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Adolescent sedentary behavior and body composition in early adulthood: results from a cohort study

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Abstract

BACKGROUND: This study investigates the cross-sectional and prospective associations between accelerometer-measured sedentary behavior and body composition from adolescence to early adulthood.

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AUTHOR CONTRIBUTIONS
E.T.H., S.G., S.M.M., P.E., and E.B. contributed to the conception and design of the study. E.T.H. led the drafting of the manuscript. E.B. and R.B. led the data acquisition, and D.W. led the cleaning of the accelerometer data. P.C.B., C.A., P.P., and S.R. provided expert technical assistance on the Santiago Longitudinal Study. E.B. and S.G. supervised the project. All co-authors participated in the review and writing of the final version of the manuscript and gave final approval of this version to be published.

COMPETING INTERESTS
The authors declare no competing interests.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE
All participants provided assent at the adolescent visit (age 16 years) and informed consent at the early adulthood visit (age 23 years).

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METHODS: Data from the Santiago Longitudinal Study were analyzed ($n = 212$). Sedentary time was measured at age 16 years, and body composition (body mass index [BMI], waist circumference, waist-to-height ratio [WHtR], fat mass percentage, and lean mass percentage) was examined at both age 16 and 23 years. Adjusted linear regression models estimated associations between sedentary time, sedentary bout duration, and body composition, overall and by sex.

RESULTS: In all analyses, mean sedentary bout duration was not associated with body composition. In cross-sectional analyses, more sedentary time during adolescence was significantly associated with lower BMI, waist circumference, WHtR, fat mass percentage, and higher lean mass percentage ($p < 0.05$). One standard deviation increase in daily sedentary time was prospectively associated with lower body mass index ($\beta = -1.22$ kg/m^2, 95% CI: −2.02, −0.42), waist circumference ($\beta = -2.39$ cm, 95% CI: −4.03, −0.75), and WHtR ($\beta = -0.014$, 95% CI: −0.024, −0.004). Sedentary time at 16 years was not associated with changes in body composition from 16 to 23 years.

CONCLUSIONS: Sedentary behavior in adolescence is not adversely associated with body composition profiles in early adulthood.

INTRODUCTION

Between 1975 and 2016, the worldwide prevalence of obesity among children and adolescents aged 5–19 years increased over fourfold, from about 4% to over 18%.[1] Understanding behaviors associated with unfavorable body composition (e.g., body mass index [BMI], waist circumference, excess adiposity) in adolescence and young adulthood is a critical public health concern. While physical activity has been shown to improve weight status in youth, the relation of sedentary behavior and body composition is less clear.[2–5] Sedentary behavior is defined as low-energy-expenditure activities ≤1.5 metabolic equivalents in a sitting or reclining posture.[6]

Several studies have reported a significant association between self-reported screen time, a proxy for sedentary time, and unfavorable body composition in youth.[3–5] However, results of studies relying on self-reported sedentary behaviors are prone to misclassification bias and are unable to accurately capture accumulated time spent in short lengths of time, or bouts, sedentary.[7] Use of devices, including accelerometers, to measure sedentary behavior can help mitigate this bias.[8] Even so, studies using accelerometer-measured sedentary behavior have reported limited evidence for an association with body composition in youth.[9–11] A 2013 study found higher accelerometer-measured sedentary behavior was associated with greater increases in BMI between ages 9 and 15 years.[12] However, two more recent studies reported that greater accelerometer-measured sedentary behavior was not prospectively associated with increased fat mass accrual during adolescence or early adulthood.[13,14] Overall, the quality of evidence for an association between objectively-measured sedentary behavior and body composition is low.[3,11] Many studies are cross-sectional, rely on BMI as a proxy measure of body composition, and do not thoroughly examine the period from adolescence to early adulthood.[11]

While health behaviors begin developing during childhood, there are critical periods, such as during the transition from adolescence to early adulthood, when physical activity decreases and sedentary behavior increases and these changes may differ by sex.[15,16] An analysis of National Health and Nutrition Examination Survey data indicated that self-reported total sitting time increased from 7.0 to 8.2 h/day from 2007 to 2016 among U.S. adolescents (ages 12–19 years).[17] This increase stresses the importance of developing a better understanding of how sedentary behavior affects health outcomes.

Our objective was to examine prospective associations between accelerometer-measured sedentary behavior (i.e., daily sedentary time and mean sedentary bout duration) and body composition measures (i.e., BMI, waist circumference, waist-to-height ratio [WHtR], fat mass percentage, and lean mass percentage) from adolescence to early adulthood. We studied participants of a Chilean birth cohort followed from infancy to young adulthood, the Santiago Longitudinal Study (SLS) and hypothesized that more sedentary behavior in adolescence would be associated with higher BMI, waist circumference, WHtR, and fat mass percentage at both adolescence and in early adulthood.

METHODS

Study design

Participants were part of an infancy iron deficiency anemia prevention trial and follow-up study in Santiago, Chile.[18] During 1991–1996, healthy infants from uncomplicated singleton vaginal births at term were recruited at 6 months of age. Inclusion criteria included no iron deficiency anemia, birth weight ≥3 kg, and residence in one of four low- to middle-socioeconomic neighborhoods in Santiago, Chile. A total of 1657 infants participated in the trial in which they were randomly assigned to receive either iron supplementation (low or high supplementation) or usual nutrition (no iron supplementation) between ages 6 and 12 months. The cohort was followed up several times in childhood (5 and 10 years), adolescence (16 years), and young adulthood (23 years). For this study, we used data collected when participants were 16 and 23 years between 2008–2012[19] and 2015–2018,[20] respectively. At the 16-year follow-up, 679 participants were invited to take part in a study that measured cardiovascular risks and body composition (i.e., individuals from two of the three randomly assigned iron supplementation groups at infancy). Of this group, a convenience sub-sample of 350 adolescents were invited to wear an accelerometer to measure physical activity. Among 313 participants who had usable accelerometry data at age 16 years, 212 also provided cardiometabolic data at age 23 years. These 212 individuals comprise this study’s analytic sample. Included and excluded participants were similar across demographic and lifestyle characteristics at age 16 years (e.g., sex, socioeconomic status, diet, alcohol consumption, maternal education, and parental history of cardiovascular disease). They differed in that the 212 studied here were less likely to have smoked during the previous 30 days than those excluded (Supplementary Table 1). A post hoc analysis was conducted for power estimation. With a significance criterion of $\alpha = 0.05$ and sample = 212, power ranged from 60 to 80% for the anthropometric measures and under 6% for both fat and lean mass percentage.

All participants provided written informed consent at the time of accelerometer and cardiometabolic data collection at ages 16 and 23 years. Adolescents’ mothers provided written informed consent for the adolescent cardiovascular study. The study was approved by the institutional review boards of the University of California, San Diego, the University of Michigan, and the University of Chile Institute of Nutrition and Food Technology (INTA).

Sedentary behaviors: independent variables

Adolescents were scheduled for a half-day assessment at INTA. A week before evaluation, study personnel met with each participant to explain research procedures, including placement of the ActiGraph GT3X + (ActiGraph, Pensacola, FL) hip-worn accelerometer. Participants were instructed to wear the accelerometer during waking hours on an elastic band worn on top of clothing and to remove the device for showering, swimming, and sleeping. Using ActiLife software (version 6.5.3; ActiGraph, Pensacola, FL), devices were initialized to record activity at a sampling rate of 30 Hz and downloaded using a 15 s epoch. Data were cleaned and processed to ensure that devices were worn for ≥10 h/day for ≥5 days or ≥3000 min during a 4-day period using the Choi algorithm.[21] At least one of the included days was a weekend day. Evenson cut points were applied to classify the time spent sedentary (0–25 counts/15 s) and in moderate-to-vigorous intensity physical activity (574–10,000 counts/15 s).[22] Average daily sedentary time was calculated by summing the total amount of sedentary time during the measurement period divided by the number of days measured. A sedentary bout was defined as a stretch of sedentary time lasting at least 30 min with 1 min of “drop” time allowed. Average length of sedentary bouts was calculated by summing all sedentary bout durations during the measurement period divided by the total number of bouts.

Anthropometry: dependent variables

Body composition measures were taken at both age 16 and 23 years. During the half-day evaluation, body mass (kg), height (cm), and waist circumference (cm) were measured twice by a trained physician at INTA, and an additional measurement was taken if the difference between the first two exceeded 0.3 kg for weight, 0.5 cm for height, or 1.0 cm for waist circumference and averages across the 3 measurements were computed. BMI (kg/m^2) was calculated from body weight and height measures, and waist circumference was measured with non-elastic flexible tape at the high point of the iliac crest around the abdomen and recorded to the nearest 0.1 cm. WHtR was calculated as waist circumference (cm) divided by height (cm), where the standard is that an individual’s waist circumference should be less than half their height (i.e., WHtR <0.5) to reduce increased risk of morbidity.[23] Dual-energy X-ray absorptiometry (Lunar DPX-LIQ model [Lunar Corp., Madison, WI] and Lunar iDXA Encore 2001 software [Version 13.60.033 Copyright © 1998–2010]) was used to estimate fat mass percentage and lean mass percentage.

Demographic and lifestyle characteristics: covariates

The following variables were examined as covariates. Biological sex was categorized as male or female. Socioeconomic status was assessed using the Graffar Index,[24] which is a sum of 10 indices such as parental education, employment, family composition, and housing characteristics, which are summed to create a scale (range = 10–60), with higher values indicating more socioeconomic disadvantage. Dietary nutritional quality was assessed using the Intake Habits Survey,[25] where higher scores reflect better nutritional quality (range = 0–10). Participants were asked “Have you ever smoked cigarettes?” and “Have you ever drunk alcohol?" Those who reported any prior use were asked a series of follow-up questions about frequency and quantity of use. Cigarette use during the past 30 days at age 16 years was dichotomized as yes or no, and the number of days participants reported drinking alcohol over the past 30 days at age 16 years was recorded as a continuous variable. Total years of maternal education and parental history of cardiovascular disease (e.g., diabetes, high cholesterol, hypertension and/or heart attack before age 60 years) were self-reported (yes/no) by mothers. Last, daily minutes of moderate-to-vigorous physical activity (MVPA) were included as a covariate to isolate the independent effect of sedentary behavior on body composition. Due to little variation in age at baseline (mean (SD) = 16.8 (0.26) years), it was not included as a covariate.

Statistical analysis

For descriptive purposes, means and standard deviations of baseline characteristics are shown by sex and tertiles of average daily sedentary time. Body composition metrics at age 16 and 23, and 7-year changes are presented by sex, and paired *t* tests were used to test for significant changes over time. Multivariable adjusted linear regression models were used to examine the associations between daily sedentary time and mean sedentary bout duration with each body composition metric. All analyses were performed in the overall sample and by sex due to sex-based differences in body composition measures at both study timepoints. Both average daily sedentary time and mean sedentary bout duration were analyzed continuously per standard deviation increments. Cross-sectional associations between sedentary behavior and body composition at age 16 years were conducted, followed by the longitudinal associations between sedentary behavior at age 16 years and body composition at age 23 years. Lastly, longitudinal associations between sedentary behavior at age 16 and change in body composition from age 16 to 23 years (e.g., BMI at age 16 years subtracted from BMI at age 23 years) was examined. Models were adjusted for sex (overall models only), socioeconomic status, dietary nutritional quality, maternal education, past 30-day alcohol use, past 30-day cigarette use, parental history of cardiovascular disease, and average minutes of daily MVPA. Models examining longitudinal changes in body composition further adjusted for the same body composition measure at age 16 years (i.e., models for change in BMI adjusted for BMI at age 16 years). Results from unadjusted models are included in supplementary materials. Although the focus of this analysis was sedentary time, we also conducted a sensitivity analysis testing whether average minutes of daily MVPA was associated with body composition at 16 years. Multiple imputation using chained equations with predictive mean matching was used to account for missing covariate data. Variables with missing values included maternal education (10.8%), past 30-day cigarette use (6.6%), past 30-day alcohol use (5.2%), and parental history of cardiovascular disease (5.2%). All analyses were conducted in SAS ® Studio (v3.8, SAS Institute Inc., Cary, NC).

RESULTS

Descriptive statistics for demographic and lifestyle characteristics stratified by tertile of average daily sedentary time are shown in Table 1. The average daily sedentary time for the total sample was 608.0 min/day (standard deviation [SD] = 86.5 min/day). Female participants averaged 617.4 min/day (SD = 85.0), and males averaged 598.7 min/day (SD = 87.5) of sedentary time. Mean sedentary bout duration was 44.3 min (SD = 7.7) overall, 44.4 min (SD = 7.5) for males, and 44.2 min (SD = 7.8) for females (data not shown). The proportion of participants who were female was higher as tertile of sedentary time increased. Rates of smoking in the past 30 days and average daily MVPA decreased with increasing tertile of sedentary time. All other covariates were similar across tertiles of sedentary time.

Body composition metrics and changes in metrics by sex and age are shown in Table 2. At age 16 years, more than half of males (59.8%) and females (59.1%) were normal weight; however, this decreased in both males and females at age 23 years (males: 36.4%; females: 43.8%). In terms of changes over time, BMI increased between ages 16 and 23 years similarly in both males (3.1 kg/m^2) and females (2.7 kg/m^2). However, waist circumference increased in males (4.7 cm [SD = 7.0]) but decreased in females (2.2 cm [SD = 7.5]). In addition, males had a more pronounced increase in fat mass percentage and decrease in lean mass than females did from age 16 to 23 years. All changes in body composition metrics from age 16 to 23 years were statistically significant ($p < 0.01$).

Mean sedentary bout duration was not associated with body composition metrics in male or female participants in any analyses (all p values >0.05). Overall, more sedentary time was cross-sectionally associated with lower BMI, waist circumference, WHtR, fat mass percentage, and higher lean mass percentage (Table 3). Among males, one standard deviation more daily sedentary time was associated with −1.02 kg/m^2 (95% confidence interval (CI): −1.83, −0.20) in BMI, −2.30 cm (95% CI: −4.43, −0.16) in waist circumference, and −0.014 (95% CI: −0.027, −0.002) in WHtR. Among females, one standard deviation more sedentary time was associated with −1.14 kg/m^2 (95% CI: −2.19, −0.09) in BMI. Supplementary Table 2 shows the results of unadjusted cross-sectional associations between sedentary behavior (time and bout duration) and body composition.

Prospective associations between sedentary time at age 16 years and body composition at age 23 years are shown in Table 4. Overall, associations between sedentary time at 16 years and BMI, waist circumference, and WHtR at age 23 years were statistically significant ($p < 0.05$), although associations were significant only for females in stratified analyses. Among females, one standard deviation more sedentary time at age 16 was associated with −1.67 kg/m^2 (95% CI: −3.00, −0.35) in BMI and −3.15 cm (95% CI: −5.86, −0.44) in waist circumference. Last, sedentary time at age 16 years was not significantly associated with changes in any body composition metrics between ages 16 and 23 years (Table 5). Unadjusted prospective associations between sedentary behavior and body composition can be seen in Supplementary Tables 3 and 4.

In the sensitivity analysis (Supplementary Table 5), we observed that cross-sectional associations between daily MVPA and markers of body composition were in the expected direction (i.e., higher MVPA associated with decreased BMI, waist circumference, WHtR, fat mass percentage and increased lean mass percentage), with statistically significant results for fat and lean mass percent in both the overall sample and in males only.

DISCUSSION

In this study of 212 Chilean participants, more sedentary time during adolescence was not significantly associated with *less* favorable body composition measures at adolescence and early adulthood. Prospectively, more sedentary time was significantly associated with *lower* BMI, waist circumference, and WHtR at age 23 years. However, the observed statistically significant effect sizes were generally small and not likely to be clinically relevant. To our knowledge, this is the first study to assess the association between accelerometer-estimated sedentary time and body composition during the transition from adolescence to early adulthood. Our findings were mostly contrary to our hypothesized association of increased sedentary time and less favorable body composition, which is sometimes seen in adults.[26,27]

While previous studies provide evidence of a significant positive association between sedentary behavior and increased risk of chronic disease in adults, associations between objectively measured sedentary behavior and body composition are less well-understood especially among adolescents and young adults.[2–5,26–29] A 2016 systematic review identified 10 longitudinal studies of accelerometer-measured sedentary behavior and adiposity in adolescents and reported primarily null findings.[3] Another systematic review identified 13 studies and came to similar conclusions of finding no association in both youth and adolescents and high risk of bias in the included studies.[11] Our results add to the small but growing body of literature indicating no adverse association between device-measured sedentary time and body composition in adolescence and early adulthood.[3,11–14]

There are several possible explanations for our unexpected finding of more sedentary time being prospectively associated with more favorable body composition profiles. First, the hypothesized positive associations between sedentary time and body composition may have occurred during an earlier period, such as the transition between childhood and adolescence,[15] and therefore the effects had already occurred before our observation period. Second, in our sample of Chilean adolescents aged 16 years at baseline, we observed an average daily sedentary time of 608 min/day or 10.1 hours/day). A study using 2003–2004 National Health and Nutrition Examination Survey accelerometry data found US youth ages 16–19 years spent approximately 8 h/day in sedentary time.[30] The relatively higher amount of sedentary time observed in our study may have led to a “ceiling effect” on the observed associations with most body composition indicators. Last, the observed significant associations may be due in part to other factors that were not measured in our study, including sleep and energy balance, which are known to be associated with body composition.[4,31–33] Future studies may consider examining different transition periods, including samples with greater diversity in distributions of sedentary time and body composition metrics, and including measures of sleep and energy intake to further our understanding of the relation between sedentary time and body composition.

Our study has several limitations. The prohibitive administrative costs and participant burden associated with accelerometry meant we were unable to assess all participants at 16 and 23 years, which contributed to our limited sample size. Sample size was determined by these factors and not by a power analysis performed a priori, and the limited sample size may have decreased our ability to detect some differences particularly for fat and lean mass percentage where our study was underpowered. In addition, there may have been residual confounding due to the measure used for dietary nutritional quality (the Intake Habits Survey[25]) that measures overall quality and not total energy intake, which is known to be associated with body composition. Strengths of this study include sedentary behavior objectively estimated by accelerometers worn on the hip, and body composition measured using dual-energy X-ray absorptiometry and standardized procedures at a nutrition research institute. Accelerometer-measured activity allowed us to conduct a sensitivity analysis to confirm with existing evidence that higher MVPA is associated with improved markers of body composition in youth.[2,34] Lastly, the Santiago Longitudinal Study represents an understudied group of adolescents and adults, and this study is one of the few in this population to include accelerometer measures of sedentary behavior.

CONCLUSION

In the current study, more accelerometer-measured sedentary time during adolescence was significantly associated with lower BMI, waist circumference, and WHtR at both adolescence and early adulthood. While this relation seemingly indicates improved health and/or reduced disease risk, the observed point estimates were small and may not be clinically meaningful. While the existing literature is inconsistent about observed associations between sedentary behavior and body composition during this transition period, our findings were contrary to expectations and may be the result of a relatively small sample size and unmeasured or residual confounding. Future larger studies with improved confounder measurement and repeated measures of both sedentary time and body composition would be helpful in more firmly evaluating how sedentary behavior affects body composition.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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DATA AVAILABILITY

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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IMPACT:

- Little is known about the effect of device-measured sedentary behavior on body composition during the transition from adolescence to early adulthood.
- Among participants in the Santiago Longitudinal Study, more accelerometer-measured sedentary time during adolescence was associated with lower BMI, waist circumference, and waist-to-height ratio in early adulthood though point estimates were generally small in magnitude.
- Sedentary behavior in adolescence was not detrimentally associated with healthy body composition profiles in early adulthood. Public health interventions aimed at reducing obesity rates could consider other behaviors, such as physical activity and healthy diet, instead of sitting time.

Table 1.

Demographic and lifestyle characteristics of participants at age 16 by tertile of average daily sedentary time, $N = 212$.

Characteristic	Overall	Average daily sedentary time		
		T1	T2	T3
		415–567 min/day	568–642 min/day	643–818 min/day
Average daily sedentary time, min/day, 16 y	608.0 (86.5)	511.3 (38.1)	604.8 (22.8)	703.6 (41.0)
Female	105 (49.5%)	29 (41.4%)	35 (50.7%)	41 (56.2%)
Socioeconomic status[a]	26.6 (6.5)	27.2 (6.8)	27.0 (6.4)	25.8 (6.3)
Dietary nutritional quality[b], 16 y	5.4 (1.3)	5.3 (1.3)	5.4 (1.4)	5.7 (1.3)
Number of days drank alcohol in the past 30 days, 16 y	0.9 (2.2)	1.2 (2.2)	0.7 (2.1)	0.7 (2.2)
Smoked any cigarettes in the past 30 days, 16 y	24 (11.3%)	13 (18.6%)	9 (13.0%)	2 (2.7%)
Maternal education, years	10.1 (3.0)	9.8 (2.9)	10.1 (3.3)	10.3 (2.8)
Parental history of cardiovascular disease[c], 16 y	115 (54.3%)	38 (54.3%)	36 (52.2%)	41 (56.2%)
Average daily MVPA, min/day, 16 y	51.0 (24.8)	62.1 (29.5)	49.7 (21.2)	41.6 (18.3)

Data are presented as mean (SD) for continuous variables and frequency (proportion) for categorical variables. Sixteen years represent variables assessed at 16-year follow-up. All other variables were measured at trial baseline (i.e., infancy).

MVPA moderate-to-vigorous physical activity.

[a]Socioeconomic status measured with the Graffar Index, with higher scores indicating greater disadvantage.

[b]Dietary nutritional quality questionnaire on a 10-point scale, with higher scores indicating better nutritional quality.

[c]Parent-reported history of diabetes, high cholesterol, hypertension, or heart attack before age 60 years.

Table 2.

Body composition metrics participants, by sex and age, $N = 212$.

Body composition metric[a]	Males (N = 107)				Females (N = 105)			
	16 years	**23 years**	**Change**	***p* value[b]**	**16 years**	**23 years**	**Change**	***p* value[b]**
BMI, kg/m^2	23.8 (4.3)	26.9 (4.8)	3.1 (2.6)	<0.001	24.4 (4.9)	27.1 (6.2)	2.7 (3.0)	<0.001
BMI category, *n* (%)								
Normal	64 (59.8%)	39 (36.4%)			62 (59.1%)	46 (43.8%)		
Overweight	29 (27.1%)	41 (38.3%)			24 (22.9%)	30 (28.6%)		
Obese	14 (13.1%)	27 (25.2%)			19 (18.1%)	29 (27.6%)		
Waist circumference, cm	81.7 (11.0)	86.4 (10.1)	4.7 (7.0)	<0.001	81.7 (12.5)	79.5 (12.5)	2.2 (7.5)	0.003
Waist-to-height ratio	0.48 (0.06)	0.50 (0.06)	0.02 (0.04)	<0.001	0.51 (0.08)	0.49 (0.08)	0.02 (0.05)	<0.001
Fat mass percentage	23.0 (8.5)	31.0 (7.1)	8.0 (6.4)	<0.001	36.7 (7.0)	42.2 (7.0)	5.4 (4.5)	<0.001
Lean mass percentage	74.1 (8.7)	66.6 (6.8)	7.4 (6.3)	<0.001	59.8 (6.9)	55.6 (6.8)	4.1 (4.6)	<0.001

BMI body mass index.

[a] Mean (SD) are presented unless otherwise specified.

[b] *p* value from a paired *t* test for changes in body composition metric from age 16 to 23 years.

Table 3.

Cross-sectional associations between sedentary behavior and body composition at age 16 years, overall and by sex.

	Body mass index	Waist circumference	Waist-to-height ratio	Fat mass percentage	Lean mass percentage
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Overall (N = 212)					
Sedentary time[a]	−1.07 (−1.72, −0.41)*	−2.23 (−3.92, −0.54)*	−0.01 (−0.02, −<0.01)*	−1.11 (−2.21, −0.01)*	1.18 (0.07, 2.29)*
Bout duration[b]	−0.29 (−0.91, 0.33)	−0.97 (−2.56, 0.62)	−0.01 (−0.02, <0.01)	−0.66 (−1.69, 0.38)	0.68 (−0.37, 1.72)
Males (N = 107)					
Sedentary time[a]	−1.02 (−1.83, −0.20)*	−2.30 (−4.43, −0.16)*	−0.01 (−0.03, −<0.01)*	−1.37 (−2.98, 0.24)	1.48 (−0.17, 3.12)
Bout duration[b]	−0.32 (−1.19, 0.54)	−1.02 (−3.29, 1.25)	−0.01 (−0.02, 0.01)	−1.09 (−2.82, 0.65)	1.13 (−0.66, 2.91)
Females (N = 105)					
Sedentary time[a]	−1.14 (−2.19, −0.09)*	−2.36 (−5.04, 0.33)	−0.01 (−0.03, 0.01)	−1.11 (−2.55, 0.33)	1.15 (−0.27, 2.56)
Bout duration[b]	−0.39 (−1.30, 0.52)	−1.01 (−3.33, 1.30)	−0.01 (−0.02, 0.01)	−0.52 (−1.76, 0.72)	0.54 (−0.68, 1.76)

Models adjusted for sex, socioeconomic status, nutritional quality, maternal education, alcohol use in past 30 days, cigarette use in past 30 days, parental history of cardiovascular disease, and average daily moderate-to-vigorous physical activity. Sex is not included as a covariate in sex-stratified models. Regression coefficients are non-standardized.

[a] Per one-standard deviation increment (86.5 min/day) in daily average total sedentary time.

[b] Per one-standard deviation increment (7.7 min) in mean sedentary bout duration.

* $p < 0.05$.

Table 4.

Prospective associations between sedentary behavior at age 16 years and body composition at age 23 years, overall and by sex.

	Body mass index	Waist circumference	Waist-to-height ratio	Fat mass percentage	Lean mass percentage
	β (95% CI)	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
Overall (N = 212)					
Sedentary time[a]	−1.22 (−2.02, −0.42)[*]	−2.39 (−4.03, −0.75)[*]	−0.01 (−0.02, −<0.01)[*]	−0.82 (−1.84, 0.21)	0.75 (−0.25, 1.74)
Bout duration[b]	−0.40 (−1.16, 0.34)	−0.87 (−2.42, 0.67)	−<0.01 (−0.01, 0.01)	−0.70 (−1.65, 0.26)	0.70 (−0.22, 1.63)
Males (N = 107)					
Sedentary time[a]	−0.75 (−1.68, 0.18)	−1.71 (−3.71, 0.29)	−0.01 (−0.02, <0.01)	−0.53 (−1.94, 0.89)	0.53 (−0.83, 1.88)
Bout duration[b]	−0.40 (−1.37, 0.57)	−0.97 (−3.03, 1.10)	−0.01 (−0.02, 0.01)	−1.07 (−2.53, 0.39)	1.05 (−0.35, 2.44)
Females (N = 105)					
Sedentary time[a]	−1.67 (−3.00, −0.35)[*]	−3.15 (−5.86, −0.44)[*]	−0.02 (−0.03, <0.01)	−1.26 (−2.75, 0.23)	1.17 (−0.29, 2.62)
Bout duration[b]	−0.59 (−1.74, 0.57)	−1.02 (−3.39, 1.34)	−0.01 (−0.02, 0.01)	−0.74 (−2.02, 0.55)	0.79 (−0.46, 2.04)

Models adjusted for sex, socioeconomic status, nutritional quality, maternal education, alcohol use in past 30 days, cigarette use in past 30 days, parental history of cardiovascular disease, and average daily moderate-to-vigorous physical activity. Sex is not included as a covariate in sex-stratified models. Regression coefficients are non-standardized.

[a] Per one-standard deviation increment (86.5 min/day) in daily average total sedentary time.

[b] Per one-standard deviation increment (7.7 min) in mean sedentary bout duration.

[*] $p < 0.05$.

Table 5.

Prospective associations between sedentary behavior at age 16 years and changes in body composition from age 16 to 23 years, overall and by sex.

	Body mass index	**Waist circumference**	**Waist-to-height ratio**	**Fat mass percentage**	**Lean mass percentage**
	β (95% CI)	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**	**β (95% CI)**
Overall (*N* = 212)					
Sedentary time[a]	−0.11 (−0.53, 0.31)	−0.67 (−1.67, 0.34)	−<0.01 (−0.01, <0.01)	−0.06 (−0.77, 0.65)	−0.01 (−0.71, 0.68)
Bout duration[b]	−0.10 (−0.48, 0.27)	−0.12 (−1.04, 0.80)	−<0.01 (−0.01, 0.01)	−0.25 (−0.91, 0.40)	0.27 (−0.37, 0.91)
Males (*N* = 107)					
Sedentary time[a]	0.21 (−0.33, 0.76)	−0.09 (−1.43, 1.25)	−<0.01 (−0.01, 0.01)	0.26 (−0.82, 1.35)	−0.28 (−1.31, 0.74)
Bout duration[b]	−0.10 (−0.65, 0.44)	−0.25 (−1.60, 1.09)	−<0.01 (−0.01, 0.01)	−0.45 (−1.56, 0.65)	0.44 (−0.60, 1.48)
Females (*N* = 105)					
Sedentary time[a]	−0.41 (−1.05, 0.24)	−1.17 (−2.69, 0.36)	−0.01 (−0.02, <0.01)	−0.33 (−1.23, 0.57)	0.24 (−0.67, 1.14)
Bout duration[b]	−0.15 (−0.69, 0.40)	−0.16 (−1.46, 1.15)	−<0.01 (−0.01, 0.01)	−0.30 (−1.07, 0.46)	0.36 (−0.41, 1.12)

Models adjusted for body composition measure at age 16 sex, socioeconomic status, nutritional quality, maternal education, alcohol use in past 30 days, cigarette use in past 30 days, parental history of cardiovascular disease, and average daily moderate-to-vigorous physical activity. Sex is not included as a covariate in sex-stratified models. Regression coefficients are non-standardized.

[a] Per one-standard deviation increment (86.5 min/day) in daily average total sedentary time.

[b] Per one-standard deviation increment (7.7 min) in mean sedentary bout duration.