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Sedentary time, physical activity and compliance with IOM recommendations in young children at childcare

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ABSTRACT

The aim of this study was to report patterns of sitting, standing and physical activity (PA) and compliance with Institute of Medicine (IOM) recommendations for sedentary behavior (SB) and PA among children aged 1 to 5 years at childcare, and examine sociodemographic variations.

Sitting, standing and PA time was assessed using an activPAL inclinometer over a period of 1 to 5 days in 301 children (49% boys; mean age = 3.7 ± 1.0 years) across 11 childcare services in Illawarra, NSW, Australia. Breaks and bouts of sitting and standing were calculated and categorized. Height and weight were assessed and parents completed a demographic survey. Differences by sex, age category (<3 vs ≥3 years), weight status and SES were examined.

Children spent 48.4% of their time at childcare sitting, 32.5% standing, and 19.1% in PA. Boys spent significantly more time in PA compared to girls (20.8% vs 17.7%; $P = 0.003$). Toddlers (<3 years) spent significantly more time in PA compared to preschoolers (≥3 years) (22.2% vs 18.3%; $P < 0.001$). Children who were underweight spent significantly more time sitting compared with their overweight peers (52.4% vs 46.8%; $P = 0.003$). 56% and 16% of children met the IOM SB and PA recommendations, respectively. Girls (odds ratio [OR]; 95%CI = 0.26; 0.13 to 0.55) and preschoolers (0.16; 0.07 to 0.38) were less likely to meet the IOM PA recommendation compared to boys and toddlers. Young children spent ~50% of their time at childcare sitting. Girls and preschoolers sit more and are less likely to meet PA recommendations, making them important groups to target in future interventions.

1. Background

Young children are showing high levels of sedentary behavior (SB) and low levels of physical activity (PA) (Okely et al., 2008; Reilly, 2010). There is growing evidence that spending excessive time in sedentary pursuits, independent of the amount of moderate- to vigorous-intensity physical activity (MVPA) undertaken, may be adversely associated with adiposity and cardio metabolic health outcomes in children, particularly among those overweight, obese or at-risk of overweight and obesity (Cliff et al., 2014; Saunders et al., 2013). Furthermore, studies in adults have shown that standing and breaking up sitting time are beneficial for cardio-metabolic health (Healy et al., 2015; Júdice et al., 2016). Participation in PA during early childhood has been shown to be beneficial for health and development (Carson et al., 2015; Janssen and LeBlanc, 2010). However, among preschoolers it has been reported that around 73% of their waking hours are spent in SB (Salmon et al., 2011), and that this particular behavior tracks from early childhood (aged 3–5 years) into childhood (aged 5–8 years) (Jones et al., 2013).

Several countries and organisations have acknowledged the importance of limiting sedentary time and increasing PA in young children (Canadian Society for Exercise Physiology, 2012; Department of Health, 2011; Department of Health and Aging, 2010). More recently, the Institute Of Medicine (IOM) in the US has provided specific recommendations around SB and PA for childcare or preschool; stating that young children should be allowed to move freely and that sitting or standing still should be limited to 30 min at one time, and providing opportunities for children to participate in PA for at least 15 min per hour while in care (Institute of Medicine, 2011). Few studies have objectively examined the prevalence of sitting, standing and PA time among children while they attend childcare (Brown et al., 2009), however none have examined how sitting varies by socio-demographic factors, which is important to determine if targeted interventions are required. Furthermore, limited data are available on compliance with current IOM recommendations (Pate et al., 2015). Only one study has objectively assessed PA at childcare, and it was conducted in the USA (Pate et al., 2015). Reporting data from other countries is important to understand prevalence rates across different countries. Accelerometers worn on the waist are currently the most common method to measure SB and

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PA in children, however this approach has difficulties discriminating between sitting and standing still (Kozey-Keadle et al., 2011), which is important for accurately assessing SB. The activPal is a unique device that is capable of detecting postures, particularly sitting and standing due to its placement on the thigh (De Decker et al., 2013).

The purpose of this study was to 1) report sitting, standing and PA among children aged 1–5 years in childcare; 2) investigate the differences in sitting, standing and PA and sitting and standing breaks and bouts by sex, age, weight-status and socio-economic status; and 3) determine the compliance with IOM recommendations for SB and PA among young children while they attend childcare using a posture-based motion sensor.

2. Methods

2.1. Study design

The Standing Preschools Project was a cross-sectional study of 11 childcare services within the Illawarra and Shoalhaven regions of NSW, Australia (population. 0.4 million). Five of the 11 services were located in middle/high socio-economic status (SES) suburbs and six in low SES suburbs. The SES status of the centre suburb was based on the 2011 Socio-Economic Indices for Areas (SEIFA) Index of Relative Socio-Economic Disadvantage (Australian Bureau of Statistics, 2011). If the score of a suburb was located below the fourth decile, it was categorized as low SES, otherwise middle/high SES. Recruitment and data collection took place over a 6-month period (February–July 2013).

2.2. Participants

All parents/guardians of 1- to 5-year-old children attending the services were invited to participate via written information letters and provided consent for their child to participate. To be eligible, a child needed to be independently mobile. This study received approval by the Human Research Ethics Committee at the University of Wollongong (HE13/406).

2.3. Measures

Total time spent in sitting, standing and PA were assessed on each weekday that the child attended the service using an activPAL inclinometer during a 1-week period. The activPAL has shown to be a valid measurement tool for discriminating between different postures in young children (Janssen et al., 2014). The activPAL was placed on participants' upper thigh (Davies et al., 2012; Janssen et al., 2014). Trained research assistants attached the activPAL as each child arrived at the service. The staff or parent/guardian removed the monitor when the child departed childcare in the afternoon. On and off times were recorded by the research assistant or staff. After the monitors were collected from each service, data were downloaded and entered using activPAL software (v7.2.32). Fifteen second epoch files were used with the Centre for Physical Activity and Health Research (CPAHR) MATLAB program to calculate sitting/lying, standing, PA and non-wear time for each participant per day (Dowd et al., 2012). Times before arrival and departure were manually removed from the total minutes monitored. Naptime was excluded for toddlers and so considered non-weartime, as it was shown that over 90% of children this age still nap (Blair et al., 2012). This was not done for preschoolers as research suggests that nearly three-quarters of preschoolers do not sleep during nap time (Pattinson et al., 2014). For a day to be considered valid, children needed to wear the activPAL ≥180 min and needed >1 valid day to be included in the analyses (Byun et al., 2013). Sitting breaks and bouts were determined from activPAL outputs. Mean breaks per hour of sitting were calculated as the total sum of all the number of bouts (Dowd et al., 2012). Bouts of sitting were categorized as: <1 min, 1–4 min, 5–9 min, 10–19 min, 20–29 min, or ≥30 min (Carson et al., 2014). Compliance with the IOM SB recommendation was derived by calculating the combined sitting and standing bouts ≥30 min from the eventfile. Children without a sitting and standing bout ≥30 min were categorized as complying with the recommendation. To report if children spent 15 min in PA per hour, their percentage needed to be ≥25% per hour.

Children aged 1.0 to 2.9 years were categorized as toddlers, and 3.0 to 5.9 years as preschoolers. Each child's date of birth and sex were collected on the consent form. Height and weight were measured and body mass index (BMI: kg/m^2) was calculated using a portable stadiometer (PE87; Mentone Educational Centre) and a calibrated electronic weight scale (Tanita BF-681; Tanita Corporation of America), according to standardised protocols (Wake et al., 2002). Weight status was calculated using LMSGrowth (Medical Research Council, United Kingdom) and UK reference curves (Cole et al., 1995). Children >2 years were categorized as underweight, normal weight, overweight, or obese based on the IOTF (International Obesity Task Force) age- and gender-specific cut-points (Cole et al., 1995). For children <2 years, percentiles were calculated and categorized in weight statuses using UK reference curves (Cole et al., 1995).

2.4. Sample size and power

The sample size calculated was based on the ability to provide a reliable estimate of the time spent sitting and to detect differences between demographically defined groups. These estimates were calculated based on a relative standard error of <25% (Booth et al., 2005) using the formula: $N = pq/s^2$, where N = sample size; p = estimated prevalence; q = 1 − p; and s = required SE of the prevalence statistic. Based on our feasibility study, it was highly unlikely that a child would spend <10% of the day in childcare sitting, requiring 144 children per day to be sampled. As the childcare service was the unit of observation, the sample size was increased by a design effect of 1.5 – to 216 children – to account for clustering.

2.5. Statistical analyses

Analyses were performed in STATA 13 and SPSS21. Descriptive statistics were calculated using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. To determine if differences existed in proportion of sample size within sex, age, weight status and SES, independent samples *t*-tests or Mann-Whitney *U* tests were used. Mixed linear regressions were used to examine the difference between sitting, standing and PA time by sex, age, weight status and SES of center and to calculate the intraclass correlation coefficient across the centers. To account for the clustered nature of the data, the models included childcare service as a random effect. Fixed effects such as age, sex and weight status were included as covariates in the mixed models when they were not the predictor being tested. Differences in breaks and bouts between boys and girls; toddlers (1–2 years) and preschoolers (3–5 years); underweight, normal weight, overweight and obese; and low and medium SES groups were examined using linear regression and repeated measures ANOVA. To interpret the differences in percentages of children meeting SB and PA recommendations, odds ratios were calculated by using a logistic regression.

3. Results

Descriptive characteristics are reported in Table 1. Of the 799 eligible 1- to 5-year-old children from 11 childcare services, 550 children (68%) provided parental consent. Of these, 3 children were absent and 28 children declined to participate on the day of testing, 81 children did not have height and weight measured, and 6 monitors were not returned. Data from 145 children were excluded due to no monitor data, a