a structured activity breaks into school schedules to promote physical activity among young growing children's, limiting recreational screen use and encouraging parental co-participation in physical activity.

Future studies should validate culturally appropriate screen-time tools in Indian children, adopt longitudinal designs to explore causal

relationships, and expand to diverse school types and regions. Additionally, research could test school-based interventions, such as integrating structured activity breaks into online and classroom schedules, to better understand strategies for reducing sedentary behaviour.

Declarations

Ethical Consideration

The study was approved by the Institutional Ethical Committee of MGM Institute of Health Sciences (MGMIHS/IEC/04/2022 dated 07/02/2022). Written informed consent was obtained from parents/guardians, and assent was obtained from participating children. Confidentiality and anonymity of participants were maintained throughout.

Conflict of Interest

The authors declare no conflicts of interest.

Authors' Contribution

SM: Conceptualization, methodology, data collection, analysis, drafting, critical revision of the manuscript and final approval. NR: Data collection, analysis, and manuscript drafting.

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