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Screen-Based Sedentary Behavior and Cardiorespiratory Fitness from Age 11 To 13

Jonathan A. Mitchell¹, Russell R. Pate¹, and Steven N. Blair^{1,2}

¹University of South Carolina, Arnold School of Public Health, Department of Exercise Science, Columbia, SC 29208

²University of South Carolina, Arnold School of Public Health, Department of Epidemiology and Biostatistics, Columbia, SC 29208

Abstract

Purpose—To determine if time spent in screen-based sedentary behavior is associated with change in cardiorespiratory fitness (CRF) levels in children from age 11 to 13, adjusting for vigorous physical activity (VPA).

Methods—Participants were children (n=2,097) enrolled in the control arm of the HEALTHY Study, who performed 20m shuttle run tests at ages 11 and 13. Self-reported screen time was used as a measure of sedentary behavior. Longitudinal quantile regression was used to model the influence of predictors on changes at the 10th, 25th, 50th, 75th and 90th shuttle run lap percentiles. Screen time (hrs/d) was the main predictor and adjustment was also made for VPA, body mass index and household education.

Results—In boys, more screen time was associated with fewer shuttle run laps completed from age 11 to 13 at the 25th, 50th and 75th shuttle run lap percentiles; the strongest association was at the 75th shuttle run percentile (-0.57, 95% CI: -0.93 to -0.21). In girls, more screen time was associated with fewer shuttle run laps completed from age 11 to 13 at the 50th, 75th and 90th shuttle run lap percentiles; the strongest association was at the 90th shuttle run percentile (-0.65, -1.01 to -0.30). Borderline negative associations were found between screen time and shuttle run laps at the 10th shuttle run percentile in boys and girls (-0.28, -0.57 to 0.01 and -0.17, -0.41 to 0.06, respectively).

Conclusion—More screen time was associated with lower CRF from age 11 to 13, independent of VPA. However, the association was weakest at the lower tail of the CRF distribution.

Keywords

aerobic; shuttle run; pacer; television; computer; longitudinal

Corresponding author: Jonathan A. Mitchell Department of Exercise Science, Arnold School of Public Health, Public Health Research Centre, Suite 212, 921 Assembly St, Columbia, SC 29208 mitch32@email.sc.edu; Tel: 803 777 9626; Fax: 803 777 2504.

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Introduction

There is evidence that low cardiorespiratory fitness (CRF) is associated with impaired metabolic risk profiles in children (5, 7, 13, 18). The associations are particularly evident when comparing the lowest CRF category with moderate and high CRF categories (5, 13, 18). Large proportions of children have low CRF levels (25, 29), and in the U.S. it is estimated that 45% of boys and 36% of girls, aged 12-13 years, do not meet CRF standards (25). It is therefore important to identify approaches that can increase CRF levels in childhood.

Spending time in moderate-to-vigorous physical activity (MVPA) has been associated with increased CRF levels among children (25, 30), and such findings contributed to the recommendation that children spend at least 60 minutes per day in MVPA (26). However, even if children meet this recommendation a large proportion of their time can be spent in sedentary behavior (24). There has been little research conducted to determine if time spent in sedentary behavior is associated with CRF levels in children, adjusting for physical activity levels (11). This is notable as there is evidence that aging from childhood to adolescence is a key period during the life course when time spent in sedentary behavior increases (21). Longitudinal studies are needed to investigate if time spent in sedentary behavior is independently associated with changes in CRF levels during childhood.

Cross-sectional studies involving children have reported negative associations between screen-based sedentary behavior and several measures of CRF that include 1-mile run times, 20m shuttle run laps and peak oxygen uptakes estimated from submaximal tests (1, 11, 17, 25). However, only the study by Hardy et al. adjusted for physical activity levels, and in that study the negative association between screen time and the number of shuttle run laps completed remained after the adjustment (11). That cross-sectional finding suggests that screen time is independently associated with CRF levels in children. To the best of our knowledge no longitudinal studies have determined if screen-based sedentary behavior is associated with changes in CRF levels during childhood, adjusting for physical activity. The purpose of the present study is to determine if time spent in screen-based sedentary behavior is associated with changes in CRF in a sample of children as they age from 11 to 13, adjusting for physical activity levels.

Methods

Study Design

We used a longitudinal observational study design to address the aim of the present study. Participants completed 20m shuttle run tests at ages 11 and 13, and the number of laps completed was used as a measure of CRF levels. At the same ages, the participants self-reported the time spent watching television, using a computer and playing video games to provide a measure of screen based sedentary behavior.

Participants

The children included in the current study were participants in the HEALTHY Study, which has been described in full detail elsewhere (12). The HEALTHY Study was designed as a cluster randomized controlled trial with middle schools the unit of randomization. Middle schools were selected from seven field centers (six schools per field center): (1) Baylor College of Medicine, Houston, TX, USA; (2) Oregon Health & Science University, Portland, OR, USA; (3) University of California at Irvine, Irvine, CA, USA; (4) Temple University, Philadelphia, PA, USA; (5) University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; (6) University of Pittsburgh, Pittsburgh, PA, USA; and (7) University of Texas Health Science Center at San Antonio, San Antonio, TX, USA. To be included in the

HEALTHY Study the middle schools had to have a student body that was 50% minority (African American, Hispanic/Latino, and/or American Indian) or have 50% of students eligible for a free lunch (Figure 1). Children attending the schools assigned to the control arm received no intervention materials during the study period, and based on the purpose of the current study only the children attending these schools were included in our analyses (Figure 1). The screen time and CRF levels of the children attending the schools assigned to the intervention arm of the study may have been influenced by exposure to the intervention components (nutrition, physical education, behavior and communication components) and so were excluded. Institutional review boards at each field center provided ethical approval for the study. The children provided written informed assent, and their parents provided written informed consent, for participation in the HEALTHY Study.

Cardiorespiratory Fitness (CRF)

Participants performed 20m shuttle run tests during physical education lessons. This field test required the participants to run back and forth between markers set 20m apart, at an initial speed of 8.5 km/h. The pace of the test increased by 0.5 km/h every minute, and audio signals determined if each lap was completed on time. Research assistants recorded the shuttle run laps completed, and if two laps were not completed within the required time that specific participant's test ended. The total number of laps completed was used as a measure of CRF in the current study. This field test has been validated against laboratory measured maximal oxygen uptake in children (3, 16); and has been shown to provide a reliable estimate of CRF among children (19, 23).

Sedentary Behavior

The participants self-reported the time they spent watching television/videos, using a computer/internet and playing video games over two days, using the Self-Administered Physical Activity Checklist (SAPAC) (31). Children have a limited ability to recall behaviors and so a two-day recall was used in the HEALTHY Study (12). The SAPAC was administered on a Wednesday, Thursday or Friday to capture weekday screen time. Total screen time before and after school was determined, and screen times that exceeded 150 minutes before school and 450 minutes after school were considered excessive, and self-reported times at or below these values were considered plausible. These cut point values were close to the 90th screen time percentiles values. Participants who reported screen time in excess of these cut points had their times Windsorized to the cut point values, and this approach has been used in past studies (32). The screen times before and after school were then summed, and the average hours per day spent engaged in screen time over two days was used as a measure of overall screen time.

Physical Activity

Spending time in physical activity, and especially vigorous physical activity (VPA), is associated with higher CRF in children (30). For this reason self-reported time spent in VPA was included in the current study as a covariate. The SAPAC included a range of activities, but only physical activities of 6 or more metabolic equivalents (METs) were used to estimate the time spent in VPA. The physical activity compendium was used to assign MET values to each activity (27). The children recalled the physical activities they performed on the previous two days. The SAPAC was administered on a Wednesday, Thursday or Friday to provide a measure of weekday physical activity. The time spent in VPA before, during and after school was determined for each participant, and self-reported times that exceeded 60 minutes before school, 80 minutes during school and 240 minutes after school were considered excessive. These cut points were close to the 95th VPA percentiles and were thought to be the upper limit of plausible times during each period. Participants who reported VPA in excess of these cut points had their times Windsorized to the cut point

values, and this approach has been used in past studies (32). The times spent in each period were summed, and the average minutes per day of VPA over two days was used as a measure of time spent in VPA.

Additional Confounders

Gender, socioeconomic status (SES) and body mass index (BMI) were also included in the current study as covariates. There is evidence that time spent in sedentary behavior varies between boys and girls, with evidence that screen time is higher among boys (10). Further, there are data showing that boys have higher CRF levels than girls (25). In addition, lower SES and higher BMI levels associate with more time spent in sedentary behavior (15, 21), and lower CRF levels (25). The highest education level attained by the head of the household was reported and household education level, high school or some college, was used as a measure of SES in the current study. The children were categorized into BMI percentile categories based on CDC growth chart reference values; the categories were 30th percentile, 31st to 84th percentile, 85th to 95th percentile or 95th percentile.

Statistical Analysis

For descriptive purposes the means and standard deviations (SD) for the continuous variables, and frequencies and percents for categorical variables, are presented. We used longitudinal quantile regression models to address the aims of the study. Traditional regression models focus on the mean, and so are limited in that they do not extend to the non-central locations of a distribution (i.e., upper and lower tails) (9). In the context of CRF, there is a particular interest in the effect of predictors at the lower tail of the CRF distribution (5, 6). Quantile regression is an extension of ordinary least squares (OLS) regression, and the coefficients from both statistical approaches are interpreted in the same manner (i.e. the coefficients in the present study represent the change in CRF for each unit change in the independent variable) (9). First, we created longitudinal quantile regression models to describe changes at the 10th, 25th, 50th, 75th and 90th screen time percentiles from age 11 to 13. This was to determine if changes in screen time with age were equal across the screen time distribution. Screen time was modeled as the dependent variable and age (coded: 0 and 2) was included as the independent variable. Second, we created longitudinal quantile regression models to describe changes at the 10th, 25th, 50th, 75th and 90th shuttle run lap percentiles from age 11 to 13. Shuttle run laps were modeled as the dependent variable, and age gender and age x gender were included as independent variables. This was to determine if changes in shuttle run laps were equal across the shuttle run lap distribution, and if the changes were equal for boys and girls. Third, we created longitudinal quantile regression models to determine if screen time was associated with changes at the 10th, 25th, 50th, 75th and 90th shuttle run lap percentiles from age 11 to 13. In model 1, shuttle run laps was modeled as the dependent variable with age, screen time, BMI and SES included as independent variable. This was done to determine if screen time was associated with changes in shuttle run laps, and if the changes were equal across the shuttle run lap distribution, adjusting for BMI and SES. In model 2, VPA was also included an independent variable covariate to determine if any associations between screen time and the shuttle run lap percentiles were independent of VPA. The correlation between repeated measures on individuals was accounted for by using a first order autoregressive [AR(1)] correlation structure (34). The 95% confidence intervals were estimated using 500 cluster bootstrap samples to account for the dependence between repeated measures (34). All analyses were conducted using Stata (SE, release 10.0).

Results

A total of 2,097 children had baseline and follow-up shuttle run data, and of these 988 were boys and 1,109 were girls. In terms of race/ethnicity the sample was 54.3% Hispanic, 15.6% Black, 21.2% White and 9.0% other (Table 1). The sample was approximately split in terms of household education level (51.5% from households where the highest level of education attained was high school or less; and 48.5% from households where the highest education level attained was some college or more) (Table 1). The demographic characteristics of the sample reflect the selection protocol used for the HEALTHY Study (Figure 1).

The mean screen times by gender and age are shown in Table 1. On average, the children spent 3.5 and 3.8 hours per day in screen time at age 11 and 13 respectively. Using quantile regression it was observed that increases in screen time from age 11 to 13 were different across the screen time distribution (Table 2). The greatest increase in screen time was observed at the 75th screen time percentile (5.00 to 5.50 hours per day) and the smallest increase was observed at the 10th screen time percentile (0.75 to 1.01 hours per day) (Table 2). In contrast, the 90th screen time percentile remained stable over time at 7.50 hours per day (Table 2). The quantile regression models were tested for visit x gender interaction terms, but there was no evidence that screen time changed differentially over time for boys or girls.

The mean number of shuttle run laps completed was greater among the boys compared to the girls in the 6th grade (Table 1). Further, there was an increase in the mean number of shuttle run laps from age 11 to 13 among the boys, but not the girls (Table 1). Using quantile regression, changes in shuttle run laps were different for boys and girls (Table 3). For the boys, increases were observed at all shuttle run percentiles with the greatest increase at the 90th shuttle run lap percentile (+18 laps over time), and smallest increase at the 10th shuttle run lap percentile (+3 laps over time). For the girls there were no changes at the 10th and 25th shuttle run lap percentiles over time; and small increases in shuttle run laps at the 50th, 75th, and 90th shuttle run lap percentiles (+2 laps, +1 lap and +2 laps, respectively).

Due to the gender specific changes in shuttle run laps over time the associations between screen time and shuttle run lap percentiles are presented by gender in Table 4. In our sample of boys, more screen time was negatively associated with changes in shuttle run laps at the 25th, 50th and 75th shuttle run percentiles (Table 4). The negative associations between screen time and number of shuttle run laps were progressively stronger from the 25th to the 75th shuttle run percentiles in the boys (Table 4). Negative associations were observed between screen time and changes in shuttle run laps at the 10th and 90th shuttle run percentiles, but these associations did not reach statistical significance. The observed associations were similar after adjusting for VPA levels (Table 4). The results were similar when adjusted for moderate-to-vigorous physical activity (4+ MET activities; data not shown).

For the girls, screen time was negatively associated with changes in shuttle run laps at the 50th, 75th and 90th shuttle run percentiles (Table 4). The strength of the negative associations between screen time and shuttle run laps were progressively stronger from the 50th to the 90th shuttle run percentiles in the girls (Table 4). Negative associations were observed between screen time and changes in shuttle run laps at the 10th and 25th shuttle run percentiles, but these associations did not reach statistical significance (Table 4). The observed associations were similar after adjusting for VPA levels (Table 4). The results were similar when adjusted for moderate-to-vigorous physical activity (4+ MET activities; data not shown).

In Figure 2, shuttle run lap distributions at each grade are presented by high and low screen times. The 10th percentile and 90th screen time percentiles described in Table 2 are used to define low and high screen time, respectively. It can be observed that the shuttle run distribution was predicted to shift to the right if all boys and girls in our sample had low screen time. The rightward shift was predicted to be most prominent at the upper tail in the girls, and most prominent in the middle of the distribution for the boys.

Discussion

In boys we observed increases in CRF from age 11 to 13 with the greatest increase observed at the 90th CRF percentile. However, more screen time was associated with lower CRF from age 11 to 13 at the 25th, 50th and 75th CRF percentiles. It was predicted that if all boys in our sample reduced their screen time, the CRF distribution would shift to the right, with the greatest rightward shift occurring at the 75th percentile. In girls, we observed that CRF remained relatively stable from age 11 to 13. However, more screen time was associated with lower CRF from age 11 to 13 at the 50th, 75th and 90th CRF percentiles. It was predicted that if all the girls reduced their screen time, the shuttle run lap distribution would shift to the right, with the greatest shift occurring at the 90th percentile. In both boys and girls, borderline negative associations were observed between screen time and shuttle run laps at the 10th CRF percentile.

The negative associations we observed between screen time and changes in CRF were adjusted for self-reported VPA. Previous cross-sectional studies have investigated the association between screen time and measures of CRF (1, 11, 17, 25), but only the study by Hardy et al. adjusted for physical activity levels (11). In that study median shuttle run laps were higher among children in the lowest screen time quintile, compared to children in the highest screen time quintile (11). To the best of our knowledge no longitudinal studies have investigated the relationship between sedentary behavior and changes in CRF in children, adjusting for time spent in physical activity. We identified one longitudinal study that specifically assessed changes in mean CRF from age 7 to 9 in relation to television viewing, and there was evidence that more television viewing associated with reduced CRF levels over time (22). However, that study did not adjust for physical activity levels (22). Additional longitudinal studies are needed to confirm if screen time is independently associated with changes in measures of CRF during childhood. The findings in the current longitudinal study and those reported cross-sectionally by Hardy et al. suggest that more screen time may lead to lower CRF levels during childhood (11).

There is also a need to replicate our study using objective measures of sedentary behavior. The relationship between accelerometry measured sedentary behavior and CRF has been investigated in a cross-sectional study of European children (20). The investigators categorized children into low and high sedentary behavior groups, based on percent time spent in sedentary behavior (<69% and ≥69% of time, respectively) (20). There was no difference in the mean number of shuttle run stages completed between low and high sedentary behavior groups in the boys (20). The mean number of shuttle run stages completed was lower for girls in the high sedentary behavior category. However, there was no association between sedentary behavior and mean shuttle run stages if the girls spent 60 minutes or more per day in MVPA (20). These data suggest that the association between sedentary behavior and CRF in girls is not independent of MVPA. Direct comparisons between this cross-sectional study and our longitudinal study are limited by the different study designs and methodologies used to measure and report time spent in sedentary behavior (20). Further, the different populations under observation (European children aged 12 to 17 versus U.S. children aged 11 to 13) also need to be taken into consideration when drawing comparisons (20).

We used longitudinal quantile regression models to analyze our data, which allowed for the investigation of screen time on changes across the CRF distribution (9). We found that the association between screen time and CRF was not uniform across the CRF distribution. This finding is of interest in the context of the population-based approach to preventive medicine (28). Based on our results, if all children reduced their screen time the CRF distribution would shift to the right; however, the rightward shift would not be uniform, and would be minimal at the lower tail of the CRF distribution. There is evidence that the largest gains in health associated with higher CRF levels are observed between the lowest and middle CRF categories in children (5, 13, 18). The same findings were first observed in adults (2, 6), indicating that a rightward shift at the lower tail of the CRF distribution is of most clinical importance. Further research is needed replicate our findings, and to identify if there are preventive measures that associate with a rightward shift at the lower tail of the CRF distribution.

Interestingly, age was a strong predictor of CRF increases among the boys, especially at the upper tail of the CRF distribution, but not among the girls. In addition, the age association remained after including the amount of screen time, and the other covariates, in our models. This indicates that biological maturation is a driver of increases in CRF in boys, but not in the girls. Hormonal and body composition changes (increase in skeletal muscle) in boys, compared to the hormonal and body composition changes (increase in adipose tissue) in girls, may explain why we observed CRF increases in the boys from age 11 to 13 (14).

One explanation as to why we observed a non-uniform association between screen time and age-related changes in CRF is that CRF is a partly heritable trait (4). It has been shown in a study of family members that aerobic exercise training does not uniformly increase CRF levels, with some families being non-responders (4). It is likely that children genetically predisposed to lower CRF levels are at the lower tail of the CRF distribution, and this may explain the minimal leftward shift at the lower tail of the CRF distribution (i.e. there may be nonresponders at the lower tail of the distribution, resistant to age and screen time associated changes in CRF due to genetic predispositions) (4).

Strengths of the current study include the repeated measures of CRF at ages 11 and 13. We adjusted for self-reported VPA and only a single cross-sectional study has controlled for this key covariate in the past (11). Further, we used longitudinal quantile regression to study the association between screen time and changes in CRF. This approach allowed for the study of screen time at the tails of the CRF distribution, and past studies have only investigated the median or mean CRF levels (9). There are limitations in the current study. Self-reported time spent in screen time was used as a measure of sedentary behavior and there is evidence that screen time may not provide a good representation of total sedentary behavior (8). It is therefore possible that those with low screen time spent time in sedentary behavior through other behaviors (e.g. sitting talking to friends) (8). It is also a limitation that screen time was assessed over two days, due to the recall abilities of children. Studies assessing screen time over a longer period, perhaps through momentary recall diaries, could advance this area of research; this would also allow for the investigation of other sedentary behaviors in relation to CRF (8). Time spent in VPA was self-reported and the children may not have accurately recalled the specific time spent in each activity (33). Using an objective measure of sedentary behavior and physical activity would overcome many of the limitations of self-reported screen time and VPA (20, 30). The 20m shuttle run test is a desirable method to assess CRF levels in large number of children in the field setting; maximal aerobic exercise tests provide better measures of CRF, but are impractical in such a large study (23). We were only able to measure the linear change in CRF levels between age 11 and 13, and additional studies following children for longer periods of time are needed to better determine changes in CRF levels during childhood. Over half of our sample was Hispanic

and all children were in the U.S. Further research is needed to determine if similar associations between screen time and changes in CRF are observed in other populations of children.

In conclusion, screen time was negatively associated changes in CRF from age 11 to 13 in boys at the 25th, 50th and 75th CRF percentiles, independent of VPA. For girls, more screen time was negatively associated with changes in CRF from age 11 to 13 at the 50th, 75th and 90th CRF percentiles, independent of VPA. Borderline negative associations were observed between screen time and changes in CRF from age 11 to 13 at the 10th CRF percentile in the boys and girls.

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Figure 1.

Participants recruited into the HEALTHY Study and flow of participants included in the current study. CRF, cardiorespiratory fitness; 20m ST, 20m shuttle run

Figure 2.

Changes in shuttle run lap distributions by gender in the 6th to 8th grade if all children had low screen time (solid) or high screen time (dashed). Low screen time was defined as 0.75 hours per day and 1.0 hour per day at the 6th and 8th grades, respectively. High screen time was defined as 7.5 hours per day at both the 6th and 8th grades. Kernel density estimation was used to plot the distributions (Epanechnikov, bandwidth 5).

Table 1

Descriptive statistics for HEATLHY Study participants providing baseline and follow-up 20m shuttle run data

	Baseline	Follow-up
Age, mean (SD), yrs		
Boys	11.4 (0.61)	13.7 (0.69)
Girls	11.3 (0.59)	13.6 (0.65)
CRF, mean (SD), laps		
Boys	23.7 (13.9)	35.0 (19.4)
Girls	19.3 (10.2)	20.9 (11.6)
Screen time, mean (SD), hr/d		
Boys	3.55 (2.50)	4.00 (2.38)
Girls	3.44 (2.43)	3.67 (2.40)
VPA, mean (SD), min/d		
Boys	95.3 (79.3)	73.5 (72.5)
Girls	83.9 (72.2)	57.2 (64.7)
BMI Categories, N (%)		
30 th CDC percentile	265 (13.4)	208 (10.5)
31 st to 84 th CDC percentile	764 (38.5)	901 (45.3)
85 th to 95 th CDC percentile	319 (16.1)	337 (16.9)
95 th CDC percentile	637 (32.1)	544 (27.3)
Household Education, N (%)		
High school or less	1,048 (51.5)	
Some college or more	987 (48.5)	
Race/Ethnicity, N (%)		
Hispanic	1,138 (54.3)	
Black	327 (15.6)	
White	444 (21.2)	
Other	188 (9.0)	

CRF, cardiorespiratory fitness; Screen time, total time spent watching television/videos, using a computer/internet and playing video games; VPA, vigorous physical activity; BMI, body mass index; CDC, Center for Disease Control and Prevention. Screen time missing at age 11: n=74 boys & n=73 girls; Screen time missing at age 13: n=110 boys & n=94 girls; VPA missing at age 11: n=77 boys & n=96 girls; and VPA missing at age 13: n=117 boys & n=142 girls.

Descriptive changes in the sedentary behavior distribution over time using quantile regression

Table 2

Screen time (hours per day)					
	10 th Percentile	25 th Percentile	50 th Percentile	75 th Percentile	90 th Percentile
Intercept	0.75 (0.69, 0.81)	1.50 (1.46, 1.54)	2.87 (2.70, 3.03)	5.00 (4.78, 5.22)	7.50 (7.46, 7.54)
Age	0.13 (0.08, 0.17)	0.21 (0.14, 0.28)	0.23 (0.12, 0.34)	0.25 (0.10, 0.40)	0.00 (-0.05, 0.05)

Screen time, sum of self-reported time spent watching television/videos, using a computer/internet and playing video games. Age is coded 0 and 2 to represent ages 11 and 13 respectively; therefore the age coefficients are interpreted as change in hours of screen time per year.

Table 3

Descriptive changes in 20m shuttle run laps from age 11 to 13 using quantile regression

	20m Shuttle Run Laps				
	10 th Percentile	25 th Percentile	50 th Percentile	75 th Percentile	90 th Percentile
Intercept	9.0 (8.71, 9.29)	13.0 (11.9, 14.1)	20.0 (18.8, 21.2)	32.0 (30.3, 33.7)	44.0 (41.5, 46.5)
Age	1.5 (0.85, 2.15)	3.0 (2.25, 3.75)	6.0 (5.25, 6.74)	7.50 (6.28, 8.72)	9.0 (7.57, 10.4)
Gender	0.0 (-0.98, 0.98)	-1.0 (-2.41, 0.41)	-3.0 (-4.47, -1.53)	-7.00 (-8.94, -5.06)	-10.0 (-12.9, -7.09)
Gender × Age	-1.5 (-2.35, -0.65)	-3.0 (-3.97, -2.03)	-5.0 (-5.97, -4.03)	-7.00 (-8.42, -5.58)	-8.0 (-9.84, -6.16)

Age is coded 0 and 2 to represent ages 11 and 13 respectively; therefore the age coefficients are interpreted as change in number of laps per year. Gender is coded 0 and 1 for boys and girls respectively. Gender × age is coded 0 for boys and girls at age 11; and is coded 0 for boys and 2 for girls at age 13.

Table 4

Association between screen-based sedentary behavior and changes in 20m shuttle run laps from age 11 to 13

		Boys, 20m Shuttle Run Laps			
		10 th Percentile	25 th Percentile	50 th Percentile	75 th Percentile
Model 1^a:					
Intercept		15.5 (13.4, 17.6)	24.3 (22.3, 26.2)	37.2 (33.3, 41.0)	51.9 (48.7, 55.2)
Age		1.59 (1.12, 2.06)	3.19 (2.63, 3.75)	5.32 (4.33, 6.31)	6.59 (5.93, 7.24)
Screen time (hr/d)		-0.29 (-0.58, 0.01)	-0.42 (-0.64, -0.21)	-0.48 (-0.82, -0.13)	-0.47 (-0.79, -0.16)
Model 2^b:					
Intercept		15.9 (13.5, 18.4)	24.1 (21.9, 26.4)	35.6 (31.3, 39.8)	50.3 (46.9, 53.7)
Age		1.60 (1.05, 2.14)	3.31 (2.68, 3.95)	5.61 (4.61, 6.61)	6.90 (6.08, 7.23)
Screen time (hr/d)		-0.28 (-0.57, 0.01)	-0.42 (-0.68, -0.17)	-0.52 (-0.89, -0.15)	-0.57 (-0.93, -0.21)
		Girls, 20m Shuttle Run Laps			
Model 1^a:					
Intercept		12.3 (10.8, 13.8)	17.2 (16.1, 18.3)	24.9 (23.0, 26.8)	34.2 (31.2, 37.2)
Age		-0.03 (-0.42, 0.35)	0.62 (0.30, 0.95)	0.69 (0.23, 1.16)	1.64 (0.98, 2.31)
Screen time (hr/d)		-0.07 (-0.26, 0.12)	-0.14 (-0.33, 0.05)	-0.37 (-0.61, -0.13)	-0.36 (-0.67, -0.05)
Model 2^b:					
Intercept		13.2 (11.4, 14.9)	17.1 (15.7, 18.5)	23.8 (21.4, 26.2)	32.1 (29.6, 34.5)
Age		0.05 (-0.38, 0.49)	0.81 (0.44, 1.17)	1.10 (0.54, 1.67)	2.03 (1.43, 2.63)
Screen time (hr/d)		-0.17 (-0.41, 0.06)	-0.15 (-0.32, 0.03)	-0.30 (-0.52, -0.09)	-0.41 (-0.70, -0.12)

Age is coded 0 and 2 to represent age 11 and 13, respectively; therefore the age coefficients are interpreted as change in number of laps per year. Screen time, sum of self-reported time spent watching television/videos, using a computer/internet and playing video games.

^a Adjusted for body mass index and household education level

^b Adjusted for body mass index, household education level and vigorous physical activity.