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Socioeconomic position and sedentary behavior in Brazilian adolescents: A life-course approach

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ABSTRACT

Socioeconomic position (SEP) is a potential correlate of sedentary behavior in adolescents. The aim of this study was to examine the associations between SEP and self-reported and objective measures of sedentary behavior in adolescents, using a life-course approach. Data from the 1993 Pelotas (Brazil) Birth Cohort Study were analyzed (N = 5249). Cross-sectional and longitudinal associations between multiple SEP indicators (maternal education, family income, SEP composite, cumulative family income) at birth, 11, 15 and 18 years, and five sedentary behavior outcomes (≥ 4 h/day screen time; ≥ 4 h/day TV; ≥ 2 h/day computer; ≥ 2 h/day video game; ≥ 12.7 h/day objectively measured sedentary time) at 11, 15 and 18 years, were examined. In cross-sectional analyses, higher SEP was positively associated with more screen time at ages 11 and 15 years. There was a consistent and positive association between higher SEP with time spent using a computer, and with sedentary time assessed through accelerometry. SEP at birth had a positive and direct effect on screen, computer and total sedentary time at 18 years. Participants in the highest cumulative income group had higher odds of high sedentary behavior in screen (OR: 2.40; 95% CI: 1.50–3.54), computer (OR: 7.35; 95% CI: 4.19–12.89) and total sedentary time (OR: 5.40; 95% CI: 3.53–10.35), respectively, compared with their counterparts with lower cumulative income. Our findings showed that SEP is an early determinant of sedentary behavior in adolescents.

1. Introduction

Adolescents spend a large proportion of their awake time sedentary (Sherar et al., 2016). Data from the International Children's Accelerometry Database study, which includes information from > 11,000 children and adolescents from nine countries, shows that around two thirds of young people spend > 2 h/day in screen-based activities (Atkin et al., 2014). In Brazil, the National Adolescent School-based Health Survey (Malta et al., 2014), found that approximately 80% of adolescents spent more than 2 h/day watching television.

Our recent systematic review and meta-analysis of the association between socioeconomic position (SEP) and sedentary behavior in adolescents showed that the SEP-sedentary behavior association differs in high and low-middle income countries and varies by domain of sedentary behavior and by measure of SEP (Mielke et al., 2017). Most studies included in that review used self-report measures and were cross-sectional in design. Few studies have investigated prospective associations between SEP and sedentary time in adolescents (Kipping et al., 2015; Dumith et al., 2012).

This paucity of prospective data makes it difficult to evaluate whether SEP in specific periods of life has an impact throughout life, independent of circumstances through childhood and adolescence. Also, no studies have explored different models commonly used in life-course epidemiology, such as accumulation, or direct and indirect effects (Kuh et al., 2003) on the association between SEP and sedentary behavior in adolescents. To our knowledge, no studies have investigated the association between SEP and sedentary behavior in adolescents using measures of SEP at different ages from birth to late adolescence.

The aim of this study was to examine associations between multiple indicators of SEP and multiple domains of sedentary behavior (including an objective measure) in adolescents from the 1993 Pelotas Birth (Brazil) Cohort Study. The specific purposes were to: (1) examine if cross-sectional associations between SEP and sedentary behavior domains vary during adolescence; (2) investigate the potential longitudinal association between early SEP and sedentary behavior in late

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adolescence; (3) examine the association between cumulative family income during childhood and adolescence with sedentary behavior at 18 years.

2. Methods

2.1. Design and participants

Data were from participants enrolled in the 1993 Pelotas (Brazil) Birth Cohort Study. The original cohort included 5249 of the 5265 children born in 1993 in Pelotas, a medium-sized city in the state of Rio Grande do Sul, Brazil. All participants from the original cohort were invited to follow-ups in 2004, 2008 and 2011, when they were aged 11, 15 and 18 years. Of the 5249 participants included in the original cohort (50.6% females), 87.5% (n = 4452), 85.7% (n = 4349) and 81.3% (n = 4106) attended the 11, 15 and 18-year follow-ups, respectively. Before participating in the study, written parental consents were obtained. The study protocols were approved by the Ethics Committee of the Medical School from the Federal University of Pelotas. More details of the methods have been reported previously (Victora et al., 2008; Goncalves et al., 2014).

2.2. Socioeconomic position indicators

At all measurement visits information about maternal education and family income was collected. Maternal education was categorized as number of years of formal education (0–4; 5–8; 9–11; 12 +). Family income was categorized in quartiles.

A composite score of maternal education and family income was created, by assigning the lowest category of each variable a score of zero and the highest category a three. Scores for each indicator were summed, resulting an SEP composite score ranging from 0 to 6, where the lowest group was participants with 0–4 years of maternal education and in the lowest quartile of family income.

A cumulative family income score was also created, by summing family income scores (0 to 3) at each survey (at birth, 11, 15 and 18 years). This ranged from 0 to 12, where a score of 0 indicates the lowest quartile of family income at every age and 12 the highest.

2.3. Sedentary behavior outcomes

Information about sedentary behavior was collected when adolescents were 11, 15 and 18 years. Sedentary behavior was self-reported through face-to-face interviews using a standardized questionnaire, including questions about time spent watching television, using a computer and playing video games, on a normal weekday. Total screen time was calculated as the sum of time spent in these three domains. The following cut-offs were used to define high sedentary behavior in each domain: a) screen time ≥ 4 h/day; b) television viewing time ≥ 4 h/day; c) computer time ≥ 2 h/day; d) video game time ≥ 2 h/day. These cut-offs were based on data distribution have been broadly used in the literature (Mielke et al., 2017).

Objectively measured sedentary time was obtained using the GENEActive accelerometer (ActivInsights, Kimbolton, UK) at 18 years of age. Each participant wore the accelerometer on their non-dominant wrist for 4–7 days, for 24 h a day, including at least one weekend day. Data from participants with activity recordings for at least 2 days were analyzed. Measured acceleration was first calibrated and referenced to local gravity (van Hees et al., 2014), from which acceleration due to physical activity was extracted (van Hees et al., 2013) and activity intensity time-series in 5-s epochs generated. From these time-series, sedentary time was estimated as time spent below a threshold of 50 milligrams (mg) (1000 mg = 1 g = 9.79 m/s^2), which discriminates between sitting/standing and slow walking (Hildebrand et al., 2014). Nonwear periods defined as prolonged (> 60 min) non-variability in acceleration (sd < 13 mg in all three axes) were flagged and imputed using each person's diurnal pattern. The hours between 11:00 p.m. and 7:00 a.m. (assumed to be sleeping) were excluded from analysis. Accelerometer data in binary format were analyzed with R-package GGIR (http://cran.r.project.org0, van Hees et al., 2013). Further information about the accelerometer procedures is available elsewhere (Knuth et al., 2013; da Silva et al., 2014). Total sedentary time was divided into quintiles, with the top quintile categorized as high sedentary time, which corresponded with > 12.7 h/day sedentary.

2.4. Statistical analysis

To elucidate the associations between SEP and sedentary behavior, the analyses were performed in four steps. First, cross-sectional analyses between maternal education, family income and sedentary behavior were conducted using data collected at ages 11, 15 and 18. Second, longitudinal analyses of the association between maternal education and family income at each survey (birth, 11 and 15 years), with sedentary behavior variables at 18 years, were performed. Analyses of associations between each SEP indicator (maternal education and family income) and each individual sedentary behavior measure were conducted using series of logistic regressions. Only linear trend coefficients are presented. The descriptive analyses and categorical coefficients (comparing highest SEP with lowest SEP), can be found in the online appendix. Unadjusted and adjusted analyses were performed, with simultaneous adjustment for each SEP indicator. As there was no evidence of any gender-interaction in the relationships between SEP and the outcomes, data from boys and girls were combined, with gender included as a covariate in the models. There was no evidence of collinearity in the adjusted models, with variance inflation factors ranging from 1.07 to 1.32.

Third, path analysis by structural equation modeling was used to explore whether the association between SEP at a specific age (for example, at 11 years) and sedentary behavior at age 18 is mediated by SEP at age 15 or 18, or whether there is a direct effect of SEP at each age (i.e. an effect that operates through pathways other than through SEP at other ages). The theoretical model and hypothesized associations between variables are shown in Fig. 1 in the online appendix.

Fourth, the associations between cumulative income, from birth to age 18, and the sedentary behavior variables at age 18 were examined. The odds of high sedentary behavior were calculated for each level of the cumulative income variable, compared with participants in the lowest cumulative income score, which was defined as being in the lowest quartile of income at all surveys. Odds ratios and 95% confidence intervals are presented.

All analyses were conducted using STATA 12.1. Assumptions of logistic regression, and path analysis models were checked and there was no evidence of violation of the assumptions.

3. Results

3.1. Sample characteristics and sedentary behavior

Descriptive characteristics of the sample are presented in Table 1. There was a slight increase in the proportion of participants who spent more than 4 h/day in total screen time from 11 (43.2%) to 15 years old (52.7%) ($p < 0.0001$); this then remained constant until 18 years. At 18 years, adolescents spent, on average, 5.1 h/day in screen time, mainly as television viewing (2.3 h/day) and computer use (2.3 h/day). At 11 and 15 years, time spent watching television was higher than in the other domains. From 11 to 18 years, there was a decrease in television time, notably between 15 and 18 years. In contrast, there was a sharp increase in time spent in computer use during both the 11 to 15, and 15 to 18-year periods. Time spent playing video games remained constant. Accelerometer data showed that adolescents spent, on average, 11.5 h of their daily awake time in sedentary activities at age 18.

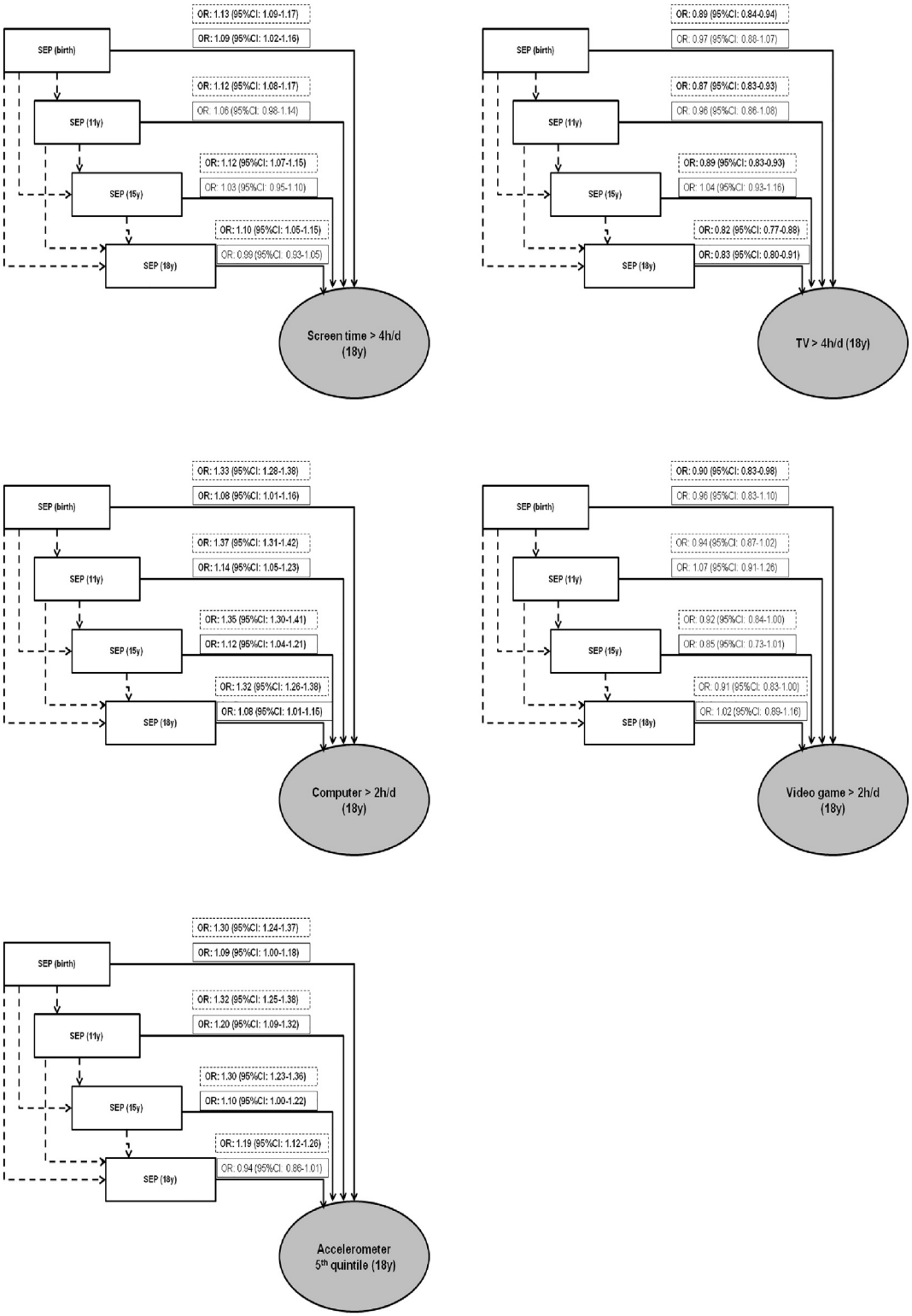

Fig. 1. Path analyses showing relationships between SEP at birth, 11 and 15 years and sedentary behavior variables at 18 years. 1993 Pelotas Birth Cohort.
a - Linear ORs indicate the odds of being in the high-risk group for each sedentary behavior domain for one category change in the composite SEP score.
b - ORs in dashed boxes indicate crude associations between SEP at each age and sedentary behavior variables at 18 years.
c - ORs in solid line boxes indicate direct effects (i.e. those that do not operate through SEP pathways) of SEP at each age on sedentary behavior variables at 18 years.

3.2. Cross-sectional relationships between SEP indicators and sedentary behavior throughout adolescence

The cross-sectional analyses of associations between maternal education, family income and sedentary behavior variables throughout adolescence are shown in Table 2. Higher maternal education and higher family income were positively associated with more screen time when participants were 11 and 15 years old. At these ages, the magnitude of associations with maternal education and family income were similar. However, when the participants were 18 years old, only

Table 1
Descriptive characteristics of the sample. 1993 Pelotas Birth Cohort.

Categorical variables	Birth (n = 5249)	11 years (n = 4441)	15 years (n = 4321)	18 years (n = 4106)
	%	%	%	%
Male	49.6	49.1	48.8	49.1
Maternal education[a]				
0–4	28.0	25.9	23.1	25.1
5–8	46.2	43.1	41.2	40.5
9–11	17.6	21.5	23.5	28.7
12 +	8.2	9.5	12.2	5.7
SEP composite score[b]				
I (lowest)	13.0	11.6	10.3	9.5
II	20.0	19.3	19.2	17.8
III	19.4	19.6	18.4	22.2
IV	18.6	18.3	18.9	21.8
V	13.6	13.6	14.2	16.0
VI	8.9	9.9	9.9	9.7
VII (highest)	6.6	7.8	9.2	3.1
Cumulative income[c]				
Always lowest quartile	-	-	-	3.4
Always highest quartile	-	-	-	7.3
Screen time (> 4 h/day)[d]	-	43.2	52.7	49.4
Television (> 4 h/day)[d]	-	29.7	23.1	11.8
Computer (> 2 h/day)[d]	-	2.3	21.2	36.6
Video game (> 2 h/day)[d]	-	6.5	7.2	5.4

Continuous variables	Birth (n = 5249)	11 years (n = 4441)	15 years (n = 4321)	18 years (n = 4106)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Family income (minimum wages)[e]				
1st quartile	1.1 (0.3)	0.8 (0.4)	0.5 (0.4)	0.7 (0.5)
2nd quartile	2.1 (0.3)	1.9 (0.3)	1.5 (0.3)	2.0 (0.4)
3th quartile	3.5 (0.6)	3.2 (0.5)	2.7 (0.5)	3.5 (0.5)
4th quartile	10.6 (8.9)	10.9 (15.7)	8.4 (8.0)	9.6 (9.2)
Screen time (h/day)	-	4.3 (2.7)	5.2 (3.4)	5.1 (3.7)
Television (h/day)	-	3.5 (2.2)	3.2 (2.3)	2.3 (2.2)
Computer (h/day)	-	0.3 (0.8)	1.4 (2.0)	2.3 (2.5)
Video game (h/day)	-	0.5 (1.1)	0.5 (1.2)	0.5 (1.1)
Accelerometer (h/day)	-	-	-	11.5 (1.5)

[a] N for maternal education: 5242; 4414; 4035; 3735.
[b] N for SEP composite: 5130; 4414; 4000; 3735.
[c] N for cumulative: 3789.
[d] N for self-reported measures of sedentary behavior between 4088 and 4445; N for accelerometer data 3589.
[e] Minimum monthly wage: approximately US$ 100.00 in 2004 (11 years), US$ 180.00 (15 years) in 2008 and US$ 290.00 in 2011 (18 years).

maternal education was positively associated with screen time. The strongest effects of maternal education and family income on screen time were observed when adolescents were 15 years old.

When sedentary behavior domains were analyzed individually, different patterns of association were observed. Income was inversely associated with television time only at 18 years of age. However, there was a consistent and positive association between indicators of higher SEP and time spent at computers, and with objectively measured sedentary time. At age 18, the magnitude of association with maternal education was stronger than the magnitude of association with family income. Family income was positively associated with time playing videogames only when the adolescents were 11 years old.

3.3. Longitudinal associations between SEP indicators at birth, 11, and 15 years and sedentary behavior at 18

Associations between maternal education and family income at birth, 11 and 15 years, with sedentary behavior variables at 18 years, are presented in Table 3. Generally, the patterns observed in the cross-sectional analyses were confirmed in the longitudinal analyses; indictors of higher socioeconomic position were associated with more time spent in total screen time, and the effects were even more marked for accelerometer measured sedentary time. Both high maternal education and high family income at birth were associated with less television time at 18 years. However, only family income at 11 and 15 years was inversely associated with television time at 18 years. Socioeconomic indicators at all ages were positively associated with more computer time when the adolescents were 18 years old. High family income at birth and 15 years were inversely associated with videogame time at age 18, however these associations were not observed in the analyses adjusted for maternal education.

3.4. Direct and indirect associations between SEP and sedentary behavior

The associations between SEP throughout adolescence and sedentary behavior at 18 years were also examined using path analyses. The direct associations between SEP at each age and sedentary behavior variables at 18 years are shown in Fig. 1. SEP at birth was positively associated with total screen time at 18 years, with most of this association mediated by SEP at other ages. For television time, higher SEP at birth and 11 years was associated with less television time at 18 years, with most of this effect mediated by SEP at other ages. A different pattern was observed for computer time and the accelerometer measure. For both these measures, there was a clear direct positive association between SEP at birth (even after considering SEP at other ages), and computer time and sedentary time at 18 years.

Table 2
Cross-sectional association between socioeconomic indicators and sedentary behavior variables at 11, 15 and 18 years. 1993 Pelotas Birth Cohort. Analytical sample between 4441 and 3275.

	11 years		15 years		18 years	
	OR[b] (95% CI) $_{crude}$	OR[b] (95% CI)$_{adjusted}$[a]	OR[b] (95% CI)$_{crude}$	OR[b] (95% CI)$_{adjusted}$[a]	OR[b] (95% CI)$_{crude}$	OR[b] (95% CI)$_{adjusted}$[a]
Screen time (> 4 h/day)						
Maternal education	1.23 (1.16–1.32)	1.16 (1.07–1.25)	1.52 (1.42–1.63)	1.35 (1.25–1.46)	1.21 (1.12–1.31)	1.20 (1.11–1.29)
Income	1.18 (1.12–1.24)	1.11 (1.05–1.18)	1.40 (1.32–1.48)	1.25 (1.17–1.33)	1.07 (1.01–1.13)	1.04 (0.98–1.10)
Television (> 4 h/day)						
Maternal education	0.98 (0.92–1.05)	1.00 (0.92–1.08)	0.91 (0.84–0.99)	0.92 (0.84–1.01)	0.83 (0.73–0.93)	0.89 (0.79–1.01)
Income	0.98 (0.92–1.04)	0.98 (0.92–1.05)	0.95 (0.89–1.01)	0.98 (0.91–1.05)	0.75 (0.68–0.81)	0.77 (0.70–0.85)
Computer (> 2 h/day)						
Maternal education	3.21 (2.59–3.97)	2.18 (1.71–2.79)	2.22 (2.03–2.41)	1.73 (1.57–1.91)	1.70 (1.57–1.85)	1.63 (1.50–1.77)
Income	3.08 (2.40–3.96)	2.01 (1.53–2.64)	1.99 (1.85–2.15)	1.59 (1.46–1.73)	1.24 (1.17–1.31)	1.15 (1.07–1.22)
Video game (> 2 h/day)						
Maternal education	1.16 (1.02–1.32)	1.04 (0.90–1.20)	1.11 (0.98–1.26)	1.04 (0.91–1.21)	0.86 (0.73–1.01)	0.88 (0.74–1.04)
Income	1.21 (1.08–1.34)	1.20 (1.05–1.35)	1.13 (1.02–1.25)	1.12 (0.99–1.27)	0.92 (0.82–1.04)	0.94 (0.82–1.07)
Accelerometer (5th quintile)[c]						
Maternal education	-	-	-	-	1.52 (1.36–1.68)	1.51 (1.35–1.68)
Income	-	-	-	-	1.13 (1.04–1.21)	1.01 (0.93–1.10)

[a] Mutually adjusted for maternal education and income.
[b] Linear ORs indicate the change in odds of being in the high-risk group for each sedentary behavior domain, for each category increase in each of the SES indicators.
[c] Accelerometer 5th quintile: > 12.7 h/day.

3.5. Cumulative effect of income over 18 years on sedentary behavior

Different patterns of association between cumulative income and sedentary behavior variables were found (Fig. 2). Except for video game time, higher cumulative income was associated with time spent in sedentary behavior. However, the direction and magnitude of these associations varied according to the domain. Compared with those in the bottom quartile of income, participants in the top quartile at all ages had twice the odds of spending more than 4 h/day in screen time. There was a negative association between cumulative income and television time. The strongest positive and linear gradient between cumulative income and sedentary behavior domain was found for computer time ($p < 0.001$). When sedentary time was measured by accelerometer, the group of highest cumulative income had 5.4 times higher odds of being in the top quintile of sedentary time, compared to the lowest income group.

4. Discussion

This was one of the first studies to investigate the association between SEP and sedentary behavior in adolescents using a range of models to encompass an early life-course approach. The findings reinforce the importance of evaluating sedentary behavior by domains, instead of using a single estimate. For example, as in previous studies (Silva et al., 2014; Cui et al., 2011), there was a slight increase in total screen time from 11 to 15 years old, which then remained constant until 18 years. This overall trend masked decreases in television time and increases in computer time, which should be considered in the development of targeted interventions to decrease sedentary behavior.

Overall, there was a socioeconomic gradient in sedentary behavior,

Table 3
Longitudinal association between socioeconomic position at birth, 11 and 15 years with sedentary behavior variables at 18 years. 1993 Pelotas Birth Cohort. Analytical sample between 4088 and 3275.

	Birth		11 years		15 years	
	OR[b] (95% CI)$_{crude}$	OR[b] (95% CI)$_{adjusted}$[a]	OR[b] (95% CI)$_{crude}$	OR[b] (95% CI)$_{adjusted}$[a]	OR[b] (95% CI)$_{crude}$	OR[b] (95% CI)$_{adjusted}$[a]
Screen time (> 4 h/day)						
Maternal education	1.22 (1.13–1.31)	1.13 (1.04–1.23)	1.20 (1.12–1.29)	1.11 (1.03–1.21)	1.19 (1.11–1.27)	1.12 (1.03–1.21)
Income	1.18 (1.11–1.24)	1.13 (1.06–1.20)	1.18 (1.12–1.25)	1.13 (1.06–1.21)	1.17 (1.10–1.23)	1.11 (1.03–1.18)
Television (> 4 h/day)						
Maternal education	0.80 (0.71–0.89)	0.85 (0.74–0.97)	0.82 (0.74–0.92)	0.90 (0.80–1.02)	0.82 (0.74–0.92)	0.88 (0.77–0.99)
Income	0.86 (0.79–0.94)	0.91 (0.83–1.01)	0.82 (0.75–0.89)	0.85 (0.77–0.94)	0.83 (0.76–0.91)	0.89 (0.79–0.98)
Computer (> 2 h/day)						
Maternal education	1.70 (1.57–1.83)	1.51 (1.38–1.64)	1.67 (1.55–1.80)	1.41 (1.30–1.54)	1.64 (1.52–1.76)	1.40 (1.30–1.53)
Income	1.40 (1.32–1.42)	1.21 (1.13–1.29)	1.52 (1.44–1.62)	1.33 (1.24–1.43)	1.51 (1.42–1.60)	1.31 (1.22–1.41)
Video game (> 2 h/day)						
Maternal education	0.85 (0.73–1.01)	0.89 (0.74–1.07)	0.88 (0.75–1.02)	0.88 (0.73–1.05)	0.91 (0.78–1.07)	1.00 (0.83–1.20)
Income	0.87 (0.77–0.99)	0.91 (0.79–1.04)	0.95 (0.84–1.07)	0.95 (0.87–1.15)	0.83 (0.73–0.94)	0.85 (0.73–1.00)
Accelerometer (5th quintile)[c]						
Maternal education	1.65 (1.51–1.81)	1.48 (1.33–1.65)	1.65 (1.51–1.81)	1.48 (1.33–1.65)	1.60 (1.46–1.75)	1.42 (1.29–1.58)
Income	1.37 (1.27–1.47)	1.18 (1.08–1.29)	1.42 (1.31–1.53)	1.20 (1.10–1.31)	1.40 (1.30–1.52)	1.20 (1.09–1.31)

[a] Mutually adjusted to maternal education and income.
[b] Linear ORs indicates the odds of being in the high-risk group for each sedentary behavior domain for one category increase in SES indicators.
[c] Accelerometer 5th quintile: > 12.7 h/day.

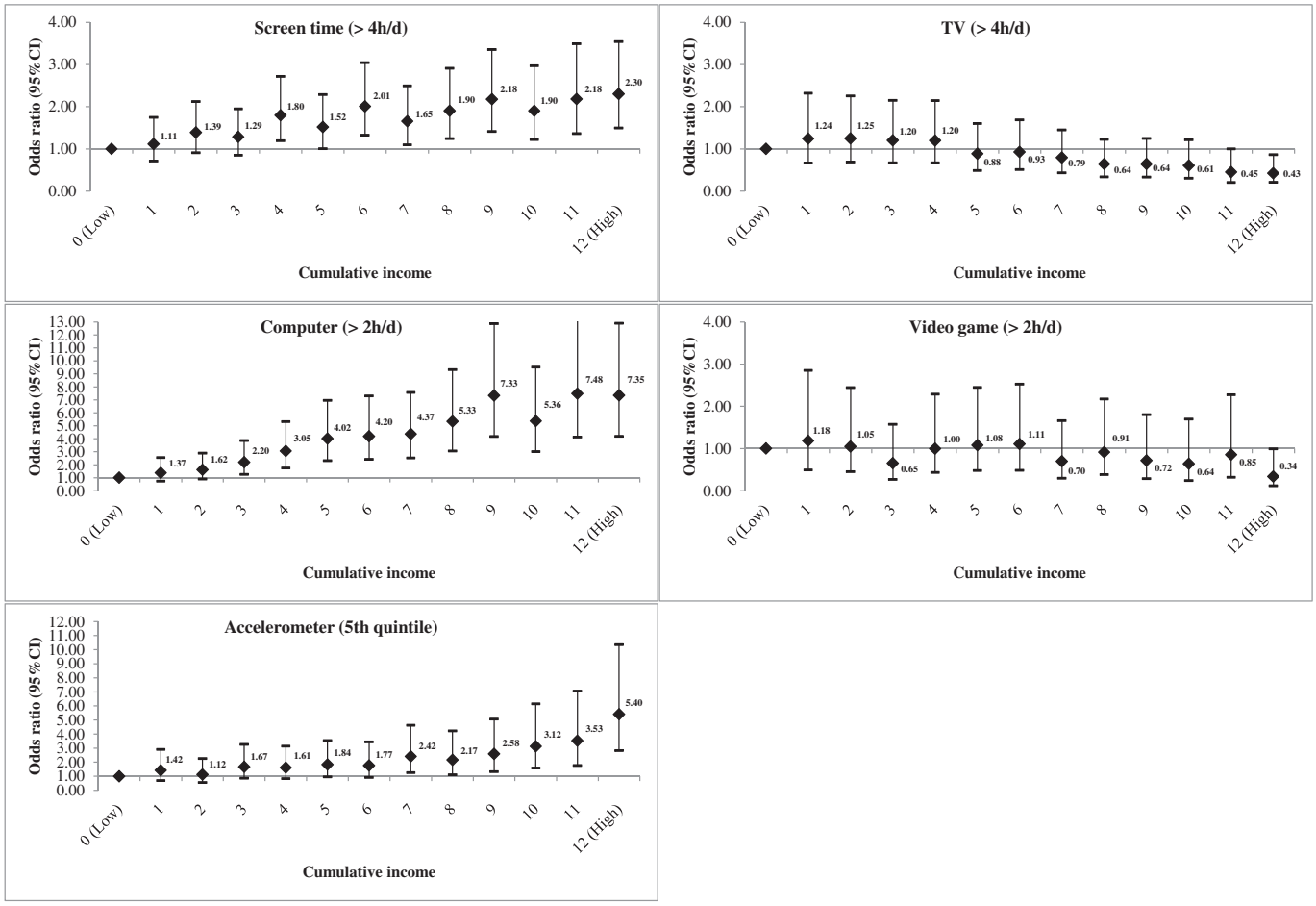

Fig. 2. Cumulative effect of income from birth throughout adolescence on screen time; television viewing time; computer time; video game time; and Accelerometry-measured sedentary time (> 12.7 h/day), at 18 years old. 1993 Pelotas Birth Cohort.* Linear ORs indicate the in odds of being in the high sedentary behavior group for each cumulative score category.

but the direction of the association varied by both the SEP measure and sedentary behavior domain. Lower SEP was associated with more television time, while higher SEP was associated with more time at computers and higher objectively measured sedentary time. The inverse association between SEP and time spent watching television may be explained by a lack of access to other sedentary pastimes among the more disadvantaged. Previous studies have also found different patterns of association when comparing television and other domains of sedentary behavior (Coombs et al., 2013; Babey et al., 2013; Patriarca et al., 2009).

Our finding of a positive association between SEP and objectively measured sedentary time is not consistent with previous studies (Coombs et al., 2013; Ruiz et al., 2011; van Sluijs et al., 2010). The differences may reflect differential SEP-sedentary behavior associations in low-middle and high-income countries (Mielke et al., 2017); in the former, it is possible that more low SEP adolescents are more likely to be engaged in manual labor and therefore are less sedentary, whereas those from high SEP are more likely to spend time studying. More studies are required to clarify this observation.

The direction and magnitude of the associations between SEP variables and sedentary behavior domains changed across the adolescent period in this cohort. Higher maternal education and higher family income were positively associated with more screen time and more computer time when participants were 11 and 15 years old. However, at 18 years only maternal education was positively associated with screen time and objectively measured sedentary behavior, while income was inversely associated with television viewing. Given that computer time accounts for a considerable proportion of total screen time, and objectively measured sedentary behavior at 18 years, this finding may reflect a strong effect of maternal education on computer time. The consistent and positive association between indicators of higher SEP and time spent at computers has also been observed in previous studies (Silva et al., 2014; Babey et al., 2013).

When longitudinal associations between SEP indicators in early life and sedentary behavior domains at 18 years old were investigated, we observed similar patterns to those found in the cross-sectional analyses. These findings may reflect the strong correlations between SEP indicators across the years (Supplementary Table 1) and the low social mobility of the cohort participants, rather than a real prospective effect of early SEP on sedentary behavior in late adolescence/early adulthood. To exemplify this low social mobility, more than one third of participants who were in the lowest income group at birth, were still in this group at 18 years, while around half of those in the highest income group, were still in the highest group at age 18.

To understand possible specific effects of SEP at each age on sedentary behavior at 18 years, independent of SEP at other ages, we performed pathway analyses. The results showed a positive and direct association between SEP at birth and screen time, computer use and objectively measured sedentary behavior at 18 years. SEP at each age also had a direct effect on computer time and objectively measured sedentary behavior at 18 years. Despite these 'direct' effects, some of the relationship between SEP and sedentary behavior is not mediated by SEP conditions at different ages, and there is a need to further investigate the proximal mediating mechanisms through which SEP affects sedentary behavior.

In recent years, there has been growing interest in the impact of the

cumulative effects of SEP across the life course on health outcomes (Singh-Manoux et al., 2004; Graham, 2002; Lynch and Smith, 2005). Our results indicate that participants with higher family income had higher odds of being highly sedentary, especially in computer time and objectively measured sedentary time, than those from families earning less. No previous studies have reported similar models of risk accumulation for sedentary behavior.

Some limitations should be considered in the interpretation of findings. First, bias related to self-reported sedentary behavior might be a limitation of this study. Second, due to non-normality of continuous variables, we chose cut-offs based on data distribution to define high sedentary behavior. However, all analyses were conducted using both categorical variables with different cut-points, and continuous variables, and the results were always in the same directions (data not shown but available upon request). Third, our results could represent a cohort effect, rather than an age effect, so that the results are explained by contextual differences at the time of follow up, rather than differences in age. For example, the social context in Brazil in 2004 was different from that in 2011. Fourth, due to the substantial number of statistical tests, we cannot rule out the possibility of Type 1 errors.

The strengths of our study include: (a) the assessment of different domains of sedentary behaviors at several ages; (b) the use of an objective measure; (c) the assessment of multiple measures of SEP in a contemporary birth cohort collected over 18 years; (d) the use of different analytical strategies, showing consistent results; and (e) the use of a representative sample of all adolescents of the city, with > 80% of the original cohort followed up after 18 years, thus minimizing the likelihood of selection bias. However, the extrapolation of the associations described here to other contexts, should be done carefully and considering the social context of each location.

In conclusion, this study provides new insights into the associations between SEP and sedentary behaviors in adolescents, using a life-course approach. The results showed that SEP is an early determinant of sedentary behavior in adolescents, with contrasting associations for different sedentary behavior domains, which are in turn influenced by the socioeconomic trajectories of individuals.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2017.12.008.

Conflict of interest statement

There are no potential conflicts of interest, real or perceived. All authors declare no conflicts of interest.

Transparency document

The Transparency document associated with this article can be found, in online version.

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