"Physical Activity Throughout Adolescence and Hba1c in Early Adulthood: Birth Cohort Study" by Nakamura PM et al.
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Physical activity throughout adolescence and HbA1c in early adulthood: birth cohort study

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Abstract

Background: Physical inactivity is responsible for 7% of diabetes deaths worldwide, but little is known whether low levels of physical activity (PA) during adolescence increase the risk of diabetes in early adulthood. We evaluated the cross-sectional and longitudinal associations between PA throughout adolescence and HbA1c concentration in early adulthood. **Methods:** HbA1c was measured by high performance liquid chromatography. PA was assessed by self-report at the ages of 11, 15 and 18 years and by accelerometry at the ages of 13 (sub-sample) and 18 years. The loss percentages of follow up were: 12.5% at 11 y; 14.4% at 15 y and 18.7% at 18 y. **Results:** At 18 years, boys showed higher HbA1c than girls. At age 18 years, accelerometry-based PA at 18 years was inversely related to HbA1c levels in boys. Self-reported leisure-time PA at ages 11, 15 and 18 were unrelated to HbA1c in both genders. PA at 13 years of age was unrelated to HbA1c among both genders. In trajectory analysis, PA and accelerometer PA trajectories were not associated with later HbA1c. **Conclusion:** Objectively measured PA at 18 years was cross-sectionally inversely associated with HbA1c in boys only. No prospective associations were identified.

Key words: Glycosylated hemoglobin, Brazil, longitudinal study, motor activity.

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Introduction

Diabetes is estimated to affect 422 million people around the world. In 2012, 3.7 million deaths were attributable to the disease and its cost was estimated at USD 471 billion worldwide[1,2]. It is predicted that by 2030, 552 million people will have diabetes[2]. The prevalence of self-reported diabetes among adults in Brazil is 6.9%[3], however the true prevalence is likely higher due to a large number of undiagnosed cases[4]. Related to the adolescents, the prevalence of diabetes in the worldwide ranges the 0.2% (England) to 50.0% (Arizona) and in Brazil the 0.4% to 7.7%[5,6]. The diabetes-related mortality rate in Brazil is 121,000 deaths per year, which is the highest in South and Central America[2].

While a number of genetic markers have been identified for type 2 diabetes[7] the global increase in the prevalence of type 2 diabetes is paralleled by rising rates of obesity and likely associated with population shifts in physical activity and dietary habits in combination with the aging of the population. This is particularly relevant for low and middle-income countries, where rapid nutritional, epidemiological and demographic transitions are taking place[8]. For example, physical inactivity is estimated to be responsible for 7.2% of diabetes deaths worldwide and 10.1% in Brazil[9].

Original studies and systematic reviews have reported that physical activity is associated with incident diabetes[10,11] and with biochemical indicators of diabetes, such as blood glycosylated hemoglobin (HbA1c) and fasting glucose[12-15]. However, most studies on this topic were conducted with adults, and little is known on whether physical activity during early adolescence is associated with risk factors for type 2 diabetes at 18 years.

The aim of the present study was to examine the prospective and cross-sectional associations between self-reported and objectively-measured physical activity during adolescence and HbA1c concentration in early adulthood in a large cohort of Brazilians

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followed up from birth. Further, our original hypothesis was that more active adolescents at each age would present lower levels of HbA1c at age 18y.

Methods

The city of Pelotas is located in the extreme South of Brazil, near the border with Uruguay. Pelotas has approximately 342,000 inhabitants, and the main economic activities are rice production, commerce and education[16]. In the calendar year of 1993, all children born in hospitals whose families lived in the city were eligible and invited for the study. Over 99% of all deliveries in the city at that year took place in hospitals. Out of 5,265 mothers invited, 5,249 authorized their children to take part in the birth cohort study. Further details on the methods of the 1993 Pelotas (Brazil) Birth Cohort Study are available elsewhere[17,18]. Ethical approval was obtained by the School of Medicine Ethics Committee of the Federal University of Pelotas.

Participants of the 1993 cohort were followed up at the mean ages of 11, 15 and 18 years. At the 11 years follow up visit, 4,452 adolescents were interviewed and 141 were known to have died, leading to a follow-up rate of 87.5% (4,452+141/5.249 number of children interviewed in 1993). At the 15 years follow-up, 4,325 adolescents were located and 147 were known to have died, leading to a response rate of 85.7%. At 18 years of age, we successfully interviewed 4,106 subjects and a total of 164 were known to have died; the follow up rate was therefore 81.3%. In addition, a subsample of around 500 cohort members was included in a detailed study on body composition and physical activity at 13 years of age. These individuals were randomly selected from the cohort database.

Self-reported physical activity was collected at 11 and 15 years of age using a questionnaire specifically developed for the study. The most frequently performed physical activities during leisure-time at age 11 and 15 years were assessed in pilot studies and included in the questionnaire. Adolescents were asked about their practice of each activity

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with an option to include additional activities not listed. For each activity, weekly frequency and duration was reported, and a summary score (in minutes per week) of leisure-time physical activity was calculated. Additional questions about the duration and frequency of active transportation to and from school were included and a summary score (min / week) of transport related physical activity was calculated for each individual. The reliability and validity of the questionnaire was tested in an independent sample and showed good reliability (rho 0.62; $p<0.001$), although fairly low concurrent validity as compared to pedometers (rho 0.26; $p=0.02$). At 18 years of age, screen time, leisure-time and transport-related physical activities were assessed using the International Physical Activity Questionnaire, long version[19].

Screen time at 11 and 15 years were collected through face-to-face interviews with the adolescents. The instrument included questions on whether the adolescent watched television (TV), played video games, and used the computer. The translated questions were (1) "How much time do you watch TV?"; (2) "How much time do you play video game?"; (3) "How much time do you use the computer?". Interviewers were trained to identify possible overlap (e.g., if the same time is reported in both situations) and ask the respondent to choose the appropriate answer in such cases. The mean time spent in front of each of these electronic media (in a typical week) was noted separately for weekdays and weekends. The outcomes were constructed by adding the weighted mean screen time (TV _ video game _ computer), assigning the weight 5 to weekdays, 2 to weekends, and dividing the result by 7 to obtain the mean time in minutes per day.

At 13 (N=457) and 18 (N=3,615) years of age, physical activity was measured by accelerometry. The ActiGraph GT1M accelerometer with an epoch set to 5 s was used at 13 years, and the GENEActiv® accelerometer sampling at 80Hz was used at 18 years. At 13 years, participants were asked to wear the accelerometers all day long on the waist, except

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when showering, bathing or swimming. Accelerometers (ActiGraph) were delivered to the individual on Wednesdays; and fieldworkers visited the participant's home on the following Monday to collect the device. Data were downloaded according to the manufacturer's instructions, and data were analyzed using the MAHuffe software (available at www.mrc-epid.cam.ac.uk). Days with < 600 min of registered data and periods of time above 60 min of consecutive zero counts were excluded. Further details on the accelerometer methods at 13 years are available elsewhere[20]. At 18 years physical activity was measured by a wrist mounted accelerometer (GENEActiv®) for 5 days. Adolescents were instructed to wear this monitor throughout the collection period (24 hours/day); even while bathing and during sleep. Gravitational acceleration was subtracted from derived vector magnitude and data were analyzed in 5-s epochs. Further details on the accelerometer methods at 18 years are available elsewhere[21].

The families' socioeconomic status was assessed using the Brazilian Economic Classification divided into 5 levels (A, B, C, D, and E), with levels A and E corresponding to the families with the highest and lowest incomes, respectively. Parents and/or guardians of the children answered this questionnaire. Body mass and height at 11 and 15 years old were measured using portable scales (SECA, Birmingham, UK), with a capacity of 150kg, accurate to 100g, and aluminum anthropometers, accurate to 1mm. At 18 years the BMI was obtained by dual energy x-ray absorptiometry (DXA) (Lunar Prodigy Advance- GE® Germany).

Consumption of food was assessed by a questionnaire developed by Block[22], which is divided into two sections. The first section, comprising 15 food items, aims to identify the frequency of intake of foods rich in fat. The second section, comprising 9 items, investigates the intake of foods rich in fiber.

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At the 18 years visit, non-fasting blood samples were collected; 50 µL of blood was pipetted in filter papers card (Protein Saver ™ 903® card, Whatman) and dried at room temperature and thereafter stored in -80ºC freezers on the day of collection. HbA1c was measured by high performance liquid chromatography precision equipment using the VARIANT II kit PROGRAM HEMOGLOBIN HbA1c (manufacturer Laboratories In Bio-Rad, Hercules, CA). We used two levels of controls (LYPHOCHEK DIABETES, manufacturer Laboratories In Bio-Rad, Hercules, CA) in dosage.

Data analyses were performed using Stata v.12.1 (StataCorp., Stata Statistical Software). Self-reported physical activity at different ages was divided into four categories (0, 1-149, 150-299, ≥300 min/wk). Overall physical activity measured by accelerometry (counts min/week at 13 y and mean acceleration at 18 y) was stratified into tertiles. Following unadjusted analyses, multivariable linear regression models were run for the continuous outcomes. All analyses were stratified by sex. Confounding variables included family income, BMI (kg/m^2), consumption of food, level of glucose and screen time at 18 years. We also contrasted extreme groups in terms of trajectories of self-reported physical activity by comparing HbA1c (mmol/mol) among those who were consistently active (≥420 min/wk) in all follow ups (11, 15 and 18y) versus those who were consistently inactive (<420 min/wk).

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Results

Table 1 describes the characteristics of the individuals located in the 11, 15 and 18 years follow-up compared with the full cohort. In all moments no difference were found between the proportions of sex. Further, in all moments the level of socioeconomic were intermediate and the maternal schooling were the 4 to 8 years.

Among the 4,106 participants evaluated at 18 years, HbA1c was measured in 3,842, and 3,528 had complete data on physical activity at 11, 15 and 18 years (by questionnaire and

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by accelerometry) and 378 at 13 years (by accelerometry). Table 2 describes the sample in terms of HbA1c concentration at 18 years, BMI, physical activity assessed by self reported and objective instruments at 11, 15 and 18 years of age, screen time at 11, 15 and 18 years, level of glucose and consumption of food at 18 years. Boys had higher HbA1c values than girls (30.7 vs. 29.4 mmol/mol) at 18 years. Leisure-time physical activity and overall physical activity scores were consistently higher among boys than girls, whereas commuting physical activity was lower at 11 and 15 years of age and slightly higher among boys at 18 years. Overall physical activity assessed by wrist-worn accelerometry at 13 and 18 years were higher in boys (43.6 g; 462.7count/min) than in girls (35.1 g; 391.2 count/min). Additionally, level of glucose, screen time (hours/weekday) and consumption of food (kcal) were higher in boys than in girls.

Table 3 displays the associations between HbA1c at 18 years and objectively-measured physical activity assessed at 13 and 18 years of age, including adjustment for confounding. Physical activity at 13 years of age was unrelated to HbA1c among both boys and girls. Among boys only, there was an inverse cross-sectional association between objectively measured physical activity and HbA1c.

Table 4 displays the association between self-reported physical activity (ages 11, 15 and 18 years) and HbA1c at 18 years. Regardless of the age in which physical activity was measured (11, 15 and 18 years), regardless of gender, and regardless of the type of analysis (unadjusted and adjusted), none of the associations were significant between physical activity and HbA1c.

In Table 5, trajectories of self-reported physical activity and objectively-measured physical activity throughout adolescence are presented. Again, no significant associations were found regardless of the domain (leisure-time and commuting), gender, and type of analysis (unadjusted and adjusted).

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Discussion

The aim of the present study was to evaluate the prospective and cross-sectional associations between physical activity throughout adolescence (11, 13, 15 and 18 years of age) and HbA1c concentration in early adulthood (18 years of age) in a cohort of Brazilians followed up from birth. Our original hypothesis was that more active adolescents at each age would present lower levels of HbA1c at age 18y. However, this association was only observed in the cross-sectional analysis using objectively-measured physical activity at 18 years in boys. Physical activity has been shown to be associated with improved insulin sensitivity[20], increased lean body mass, improved physical and psychological well-being, improved lipid profile, in addition to helping glycemic control [23,24]. However, we only found a significant association between physical activity and HbA1c concentration in the cross-sectional analysis in boys, with the equivalent association in girls being non-significant although with confidence intervals overlapping the male effect estimates.

A possible explanation for our findings is that it has been shown that the previous 60 days explain 75% of the variance in current HbA1c levels, whereas the entire period before that explains the remaining 25%[25]. Recent plasma glucose levels (i.e., 3– 4 weeks earlier) contribute considerably more to the level of HbA1c than do longpast plasma glucose levels (i.e., 3–4 months earlier) because the level of HbA1c at any point in time is contributed to by all circulation erythrocytes from the oldest (120 days old) to the youngest. This explains why the level of HbA1c can increase or decrease relatively quickly with large changes in plasma glucose; it does not take 120 days to detect a clinically meaningful change in HbA1c after a change in mean plasma glucose[26]. This may explain why only the level of physical activity at 18 years was associated with HbA1c among boys, when compared with the levels of physical activity at 11,13 and 15 years. Although an equally likely explanation would be poorer statistical power owing to greater measurement error in the earlier exposure measures.

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However, these findings were not replicated among girls - a possible explanation is that the physical activity response of insulin resistance is different between girls and boys across maturation stages. In the study by Kelly et al,[27] boys had higher exercise response in sensitivity insulin and fasting glucose in Tanner stage 5 when compared with girls - this occurred because girls had poor cardiorespiratory fitness and low levels of physical activity[28]. Further, healthy females are less insulin sensitive than healthy males, and this decreased sensitivity is compensated by increased insulin secretion[29.] Also, boys at 18 years spent more time being physically active than girls. Physical activity has been shown to be related to lower values of HbA1c in healthy adolescents[30] and among those with diabetes[31].

Trajectories of physical activity were not associated with HbA1c at 18 years old. This result was similar to observations reported by Metcalf et al (2015) [32]. However, they found that the transient peak in insulin resistance occurring at ages 12–13 years was 17% lower ($p<0.001$) in the more active adolescents compared to inactive ones, independently of body fat percentage and pubertal status. However, this difference diminished progressively over the next three years and disappeared completely by the age of 16 years. This lack of influence of longitudinal physical activity on HbA1c concentration may be caused by the higher oscillation in insulin sensitivity, compensatory acute response and pancreatic b-cell function across puberty[27]. Further, some studies showed poor agreement between HbA1c and oral glucose tolerance tests criteria in classifying subjects with glucose values suggestive of type 2 diabetes in adolescents and they suggestion used HbA1c in combination with traditional glucose criteria when detecting and diagnosing diabetes or prediabetes[33,34]. However, the relationship between HbA1c and diabetes complications is unlikely to be direct but instead serves as a surrogate marker of risks[35].

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Strengths and limitations

The strength of this study is its large sample size and the long follow-up of participants (11, 13,15 and 18 years). Another potential strength is the trajectory categorization, which makes it easier to interpret findings and discuss them in the context of current physical activity guidelines for adolescents. Some methodological limitations should be mentioned. The instrument used to assess the physical activity was different at 11 and 15 years as compared to 18 years. Further, we did not have enough information on diet that would allow us adjusting our findings for food intake[36] and we do not control the menstrual cycle and pubertal stage in HBA1c analysis.

Conclusion

To the best of our knowledge, this is one of the first longitudinal studies evaluating the association between objectively-measured and self-reported physical activity and HbA1c in healthy adolescents from low and middle-income countries. Objectively measured physical activity at 18 years was cross-sectionally inversely associated with HbA1c at 18 years in boys only. All other associations tested results in null findings.

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Table 1: Follow up rates at 11,15 and 18 years according to baseline characteristics

Variable	Original N (1993)	CI (95%)	Interviewed N (11y)	CI (95%)	Interviewed N (15y)	CI (95%)	Interviewed N (18y)	CI (95%)
Sex	5.248							
Male	2.603	0.48-0.50	2.134 (81.9%)	0.47-0.51	2.111 (81.1%)	0.47-0.50	2.006 (77.1%)	0.47-0.50
Female	2.645	0.49-0.51	2.185 (82.6%)	0.49-0.52	2.214 (83.7%)	0.49-0.52	2.086 (78.8%)	0.49-0.52
Household income								
≤ 1	967	0.17-0.19	794 (82.1%)	0.17-0.19	778 (80.4%)	0.16-0.19	727 (75.2%)	0.16-0.18
1.1 to 3.0	2260	0.41-0.44	1864 (82.5%)	0.41-0.44	1871 (82.9%)	0.41-0.44	1759 (77.8%)	0.41-0.44
3.1 to 6.0	1204	0.21-0.24	1019 (84.6%)	0.22-0.24	1029 (85.5%)	0.22-0.25	982 (81.6%)	0.22-0.25
6.1 to 10.0	433	0.07-0.08	331 (76.4%)	0.06-0.08	335 (77.4%)	0.06-0.08	331 (76.4%)	0.06-0.08
> 10.0	385	0.06-0.08	311 (80.7%)	0.06-0.07	312 (81.0%)	0.06-0.07	293 (76.1%)	0.06-0.08
Maternal schooling (years)								
0	134	0.02-0.02	101 (75.4%	0.01-0.02	98 (73.1%)	0.0 1-0.02	93 (69.4%)	0.01-0.02
1 to 4	1338	0.24-0.26	1096 (81.9%)	0.23-0.26	1085 (81.1%)	0.23-0.26	1000 (74.7%)	0.23-0.26
4 to 8	2121	0.44-0.47	2050 (96.6%)	0.46-0.49	2066 (97.4%)	0.46-0.49	1952 (92.0%)	0.46-0.49
≥ 9	1350	0.24-0.26	1069 (79.2%)	0.23-0.26	1073 (79.5%)	0.23-0.26	1044 (77.3%)	0.23-0.26

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Table 2: Participant's characteristics at the ages of 11, 15 and 18 years (n= 3,528; Pelotas-Brazil).

VARIABLES	11 years		15 years		18 years	
	Girls	*Boys*	*Girls*	*Boys*	*Girls*	*Boys*
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
HbA1c (mmol/mol)	-	-	-	-	29.4 (5.6)	30.7 (6.2)*
BMI (kg/m^2)	18.5 (3.5)	18.6 (3.5)	21.6 (4.0)	21.4 (4.0)	23.4 (4.4)	23.5 (4.6)
Leisure-time physical activity (min/wk)	248.1 (387.3)	436.4 (526.0)*	248.1 (387.3)	510.7 (583.1)*	223.5 (370.8)	555.3 (658.9)*
Commuting physical activity (min/wk)	94.1 (80.0)	88.9 (71.7)*	91.9 (93.5)	85.6 (80.7)*	235.0 (398.2)	316.3 (528.3)*
Overall physical activity (min/week)	342.5 (397.4)	525.2 (533.5)*	300.1 (356.8)	596.3 (592.1)*	456.7 (572.4)	866.6 (914.1)*
Gravity acceleration (g)	-	-	-	-	35.1 (9.5)	43.6 (14.4)*
Level glucose	-	-	-	-	89.08 (18.63)	93.91 (22.64)*
Screen time (hours/weekday)	4.14 (2.53)	4.48 (2.88)*	4.86 (3.14)	5.57 (3.67)*	4.90 (3.50)	5.22 (3.89)*
Consumption of food (kcal)	-	-	-	-	2940.29 (1944.00)	3256.75 (2005.70)*

* $p<0.05$, SD- standard deviation

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Table 2: Linear regression using continuous HbA1c as the outcome variable and objectively-measured activity as the exposure variables.

	Men				Women			
	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value
Objectively-measured physical activity								
13 years (count/min)		0.890				0.285		0.188
1st tertile	31.08 (6.13)		Reference	0.922	28.30 (4.99)		Reference	
2nd tertile	30.73 (8.73)		-1.17 (-3.59; 1.24)		29.24 (4.62)		0.60 (-0.35; 1.56)	
3rd tertile	30.48 (5.75)		-0.35 (-2.74; 2.04)		29.72 (5.74)		0.59 (-0.44; 1.62)	
18 years (acc/min)		0.018				0.723		0.392
1st tertile	31.42 (5.98)		Reference	0.008	29.61 (6.40)		Reference	
2nd tertile	30.97 (6.67)		-0.63(-1.45; 0.19)		29.49 (5.02)		-0.23 (-0.84; 0.38)	
3rd tertile	30.40 (5.92)		-1.06 (-1.82; -0.27)		29.31 (5.17)		-0.30 (-1.06; 0.46)	
Objectively-measured physical activity (moderate-to-vigorous)								
13 years (count/min)		0.571				0.113		
1st tertile	30.05 (7.43)		Reference	0.628	27.47 (4.54)		Reference	0.125
2nd tertile	31.61 (9.53)		0.00 (-5.45; 5.46)		28.28 (4.86)		0.12 (-3.26; 3.50)	
3rd tertile	30.44 (5.90)		-0.53 (-5.80; 4.73)		29.69 (5.24)		1.39 (-2.01; 4.79)	
18 years (acc/min)		0.02				0.524		
1st tertile	30.86		Reference	0.170	29.42		Reference	0.496

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	Men				Women			
	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value
	(6.08)				(5.59)			
2nd tertile	31.38		0.52 (-0.32; 1.37)		29.45		-0.03 (-0.63; 0.57)	
	(6.49)				(6.06)			
3rd tertile	30.45		-0.34 (-1.13; 0.45)		29.83		0.32 (-0.43; 1.08)	
	(5.98)				(5.04)			

Adjusted for BMI, consumption of food, screen time and income at 18 years of age.

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Table 3: Linear regression using continuous HbA1c as the outcome variable and self-reported physical activity as the exposure variables.

	Men				Women			
	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value
Self-reported physical activity (leisure time)								
11 years (min/week)		0.828				0.457		0.581
< 150	30.89 (6.09)		Reference	0.779	29.40 (6.09)		Reference	
150 ; 299	30.58 (5.95)		0.00 (-0.88; 0.89)		29.34 (5.27)		0.00 (-0.68; 0.69)	
300-449	30.99 (6.20)		0.23 (-0.71; 1.17)		29.97 (5.84)		0.67 (-0.12; 1.47)	
450+	30.87 (6.25)		0.08 (-0.68; 0.85)		29.45 (5.21)		0.01 (-0.69; 0.73)	
15 years (min/week)		0.952				0.772		0.767
< 150	30.63 (6.21)		Reference	0.482	29.35 (5.40)		Reference	
150-299	30.80 (6.18)		0.12 (-0.82; 1.07)		29.49 (5.82)		0.08 (-0.58; 0.75)	
300-449	30.74 (6.08)		0.19 (-0.80; 1.19)		29.77 (5.78)		0.41 (-0.40; 1.22)	
450+	30.85 (6.25)		0.27 (-0.51; 1.05)		29.39 (5.87)		-0.00 (-0.70; 0.70)	
18 years (min/week)		0.395				0.971		0.879
< 150	30.92 (6.29)		Reference	0.748	29.45 (5.64)		Reference	
150-299	30.07 (5.38)		-0.75 (-1.85; 0.35)		29.53 (5.96)		0.01 (-0.72; 0.75)	

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	Men				Women			
	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value
300-449	30.91 (6.28)		-0.06 (-1.14; 1.00)		29.50 (5.77)		0.17 (-0.644; 0.98)	
450+	30.80 (6.27)		-0.10 (-0.96; 0.70)		29.37 (5.40)		-0.07 (-0.70; 0.55)	

Adjusted for BMI, income, consumption of food, screen time and income at 18 years of age.

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Table 4: Linear regression using continuous HbA1c as the outcome variables and trajectories of objectively-measured and self-reported physical activity (cut-off point of 420min/week) as the exposure variables.

Physical activity	Men				Women			
	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value
Leisure Time								
Always Inactive	30.83 (6.01)	0.116	Reference	0.615	29.54 (5.88)	0.732	Reference	0.435
1	30.83 (6.01)		-0.00 (-0.97; 0.96)		29.74 (5.01)		0.20 (-0.63; 1.04)	
2	30.41 (5.43)		-0.42 (-1.42; 0.57)		29.80 (6.47)		0.26 (-0.68; 1.22)	
3	31.33 (6.77)		0.49 (-0.51; 1.50)		28.13 (4.63)		-1.40 (-3.03; 0.22)	
4	29.64 (6.26)		-1.19 (-2.29; -0.09)		29.26 (5.08)		-0.27 (-1.12; 0.57)	
5	31.40 (7.44)		0.56 (-0.59; 1.72)		29.67 (5.01)		0.13 (-1.27; 1.54)	
6	31.41 (5.80)		0.58 (-0.61; 1.77)		29.09 (5.65)		-0.44 (-2.05; 1.16)	
Always Active	30.84 (5.66)		0.00 (-1.07; 1.09)		29.38 (5.26)		-0.16 (-2.61; 2.29)	
Transportation								
Always Inactive	30.94 (6.05)	0.612	Reference	0.137	29.38 (5.63)	0.595	Reference	0.101
1	30.39 (6.70)		-0.55 (-1.25; 0.15)		29.78 (5.69)		0.39 (-0.32; 1.12)	
2	31.5 (6.33)		0.63 (-4.80; 6.08)		30.71 (6.95)		1.32 (-2.18; 4.83)	
3	27.87 (0)		-3.07 (-15.24; 9.08)		27.32 (2.31)		-2.06 (-9.89; 5.77)	

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Physical activity	Men				Women			
	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value	HbA1c Mean (SD)	p value	β adjusted (95% CI)	p value
4	30.05 (0)		-0.89 (-13.05; 11.26)		33.11 (4.26)		3.73 (-1.23; 8.69)	
5								
6								
Always Active								
Overall physical activity								
Always Inactive	30.75 (5.88)	0.241	Reference	0.241	29.60 (5.99)	0.378	Reference	0.378
Always Active	31.39 (6.39)		0.64 (-0.43; 1.71)		30.42 (5.54)		0.71 (-0.87; 2.29)	

0- always inactive; 1- 11 inactive, 15 inactive and 18 active; 2- 11 inactive, 15 active and 18 inactive; 3- 11 inactive, 15 active and 18 active; 4- 11 active, 15 inactive and 18 inactive; 5- 11 active, 15 inactive and 18 active; 6- 11 active, 15 active and 18 inactive and 7- always active.