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Original Article

Association of Screen Time with Cardiopulmonary Endurance among Adolescents

Syeda Arooj Fatima Rizvi[1], Aqsa Majeed[2], Aqsa Zahid[1], Syeda Rabiba Zahra Rizvi[1]

[1] Student, University of Lahore, Lahore, Pakistan
[2] Lecturer, University of Lahore, Lahore, Pakistan

***Corresponding author: Aqsa Majeed, aqsa.majeed@uipt.uol.edu.pk**

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ABSTRACT

Background: Excessive screen exposure is increasingly common among adolescents and may contribute to sedentary behavior, reduced physical activity, and poorer health-related fitness. However, the direct association between screen time and functional cardiopulmonary capacity remains unclear, particularly in local school-going adolescent populations. Objective: This study aimed to determine the association between total, work-related, and recreational screen time and Six-Minute Walk Distance among adolescents aged 10–19 years. Methods: A cross-sectional analytical study was conducted among 194 adolescents in Lahore, Pakistan. Screen time was assessed using the Questionnaire for Screen Time of Adolescents, while functional cardiopulmonary capacity was assessed using the Six-Minute Walk Test. Pre-exercise heart rate, post-exercise heart rate, and heart rate recovery were also recorded. Data were analyzed using descriptive statistics, Pearson correlation, and multiple linear regression, with Six-Minute Walk Distance as the dependent variable. Results: The mean age was 14.54 ± 2.879 years, and male and female participants were equally represented. Mean total screen time was 6.60 ± 2.029 hours/day, while mean Six-Minute Walk Distance was 547.73 ± 80.123 m. Total screen time ($r = 0.124$, $p = 0.085$), work-related screen time ($r = 0.010$, $p = 0.885$), and recreational screen time ($r = 0.133$, $p = 0.065$) were not significantly correlated with Six-Minute Walk Distance. Pre-exercise heart rate ($r = -0.975$, $p < 0.001$) and post-exercise heart rate ($r = -0.909$, $p < 0.001$) showed strong inverse correlations with walking distance. The regression model including total screen time, age, gender, and BMI was not statistically significant, $F(4,189) = 1.620$, $p = 0.171$, and explained 3.3% of variance in Six-Minute Walk Distance. Conclusion: Screen time was not significantly associated with Six-Minute Walk Distance in this adolescent sample, whereas heart rate parameters showed stronger associations with functional walking capacity. Future studies should include objective physical activity monitoring, standardized heart rate assessment, and longitudinal designs. Keywords: Screen time; adolescents; cardiopulmonary endurance; Six-Minute Walk Test; Six-Minute Walk Distance; resting heart rate; sedentary behavior.

INTRODUCTION

Adolescence is a critical developmental period marked by rapid physical, psychological, cognitive, and social maturation, during which health-related behaviors may influence current wellbeing and later cardiometabolic risk. Adequate cardiorespiratory fitness during this stage is particularly important because it reflects the integrated capacity of the cardiovascular, respiratory, and musculoskeletal systems to support sustained physical activity and is associated with healthier body composition, better cardiovascular profiles, and lower long-term disease risk. In parallel with these developmental demands, adolescents are increasingly exposed to screen-based activities through smartphones, computers, tablets, online learning platforms, social media, video streaming, and gaming. Although digital technology has educational and social benefits, excessive and poorly regulated screen exposure may contribute to

sedentary behavior, reduced movement time, sleep disruption, postural strain, and unfavorable physical health patterns (1).

The World Health Organization defines adolescence as the period from 10 to 19 years, representing a transition between childhood and adulthood in which behavioral habits are established and health trajectories begin to consolidate (2). During this period, screen use may interact with physical activity, school demands, recreational habits, and family or cultural practices. High screen exposure has been linked in previous studies with lower physical activity, increased adiposity, adverse cardiometabolic indicators, and reduced components of physical fitness; however, the strength and direction of these associations may vary according to the type of screen use, the level of habitual physical activity, and the outcome used to represent fitness (3). Therefore, screen time should not be interpreted only as a numerical duration of device use, but also as a behavior that may displace active time, encourage prolonged sitting, and indirectly influence physiological capacity.

Cardiorespiratory fitness in adolescence has important clinical and public health relevance because poor endurance during this stage may increase vulnerability to obesity, cardiovascular risk factors, respiratory limitations, and reduced functional capacity in later life. The rapid expansion of electronic media, online education, mobile applications, gaming platforms, and social networking has made screen exposure a routine part of adolescent life, including both academic and recreational domains (4). While recreational screen time is often considered more sedentary and discretionary, work-related or academic screen use may reflect school-based requirements and may not have the same behavioral implications. Distinguishing total, recreational, and work-related screen time is therefore important when examining associations with physical fitness.

Existing literature indicates that adolescents with better physical activity patterns tend to demonstrate higher cardiorespiratory fitness, whereas excessive sedentary behavior and screen exposure may be associated with poorer health-related fitness indicators. Studies examining school routines, activity patterns, and fitness have shown that structured daily environments and adequate movement opportunities may support cardiorespiratory fitness in adolescents (5). Similarly, research on screen time and physical fitness has reported that children and adolescents with lower screen exposure often demonstrate better cardiorespiratory, muscular, and motor fitness, while those exceeding recommended sedentary thresholds may show poorer fitness profiles (6). Evidence from adolescent populations also suggests that physical activity is positively associated with cardiovascular fitness, whereas sedentary behavior and excessive recreational screen time may show inverse associations with fitness outcomes (7).

Despite these findings, the direct association between screen time and cardiopulmonary endurance remains insufficiently established, particularly in local adolescent populations where school routines, family supervision, recreational opportunities, cultural norms, and access to technology may differ from those reported in international studies. Furthermore, many previous studies have focused on cardiometabolic markers, self-reported physical activity, or broad physical fitness batteries rather than submaximal functional exercise capacity measured through the Six-Minute Walk Test. The Six-Minute Walk Distance provides a practical field-based indicator of functional exercise capacity and is suitable for school-aged populations when direct maximal cardiopulmonary testing is not feasible. However, because it reflects submaximal walking performance rather than direct maximal oxygen uptake, findings based on this measure should be interpreted as functional cardiopulmonary capacity rather than definitive maximal cardiorespiratory fitness.

Using a PICO-based framework, the population of interest in the present study was adolescents aged 10–19 years; the exposure was daily screen time, including total, recreational, and work-related screen use; the comparison was based on variation in screen-time exposure across participants; and the outcome was cardiopulmonary endurance assessed through Six-Minute Walk Distance. This study therefore aimed to determine the association between screen time and Six-Minute Walk Distance among adolescents aged

10–19 years in Lahore, Pakistan. It was hypothesized that higher screen time, particularly recreational screen time, would be associated with lower Six-Minute Walk Distance.

MATERIALS AND METHODS

This cross-sectional analytical study was conducted over a six-month period among school- and college-going adolescents aged 10–19 years in Lahore, Pakistan, to examine the association between screen time and cardiopulmonary endurance measured through the Six-Minute Walk Test. The study design was selected because it allowed assessment of exposure and outcome variables at a single time point in a natural educational setting, making it suitable for estimating the relationship between daily screen use patterns and functional exercise capacity in an adolescent population.

A total of 194 adolescents were included through a non-probability convenience sampling technique. Eligible participants were male and female students aged 10–19 years who used electronic screen-based devices, were physically able to perform the Six-Minute Walk Test, and provided consent to participate. For participants who were minors, consent was obtained from parents or guardians before data collection. Adolescents were excluded if they had known cardiovascular, respiratory, neurological, developmental, musculoskeletal, or injury-related conditions that could affect walking performance or heart rate response. Students enrolled in structured sports training programs were also excluded to reduce the influence of athletic conditioning on functional exercise capacity and to improve comparability across participants (8–11).

Data were collected using a structured proforma, the Questionnaire for Screen Time of Adolescents, and a cardiopulmonary assessment form. The structured proforma recorded demographic and anthropometric information, including age, gender, class or grade, body weight, height, and body mass index. Body mass index was calculated from measured height and weight and was used as a covariate in the regression analysis. Screen time was assessed using the Questionnaire for Screen Time of Adolescents, which recorded average daily screen exposure across work-related and recreational domains. Work-related screen time referred to screen use for academic or task-related purposes, while recreational screen time referred to non-academic screen use such as entertainment, gaming, social media, or leisure-based digital activities. Total screen time was calculated as the combined daily duration of work-related and recreational screen exposure.

Cardiopulmonary endurance was assessed using the Six-Minute Walk Test, with Six-Minute Walk Distance recorded in meters as the primary outcome variable. Before the test, resting heart rate was recorded as the pre-exercise heart rate. Participants then performed the Six-Minute Walk Test according to a standardized field-testing procedure, and the total distance walked in six minutes was documented. Heart rate was recorded immediately after completion of the test as the post-exercise heart rate. Heart rate recovery was calculated as the change in heart rate after cessation of exercise, providing an additional indicator of post-exercise cardiovascular recovery. Participants were screened for eligibility before testing, and those with conditions likely to compromise safe participation or distort walking performance were excluded.

The primary independent variable was screen time, assessed as total screen time and further categorized into work-related and recreational screen time. The primary dependent variable was Six-Minute Walk Distance. Additional physiological variables included pre-exercise heart rate, post-exercise heart rate, and heart rate recovery. Age, gender, and body mass index were treated as potential confounding variables because of their plausible influence on walking performance and adolescent physical fitness. Standardized data collection forms and uniform measurement procedures were used to reduce information bias. Restriction through eligibility criteria was applied to minimize confounding by known cardiopulmonary, neurological, musculoskeletal, developmental, injury-related, and athletic training factors.

Data were entered, coded, and analyzed using SPSS software. Descriptive statistics were used to summarize participant characteristics, anthropometric variables, heart rate parameters, screen-time variables, and Six-Minute Walk Distance. Continuous variables were reported as mean and standard deviation with minimum and maximum values, while categorical variables were summarized as frequencies and percentages. Normality of continuous variables was assessed before inferential testing. Pearson correlation analysis was used to examine bivariate associations between Six-Minute Walk Distance, heart rate variables, and screen-time variables where distributional assumptions were satisfied. Multiple linear regression analysis was performed to evaluate whether total screen time predicted Six-Minute Walk Distance after accounting for age, gender, and body mass index. Statistical significance was set at $p < 0.05$. The study was conducted after ethical approval was obtained from the Institutional Ethical Review Committee of the University of Lahore under approval number UOL/IREB/26/20/09/0029. Participation was voluntary, and informed consent was obtained before data collection. Confidentiality and anonymity of participant information were maintained throughout the study, and collected data were used only for research purposes.

RESULTS

A total of 194 adolescents aged 10–19 years were included in the analysis. The sample had a mean age of 14.54 ± 2.879 years. Male and female participants were equally represented, with 97 participants in each gender category. The mean body weight was 69.54 ± 16.029 kg and the mean height was 170.19 ± 10.293 cm. The mean Six-Minute Walk Distance was 547.73 ± 80.123 m, with observed values ranging from 400 to 700 m. Resting heart rate before exercise was 81.83 ± 8.597 bpm, post-exercise heart rate was 126.10 ± 12.043 bpm, and heart rate recovery was 23.92 ± 7.067 bpm. Mean total daily screen time was 6.60 ± 2.029 hours, comprising 2.63 ± 1.235 hours of work-related screen time and 3.97 ± 1.801 hours of recreational screen time. Normality assessment for Six-Minute Walk Distance using the Kolmogorov-Smirnov test showed no statistically significant deviation from normality, $D = 0.053$, $df = 194$, $p = 0.200$.

Table 1. Demographic, Anthropometric, Cardiopulmonary, and Screen-Time Characteristics of Participants

Variable	N	Minimum	Maximum	Mean ± SD
Age, years	194	10	19	14.54 ± 2.879
Weight, kg	194	36	112	69.54 ± 16.029
Height, cm	194	142	186	170.19 ± 10.293
HR Pre-Exercise, bpm	194	64	100	81.83 ± 8.597
HR Post-Exercise, bpm	194	102	160	126.10 ± 12.043
HR Recovery, bpm	194	12	36	23.92 ± 7.067
Work-Related Screen Time, hours/day	194	1	5	2.63 ± 1.235
Recreational Screen Time, hours/day	194	1	7	3.97 ± 1.801
Total Screen Time, hours/day	194	2	11	6.60 ± 2.029
Six-Minute Walk Distance, m	194	400	700	547.73 ± 80.123

SD, standard deviation; HR, heart rate; bpm, beats per minute.

The descriptive findings indicate that participants had a broad range of functional walking performance, with Six-Minute Walk Distance varying from 400 to 700 m. Recreational screen exposure contributed the larger proportion of total daily screen time, with participants reporting a mean of 3.97 hours/day recreational use compared with 2.63 hours/day work-related use. Heart rate increased from a mean resting value of 81.83 bpm to 126.10 bpm after exercise, while mean heart rate recovery was 23.92 bpm.

Table 2. Categorical Characteristics Reported in the Study

Variable	Category	n (%)
Gender	Male	97 (50.0)
Gender	Female	97 (50.0)
BMI category	Normal weight	158 (81.4)

BMI, body mass index.

The gender distribution was balanced, with male and female participants each representing 50.0% of the study sample. Most participants were reported to fall within the normal BMI category, accounting for 158 of 194 adolescents. Full frequency distributions for underweight, overweight, and obese categories were not reported in the supplied dataset, so these categories were not tabulated.

Pearson correlation analysis was performed to examine bivariate associations among Six-Minute Walk Distance, heart rate variables, and screen-time variables. Six-Minute Walk Distance showed a very strong inverse correlation with pre-exercise heart rate and post-exercise heart rate. In contrast, total screen time, work-related screen time, and recreational screen time were not significantly correlated with Six-Minute Walk Distance.

Table 3. Pearson Correlation Matrix for Cardiopulmonary and Screen-Time Variables

Variable	1	2	3	4	5	6	7
1. Six-Minute Walk Distance	—	−0.975	−0.909	−0.085	0.124	0.010	0.133
2. HR Pre-Exercise	−0.975	—	0.942	0.104	−0.119	−0.017	−0.123
3. HR Post-Exercise	−0.909	0.942	—	0.148	−0.083	−0.003	−0.091
4. HR Recovery	−0.085	0.104	0.148	—	−0.047	−0.080	0.002
5. Total Screen Time	0.124	−0.119	−0.083	−0.047	—	0.479	0.798
6. Work-Related Screen Time	0.010	−0.017	−0.003	−0.080	0.479	—	−0.146
7. Recreational Screen Time	0.133	−0.123	−0.091	0.002	0.798	−0.146	—

HR, heart rate. Pearson correlation coefficients are shown.

Table 4. Statistical Significance for Pearson Correlation Matrix

Variable Pair	p-value
Six-Minute Walk Distance × HR Pre-Exercise	<0.001
Six-Minute Walk Distance × HR Post-Exercise	<0.001
Six-Minute Walk Distance × HR Recovery	0.238
Six-Minute Walk Distance × Total Screen Time	0.085
Six-Minute Walk Distance × Work-Related Screen Time	0.885
Six-Minute Walk Distance × Recreational Screen Time	0.065
HR Pre-Exercise × HR Post-Exercise	<0.001
HR Pre-Exercise × HR Recovery	0.148
HR Pre-Exercise × Total Screen Time	0.098
HR Pre-Exercise × Work-Related Screen Time	0.812
HR Pre-Exercise × Recreational Screen Time	0.089
HR Post-Exercise × HR Recovery	0.039
HR Post-Exercise × Total Screen Time	0.251
HR Post-Exercise × Work-Related Screen Time	0.965
HR Post-Exercise × Recreational Screen Time	0.206
HR Recovery × Total Screen Time	0.513
HR Recovery × Work-Related Screen Time	0.268
HR Recovery × Recreational Screen Time	0.982
Total Screen Time × Work-Related Screen Time	<0.001
Total Screen Time × Recreational Screen Time	<0.001
Work-Related Screen Time × Recreational Screen Time	0.042

HR, heart rate.

Six-Minute Walk Distance was inversely correlated with pre-exercise heart rate, $r = -0.975$, $p < 0.001$, and post-exercise heart rate, $r = -0.909$, $p < 0.001$. Heart rate recovery was not significantly correlated with Six-Minute Walk Distance, $r = -0.085$, $p = 0.238$. Total screen time showed a weak positive non-significant correlation with Six-Minute Walk Distance, $r = 0.124$, $p = 0.085$. Recreational screen time also showed a weak positive non-significant correlation with Six-Minute Walk Distance, $r = 0.133$, $p = 0.065$, while work-related screen time showed no meaningful correlation, $r = 0.010$, $p = 0.885$. Total screen time was positively correlated with work-related screen time, $r = 0.479$, $p < 0.001$, and recreational screen time, $r = 0.798$, $p < 0.001$. Work-related and recreational screen time showed a weak inverse correlation, $r = -0.146$, $p = 0.042$.

A multiple linear regression model was used to assess whether total screen time, age, gender, and BMI predicted Six-Minute Walk Distance. The overall model was not statistically significant and explained a small proportion of the variance in Six-Minute Walk Distance.

Table 5. Model Summary for Multiple Linear Regression Predicting Six-Minute Walk Distance

Model	R^2	Adjusted R^2	df Regression	df Residual	F	p-value
1	0.033	0.013	4	189	1.620	0.171

Dependent variable, Six-Minute Walk Distance. Predictors, Total Screen Time, Age, Gender, BMI.

The regression model explained 3.3% of the variance in Six-Minute Walk Distance, with an adjusted R^2 of 0.013. The model was not statistically significant, $F(4,189) = 1.620$, $p = 0.171$, indicating that total screen time, age, gender, and BMI did not collectively provide a strong explanatory model for functional walking capacity in this sample.

Table 6. ANOVA Summary for Multiple Linear Regression Model

Source	df	Sum of Squares	Mean Square	F	p-value
Regression	4	41,065.708	10,266.427	1.620	0.171
Residual	189	1,197,936.354	6,338.288	—	—
Total	193	1,239,002.062	—	—	—

Dependent variable, Six-Minute Walk Distance.

The residual sum of squares was substantially larger than the regression sum of squares, indicating that most variation in Six-Minute Walk Distance remained unexplained by the predictors included in the model. This supports the weak model fit shown by the low R^2 value.

Table 7. Regression Coefficients for Predictors of Six-Minute Walk Distance

Predictor	B	Std. Error	95% CI	β	t	p-value
Constant	456.192	46.800	363.875 to 548.509	—	9.748	<0.001
Total Screen Time	4.890	2.835	−0.702 to 10.482	0.124	1.725	0.086
Age	1.904	2.050	−2.140 to 5.948	0.068	0.929	0.354
Gender	−3.745	11.462	−26.355 to 18.865	−0.023	−0.327	0.744
BMI	16.558	9.389	−1.963 to 35.079	0.130	1.763	0.079

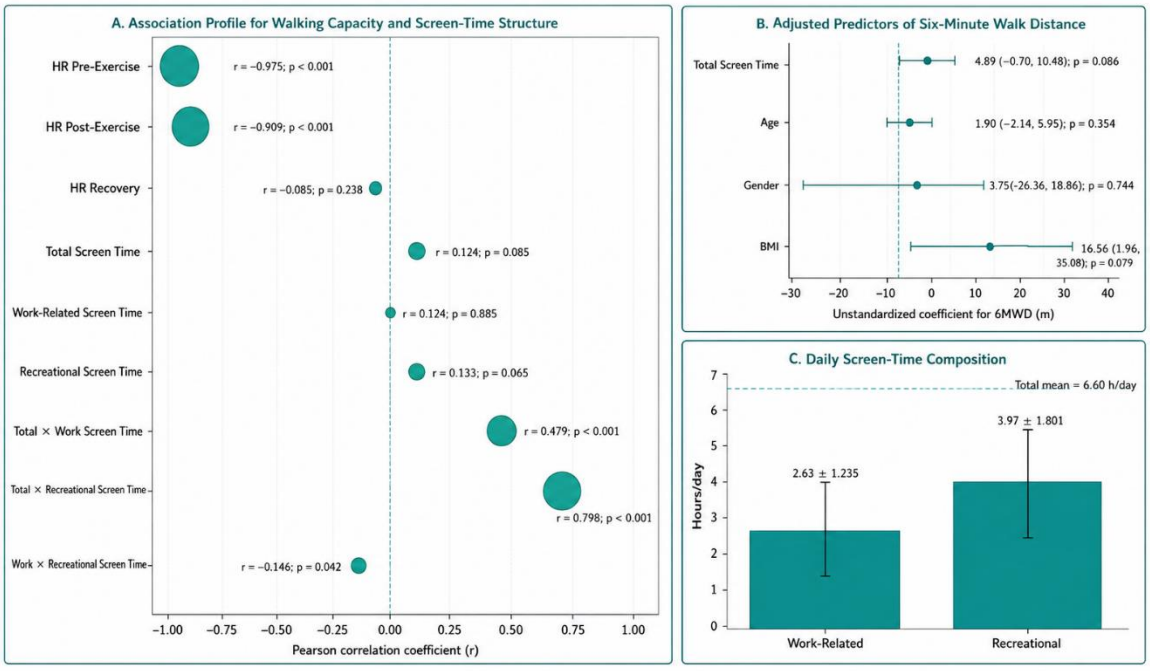

Figure 1 Integrated Cardiopulmonary and Screen-Time Patterning among Adolescents

The integrated panel demonstrates that Six-Minute Walk Distance was strongly and inversely associated with pre-exercise heart rate ($r = -0.975$, $p < 0.001$) and post-exercise heart rate ($r = -0.909$, $p < 0.001$),

whereas total screen time (r = 0.124, p = 0.085), work-related screen time (r = 0.010, p = 0.885), and recreational screen time (r = 0.133, p = 0.065) showed weak non-significant relationships with functional walking capacity. The adjusted regression layer further showed that total screen time did not independently predict Six-Minute Walk Distance after accounting for age, gender, and BMI, with the confidence interval crossing the null value (B = 4.89 m/hour/day; 95% CI: −0.70 to 10.48; p = 0.086). Recreational screen use contributed the larger share of daily screen exposure, averaging 3.97 ± 1.801 hours/day compared with 2.63 ± 1.235 hours/day for work-related screen use, while total daily screen time averaged 6.60 hours/day. Together, the pattern suggests that physiological heart-rate variables were more closely aligned with functional exercise capacity than self-reported screen-time exposure in this adolescent sample, although the unusually high heart-rate correlations warrant verification against the raw dataset before final interpretation.

None of the individual predictors reached statistical significance in the regression model. Total screen time had a positive coefficient of 4.890 m per additional hour/day, but the 95% CI crossed zero, −0.702 to 10.482, with p = 0.086. BMI also showed a positive coefficient, B = 16.558, but the 95% CI crossed zero, −1.963 to 35.079, with p = 0.079. Age and gender were not significant predictors of Six-Minute Walk Distance. Overall, the findings indicate that screen time did not independently predict Six-Minute Walk Distance after accounting for age, gender, and BMI.

Taken together, the results show that total, recreational, and work-related screen time were not significantly associated with Six-Minute Walk Distance in this adolescent sample. Heart rate variables, particularly pre-exercise and post-exercise heart rate, showed much stronger inverse correlations with walking distance than screen-time variables. However, the magnitude of the correlation between pre-exercise heart rate and Six-Minute Walk Distance was unusually high and should be verified against the raw dataset before final interpretation.

DISCUSSION

This cross-sectional study examined the association between screen time and functional cardiopulmonary capacity among adolescents aged 10–19 years using Six-Minute Walk Distance as the primary outcome. The principal finding was that total, work-related, and recreational screen time were not significantly associated with Six-Minute Walk Distance in this sample, despite the mean total daily screen exposure being 6.60 ± 2.029 hours. In contrast, pre-exercise and post-exercise heart rate demonstrated strong inverse correlations with Six-Minute Walk Distance, suggesting that physiological cardiovascular response was more closely aligned with functional walking performance than self-reported screen exposure. However, because the observed correlation between resting heart rate and Six-Minute Walk Distance was unusually high, this finding should be interpreted cautiously and verified against the raw dataset before being treated as a definitive physiological relationship.

The absence of a significant association between total screen time and Six-Minute Walk Distance is clinically relevant because it suggests that screen duration alone may be an insufficient marker of functional cardiopulmonary capacity in adolescents. Recent evidence indicates that the relationship between screen time and cardiometabolic risk is influenced by physical activity and fitness levels, with adverse associations becoming weaker when moderate-to-vigorous physical activity is considered (12). The present study did not directly measure habitual physical activity, exercise intensity, or sedentary breaks, which limits the ability to distinguish adolescents with high screen time but preserved physical activity from those with high screen time and low movement exposure. Therefore, the non-significant relationship observed in this sample may reflect the possibility that some adolescents remained sufficiently active outside screen-based activities to maintain functional walking capacity.

The findings are also consistent with research showing that excessive digital media exposure is common among school-going adolescents but may not independently explain objective or functional fitness outcomes when other behavioral factors are not measured or controlled. In the present study, the mean

total screen time exceeded commonly recommended public health targets, yet no significant reduction in Six-Minute Walk Distance was observed across higher screen-time exposure. Similar patterns have been reported in adolescent populations where screen exposure was associated with self-reported activity patterns and health behaviors, but its independent relationship with fitness outcomes was less consistent after considering broader lifestyle factors (13). This supports the interpretation that screen time may influence fitness indirectly through displacement of physical activity, sleep disturbance, dietary habits, or prolonged sitting rather than through screen exposure itself as an isolated variable.

The strong inverse association between heart rate parameters and Six-Minute Walk Distance suggests that cardiovascular response during submaximal functional testing may provide more immediate information about walking capacity than screen-time duration. Adolescents with lower pre-exercise and post-exercise heart rates walked longer distances, which may reflect better cardiovascular efficiency, lower physiological strain during exertion, or greater functional reserve. Intervention studies in sedentary adolescents have shown that structured exercise, including high-intensity interval training and moderate-intensity continuous training, can improve cardiovascular fitness and reduce resting heart rate, supporting the biological plausibility of heart rate as a fitness-related marker (14). Nevertheless, the magnitude of the correlation observed in the present study is much stronger than typically expected in field-based adolescent fitness studies. This raises the need for careful verification of data entry, measurement procedures, variable coding, and possible ordering or formula errors before overemphasizing heart rate as the dominant explanatory factor.

The weak positive but non-significant correlations of total and recreational screen time with Six-Minute Walk Distance were not in the hypothesized negative direction. This may be explained by the cross-sectional design, the use of a submaximal walking test rather than maximal oxygen uptake assessment, and the absence of objective physical activity monitoring. Recreational screen time formed the larger component of total screen exposure, averaging 3.97 ± 1.801 hours/day compared with 2.63 ± 1.235 hours/day for work-related screen time. However, recreational screen time was still not significantly associated with poorer Six-Minute Walk Distance. Studies examining post-pandemic screen and activity patterns among youth have shown that recreational screen time may increase without necessarily causing proportional reductions in physical activity when adolescents continue to participate in school movement, sports, walking, or informal play (15). The present results therefore suggest that the behavioral context of screen use may be more important than duration alone.

The relationship between screen time and adolescent fitness is further complicated by the distinction between sedentary behavior, screen exposure, and physical inactivity. A high screen-time adolescent may still engage in sufficient physical activity, whereas a low screen-time adolescent may remain sedentary through non-screen sitting behaviors. Previous large-scale evidence has shown that screen time and physical activity may have combined or interacting effects on cardiovascular risk markers, with physical activity attenuating some adverse associations of screen exposure (16). Since physical activity was not directly assessed in the present study, the findings should not be interpreted as evidence that screen time has no relevance to adolescent health. Rather, they indicate that self-reported screen duration alone did not independently predict Six-Minute Walk Distance in this sample after accounting for age, gender, and BMI.

The regression analysis further supports this interpretation. Total screen time, age, gender, and BMI collectively explained only 3.3% of the variance in Six-Minute Walk Distance, and the overall model was not statistically significant. Total screen time showed a positive but non-significant coefficient, while BMI also showed a non-significant positive coefficient with a confidence interval crossing the null value. These findings indicate that the selected demographic and screen-time predictors were insufficient to explain functional walking capacity. Other unmeasured determinants, including habitual physical activity, maturation status, body composition, sleep quality, nutritional status, motivation during testing,

school environment, and cardiorespiratory training history, may have contributed more substantially to Six-Minute Walk Distance.

This study has several limitations that should be considered when interpreting the findings. The cross-sectional design prevents any causal inference regarding the effect of screen time on cardiopulmonary endurance. Screen time was self-reported, which introduces recall bias and may not accurately capture device multitasking, sedentary breaks, or weekday-weekend variation. Physical activity was not objectively measured, limiting assessment of whether screen exposure displaced active time. The Six-Minute Walk Test is a practical measure of submaximal functional capacity but does not directly measure maximal cardiorespiratory fitness or oxygen uptake. The study also used convenience sampling from a local adolescent population, which may limit generalizability. Finally, the unusually strong inverse correlations between heart rate variables and Six-Minute Walk Distance require verification using the raw dataset and standardized measurement documentation before final interpretation.

Despite these limitations, the study contributes useful local evidence on adolescent screen exposure and functional walking capacity. Its findings suggest that interventions and future studies should move beyond screen-time duration alone and incorporate objective physical activity monitoring, sedentary behavior patterns, sleep assessment, and direct or field-based cardiorespiratory fitness measures. For clinical and school-based health promotion, reducing excessive recreational screen time remains important, but it should be paired with strategies that increase structured aerobic activity, active transport, sports participation, and regular movement breaks. Future longitudinal studies with accelerometry, standardized heart rate monitoring, and maximal or validated field-based fitness assessments are needed to clarify whether screen exposure independently affects cardiopulmonary fitness or primarily acts through reduced physical activity and other lifestyle pathways.

CONCLUSION

In this cross-sectional study of 194 adolescents aged 10–19 years, total, work-related, and recreational screen time were not significantly associated with Six-Minute Walk Distance, indicating that self-reported screen exposure alone did not independently explain functional cardiopulmonary capacity in this sample. Pre-exercise and post-exercise heart rate showed stronger inverse associations with walking distance, suggesting that physiological cardiovascular response may be more closely related to functional exercise performance than screen-time duration. However, the unusually high correlation between resting heart rate and Six-Minute Walk Distance should be verified before final interpretation. These findings support the need for future adolescent fitness studies to include objective physical activity assessment, standardized heart rate measurement, longitudinal follow-up, and more direct measures of cardiorespiratory fitness, while health promotion strategies should address both excessive sedentary screen use and the promotion of regular structured physical activity.

REFERENCES

1. Santos RMS, Mendes CG, Sen Bressani GY, de Alcantara Ventura S, de Almeida Nogueira YJ, de Miranda DM, et al. The associations between screen time and mental health in adolescents: a systematic review. BMC Psychol. 2023;11(1):127.

2. Baird S, Choonara S, Azzopardi PS, Banati P, Bessant J, Biermann O, et al. A call to action: the second Lancet Commission on adolescent health and wellbeing. Lancet. 2025;405(10493):1945-2022.

3. Lehnhard AR, Sehn AP, de Castro Silveira JF, Burns RD, Reuter CP, Franke SIR. Longitudinal relationship between screen time, cardiorespiratory fitness, and waist circumference of children and adolescents: a 3-year cohort study. BMC Pediatr. 2023;23(1):553.

4. Charoensittisup P, Udomittipong K, Mahoran K, Palamit A. Longitudinal effects of obesity on pulmonary function in obese children and adolescents. Pediatr Res. 2025;97(5):1644-9.

5. Vanhelst J, Beghin L, Drumez E, Casajus JA, De Henauw S, Widhalm K, et al. School time is associated with cardiorespiratory fitness in adolescents: The HELENA study. J Sports Sci. 2021;39(18):2068-72.

6. Dong Q, Liu H, Fu Q. Associations between physical fitness and different aspects of screen time in children and adolescents. Sci Rep. 2025;15(1):25607.

7. Kjellenberg K, Ekblom Ö, Stålman C, Helgadóttir B, Nyberg G. Associations between physical activity patterns, screen time and cardiovascular fitness levels in Swedish adolescents. Children (Basel). 2021;8(11):998.

8. Araujo RH, Werneck AO, Martins CL, Barboza LL, Tassitano RM, Aguilar-Farias N, et al. Global prevalence and gender inequalities in at least 60 min of self-reported moderate-to-vigorous physical activity 1 or more days per week: an analysis with 707,616 adolescents. J Sport Health Sci. 2024;13(5):709-16.

9. Aslam S, Bin SY. Active futures: combating youth sedentary lifestyles in Pakistan through smart use of fragmented time. Front Sports Act Living. 2025;7:1518884.

10. Raghuveer G, Hartz J, Lubans DR, Takken T, Wiltz JL, Mietus-Snyder M, et al. Cardiorespiratory fitness in youth: an important marker of health: a scientific statement from the American Heart Association. Circulation. 2020;142(7):e101-e18.

11. Chen X, Ma J, Dong L, Chen Y, Chen K. The association between physical activity and lung function in adolescents: a cross-sectional NHANES study. Front Med (Lausanne). 2025;12:1538221.

12. Horner D, Jahn M, Bønnelykke K, Chawes B, Flensborg-Madsen T, Schoos AMM, et al. Screen time is associated with cardiometabolic and cardiovascular disease risk in childhood and adolescence. J Am Heart Assoc. 2025;14(16):e041486.

13. Manuja R, Pattankar TP, Yadavannavar MC, Udgiri RS, Yadavannavar M, Udgiri Sr R. Impact of elevated screen time on school-age adolescents during the COVID-19 pandemic: an analytical study. Cureus. 2024;16(7).

14. Yahat H. Optimising adolescent health: a comparative study of high-intensity interval training and moderate-intensity continuous training on body composition and cardiovascular fitness in sedentary male youth. Front Sports Act Living. 2025;7:1655906.

15. Kägi-Braun N, Hedin L, Cassel S, Carlander A, J-Son Höök M, Löf M. Physical activity and screen time trends in Swedish youth: the Generation Pep study 2018-2023. Acta Paediatr. 2025;114(10):2589-602.

16. Nagata JM, Weinstein S, Alsamman S, Lee CM, Dooley EE, Ganson KT, et al. Association of physical activity and screen time with cardiovascular disease risk in the Adolescent Brain Cognitive Development Study. BMC Public Health. 2024;24(1):1346.