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Association between breaks in sitting time and adiposity in Australian toddlers: Results from the GET-UP! study

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Association between breaks in sitting time and adiposity in Australian toddlers: Results from the GET-UP! study

Abstract

Background: In youth, research on the health benefits of breaking up sitting time is inconsistent. Our aim was to explore the association between the number of breaks in sitting time and adiposity in Australian toddlers. Methods: This study comprised 266 toddlers (52% boys), aged 19.6 ± 4.2 months from the GET-UP! Study, Australia. Body mass index (BMI) was calculated and z-scores by age and sex were computed for waist circumference (WC). Participants were classified as overweight according to the WHO criteria for BMI. For WC, participants with a z-score≥1SD were considered overweight. Sitting time was assessed with activPALs during childcare hours and participants were classified by tertiles of the number of breaks/h in sitting time: /h; 26-39 breaks/h, and >39 breaks/h. Logistic regression assessed odds ratios for non-overweight (BMI or waist circumference categories) by number of breaks in sitting time/h, controlling for age, sex, and socioeconomic status. Results: The number of breaks in sitting time significantly predicted a lower weight status (non-overweight) according to WC values (P for trend = 0.032) after adjustments. Conclusions: Breaking up sitting time was positively associated with toddlers' waist circumference. Future studies are needed to determine whether breaking up sitting time is a protective for cardiometabolic health in toddlers.

Disciplines

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Association between Breaks in Sitting Time and Adiposity in Australian Toddlers: results from the Get-Up! Study

Running title: Sitting Time and Obesity in Children

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ABSTRACT

Background: In youth, research on the health benefits of breaking up sitting time is inconsistent. Our aim was to explore the association between the number of breaks in sitting time and adiposity in Australian toddlers.

Methods: This study comprised 266 toddlers (52% boys), aged 19.6±4.2 months from the GET-UP! Study, Australia. Body mass index (BMI) was calculated and *z*-scores by age and sex were computed for waist circumference (WC). Participants were classified as overweight according to the WHO criteria for BMI. For WC, participants with a z-score≥1SD were considered overweight. Sitting time was assessed with activPALs during childcare hours and participants were classified by tertiles of the number of breaks/hour in sitting time: <26 breaks/hour; 26-39 breaks/hour and >39 breaks/hour. Logistic regression assessed odds ratios for non-overweight (BMI or waist circumference categories) by number of breaks in sitting time/hour, controlling for age, sex and socio-economic status.

Results: The number of breaks in sitting time significantly predicted a lower weight status (non-overweight) according to WC values (*p* for trend=0.032) after adjustments.

Conclusions: Breaking up sitting time was positively associated with toddlers' waist circumference. Future studies are needed to determine whether breaking up sitting time is a protective for cardiometabolic health in toddlers.

Key words: obesity; sedentary behaviour; physical activity; youth

INTRODUCTION

Sedentary behavior is defined as any waking behavior with an energy expenditure of ≤1.5 METs while in a sitting or reclining posture(1). The detrimental effects of sedentary behavior in children and adolescents have been the focus of research in the past few years. Evidence suggests that the amount of time spent sedentary may be associated with adverse health outcomes in school-aged children(2, 3). However, a recent systematic review on the associations between sedentary behavior and health indicators in the early years showed that total sedentary time may have a negligible impact on health in this age group. Nevertheless, this review also suggested that the way sedentary time is spent may be important, with screen-based and seated sedentary behaviors being more likely to have negative health effects, whereas interactive non-screen based sedentary activities, such as reading and storytelling, more likely to have positive health and developmental effects. The authors also stated that it remains difficult to make recommendations concerning “appropriate” amounts or patterning (e.g., breaks) of total sedentary time(4).

Sitting time is defined as a type of sedentary behavior characterized by a position in which one’s weight is supported by one’s buttocks rather than one’s feet, and in which one’s back is upright. It can be divided in two different types: active sitting (any waking activity in a sitting posture characterized by an energy expenditure >1.5 METs) and passive sitting (any waking activity in a sitting posture characterized by an energy expenditure ≤1.5 METs)(1). Recently, the terms “breakers” and “prolongers” have also been suggested to distinguish between those who accumulate sitting time with frequent interruptions from those who accumulate sitting time in prolonged and continuous periods, respectively(1). In adults, studies have shown that frequent breaking of prolonged sitting, with short bouts of light- or moderate-intensity walking can improve cardiovascular health(5-7); and may have significant independent effects on all-cause mortality(8-10).

In children and adolescents, research on the health benefits of breaking up sitting time has only recently emerged and produced, so far, inconsistent results(11-14). Some studies have shown that breaking up sedentary time results in significant improvements on cardiometabolic outcomes(11, 12, 15, 16), lower waist circumference(17) and lower BMI(18). For example, in Canadian boys, aged 11-14 years, an increased number of breaks in sedentary time was associated with lower waist circumference(17). Altogether, these findings suggest that there is some evidence advocating that breaking up sitting time may be a strategy to consider in the prevention of obesity in children and adolescents, as it is known that many of the lifestyle habits begin to be established at this age and it is known that sedentary behaviors track throughout life(19, 20). Moreover, most of the research in early childhood has focused on the television viewing as a proxy for sedentary time and studies with objectively measured sedentary time within this age group are scarce.

Therefore, investigating the association between breaks in sitting time and cardiometabolic health outcomes across multiple age groups, namely in young children is warranted. To the best of our knowledge, no studies examining the associations between breaking up sitting time (as measured objectively with accelerometry) and cardiometabolic health outcomes have yet been conducted in toddlers. Thus, the aim of this study was to explore if the number of breaks in sitting time was associated with adiposity in Australian toddlers.

MATERIALS AND METHODS

Study design

This was a cross-sectional analysis using baseline data from the Get Up! Study. The rationale and protocol of the GET UP! Study can be found elsewhere(21). Briefly, the Get Up! Study is a 12-months 2-arm parallel group cluster randomized controlled trial that aimed to assess the effects of reduced sitting time on toddlers' cognitive development.

Participants and protocol

This study included 30 Early Childhood Education and Care (ECEC) services from the Illawarra region in New South Wales (NSW), Australia. Data were collected between March and August 2016. Prior to data collection, informed written consents were obtained from children's parents or guardians. Apparently healthy toddlers, aged 11 to 29 months, were eligible to participate if they attended the ECEC service, at least twice a week.

The study was approved by the University of Wollongong's Human Research Ethics Committee (HE15/236) and conducted according to the Helsinki Declaration for Human Studies(22).

335 children aged 15 to 24 months (19.6±4.2) were assessed at baseline of study. Of those, a total of 266 children (79%), had complete data on the variables of interest for the present report (52% boys). All children were apparently healthy and independent walkers.

Measures

Anthropometrics

Height, weight and waist circumference were assessed following standard procedures(23). Height was measured to the nearest 0.1 cm in bare or stocking feet while the child stood upright against a portable stadiometer (Seca 254 Hamburg, Germany). Weight was measured to the nearest 0.1 kg, lightly dressed (without diapers and shoes), using a portable electronic weight scale (Seca 254 Hamburg, Germany).

Body Mass Index (BMI) was calculated as weight (kg)/height(m)^2. Participants were classified as underweight, normal weight, overweight or obese, according to the World Health Organization age and sex specific criteria(24). Participants were then divided into two groups: non-overweight (including the underweight and normal weight children) and overweight (including the overweight and obese children), due to the small amount of underweight and obese children.

Waist circumference was measured with a non-elastic tape at the top of the iliac crest(25). Waist circumference *z*-scores (*z*= (score-mean)/standard deviation) by age and sex were calculated and participants were then classified as non-overweight (<1 standard deviation of the z-score) and overweight (≥1 standard deviation of the z-score).

All measures were taken twice by specialized research assistants and PhD students with previous experience in data gathering in this age group and that had received specific training for this data collection.

Sitting Time

Total time spent sitting during childcare hours was assessed during a one-week period with an ActivPAL devices(26). This device was placed on the front of the upper right thigh, allowing to measure different postures (lying, sitting and standing). ActivPAL accelerometer validation criteria for sitting time measures, as well as for interruptions in sedentary behavior, have been established for young children(26).

Early childhood educators were given a log sheet to record each child's activPAL on and off times, which was used to cross-reference non-wear time and to manually eliminate non-wear time data. After the monitors were collected, data were downloaded and analyzed using activPAL software (v7.2.32). Fifteen second epoch files were used to calculate the different postures and non-wear time for each participant, per day(27). Sequences of consecutive zero counts ≥20 minutes were considered non-wear time and excluded from analyses. Naps taken while wearing the activPAL were removed from the analysis and considered as non-wear time. Participants needed to have, at least, ≥1 hour of wear time on ≥3 days to be considered valid and, therefore, included in the analyses(28, 29). Sensitivity analysis were performed including only those children (n=233) who had, at least, 50% of their waking hours of childcare monitored (i.e. at least 2 hours of wear time during waking hours) and results remained the same (please see supplementary tables S1 and S2). Therefore, we decided to include all children in the main analysis.

Breaks in sitting time were defined as any change in posture from sitting/lying to standing. The total number of breaks in sitting time were summed and divided by activPal waking wear time. Participants were divided into 3 groups by tertiles of the number of breaks/hour in sitting time: tertile 1 (<26 breaks/hour), tertile 2 (26 to 39 breaks/hour) and tertile 3 (>39 breaks/hour).

Socio-economic Status

Family socio-economic status was assessed using the Australian Socio-Economic Indexes for Areas 2011 (SEIFA – Index of Relative Socio-Economic Disadvantage)(30). The SEIFA index ranges from 1 (most disadvantaged), to 10 (least disadvantaged), and is based on the postcode. Participants were divided into 3 categories: low socio-economic status (deciles 1-3), middle socio-economic status (deciles 4-6) and high socio-economic status (deciles 7-10).

Data analysis

IBM SPSS®, version 25.0 (SPSS Inc., Chicago, IL, USA) was used for data analyses. Descriptive analyses were presented as mean±standard deviation (SD). Two-tailed student's *t*-test or Mann-Whitney *U*-test were performed to examine differences between boys and girls for continuous variables.

Logistic regression models assessed odd ratios (OR) for non-overweight (BMI or waist circumference categories) from tertiles of number of breaks in sitting time. In the adjusted models, covariates included age, sex and socio-economic status.

RESULTS

Descriptive characteristics of the sample are reported in Table 1. In our sample, based on BMI values and according to the WHO criteria, 20.1% were overweight and 3.9% were obese, with no differences between boys and girls ($p>0.05$). There were no significant differences between boys and girls for BMI, waist circumference or breaks in sitting time.

Insert table 1 here

Logistic regression results predicting non-overweight are shown in tables 2 and 3. The number of breaks in sitting time was not a significant predictor of non-overweight (BMI), after adjustment for confounders, p for trend=0.065 (table 2). Whereas for waist circumference, the number of breaks in sitting time was a significant predictor of a lower weight status – non-overweight according to waist circumference (p for trend=0.032) after adjustment for confounders (table 3).

Insert tables 2 and 3 here

DISCUSSION

Our results show that the number of breaks in sitting time was significantly associated with non-overweight status according to the waist circumference values (p for trend=0.032), after adjustments for age, gender and socio-economic status.

Our results are in agreement with other studies with older children and adolescents, where a beneficial association between breaks in sitting time and adiposity was found. For example, in a cross-sectional study with Canadian children with parental history of obesity, aged 8 to 11 years old, Saunders et al.(11) found that greater fragmentation of sedentary time (i.e. more breaks in sedentary time) was associated with lower BMI *z*-scores. Similarly, Colley et al.(17) found that an increased number of breaks in sedentary time, accumulated after 3 pm on weekdays, was associated with lower waist circumference, in Canadian boys, aged 11–14 years. However, a recent longitudinal study in English children aged 6 to 15 years, showed that changes in sedentary time fragmentation (e.g. breaks in sedentary time) were not associated with changes in adiposity indicators, such as BMI and fat mass index, over a 8-year follow-up, from childhood to adolescence(18).

Although our results seemed to agree with other studies in older children and adolescents, differences in studies methodologies, such as the use of different adiposity indicators, different devices and sedentary behavior cut-points, as well as, different wear time criteria(31), should be take into consideration. Direct comparisons should, therefore, be done with caution.

Several mechanisms can be proposed to explain the beneficial association between breaks in sedentary time and overweight/obesity levels in the present study. A study with adults has showed that energy expenditure increases from sitting to standing (0.34 kcal/min) and that there is a substantially higher metabolic and energy cost for the sit to stand transition when compared with being either sitting and or standing, in both normal weight and overweight/obese men and women. Also important to notice, is that in the above mentioned study, the metabolic and energy cost responses of the three postural conditions were independent of body composition and sex(32). Indeed, during postural change, several complex physiological processes are undertaken to regulate the body's cardiovascular and musculoskeletal responses(32). Likewise, studies in rats have shown that muscles responsible for postural support (i.e. deep quadriceps) rapidly lose more than 75% of their capacity to siphon off the fat circulating in the lipoproteins from the bloodstream, when incidental contractile activity is reduced. This is due to a 90% to 95% suppression of the lipoprotein lipase (LPL) activity locally in the most oxidative skeletal muscles in the legs. One parallel consequence of this was an abnormally rapid and clinically relevant decrease in high density lipoproteins (HDL) cholesterol(33). The scarce current evidence indicates that inactivity rapidly engages signals for specific molecular responses contributing to poor lipid metabolism by suppression of skeletal muscle LPL activity(34).

If standing up from a chair requires more skeletal muscle fiber recruitment and consequently contraction than standing(32, 34), it is reasonable to assume that postural allocation can play an important role in human weight balance. Also, the cumulative number of the thousands of daily muscular contractions during non-exercise activity (which are typically of young children's movement patterns) may involve a larger energy demand than a period of continuous exercise(34).

In our study, the number of breaks in sitting time was quite high (32.7±15.7), and as expected, higher than in older children(35). This is most likely due to very internment movement pattern observed in young children(36). Our findings also showed no significant differences in number of breaks in sitting time between boys and girls, which is in agreement with a previous study(37).

We cannot leave aside the idea that the present findings might be the result of the behaviors children engage in while at childcare centers, as in our study, movement patterns were collected during childcare hours. As Zhang et al.(38) found in a recent systematic review, poorer active environments, increased sedentary opportunities, not enough time for active play, overweight or obese educators and educators with habitual low levels of physical activity were all correlated to preschoolers' increased likelihood of being overweight. Therefore, time spent at childcare, built environment features at the childcare center and the type of activities proposed by the educators may need to be rethought, to provide young children with a healthier conductive environment.

The strengths of our study include the use of objective measures of sitting time (activPal devices), which are valid and reliable devices to assess movement in this young age, and the novelty of the analysis in a very young and relatively large group of children. However, our study is not without limitations. As it was cross-sectional in nature, it precludes the determination of causality. Also, the activPal was only worn during childcare hours, due to the very young age of our sample. This happened because the use of the monitor at home would be very difficult in terms of logistics, since activPals need to be stuck on the child's tight and removed for water-based activities. Wearing the device outside childcare hours would impose a considerable burden on the parents.

CONCLUSIONS AND PERSPECTIVES

The results of the present study show that an increased number of breaks in sitting time was significantly associated with non-overweight status, as measured by waist circumference, in Australian toddlers. Our results also suggest that future studies should try to determine if breaking up sitting time is protective for cardiometabolic health in toddlers. Moreover, and because the newest Australian 24-hour movement guidelines for the early years(39-41) do not mention specific measures for breaks in sitting time, the information provided by our study might be helpful to inform future updates of the guidelines.

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Table 1. Participants characteristics

	All (n=266) Mean	All (n=266) SD	Girls (n=128) Mean	Girls (n=128) SD	Boys (n=138) Mean	Boys (n=138) SD	*p* value*
Age (months)	19.6	4.2	19.6	4.1	19.7	4.3	0.843
Body Mass Index (kg/m^2)	17.9	1.7	17.8	1.8	17.9	1.7	0.570
Waist Circumference (cm)	47.8	3.8	47.6	3.9	48.0	3.6	0.400
Breaks in sitting time per hour	32.7	15.7	31.4	14.6	33.8	16.6	0.198
Weight Status							
Overweight (%)	20.1%		21.9%		18.8%		0.825
Obesity (%)	3.9%		4.7%		5.1%		

* Two-tailed Student's *t*-test for continuous variables, weight status and *chi*-square test for categorical variables.

Table 2. Logistic regression of BMI and number of breaks per hour in sitting time.

		Non-overweight					
Variable		**Unadjusted Model**			**Adjusted Model** *		
		OR	***p* value**	**95% CI**	**OR**	***p* value**	**95% CI**
Number of breaks per hour in sitting time by tertile							
TERTILE 1 (ref.)	<26 breaks/hour	ref.	0.052 (*p* for trend)		ref.	0.065 (*p* for trend)	
TERTILE 2	Between 26 and 39 breaks/hour	2.295	**0.02**	1.141; 4.617	2.283	**0.023**	1.118; 4.663
TERTILE 3	>39 breaks/hour	1.724	0.104	0.894; 3.327	1.678	0.136	0.850; 3.314

* Adjusted for socio-economic status, gender and age.

Table 3. Logistic regression of waist circumference and number of breaks per hour in sitting time.

		Non-overweight					
Variable		**Unadjusted Model**			**Adjusted Model** *		
		OR	***p* value**	**95% CI**	**OR**	***p* value**	**95% CI**
Number of breaks per hour in sitting time by tertile							
TERTILE 1 (ref.)	<26 breaks/hour	ref.	**0.03 (*p* for trend)**		ref.	**0.032 (*p* for trend)**	
TERTILE 2	Between 26 and 39 breaks/hour	1.848	0.106	0.878; 3.893	1.835	0.115	0.863; 3.9
TERTILE 3	>39 breaks/hour	2.875	**0.011**	1.277; 6.475	2.931	**0.011**	1.279; 6.715

* Adjusted for socio-economic status, gender and age.

Table S1. Logistic regression of BMI and number of breaks per hour in sitting time.

		Non-overweight					
Variable		**Unadjusted Model**			**Adjusted Model** *		
		OR	***p* value**	**95% CI**	**OR**	***p* value**	**95% CI**
Number of breaks per hour in sitting time by tertile							
TERTILE 1 (ref.)	<26 breaks/hour	ref.	**0.034 (*p* for trend)**		ref.	0.05 (*p* for trend)	
TERTILE 2	Between 26 and 39 breaks/hour	2.4	**0.019**	1.157; 4.979	2.392	**0.023**	1.125; 5.088
TERTILE 3	>39 breaks/hour	2.05	**0.048**	1.008; 4.172	2.024	0.06	0.97; 4.225

* Adjusted for socio-economic status, gender and age.

Table S2. Logistic regression of waist circumference and number of breaks per hour in sitting time.

		Non-overweight					
Variable		**Unadjusted Model**			**Adjusted Model** *		
		OR	***p* value**	**95% CI**	**OR**	***p* value**	**95% CI**
Number of breaks per hour in sitting time by tertile							
TERTILE 1 (ref.)	<26 breaks/hour	ref.	**0.041 (*p* for trend)**		ref.	**0.038 (*p* for trend)**	
TERTILE 2	Between 26 and 39 breaks/hour	1.88	0.113	0.862; 4.1	1.928	0.107	0.868; 4.284
TERTILE 3	>39 breaks/hour	2.885	**0.016**	1.223; 6.803	3.001	**0.014**	1.247; 7.208

* Adjusted for socio-economic status, gender and age.