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Objectively Measured Sedentary Time in Youth With Cerebral Palsy Compared With Age-, Sex-, and Season-Matched Youth Who Are Developing Typically: An Explorative Study

Joyce Obeid, Astrid C.J. Balemans, Stephen G. Noorduyn, Jan Willem Gorter, Brian W. Timmons

Background. Children with cerebral palsy (CP) demonstrate reduced physical activity levels compared with children with typical development. Sedentary behavior, including the duration and frequency of sedentary bouts, has not yet been objectively examined in this population but may have clinical implications for the development of secondary health complications.

Objective. The aim of this study was to identify time spent sedentary and frequency of breaks interrupting sedentary time in youth with CP compared with youth without CP. It was hypothesized that individuals with CP would spend more hours sedentary than their peers and take fewer breaks to interrupt sedentary time.

Design. This was a cross-sectional, prospective study.

Methods. A convenience sample of 17 ambulatory children with CP (15 boys and 2 girls) (mean age = 13.0 years, SD = 2.2) and 17 age-, sex-, and season-matched youth who were developing typically (TD group) (mean age = 12.9 years, SD = 2.5) wore an accelerometer over a 7-day period. Sedentary time (in minutes) and number of breaks from sedentary time, corrected for monitoring and sedentary time, respectively, were examined. Differences between groups were determined with an independent-samples t test.

Results. Children with CP engaged in significantly more sedentary time (X = 47.5 min/h, SD = 4.9) compared with the TD group (X = 43.6 min/h, SD = 4.2), with significantly fewer breaks from sedentary time (CP group: X = 179, SD = 70; TD group: X = 232 breaks/h sedentary, SD = 61).

Limitations. The sample included only ambulatory youth with CP, classified as Gross Motor Function Classification System levels I to III.

Conclusions. Sedentary time was higher in the CP group and was characterized by less frequent breaks compared with the TD group. Future research should examine the extent to which sedentary time is associated with cardiovascular and metabolic risk in youth with CP.
Sedentary behavior is a risk factor for the development of chronic diseases in all age groups. Late childhood and adolescence (12–18 years) represents an age group that spends the second highest amount of hours sedentary. Emerging evidence shows that sedentary time is associated with chronic disease, independently of the level of physical activity, and is an important health indicator in youth.

Sedentary time may be more prominent in children with a physical disability as a consequence of the limitations in mobility. One of the most common physical disabilities in childhood, with activity limitations being obligatory for diagnosis, is cerebral palsy (CP). Cerebral palsy is caused by a nonprogressive brain lesion resulting in impaired movement and posture. Youth with CP often have increased levels of fatigue, pain, and muscle soreness—all of which may predispose them to increased sedentary behavior. A recent systematic review of physical activity and sedentary behavior in CP reported that youth with CP demonstrated a 13% to 53% reduction in habitual physical activity compared with youth with typical development; however, very little evidence was available to inform sedentary behavior in youth with CP. Sedentary time has been shown to be feasible and valid in youth with CP by our group.

Apart from the total amount of time spent sedentary, a lack of interruptions in periods of sedentary time hold stronger associations with metabolic risk factors. These interruptions (ie, breaks from sedentary time) are defined as any movement of 3 seconds or more that are of light, moderate, or vigorous intensity. The mobility limitations in people with CP may significantly reduce the frequency of breaks from sedentary time, which may predispose youth with CP to greater cardiovascular and metabolic risks. Before such associations can be investigated, however, studies are needed to assess the sedentary behavior of youth with CP. As we are not aware of any study reporting the sedentary time of youth with CP, the purpose of this study was to objectively measure time spent sedentary and frequency of breaks from sedentary time in ambulatory children and adolescents with CP compared with age-, sex-, and season-matched youth with typical development. It was hypothesized that individuals with CP would spend more hours sedentary than their peers and take fewer breaks to interrupt sedentary time.

Method
Participants
Participants were recruited in a university medical center through regional spasticity and teenage transition clinics between October 2009 and January 2011. The inclusion criteria were: (1) diagnosed with CP, (2) between the ages of 8 and 17 years, and (3) having Gross Motor Function Classification System (GMFCS) levels I to III. A convenience sample of 17 children with CP (15 boys and 2 girls, GMFCS levels I [n=9], II [n=5], or III [n=3]) with a mean age of 13.0 years (SD=2.2) participated in this study. Of these participants, 16 were classified as having spastic CP and 1 as having dyskinetic CP, with 9 participants displaying bilateral involvement, 3 unilateral right involvement, and 5 unilateral left limb involvement. Seventeen youth who were developing typically were recruited from the community and matched to the CP group by chronological age (mean age=12.9 years, SD=2.5), sex (15 boys and 2 girls), and season of data collection (±1 month between matched pairs’ activity assessments). All children and their parents received written and verbal information about the study and provided written informed consent prior to participation.

Procedure
Participants were asked to wear an accelerometer securely fastened to an elastic belt around their waist on the right side of the body. The children wore the device over a 1-week period, including all waking hours, with the exception of bathing time or swimming. A diary was kept to enable tracking of the waking hours and reasons for not wearing the device. This measurement method has been shown to be feasible and valid in youth with CP by our group and others.

Measurement and Analysis of Sedentary Time
Sedentary time was recorded with the ActiGraph accelerometer (ActiGraph, Pensacola, Florida). This device detects and records accelerations in the vertical plane ranging in magnitude from 0.05 to 2.00 g. The accelerations are digitized by a 12-bit analog-to-digital converter with a rate of 30 Hz and integrated and stored over a 3-second epoch providing a measure of counts per 3 seconds.
Sedentary behavior is now recognized as an important health behavior, although very little is known about the accumulation of sedentary time in youth with a physical disability. We found higher levels of sedentary time, characterized by more minutes of sedentary time per hour of monitoring time, and the frequency of breaks interrupting sedentary time was lower in the CP group than in the TD group (Table). The increased sedentary time and decreased breaks from sedentary time in the CP group compared with the TD group were consistent across both weekdays and weekends. Therefore, data were averaged and reported across all valid monitoring days (Table). The Figure illustrates the accumulation of sedentary time and the distribution of breaks in a representative participant dyad from each of the CP and TD groups matched for monitoring time.

Discussion
Sedentary behavior is now recognized as an important health behavior, although very little is known about the accumulation of sedentary time in youth with a physical disability. We found higher levels of sedentary time, characterized by more minutes per hour and less frequent breaks in children and adolescents with CP compared with age-, sex-, and season-matched youth who were developing typically.
The lower number of breaks that interrupt sedentary time may indicate that the duration of a given bout of sedentary time in children and adolescents with CP is longer than in peers without CP. This is an important possibility because, together with total sedentary time, sedentary bout duration is associated with increased health risk.12,13 The accumulation of greater sedentary time in individuals with CP, 4 minutes per hour, may not seem like a large difference; however, when added up over a 13-hour day (average time spent wearing the accelerometer per monitoring day by the whole group), this accumulated time could account for a difference of almost an hour. Over a week, this difference would mean 7 more hours of sedentary time. Such exaggerated time spent sedentary may contribute to the increased risk of developing secondary health conditions experienced by individuals with CP.13 Therefore, strategies to reduce sedentary time and increase the interruptions in sedentary behavior may be clinically beneficial in individuals with CP.

The question is how to reduce sedentary time. In children without disability, reducing screen time and integrating breaks at school showed potential to lower sedentary behavior.18 In people with CP, the only study that examined sedentary time based on questionnaires showed higher screen times on a weekend day than during the week.9 In the current study, we did not find any differences in sedentary behavior on weekdays compared with weekends. This discrepancy may be explained by the fact that the accelerometer cannot differentiate between screen time and nonscreen time sedentary behavior (eg, sitting in a classroom, doing homework). Interventions could specifically focus on reducing screen time, particularly during the weekend, as well as on improving the ability to integrate breaks from sedentary time into daily behavior. Future research should further examine the various forms of sedentary behavior so as to be able to design more specific and effective interventions targeting reducing sedentary time in youth with CP.

Although this is the first study, to our knowledge, to assess sedentary behavior objectively in youth with CP, it is important to note a number of study limitations. We used high-frequency accelerometry to capture movement as thoroughly as possible19; however, this measure might have overestimated the impact of breaks because the physiological relevance of a 3-second break remains unknown. Future research should investigate the relationship between the duration of breaks and cardiovascular and metabolic health. Our sample size was relatively small and included only a small group of youth with CP at GMFCS level III. Examining sedentary behavior in a larger sample and including individuals with more pronounced mobility limitations (GMFCS levels IV and V) is recommended. Finally, all participants were outfitted with accelerometers worn on the right side of the body. Whether activity counts are altered in individuals with asymmetric CP based on accelerometer placement remains unknown. Moving forward, accelerometer-based assessments may seek to identify each par-
participant’s dominant side and modify wear accordingly.

When compared with their peers without CP, children and adolescents with CP had higher sedentary time, which was characterized by less frequent breaks. Our findings suggest that it may be important for health care professionals, including physicians and physical therapists, to not only focus on physical activity in patients with CP but to also examine time spent being sedentary. Furthermore, clinicians should emphasize that simply meeting the physical activity guidelines is not enough and that prolonged bouts of sedentary time should be broken up with bouts of activity of any intensity, including light activity. Given the increased risk of secondary health conditions in CP, intervention programs should target lowering sedentary time and increasing the amount of breaks; future research should reveal if this leads to reducing cardiovascular and metabolic risks.

Ms Obeid, Dr Gorter, and Dr Timmons provided concept/idea/research design. Ms Obeid, Dr Balemans, Dr Gorter, and Dr Timmons provided writing. Ms Obeid, Mr Noorduyn, and Dr Gorter provided study participants. Dr Gorter provided institutional liaisons. Dr Balemans and Mr Noorduyn provided consultation (including review of manuscript before submission).

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This study was approved by the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board, Hamilton, Ontario, Canada.

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References

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