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Screen Time and Blood Pressure in Children and Adolescents: The Role of Obesity

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Abbreviations: BP: Blood Pressure; TV: Television; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

ABSTRACT

Objective: The increased incidence of hypertension and obesity in children raises concerns about future cardiovascular disease. In this study, the effect of leisure screen time on office blood pressure (BP) was examined in hospitalized children and adolescents, as well as obesity's influence on this association.

Design: Hospitalized children were prospectively included in the study. Detailed personal history, screen time as well as cardiovascular family history were assessed using a standard questionnaire. Office BP was measured three times in participants ≥3years old using a validated oscillometric device at the second day of hospitalization.

Results: Hypertensive children report higher daily and weekly screen time compared to normotensive children (age, sex and BMI z-score adjusted, P<0.005). Obese children with hypertension presented the highest mean weekly screen time levels (age, sex adjusted, P<0.005). In adolescents SBP and DBP z-scores inversely correlated with birth weight (r=-0.411, r=-0.460, respectively, P<0.05), positively with BMI z-score (r=0.368, r=0.433, P<0.05), daily screen time (r=0.391, r=0.361, P<0.05), and weekly screen time (r=0.423, r=0.413, P<0.05). Adolescents had a 1.18 times increased likelihood to have hypertension per each hour increase in weekly screen time, after adjustment for multiple risk factors.

Conclusion: Normal weight and active lifestyle in childhood could be crucial for preventing future hypertension.

Introduction

Several studies have reported an association between higher daily and weekly screen time with obesity, impaired lipid profile and elevated blood pressure (BP), in children and adolescents [1-4]. In 2011 the National Heart, Lung and Blood Institute expert panel and in 2013 the American Academy of Pediatrics have launched recommendations for limiting daily screen time in less than two

hours [5,6]. The possible relation between elevated screen time and increased BP levels could be attributed to many different factors. A number of studies have revealed a dose–response relationship between the average hours of television (TV) watch in young children and prevalence of obesity [7-10]. While watching television, children are more likely to eat, consuming larger food quantities than usual, and to select foods of doubtable quality, such as snacks and sweetened beverages. Additionally, more hours of screen time translate into less hours of physical activity affecting directly energy balance, thus favoring adiposity [4]. Moreover, it has been reported that heavy viewing in the preschool age predicts greater TV viewing in later childhood and adolescence [11-14] exposing youngsters for a very long period of time to "unhealthy" habits. The relation between elevated screen time and increased BP levels have been attributed to excessive screen time that results in less sleeping hours, especially in the preschool ages [3,15]. However, several studies have not found a relationship between screen time and BP levels [16-20] and the results of a systematic review concluded that there is insufficient evidence in order to establish a longitudinal relationship between sedentary time and BP levels [17]. The aims of the present study were to examine the effect of leisure screen time on office BP levels and body weight in children and adolescents. The hypothesis to be tested was that sedentary habits may have negative impact in children and adolescent health and could predispose to obesity and hypertension.

Materials and Methods

We prospectively included in the study consecutive children who were hospitalized in our Pediatric Department, located in a tertiary care affiliated institution for 3 consecutive winter months. Anthropometric measurements were performed to all children. Body weight and height were measured at the closest 0.1 Kg and 0.1 cm, respectively, with the subjects in light clothing without shoes. Body mass index (BMI) was calculated as weight (kg)/height (m2) and BMI z-score was calculated [21]. Patients were characterized as obese if their BMI was equal to or higher than 95th percentile (pc) [22]. Personal history including perinatal history, birth weight, gestational age, chronic disease, and/or treatment associated with increased BP levels, as well as family history of hypertension or cardiovascular disease in the parents or the grandparents were recorded.

Screen time was assessed from questionnaires from the parents, or both the parents and the patient in case of adolescents, asking "How many hours per day do your child/you usually watch television, play games on a computer/tablet/mobile phone, or use your computer/tablet/mobile phone for leisure activities" for weekdays and weekend days separately. Daily screen-time was computed by adding television and computer/tablet/mobile phone time (hours) per day. Weekly screen time (hours/week) was calculated as: [(screen time weekday x 5) + (screen time weekend day x 2)]/7. Informed consent to participate in the study was obtained by the children's parents and by both the parents and the adolescents. The study was performed in accordance with the declaration of Helsinki and the institutional review board approved the research protocol.

Office BP was measured three times in each arm by a validated for children and adolescents oscillometric device (Ombron 705IT) using the appropriate size cuff in all children and adolescents ≥ 3 years old. During the measurements the participant remained seated for ten minutes with the arm comfortably placed at the level of the heart. Office BP measurements for the study protocol were performed at the second day of hospitalization to decrease white coat effect due to acute illness or increased anxiety during the first day of admission. Critically ill children with hemodynamic instability were excluded. High office BP levels were defined as systolic BP (SBP) and/ or diastolic BP (DBP) were above the 90th percentile for age, gender and height [23]. Office BP was also measured in 87 mothers and 43 fathers who consented to participate in the study.

The IBM SPSS 21.0 (SPSS Inc, Chicago, Illinois, USA) statistical package was used to analyze the data. Standard descriptive statistics, two-tailed student's t-test and chi-squared test were used where appropriate to compare characteristics of the groups. Results are expressed as percentages or means ± standard deviations. Multiple comparisons between subgroups were performed using one-way analysis of variance post-hoc Tukey analysis. The nonparametric Kruskal -Wallis test was also used where appropriate. Multivariate linear and logistic regression analyses (stepwise criteria: probability of F to enter < 0.05 probability of F to remove ≥ 0.10) were also used. The collinearity statistics tolerance (tolerance=1−Ri2, where Ri is the square multiple correlation of that variable with the other independent variables) was used for collinearity diagnostics. The univariate general linear model of SPSS (analysis of covariance) analysis and the estimated marginal means application was used to correct differences of the depended variables daily and weekly screen time for sex, age and BMI z score parameters in normotensive and hypertensive children. A p value < 0.05 was considered statistically significant.

Results

The study population was consisted of 101 consecutive children (60.2% boys) aged greater than 3 years old (age range 3-17 years). The characteristics of the study population are described in Table 1. There was no significant difference in daily or weekly screen time by sex in toddlers and school age children, but adolescent boys reported higher daily and weekly screen time than girls (3.94±1.47 vs. 2.65±1.60 hours daily, 30.84±12.20 vs. 20.19±11.07 hours weekly, P <0.05). Adolescents reported higher daily and weekly screen time compared with toddlers and school age children

(adolescents vs. toddlers, 3.42±1.63 vs. 2.11±1.35 hours daily, and 26.51±12.73 vs. 15.82±10.01 hours weekly, P <0.001, adolescents vs. school age children 3.42±1.63 vs. 2.53±1.48 hours daily, and 26.51±12.73 vs. 19.54±11.03 hours weekly, P<0.05). Weekly screen time correlated with mother's BMI (r=0.210, P=0.05), but not with father's BMI.

Table 1: Characteristics of the study population.

	Mean±SD, or %
Age (years)	7.91±4.02
Sex (%boys)	60.2
Birth weight (Kg)	3.048±623.94
Gestation weeks (weeks)	38.40±2.06
BMI pc	57.12±34.74
BMI z score	0.22±1.75
SBP (mmHg)	113.38±10.63
DBP (mmHg)	68.8±8.92
SBP z score	1.16±0.97
DBP z score	0.83±1.43
eGFR (ml/min/1.73m2)	104.55±26.26
Daily screen time (hours)	2.66±1.56
Weekly screen time (hours)	20.47±12.01
Positive personal history (% yes)	47.2
Positive family history (% yes)	87
Fathers SBP (mmHg)	134.58±13.5
Fathers DBP (mmHg)	81.87±10.42
Fathers BMI (Kg/m2)	27.89±4.17
Mothers SBP (mmHg)	123.11±15.29
Mothers DBP (mmHg)	76.03±9.4
Mothers BMI (Kg/m2)	25.69±5.10

Note: Abbreviations: SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index; eGFR: Estimated Glomerular Filtration Rate

Hypertensive children report higher daily and weekly screen time compared to normotensive children (3.10±1.58 vs. 2.51±1.45 hours daily, 23.85±13.28 vs. 19.20±10.43 hours weekly, unadjusted P=0.07 and P=0.08, respectively). In hypertensive children, the 95% CI for weekly screen time estimated marginal means corrected for age, sex and BMI z score were found to be 21.72-29.06 compared to 15.19-21.14 hours in normotensive children (adjusted P< 0.005), after Bonferroni's adjustment for multiple comparisons. Similar results were found for reported daily screen time (data not shown). Obese children also reported higher daily and weekly screen time. Obese, hypertensive children presented the highest mean weekly screen time levels (Figure 1). The 95% CI for weekly screen time estimated marginal means corrected for age, and sex were found to be 21.65-33.77 hours in hypertensive, obese children compared to 13.46-20.77 hours in normotensive, normal weight children (P< 0.05), after Bonferroni's adjustment for multiple comparisons (Figure 2).

Mean SBP or DBP z score levels did not differ by gender, personal history of chronic disease or family history of hypertension and/or cardiovascular disease. Moreover, there was no association between children and parents BP levels. In toddlers and school age children, screen time did not correlate with SBP and DBP z score. In adolescents, SBP and DBP z score correlated inversely with birth weight (r= -0.411, and r= -0.460, respectively, P<0.05), and positively with BMI z score (r= 0.368, and r= 0.433, respectively, P<0.05), daily screen time (r= 0.391, and r= 0.361, P<0.05), and weekly screen time (r= 0.423, and r= 0.413, respectively, P<0.05). Logistic regression analysis, examining the effects of sex, birth weight, gestation week, BMI z score and screen time on probability of adolescents to have hypertension, showed that adolescents had a 1.18 times increased likelihood to have hypertension per additional hour of weekly screen time, while no other parameter had a significant effect on BP classification (Models R2=0.502, 95%CI 1.006-1.394, P <0.05).

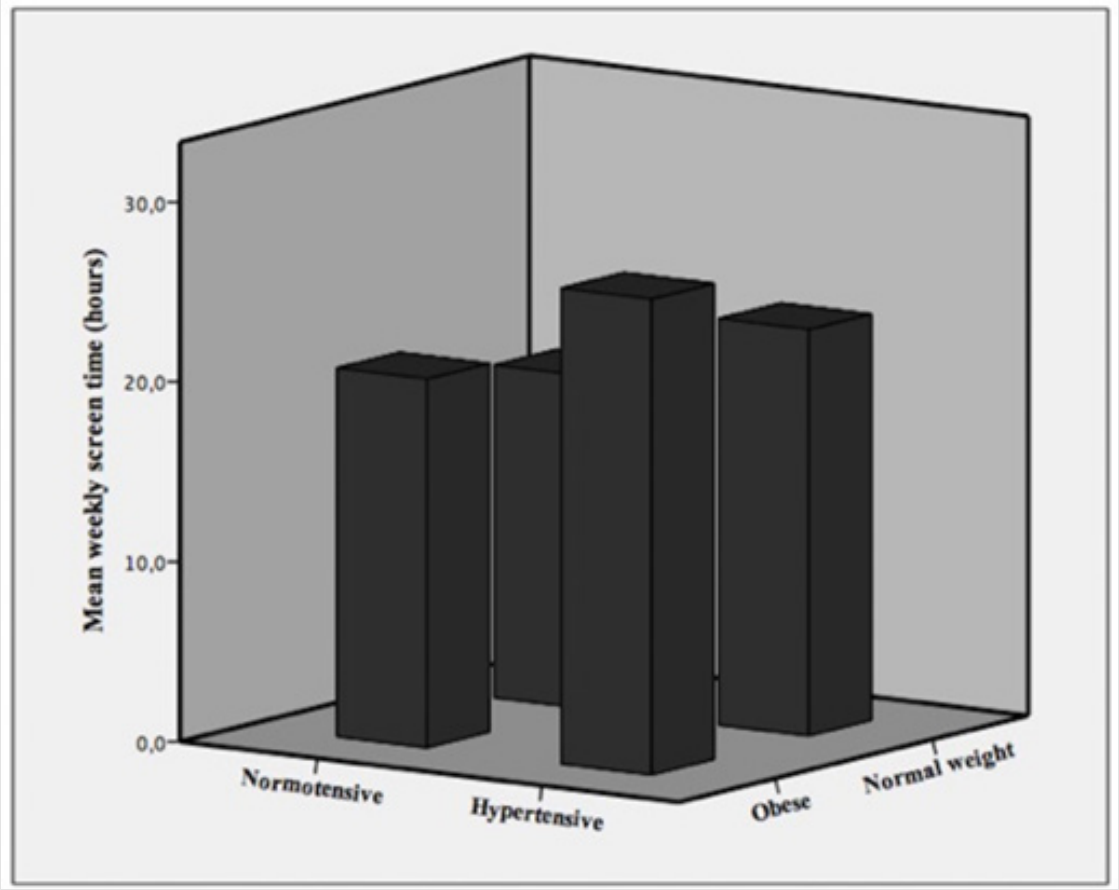

Figure 1: Weekly screen time by the BP and obesity levels.

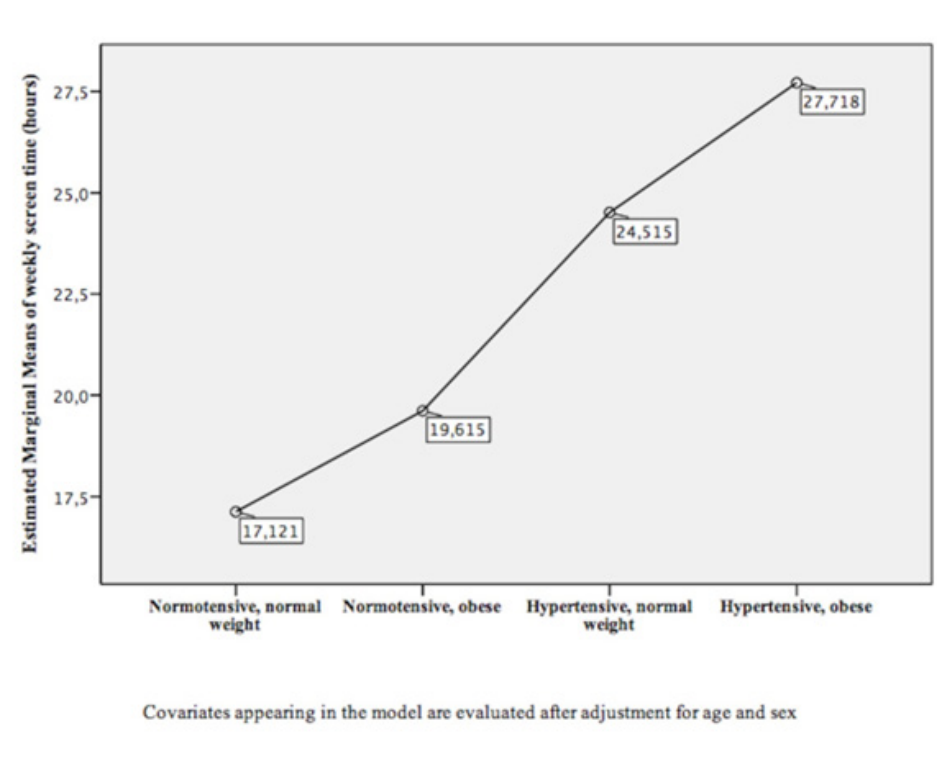

Figure 2: Weekly screen time by the BP and obesity levels after correction for age, and sex.

Discussion

The present study provides evidence that screen time is associated with hypertension and obesity in children. Screen time increases with age and seems to be a significant determinant for BP elevation in adolescents independent of other well-known risk factors including obesity, birth weight, and parental BP. Weekly screen time between boys and girls in toddlers and school age children did not differ significantly, but adolescent boys reported higher daily and weekly screen time than girls. National Health and Nutrition Examination Survey (NHANES) and the NHANES National Youth Fitness Survey reported no sex differences in the percentage of youth who watched TV for 2 hours or less daily; however, computer use did show a sex difference with a slight increased time of use in boys aged 12-15 years old.

Adolescents reported higher daily and weekly screen time compared with toddlers and school age children a finding that could be deeply concerning. Television viewing and screen time generally has been considered as a displacement behavior for physical activity. A study examining trajectories of daily physical activity, participation in organized sports, and television viewing time, confirmed the known decrease in physical activity from childhood to young adulthood and stated that developmental pathways of physical activity and television viewing behaviors could be related [24]. It is common ground that childhood and adolescence are key periods of interest since patterns of obesogenic behaviors are shaped and evidence suggests that diet, physical activity and sedentary behaviors may track into adulthood [25]. Another interesting finding was that weekly screen time correlated with mother's BMI. As stated in a systematic review published in 2015 in the early years of life, parental influences were significantly associated with young children's physical activity and screen time with moderate to strong evidence [26]. Results suggested that parents' encouragement and support could increase their children's physical activity and reducing parents own screen time could lead to decreased child screen time [26]. Moreover, parental dietary behavior and food parenting practices affect children's dietary behavior and BMI. Diet, physical activity, and sedentary behaviors in the early years of life are designated by parents through role modelling, through providing a stable home environment and by instituting a healthy modus vivendi.

In the present study hypertensive children report higher daily and weekly screen time compared to normotensive children after correction for age, sex and BMI z score. In hypertensive children, the 95% CI for weekly screen time estimated marginal means corrected for age, sex and BMI z score were found to differ significantly from those of normotensive children. Several studies support the direct influence of screen time on BP. In a 5-year prospective study each hour per day spent in total screen time was associated with a 0.69 and 0.59 mm Hg increase in DBP (P = 0.01) and mean arterial BP (P = 0.01), respectively [27]. TV viewing, but not PC or electronic games time, has been associated positively with DBP and SBP values after adjustment for other covariates [28]. Each hour per day spent in screen time, watching TV and playing video games was associated with a significant increase in DBP after adjusting for age, sex, ethnicity, parental education, height, BMI and time spent in physical activity [29]. In addition, the magnitude of retinal arteriolar narrowing has been associated with each hour daily of TV viewing and was similar to the effect of a 10-mm Hg increase in SBP in children [30]. In children aged from 3 to 8 years TV viewing and screen time, but not computer use, were positively associated with both SBP and DBP after adjusting for potential confounders [31]. Furthermore, there are also studies supporting the influence of screen time on BP levels indirectly through obesity (Schmidt) and through less sleeping time [3,15].

However, it should be noted that there is a significant number of studies concluding that there is no significant direct relationship between screen time and blood pressure levels in children or adolescents. [4,16,18-20,32-34]. The lack of significant associations between sedentary time variables and BP in children and youth has been attributed to the fact that younger people are more distal to pathophysiological developments associated with hypertension than adults thus making more difficult to detect meaningful differences in biomarkers in these age groups [18]. Although self-reported physical activity, screen time, or dietary intake were not directly related to cardiovascular disease risk in their protocol, higher activity levels have been associated with a healthier diet and lower screen time indicating an overall healthier lifestyle of the pediatric age group [33]. In agreement to the above, no significant relationships were found between self-reported total screen time and clustered cardiometabolic risk or individual risk factors in overweight and obese adolescents [34], while some studies suggest that screen time is associated only with markers of adiposity [19,20].

This study has several possible limitations. The results of the study may include selection bias due to the fact that only hospitalized children were included. Children with chronic health problems are more likely to have their BP measured both in preventive and chronic care visits and may more frequently need hospital care. Moreover, BP measurement on a single occasion in the hospital setting could not account for BP variability from visit to visit or may be subjected to increased white coat effect and thus, may overestimate BP. Another possible limitation of the study is that we used a patient-parent oriented questionnaire to measure the screen time. A reliable method to estimate screen time has been an area for researcher's interest in several decades. Time-use diaries or electronic monitoring systems such as

automated time-lapse video observations [35] and accelerometers [18,31,36] alone or in combination with self-report questionnaires [2,4,15,27,28] have been evaluated as potential screen time or sedentary time measures. However, whichever method is utilized we may keep in mind that TV time, computer time and total screen-time do not represent total sedentary time that better accessed by accelerometers. Furthermore, self-reported screen time and objectively measured sedentary time differ substantially since the former represents a specific activity, while the latter records screen time in addition to many other sedentary behaviors [18]. Even when more objective methods such as accelerometry are utilized important limitations need to be taken into account [36]. Accelerometers cannot distinguish between standing and sitting and on the other hand accelerometers are not able to map the context of sedentary activities and it is self-evident that different sedentary behaviors have different health effects [29].

In conclusion, the present study provides evidence that screen time has a significant effect on BP levels in adolescents independent of obesity. Screen time increases with age, and it is prevalent in adolescence with important BP effects even after adjustment of factors such as gender and obesity. Adolescents had increased likelihood to have hypertension per additional hour of weekly screen time a finding that may help healthcare policy makers in Europe to establish a screen time recommendation for children.

Conclusion

Obesity and sedentary behavior are predisposing factors for high BP levels in children. Therefore, having normal weight and active lifestyle in childhood seem to be of critical importance to prevent future hypertension.

Supplementary Material

None.

Statements

Acknowledgement

None.

Statement of Ethics

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee.

Disclosure Statement/Conflict of Interest

The authors have no conflicts of interest to declare.

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None.

Author Contribution

- SS: Design, the collection of the data, the analysis of the results and the preparation of the paper.
- CA: Design, the collection of the data, the analysis of the results and the preparation of the paper.
- GV: Design, the collection of the data, the analysis of the results and the preparation of the paper.
- ME: Design, the collection of the data, the analysis of the results and the preparation of the paper.
- ZS: Design, the collection of the data, the analysis of the results and the preparation of the paper.
- VK: Design, the collection of the data, the analysis of the results and the preparation of the paper.

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