Contents lists available at ScienceDirect

Preventive Medicine

Sedentary behavior in a cohort of 8- to 10-year-old children at elevated risk of obesity

Katya M. Herman [a,*], Catherine M. Sabiston [b], Marie-Eve Mathieu [c], Angelo Tremblay [d], Gilles Paradis [e]

[a] Department of Kinesiology and Physical Education, McGill University, Montreal, QC, H2W 1S4 Canada
[b] Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, ON, M5S 2W6 Canada
[c] Department of Kinesiology, Université de Montréal, Montreal, Quebec, H3C 3J7, and CHU Sainte-Justine Research Centre, Montreal, Quebec, H3T 1C5 Canada
[d] Department of Kinesiology, Université Laval, Quebec City, Quebec, G1V 0A6 Canada
[e] Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montreal, QC, H3A 1A2 Canada

ARTICLE INFO

ABSTRACT

Objectives. Sedentary behavior (SB) is distinct from physical inactivity. Children's guidelines recommend ≤2 h/day screen time and ≥60 min/day moderate-to-vigorous physical activity (MVPA). This study describes SB in children at elevated risk of obesity, including the possibility of high SB in otherwise active children.

Methods. Participants were 534 children from Quebec, Canada, aged 8–10 years with ≥1 obese parent in 2005–2008. SB and MVPA were measured by accelerometer and specific SBs by self-report, and height and weight were directly measured.

Results. Overweight/obese children were significantly more sedentary overall and reported higher screen time than normal weight children. About 19% of boys and 46% of girls met screen time but not PA guidelines; 28% of boys and 5% of girls met PA but not screen time guidelines. About 46% of overweight/obese children met neither guideline (32% normal weight); only 5% overweight/obese children met both (21% normal weight). Reported behaviors contributed 60%–80% of total SB time; the most sedentary children had the most unaccounted for SB time.

Conclusions. Overweight/obese children are more sedentary overall and report higher screen time than normal weight children. Public health efforts targeting PA and SB in children must consider sex and weight status while being cognizant that being sufficiently active is not exclusive of high levels of SB.

© 2014 Elsevier Inc. All rights reserved.

Introduction

Sedentary behavior (SB) has emerged as a separate construct from physical inactivity, rather than simply representing the low end of the physical activity (PA) continuum or an absence of moderate-to-vigorous PA (MVPA) (Tremblay et al., 2010). SB refers to any *waking* behavior characterized by low energy expenditure (≤1.5 METs) while in a sitting or reclining posture (Owen et al., 2010; Pate et al., 2008; Sedentary Behaviour Research Network, 2012). This includes sitting for long periods, use of motorized transportation, television viewing, playing passive video games or using the computer (Tremblay et al., 2011a). Importantly, even individuals classified as "active" or meeting PA guidelines can simultaneously be highly sedentary, as the former accounts for minimal time per day (Tremblay et al., 2011c). SB is associated

with health consequences distinct from those of inactivity and independent from the health benefits of PA (Ekelund et al., 2006; Healy et al., 2008; Owen et al., 2010; Tremblay et al., 2010).

On average, Canadian children spend 8.6 h/day (62% of their waking hours) in SB (Colley et al., 2011). Further, ≥6 h/day are spent in front of a screen (television or computer) (Active Healthy Kids Canada, 2012), despite current guidelines recommending ≤2 h/day of recreational screen time (Tremblay et al., 2011a). Among different SBs, screen time specifically has been shown to be associated with weight status and obesity in children (Epstein et al., 2008; Fulton et al., 2009; Saelens et al., 2002). Studies routinely assess SB either objectively by accelerometry, or subjectively by self-report. Accelerometers may accurately identify time spent in SB, but do not provide information about the type of SB engaged in, of importance as not all SBs show the same negative associations with health outcomes. (Gopinath et al., 2012; Sisson et al., 2011) On the other hand, more descriptive self-report measures may suffer from recall biases with respect to time spent. It has been recommended that these two methods be used in conjunction, providing complimentary information thereby more accurately describing SB (Lubans et al., 2011). However, to date, few studies have attempted to comprehensively describe SB in children using both objective and subjective measures. Improved the understanding

---

of childhood SB is critical in order to identify targets for intervention, particularly since SB may track better than PA over time (Biddle et al., 2010; Janz et al., 2005).

The objectives of this study were to comprehensively describe SB in a cohort of children aged 8–10 years at elevated risk of obesity due to parental obesity, using both objective and subjective measures of SB. Specifically, (a) to describe time spent in different SBs according to total objectively measured SB time, including differences by sex and weight status, and (b) to investigate the concept of SB in otherwise active children, by estimating prevalence in various combined PA/SB groups. A subobjective of the study was to evaluate the association between SB time and accelerometer wear time.

Methods

Study sample

Data were from the baseline visit of the Quebec Adipose and Lifestyle Investigation in Youth (QUALITY) study; in-depth methodology has previously been published. (Lambert et al., 2012) Briefly, the QUALITY study aims to describe the development of childhood obesity and its metabolic and cardiovascular consequences. The cohort includes 630 Caucasian children aged 8–10 years at baseline (2005–2008), and their 2 biological parents of whom at least 1 is clinically obese (BMI ≥30 kg/m^2, or waist circumference >102 cm for men or >88 cm for women). Children were recruited from primary schools within 75 km of the cities of Montreal, Quebec City and Sherbrooke in the province of Quebec, Canada. Data collection included interviewer-administered questionnaires, anthropometric measures and a 7-day accelerometer monitoring period. The QUALITY study was approved by the ethics review boards of the Centre Hospitalier Universitaire Sainte-Justine and Laval University; written informed consent and assent were obtained from the parents and children, respectively. The current report includes 534 children (286 boys, 248 girls). Non-inclusion was mainly due to missing or invalid accelerometer data (n = 94); children included and not included were similar in mean age, BMI and parental education.

Measures

Sedentary Time and physical activity—accelerometry

SB and PA were measured with the ActiGraph 7164 accelerometer (Pensacola, Florida, USA), worn on a belt over the right hip during waking hours for 7 days, with removal for bathing or swimming. Movement counts were recorded in 1-min epochs. Previously published guidelines were followed for identifying and removing invalid accelerometer data (Colley et al., 2010; Troiano et al., 2008). Accelerometer files containing implausible data or collected on documented days of illness or other activity limitation were removed. A valid day required a minimum 10 h wear time; participants needed a minimum of 4 valid days out of 7. In young children, 4 days of measurement correlates well (r = 0.80) with a full week of monitoring (Trost et al., 2000). Non-wear time was defined as ≥60 min of consecutive zero counts, with allowance for 1 interruption of 1–2 min of counts 1–100. Of the 534 children with valid data, approximately 63% had 7 valid days (no difference by age, sex and weight status), 98% of valid files included ≥1 weekend day (81% included 2) and mean and median accelerometer wear time on valid days were both 13.6 h.

SB time was defined as mean minutes/day below the accelerometer cutoff of 100 counts-per-minute (cpm) and divided into sex-specific tertiles. MVPA (min/day) was defined according to the ActiGraph pediatric cutoffs proposed by Evenson et al. (2008) and validated for use in children (Trost et al., 2011), as >2296 cpm. MVPA was divided into sex-specific tertiles, and also dichotomized at a mean of 60 min/day, approximating the Canadian PA Guidelines for children ages 5–11 years, which recommend ≥60 min MVPA daily (Tremblay et al., 2011c).

Sedentary behaviors—self-report

Children reported the number of hours/day (both weekdays/weekends) they usually watched television (including video movies), used the computer (including internet) for fun or playing video games (including Nintendo, Game Boy, etc.), did homework, read for fun and talked on the phone. Total weekly hours were estimated and converted to mean hours/day. Television and computer/video game time were summed to give total screen time. Variables were also dichotomized: homework and reading at <1 vs. ≥1 h/day, and TV,

computer/video and total screen time according to the Canadian Sedentary Behavior Guidelines for children ages 5–11 years, which recommend ≤2 h/day recreational screen time (Tremblay et al., 2011a).

Weight status

Body mass index (BMI) was calculated from measured height and weight, as weight (kg) / height (m)^2. Childhood overweight and obesity were defined as ≥85th and 95th age/sex-specific percentiles, respectively, according to the growth charts of the CDC (Kuczmarski et al., 2002). Waist circumference (WC) was measured at mid-distance between last floating rib and iliac crest, following normal expiration. Elevated WC was defined as ≥90th age/sex-specific percentile (Fernandez et al., 2004).

Analysis

Descriptive statistics (means, SD, %) were calculated by sex and weight status for sociodemographic, PA and SB variables. Differences by sex and weight status were assessed by t-test or chi-square test as appropriate. The proportion of total accelerometer wear time accounted for by SB was calculated, according to SB tertiles.

Differences in mean time spent in specific SBs was assessed by Kruskal–Wallis tests according to accelerometer-measured SB tertiles, by sex and by weight status, and the proportion of total SB unaccounted for by self-reported behaviors quantified. Corresponding differences in proportions were assessed by chi-square test. Multivariate logistic regression assessed the odds of being in the highest SB tertile or of exceeding 2 h/day screen time for overweight/obese vs. normal weight children, controlling for age, sex, Tanner stage, parent education and physical activity.

Prevalence in four combined PA/SB groups (active/sedentary, active/non-sedentary, inactive/non-sedentary and inactive-sedentary) was reported both according to the current guidelines recommending ≥60 min/day of MVPA and ≤2 h/day screen time, as well as using MVPA and SB tertiles (top tertiles = "active" and "sedentary", respectively), by sex and by weight status.

Results

Approximately 40% of the children were overweight/obese, and close to 25% had a waist circumference exceeding the 90th percentile (Table 1). Only 56% of girls and 38% of boys met screen time guidelines (≤2 h/day), and children accumulated a mean of approximately 6 h/day total SB time (no difference boys vs. girls). About 46% of boys but only 15% of girls accumulated a mean of ≥60 min/day MVPA. With respect to both total accelerometer SB time as well as television and total screen time, overweight/obese children were significantly more sedentary than their normal weight counterparts, accumulating on average 18 min/day more SB time and reporting on average 36 min/day more screen time. At the same time, a significantly lower proportion of overweight/obese children met PA guidelines compared to normal weight children.

The most sedentary children (i.e. highest SB tertile) averaged 7.25 h ± 41 min/day SB. On average, more sedentary children had higher accelerometer wear time than their less sedentary peers; however, a higher proportion of their total wear time was also spent sedentary (Table 2). For example, boys in the low, medium and high SB tertiles had mean daily SB times of 282, 358 and 437 min/day, respectively, with corresponding mean accelerometer wear times of 805, 822 and 841 min/day, demonstrating that SB forms an increasing proportion of wear time (35%, 44% and 52%) with increasing total SB time. Notably, while mean time spent sedentary increased by 76–79 min per tertile, mean accelerometer wear time increased by only 17–19 min per SB tertile. Hence, a large majority of the additional SB time/tertile was not simply due to higher wear time.

Time spent in specific self-reported SBs increased as total accelerometer SB time increased (Fig. 1). However, 20%–43% of total SB time remained unaccounted for by self-reported time spent in specific behaviors, this proportion highest in girls and in the most sedentary boys. Self-reported screen time was significantly higher in children in the highest accelerometer SB tertile compared to their peers in the lowest SB tertile. Figs. 2 and 3 illustrate proportion of children exceeding 2 h/day screen time or 1 h/day homework or reading according to SB tertile, by sex