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Objectively measured and self-reported leisure-time sedentary behavior and academic performance in youth: The UP&DOWN Study

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ABSTRACT

Objective. To examine the associations of (i) objectively measured and self-reported sedentary behavior during leisure time with academic performance and (ii) patterns of sedentary behavior with academic performance.

Methods. This study was conducted with 1146 youth aged 12.5 ± 2.5 years in Spain during 2011–2012. Leisure-time sedentary behavior during out-of-school hours was assessed by accelerometry and self-report. Academic performance was assessed through school grades.

Results. Objectively measured sedentary leisure-time was not significantly associated with academic performance. Time spent in Internet surfing, listening to music, and sitting without doing anything were negatively associated with all academic performance indicators (β ranging from −0.066 to −0.144; all $p < 0.05$). However, time spent in doing homework/study without computer and reading for fun were positively associated (β ranging from 0.058 to 0.154; all $p < 0.05$). Five major sedentary patterns were identified. The "high social-low TV/video" and the "low studying-high TV/video" patterns were negatively associated with all academic indicators (β ranging from −0.085 to −0.148; all $p < 0.05$). The "educational" pattern was positively associated with all academic indicators (β ranging from 0.063 to 0.105; all $p < 0.05$).

Conclusions. Specific domains of self-reported sedentary behavior during leisure-time, but not objectively measured sedentary leisure time, may influence academic performance.

Introduction

Sedentary behavior defined as time spent in any sitting or lying down activity (e.g. studying, listening to music or doing cognitive hobbies) that requires an energy expenditure of 1.0 to 1.5 resting metabolic rates (Pate et al., 2008), may have detrimental health consequences during youth and later in life (Hancox et al., 2004; Rezende et al., 2014). Too much time in sedentary behavior has been associated with cardiovascular and metabolic risk factors, obesity, low physical fitness, and low-grade inflammation in young people (Tremblay et al., 2011). However, sedentary behavior might be damaging not only for physical health, but also for other dimensions of health (i.e. mental, social, and intellectual) (Syväoja et al., 2014; Zimmerman and Christakis, 2005).

An increasing number of studies are investigating the potential influence of sedentary behavior on academic performance (Tremblay et al., 2011). The majority of them have focused on a particular screen-based sedentary behavior (i.e. watching TV, playing video games or using computer) (Drummond and Sauer, 2014; Hancox et al., 2005; Hastings et al., 2009; Hunley et al., 2005; Sharif and Sargent, 2006; Syväoja et al., 2013; Tsitsika et al., 2014), and only two studies covered all types of screen-based sedentary behavior

Abbreviations: CPM, counts per minute; GPA, grade point average; MVPA, moderate to vigorous physical activity.

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(Peiró-Velert et al., 2014; Syväoja et al., 2013). These studies consistently showed that screen-based sedentary behavior was negatively associated with academic performance. However, it must be taken into consideration that the time spent in screen-based activities could be only a small part of the total sedentary behavior of youth during their leisure-time (Biddle et al., 2004). It is possible that each sedentary activity may have a different influence on youth's academic performance. For example, doing homework and studying may be associated with higher academic performance, but listening to music may negatively influence academic performance (Sharif and Sargent, 2006).

The influence of one sedentary activity on academic performance may depend not only on the specific activity, but also on the activities it displaces (Guallar-Castillón et al., 2014). Thus, it is important to identify specific sedentary patterns, not only individual sedentary activities, which are associated with low academic performance. To our knowledge, no studies have examined the associations between patterns of multiple sedentary behaviors beyond screen-based activities and academic performance in youth. Accordingly, the present study examined (i) the associations of objectively measured and self-reported sedentary behavior during leisure time with academic performance and (ii) the associations between patterns of sedentary behavior and academic performance in children and adolescents.

Methods

Participants

Participants were recruited from the UP&DOWN Study, which is a 3-year longitudinal study of the impact over time of physical activity and sedentary behavior on health indicators in a Spanish sample of children and adolescents (Castro-Piñero et al., 2014). Baseline data collection was undertaken from September 2011 to June 2012. Children and adolescents were recruited from schools in the Cadiz and Madrid regions, respectively. A total of 2225 youth aged 6 to 18 years participated in the UP&DOWN Study. Those youth who did not meet the accelerometry criteria were excluded from the present analysis. Additionally, 6-year-old children did not complete sedentary behavior questionnaires due to possible bias. Hence, the present analysis included 1146 youth aged 12.5 ± 2.5 years (564 girls).

Parents and school supervisors were informed by letter about the study, and written informed consent was provided. The study protocols were approved by the Ethics Committee of the *Hospital Puerta de Hierro* (Madrid, Spain), the Bioethics Committee of the National Research Council (Madrid, Spain) and the Committee for Research Involving Human Subjects at UCA.

Objectively measured leisure-time sedentary behavior

Objectively measured sedentary behavior was obtained by the ActiGraph accelerometer models GT1M, GT3X and GT3X+ (Actigraph TM, LLC, Pemsacola, FL, US). Detailed description about accelerometer methods is available elsewhere (Esteban-Cornejo et al., 2014c). Sedentary behavior in min/day was estimated by using the cut-point value of <100 cpm (Fischer et al., 2012; Treuth et al., 2004). Leisure-time sedentary behavior was determined by average non-school sedentary time during weekdays (i.e. total sedentary time − school sedentary time using school start and end times from each school) and average sedentary time during weekends, and then, the average of these periods was computed as follows: [(weekday time * 5) + (weekend time * 2) / 7] (Castro-Piñero et al., 2014).

Self-reported leisure-time sedentary behavior

Information on leisure-time sedentary behavior by self-report was assessed using the Youth Sedentary Behavior Questionnaire (unpublished observation). This questionnaire was created based on categories of the STILL project diary (Biddle et al., 2009). Participants were asked about 'how much time', on average, they spent in 12 sedentary activities per day during the weekday and weekend days separately. For more prevalent behaviors responses were recorded as 0 min, 30 min, 60 min, 120 min, 180 min, 240 min and 300 min or more: (i) watching TV/video, (ii) playing computer/video games, (iii) internet surfing, (iv) doing homework/study with computer, (v) doing homework/study without computer, (vi) sitting and talking, (vii) talking on the telephone, and (viii) sitting without doing anything. For more sporadic behaviors, responses were recorded as 0 min, 15 min, 30 min, 60 min, 90 min, 120 min and 150 min or more: (ix) reading for fun, (x) listening to music, (xi) doing cognitive hobbies such as jigsaw and crossword puzzles, chess or checkers, and (xii) traveling on motorized transport. To avoid over-reporting, an adjustment to leisure time taking into account sleep hours, school time, prevalence of each sedentary behavior and physical activities was applying before performing analyses. The average time in min/day for each behavior was calculated as follows: [(weekday sedentary behavior * 5) + (weekend sedentary behavior * 2) / 7]. The questionnaire has shown a good reliability and adequate validity to assess sedentary behavior in youth (unpublished observation).

Academic performance

Academic performance was assessed through school records at the end of the academic year and was based on four indicators: Math, Language, an average of these two core subjects and grade point average (GPA) score. GPA score was calculated as a single average of the scores achieved by students in all subjects. For standardized purposes, individual letter grades were converted to numeric data as follows: A = 5, B = 4, C = 3, D = 2, and F = 1.

Covariates

Information on age, sex, city (Madrid/Cadiz) and maternal education level (below university education and university education as those who at least completed a bachelor degree) were recorded (Klein-Platat et al., 2003). Neonatal characteristics, such as gestational age at time of delivery (weeks) and birth weight (kg) were reported by parents (Esteban-Cornejo et al., 2014a). Anthropometric and physical fitness measurements were assessed with the ALPHA health-related fitness test battery for youth (Ruiz et al., 2011). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). A physical fitness score was calculated as the mean of the two z-standardized scores of the cardiorespiratory and motor fitness tests (Esteban-Cornejo et al., 2014b). Moderate to vigorous physical activity (MVPA) was estimated using the accelerometer cut-point of 2000 cpm (Freedson et al., 2005).

Statistical analysis

The characteristics of study sample are presented as means (SD) or percentages. Differences between sexes were determined by one-way analysis of variance and Chi-squared tests for continuous and nominal variables, respectively. Preliminary analyses showed no significant interactions between sex, age, and sedentary behavior variables (all $p > 0.1$); therefore, all analyses were performed with the whole sample.

The association of objectively measured and self-reported leisure-time sedentary behavior with academic performance was analyzed by linear regression controlling for age, city, maternal education, birth weight, gestational age, body mass index, physical fitness and MVPA. Analyses with objectively measured leisure-time sedentary behavior were additionally adjusted for wearing time.

The association of patterns of leisure-time sedentary behavior with academic performance was analyzed by linear regression controlling for the same covariates. We identified major patterns of leisure-time sedentary behavior by applying factor analysis (principal components) to the amount of time in minutes devoted to each self-reported sedentary behavior. Before the exploratory analysis, Kaiser–Meyer–Olkin (KMO) and Bartlett's sphericity tests were used to measure the sampling adequacy. The analysis retained various patterns (factors) that consisted of behaviors with high degree of correlation. These factors were rotated by the orthogonal method (Varimax rotation). Patterns to be retained for future analyses required an eigenvalue >1 on the Scree test plot, where the patterns with eigenvalues >1 explain more variance than each individual behavior. Each behavior obtained a factor loading and those behaviors with the largest factor loadings were correlated most strongly with each sedentary pattern. Additionally, partial correlations adjusted by age, sex, city, and wearing time were performed to examine associations between each pattern and objectively measured leisure-time sedentary behavior. Analyses were performed with the IBM SPSS Statistics 18.0 for Windows and the level of significance was set to 0.05.

Results

Table 1 shows the characteristics of the study sample. Table 2 presents the association of objectively measured and self-reported