



Outdoor play in children: Associations with objectively-measured physical activity, sedentary behavior and weight status



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ABSTRACT

Objectives. To determine the amount of time children play outdoors and examine associations with weekday, weekend and after-school physical activity (PA), sedentary behavior (SB), and weight-status (normal-weight, overweight/obese).

Methods. Data were extracted from Project BEAT (Toronto, 2010–2011; www.beat.utoronto.ca). Children's ($n = 856$; mean age = 11 ± 0.6 years) PA and SB were measured using accelerometry. Outdoor play (OP) was assessed via parental report and collapsed into three categories (<1 h/day, 1–2 h/day, >2 h/day) and differences in anthropometric and PA characteristics were assessed.

Results. 55.1%, 37.2%, and 7.7% of children played outdoors for <1 h/day, 1–2 h/day and >2 h/day, respectively, on weekdays. OP was higher on weekends and in boys. OP was associated with SB, light PA and MVPA at all time-points, whereby children attaining <1 h/day had lower activity profiles. Boys playing outdoors for <1 h/day were more likely to be overweight/obese and had lower PA levels than normal weight boys. However, overweight/obese boys who spent >2 h/day playing outdoors had PA profiles similar to normal weight counterparts.

Conclusion. Encouraging children to spend more time outdoors may be an effective strategy for increasing PA, reducing SB, and preventing excess weight gain (particularly boys' play).

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Introduction

Declining rates of physical activity (PA) and increased time spent sedentary in childhood have stimulated investigations into prevention strategies. Taking a historical perspective offers insight into factors that might partially explain these low PA levels. Outdoor play (OP) in childhood is one factor. As Tim Gill (2010) writes, “many adults today have vivid childhood memories of everyday freedom, playing outdoors for hours at a time...often well beyond the anxious gaze of parents”. Often, the same cannot be said for today's children. Declines in OP over time have been documented globally, from the United States (Gaster, 1991; Hofferth and Sandberg, 2001) to the United Kingdom (O'Brien et al., 2000), the Netherlands (Karsten, 2005), Japan (Kinoshita, 2009) and Australia (Cleland et al., 2008), with parents noting that their children play outdoors less than they did as children themselves (Clements, 2004). Considering that play is critical for healthy development (Gleave and Cole-Hamilton, 2012), these are troubling trends that need to be considered on an international scale.

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While there is evidence of declines in OP over the past few decades, international subjective and objective measurements of time spent playing outdoors by children are conflicting (Aarts et al., 2012; Cleland et al., 2008; Cooper et al., 2010; Grigsby-Toussaint et al., 2011; Kimbro et al., 2011; Larson et al., 2011; Marino et al., 2012; Wen et al., 2009). However, all data show that more time is spent outdoors on weekend than week days (Cleland et al., 2008; Larson et al., 2011) and that boys are more likely than girls to spend time outdoors (Aarts et al., 2012; Cleland et al., 2008; Grigsby-Toussaint et al., 2011; Larson et al., 2011).

Canadian data on outdoor play in children is particularly limited. A previous study suggests the majority (80%) of children aged 5–12 years play outdoors after school, compared to 43% of 13–17 year olds (Canadian Fitness and Lifestyle Research Institute (CFLRI), 2012). A recent study echoes the results for older youth (David Suzuki Foundation, 2012). While adults value time outdoors, they strongly agree that children are not spending enough time outdoors (Canadian Parks and Recreation Association, 2012). The emergence of these more recent data on OP (David Suzuki Foundation, 2012) is useful, yet findings are only generalizable to Canadian youth. An examination of the actual amount of time (hours/day) a cohort of younger Canadian children (<13 years) spend playing outdoors is missing.

Given the global historical declines in children's PA and OP, an examination of children's OP and their PA behavior could uncover associations between the two constructs. Recent advances in and use of

objective measures of PA (pedometers, accelerometers) are now providing evidence of associations. Data from the CFLRI CANPLAY study (2010; a national study of approximately 10,000 children and youth, aged 5 to 19) illustrate children and youth who play outdoors after-school accumulate an average of 2000 more steps/day than those who do not. This additional 2000 steps/day would contribute 15% of a child's recommended daily PA, and assist the 95% who are not meeting daily guidelines (Colley et al., 2011) to meet this goal. Other studies support this link between OP and PA (Cleland et al., 2008; Cooper et al., 2010).

Together, the evidence illustrates a relationship between OP and PA in children. However, studies have focused only on associations with overall volume of PA and one "intensity category" (MVPA). Emerging physiological (Hamilton et al., 2004, 2007, 2008; Healy et al., 2008; Owen et al., 2000; Pate et al., 2008; Rosenberg et al., 2008) and epidemiological (Katzmarzyk et al., 2009; Owen et al., 2010) evidence suggests SB has independent, negative effects on metabolism, physical function and health outcomes, with extended SB elevating the risk of all-cause mortality independent of PA (Koster et al., 2012). SB has become an increasing concern for children after a study illustrated 62% of waking hours are spent sedentary, with the remaining 29% in light PA and 9% in MVPA (Colley et al., 2011). More attention is now being paid to reducing SB and encouraging the transition to light PA. Recent evidence suggests health benefits accrue when SB is replaced with light PA (Healy et al., 2008). Including measures of light PA in explorations with health outcomes is now recommended (Powel et al., 2011). To the authors' knowledge, no studies have investigated the possible association of OP with multiple characteristics of PA behavior in children (time spent sedentary, light and MVPA). Given the above evidence, addressing this gap seems warranted.

Little and conflicting evidence also exists for an association of OP with body mass index (BMI) or weight status (normal weight, overweight/obese). Some (Cleland et al., 2008; Kimbro et al., 2011) but not all (Burdette and Whitaker, 2005; Marino et al., 2012) studies have found lower levels of OP among children with higher BMIs. While Kimbro et al. (2011) reported a cross-sectional relationship of OP with BMI in young children (aged 5 years), Cleland et al. (2008) did not, finding relationships in older children only (aged 10 to 12 years). These observations are based on the US and Australian data. To the authors' knowledge, associations of OP with BMI/weight status have not been explored in Canadian children. Moreover, no study has examined multiple characteristics of PA behavior among children who vary according to weight status and OP. PA levels are typically lower in overweight/obese children compared to normal weight counterparts (Stone et al., 2009a). OP could be an important factor, possibly allowing overweight/obese children to achieve similar (or near similar) PA levels to normal weight peers.

The objectives of this study are therefore to, a) illustrate the amount of time a cohort of children (Project BEAT; www.beat.utoronto.ca) spend outdoors across weekdays and over the weekend; b) examine whether multiple characteristics of PA (time spent sedentary, light and MVPA) differ according to level of OP (<1 h/day, 1–2 h/day, >2 h/day); c) examine whether OP is associated with weight status (normal weight vs. overweight/obese); and d) examine whether PA behavior varies according to OP and weight status.

Methods

Experimental design: Project BEAT

Results are based on data collected from a cohort of children in Toronto, Canada (Stone et al., 2013). Children were recruited from sixteen elementary schools from diverse Toronto neighborhoods that varied according to the physical layout (built environment; suburban, looping street layout vs. urban grid-based street layout) and social characteristics (socioeconomic status (SES); low- and high-income households were based on the median household income reported in the 2006 Canadian Census). Half of the surveyed schools were low-SES schools, and the other half were high-SES schools. Approval

from the University of Toronto Ethics Committee and Toronto District School Board was granted. Written consent was obtained from individual schools, parents and students.

Participants

1027 parents/guardians gave consent for their children to participate (response rate = 60.3%; boys, $n = 478$; girls, $n = 549$; mean age = 11 ± 0.6 years). Direct height and weight measurements were taken by the primary research coordinator. Height was recorded to the nearest 0.1 cm using a rigid stadiometer, and weight was recorded to the nearest 0.1 kg using an electronic weighing scale. Measurements were taken twice, and the average of the two measures recorded. Measurements were taken in a private setting in each child's school, with children wearing light clothing and after they had removed their shoes. Using age- and sex-specific BMI cut-points, participants were classified as normal weight, overweight or obese (Cole et al., 2000). Accelerometer-measured PA data were collected on 1,001 children. Of those, 85.5% had at least three weekdays and one weekend day of valid data ($n = 856$; boys = 389; girls = 467).

Measurement of physical activity

Children's PA was measured for seven days using accelerometry (ActiGraph GT1M; ActiGraph LLC, Pensacola, FL, US). A 5 s epoch (interval) captured rapid transitions in activity (Stone et al., 2009c). For inclusion in data analysis, each child required a minimum 10 h of wear time for at least 3 weekdays and 1 weekend day (Stone et al., 2009a). Time spent at various levels of movement intensity (sedentary: 0–300 counts min^{-1} ; light: 300–3581 counts min^{-1} ; MVPA: >3581 counts min^{-1}) was classified according to published thresholds (Stone et al., 2009b) and used to determine weekday, weekend and after-school (2 h after end-of-school bell) PA. PA variables included time spent sedentary (% of day) and minutes of light PA and MVPA. Data collection took place during spring/summer (April to June) and fall (September to December) to limit seasonal effects.

Measurement of outdoor play

Outdoor play was assessed via parental report (Wen et al., 2009). Parents were asked: "On a typical weekday, how much time does your child spend playing outdoors?" Parents reported one option: none; less than 30 min; 30 min to 1 h; 1 to 1.5 h; 1.5 to 2 h; 2 to 2.5 h; 2.5 to 3 h; more than 3 h. A frequency analysis was conducted and results used to establish three OP categories: <1 h (low outdoor play (LOP; $n = 472$)), 1–2 h (medium outdoor play (MOP; $n = 318$)) and >2 h (high outdoor play (HOP; $n = 66$)). The same analysis was conducted for weekend OP (LOP, $n = 329$; MOP, $n = 278$; HOP, $n = 249$).

Statistical analyses

Descriptive characteristics (age, height, weight, BMI), PA characteristics (light, MVPA) and time spent sedentary for weekdays, weekends and after-school were examined using multivariate analysis of variance (MANOVAs). Chi-square analyses tested for differences in OP by sex and day (weekday vs. weekend), and determined whether the proportion of normal weight and overweight/obese participants was significantly different between OP groups. Spearman correlations tested associations between OP and weight status (normal weight vs. overweight/obese). Differences in PA by OP group and weight status were assessed using two-factor ANOVAs. Given that sex-specific differences in OP and PA exist, analyses were run according to sex. The alpha level was set at 0.05. SPSS version 20.0 was used for all analyses.

Results

Descriptive characteristics, including weight classification

Data for 856 participants are presented (mean age 11.0 ± 0.6 years; boys, $n = 389$, girls, $n = 467$, Tables 1, 2). Descriptive analyses revealed no significant differences in age, height, weight, BMI or weight classification between outdoor play groups ($p > 0.05$; Tables 1, 2), with one exception: boys who played outside for <1 h/day on weekdays and weekends were more likely to be overweight/obese compared to boys who played outside for >2 h/day (weekdays: $X(2) = 5.21$, $p = 0.023$;

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