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Maternal body mass index, change in weight status from childhood to late adulthood and physical activity in older age

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Abstract

This study aimed to examine the longitudinal associations of maternal body mass index (BMI), weight status in childhood and late adulthood and device-measured total physical activity (TPA) in older age.

The study involves 552 participants from Helsinki Birth Cohort Study who were born in Helsinki, Finland in 1934–1944. TPA was measured with a multisensory body monitor at a mean age of 70 years and expressed in metabolic equivalent of task-hours/day (METh/d). Childhood overweight (BMI >85th percentile) was based on school health records at 6-7 years of age and late adulthood overweight (BMI ≥25 kg/m^2) was based on clinical measurements at the mean age of 61 years.

Childhood overweight was associated with lower TPA, particularly in older women (mean difference -3.2 METh/d, 95% confidence interval (CI) -4.6– -1.9), and late adulthood overweight was associated with lower TPA both in older women (mean difference -6.2, 95% CI (-7.2– -5.1) and in older men (mean difference -2.6 METh/d, 95% CI -3.7 – -1.5). TPA in older age was highest in participants who were normal weight both in childhood and adulthood and lowest in participants who were overweight in childhood and adulthood. In participants with childhood overweight, TPA was lower in participants who were overweight in childhood and adulthood, compared to those who were overweight only in childhood. There was a U-shaped distribution of TPA according to maternal BMI in older women (p=0.002), but not in older men.

In conclusion, reaching normal weight after childhood predicted higher physical activity levels in older age.

Keywords: Physical activity, overweight, obesity, maternal obesity

Introduction

Physical activity is associated with well-recognized health benefits, such as a reduced risk of type 2 diabetes, cardiovascular mortality and all-cause mortality[1,2]. In older people, physical activity reduces the risk of functional limitations and cognitive impairment, which consequently improves independence and quality of life[3-5]. The recommended weekly amount of physical activity in older people is at least 150 minutes of moderate intensity aerobic physical activity or at least 75 minutes of vigorous intensity aerobic physical activity or an equivalent combination of the two[6]. Nevertheless, despite the well-known health benefits, over a quarter of adults globally were insufficiently physically active in 2016 when assessed according to the World Health Organization (WHO) recommendations[7].

In cross-sectional studies, physical inactivity has been strongly linked to overweight and obesity [8]. Exercise interventions, however, seem to have only a modest effect on weight reduction[9]. Moreover, longitudinal studies have shown that obesity and weight gain predict physical inactivity later in life[10-12]. The causality between overweight and physical activity may, thus, be reciprocal. To the best of our knowledge, no studies have investigated the association between overweight and physical activity from a life-course perspective. Furthermore, most studies on overweight and physical activity used self-reported information on physical activity[11,12]. While, self-administered questionnaires are a cost effective and easy way to retrieve information on physical activity levels, they are generally less accurate than objective measurements, especially in estimating light to moderate intensity physical activity[13].

In addition to weight status, there are many other behavioral, demographic and biological correlates of physical activity, e.g. education, socioeconomic status, activity history, smoking, and ethnic origin [14]. Recently, developmental programming of physical activity has received increasing attention[14,15]. Developmental programming of health and disease suggests that developmental factors in early life may have long-term consequences on an individual's health[16]. Recently, maternal obesity as a determinant of offspring later health has gained increasing interest[17]. Maternal obesity has been linked to offspring overweight and obesity both in childhood and in adulthood[18,19]. Furthermore, animal studies and observational studies on children suggest that maternal obesity may be connected to lower physical activity in the offspring [20,21].

This study contributes to existing research by studying the complex associations of weight status and physical activity from a life-course perspective by using reliable measurements of weight status in childhood and late adulthood and device-measured physical activity in older age. The main aim of this study is to investigate longitudinal associations of maternal body mass index (BMI), weight status in childhood at 7 years of age and in late adulthood at 61 years of age and device-measured total physical activity in older adults at 70 years of age. In addition, we studied whether the associations between change in weight status from childhood to late adulthood and physical activity in older adults were modified by maternal BMI or by the participants smoking status, educational attainment or self-reported leisure-time physical activity (LTPA) in late adulthood.

Material and methods

This longitudinal cohort study is part of the Helsinki Birth Cohort Study (HBCS). HBCS includes 13,345 individuals who were born in one of two major maternity hospitals in Helsinki between 1934 and 1944 and who lived in Finland in 1971, when all Finnish residents received a personal social security number [22]. In years 2001-2004, a subset of randomly selected participants (n=2,691), that were still alive and lived in Finland, were invited to participate in a clinical study. Of the invited, 2,003 participated. In 2011–2013 a clinical follow-up study was conducted. Of the 2,003 individuals that had attended the first clinical examination, 151 had died, 212 had declined further participation in clinical studies and 236 lived more than 100 km from Helsinki. Consequently, 1,404 participants of the first clinical study were still traceable and invited to the second clinical study and 1,094 participants did attend [23]. Out of these participants, 552 (255 men and 297 women) had adequate data on maternal and childhood characteristics as well as device-measured physical activity and were included in this study. A comparison analysis of the analytic cohort (n=552) and the rest of the baseline cohort from the first clinical examination (n=1,451) is presented in appendix 1.

Data on offspring and maternal characteristics were collected from hospital birth records, child welfare clinic records and school healthcare records. Figure 1 shows a flowchart of the study cohort and of data collection. Maternal BMI was calculated with the formula (weight in kilograms/ (height in meters)^2 and maternal weight and height obtained from hospital birth records in late pregnancy were used. The median of maternal BMI, 26.3 kg/m^2, was used as a cutoff for high maternal BMI in this study. The collected data also included maternal parity, offspring gestational age, social class during childhood and childhood weight and height. Childhood social class was based on the fathers' occupation and the highest occupational grade was used. Participants' weight and height in childhood were measured at 6 or 7 years of age. In case of several measurements during this time period, the values measured closest to 7 years of age were used. These values were used to calculate childhood BMI with the formula (weight in kilograms/ (height in meters)^2. Childhood overweight was defined as BMI ≥ 85th percentile based on sex specific BMI-percentile in this study cohort. 85th percentile is used as a cutoff for childhood overweight in the WHO Child Growth Standards in 2007 [24].

Participants' BMI in late adulthood was calculated based on weight and height measured at the first clinical examination at mean age of 61 years. BMI ≥25.0 kg/m^2 was used as the cut-off for overweight according to the WHO guidelines [25]. Data on smoking status, educational attainment and self-reported physical activity were also retrieved at the time of the first clinical examination. Smoking status was retrieved from a clinical questionnaire and divided into two categories, never smoked or smoked at some point, either at the time or previously. Educational attainment was based on years of education and retrieved from a clinical questionnaire and divided dichotomously with ten years of studying as a cutoff. Self-reported LTPA was assessed at the first clinical examination with the Kuopio Ischemic Heart Disease (KIHD) 12-month history questionnaire. The questionnaire includes questions about duration, frequency and intensity of LTPA and it has been validated in a middle-aged Finnish population [26]. The data was used to evaluate metabolic equivalent of task (MET) hours/day (METh/d). Self-reported LTPA was divided into two equally large groups with the median, 35.4 METh/d as cutoff.

Total physical activity (TPA) was measured in 2012–2013 with a multisensory body monitor SenseWear Pro 3 Armband (SWA) (BodyMedia, Inc., Pittsburg, PA, USA). The SWA has been found to accurately estimate energy expenditure in older people in free-living conditions [27].The SWA is worn on the right upper arm over the triceps. It measures a variety of parameters, including biaxial acceleration, heat flux, skin temperature, near-body temperature and galvanic skin reaction. Participants were advised to wear the SWA for ten consecutive days, even during sleep, and to remove the SWA only when showering, swimming or bathing. In this study, participants who had sufficient data from the SWA for at least four weekdays and one day during the weekend were included. If the participant had more than 5 days of valid data, the days with the highest amount of data, i.e. the most measured minutes, were chosen. A day with valid data was defined as at least 1296 minutes of data, which equals 90% of a whole 24-hour period. To standardize the measurement period to 24 hours a day, one MET, which corresponds to the metabolic rate of sitting at rest, was added for every missing minute. The collected data was analyzed by Innerview Sensewear Professional Software (version 6.1). Data was converted into METh/d. Reaching the recommended amount of physical activity was defined as having engaged daily in at least 30 minutes of moderate to vigorous intensity physical activity during a period of five days, which results in the weekly recommended amount of at least 150 minutes of moderate intensity aerobic physical [6]. Moderate to vigorous intensity physical activity was defined as physical activity with an intensity at least 3.0 MET [28].

Main chronic diseases were asked during the second clinical examination and this data was used to calculate a variable for chronic disease load. Diseases included were hypertension, heart failure, coronary heart disease, stroke, cancer, diabetes, bronchial asthma and chronic obstructive lung disease. The data was categorized into three categories; no chronic diseases, one chronic disease and two or more chronic diseases.

The Ethics Committee of Hospital District of Helsinki and Uusimaa approved the study protocol. All participants gave a written informed consent and the study was conducted according to the Declaration of Helsinki guidelines.

Statistical analyses

Maternal and participant characteristics were reported as means and standard deviations or number and percentages.

General linear models were used in the main analyses. Firstly, the associations between maternal BMI and offspring TPA in older age, between childhood overweight and TPA in older age and between overweight in late adulthood and TPA in older age were assessed. The associations of maternal BMI and offspring TPA were assessed with maternal BMI as a continuous variable and with the median of maternal BMI as a cutoff. Analyses were conducted for both sexes combined and separately for men and women.

Secondly, we assessed whether a change in weight status from childhood (7 years of age) to late adulthood (61 years of age) was associated with TPA in older age (70 years of age). Participants were divided in four groups. Group 1 included participants who were normal weight in childhood and in late adulthood (n=165). Group 2 included participants who were overweight in childhood but were normal weight in late adulthood (n=14). Group 3 included participants who were normal weight in childhood but overweight in late adulthood (n=306) and group 4 included participants who were overweight at in childhood and late adulthood (n=67).

Further, we analyzed whether high maternal BMI, childhood overweight, late adulthood overweight or change in weight status were associated with performing moderate to vigorous intensity (≥ 3 METs) physical activities for at least 30 minutes for 5 days in older age.

Lastly, the associations between change in weight status and TPA in older age were analyzed separately according to maternal BMI, smoking status, educational attainment and self-reported LTPA at mean age of 61 years. Interaction analyses were also performed for maternal BMI, smoking status, educational attainment, self-reported LTPA at 61 years of age and the associations between change in weight status and physical activity in older age.

The analyses were adjusted for gestational age, parity, childhood social class, age at second clinical examination, follow-up time from first clinical examination to TPA measurement, month of TPA measurement, smoking status, chronic diseases and sex in the analyses with both sexes combined. We applied bootstrap style analyses in the case of not meeting the model assumptions (e.g. normal distribution). A threshold for statistical significance was set at P-value <0.05. All analyses were performed with Stata/MP 15.1 (StataCorp, 4905 Lakeway Dr, College Station, TX 77845, USA).

Results

Maternal and participant characteristics according to change in weight status from childhood (7 years) to late adulthood (61 years) are shown in Table 1.

Table 2 describes TPA in older age as METh/d according to high maternal BMI, childhood overweight and late adulthood overweight. High maternal BMI was not associated with TPA in older aged offspring in the analyses with median maternal BMI used as cutoff. However, when using maternal BMI as a continuous variable, there was a slightly u-shaped association between maternal BMI and offspring TPA in older aged women (p=0.002), but no association in men (p=0.97) (appendix 2). There was an inverse association between childhood overweight and TPA in older age (mean difference for both sexes combined -1.8 METh/d (95% confidence interval (CI) -2.7– 0.9). The association was statistically significant in women (mean difference -3.2 METh/d, 95% CI -4.6– -1.9) but not in men (mean difference -0.3 METh/d, 95% CI -1.5– 0.9). Overweight in late adulthood was associated with lower TPA in older age. Mean TPA was 28.0 METh/d in participants with overweight in late adulthood compared to 32.5 METh/d in normal weight participants (mean difference -4.6 METh/d, 95% CI -5.4– -3.8). The association was apparent both in women (mean difference -6.2 METh/d, 95% CI -7.2– -5.1) and in men (mean difference -2.6 METh/d, 95% CI -3.7– -1.5).

Figure 2 describes changes in weight status from childhood to late adulthood and TPA in older age. TPA was highest in those older people who were normal weight both in childhood and in late adulthood. In participants with overweight only in childhood, mean TPA in older age was lower compared to participants who had not been overweight ($p=0.002$). Overweight only in late adulthood and overweight both in childhood and late adulthood were associated with a lower TPA in older age compared to those who were not overweight at either time points (both $p<0.001$ respectively). TPA was significantly lower in those older people who were overweight both in childhood and late adulthood compared to those who were overweight only in childhood.

51.2% of men and 40.4% of women in this study reached TPA levels of at least 30 minutes of moderate to vigorous physical activity for five days ($p=0.013$). Table 3 describes odds ratios (OR) for reaching the recommended amount of TPA in older age according to high maternal BMI, childhood overweight, late adulthood overweight and change in weight status. High maternal BMI was not associated with reaching the recommended amount of TPA in older aged offspring (OR 0.90, 95% CI 0.62-1.30). Both childhood overweight (OR 0.53, 95% CI 0.31–0.91) and adulthood overweight (OR 0.30, 95% CI 0.20–0.46) lowered the odds of reaching the recommended amount of TPA in older age. In analyses with changes in weight status, the group with normal weight in childhood and adulthood was used as a reference. The odds of reaching the recommended amount of TPA were lower both in the group with overweight only in adulthood (OR 0.32, 95% CI 0.21–0.49) and in the group with overweight in childhood and adulthood (OR 0.25, 95% CI 0.13–0.49). Overweight only in childhood was not associated with reaching the recommended amount of TPA in older age.

Figure 3 shows changes of weight status and TPA in older age according to maternal BMI. Maternal BMI did not modify the association of changes in weight status and physical activity in older age (p for interaction=0.74). Furthermore, the association between change in weight status and physical activity at mean age of 70 years was not modified by smoking status (p for interaction=0.22), educational attainment (p for interaction=0.18) or self-reported LTPA (p for interaction=0.83) at the mean age of 61 years.

Discussion

We have studied the associations between maternal BMI, weight status in childhood and late adulthood and physical activity in older age by using longitudinal data from the HBCS. Childhood overweight was associated with lower levels of TPA in older age, especially in women, and the association was significant even if the participants reached normal weight before late adulthood. Of the 81 participants who were overweight in childhood, only 14 were, however, able to reach normal weight in late adulthood. Furthermore, participants who were overweight only in childhood had higher TPA levels in older age than participants who were overweight both in childhood and late adulthood These findings emphasize the importance of weight control in children and young adults as a mean of improving physical activity in older age.

Overweight in late adulthood predicted lower physical activity levels and lower odds of reaching the recommended amount of physical activity in older age. These findings are in line with previous prospective studies[10,11]. As a potential mechanism, overweight and obesity may cause discomfort, such as musculoskeletal pain and dyspnea, which in turn result in lower levels of physical activity[29,30]. Overweight also increases the energy expenditure required to complete a certain activity, which might contribute to lower amount of time spent in physical activity [31]. Notably, physical inactivity has also been recognized as a risk factor for overweight and obesity and the causal relationship of overweight and physical activity may, thus, be bidirectional [8]. This particular study adds to pre-existing research on weight status and physical activity by studying these associations in a cohort with a long follow-up time, reliable clinical measurements of childhood and late adulthood weight status and device-measured physical activity in older age. Increased knowledge in the associations of weight status and physical activity may help to improve clinical strategies in promoting weight control and physical activity. In future research, the longitudinal associations of weight status with specific intensities and types of physical activity should be studied in order to provide more detailed information for the physical activity recommendations.

There is limited research on the associations of life-course weight patterns and later health and diseases. A recent large-scale longitudinal cohort study from Denmark studied how a remission of overweight from childhood to early adulthood affected risk of type 2 diabetes. The authors reported that overweight in childhood was associated with a higher risk of type 2 diabetes only if the overweight persisted into adulthood.[32] Education, leisure time physical activity and smoking did not modify the results [33]. Likewise, in the present study, education, smoking status and self-reported LTPA did not modify the association between change in weight status from childhood to late adulthood and TPA in older age.

We found a slightly U-shaped association between maternal BMI and offspring physical activity in older women, although the limited number of participants with high maternal BMI limit the interpretation of the findings. There was no association between maternal BMI and offspring physical activity in men. Maternal BMI did not modify the association between change in weight status and physical activity. Some animal studies and observational studies in children have reported an association between maternal adiposity and offspring physical activity, while others have not found an association [20,21,34]. Maternal adiposity seems to alter offspring later health, at least in part, through epigenetic programming [17]. Maternal obesity has been found to alter hypothalamic feeding circuits and to increase leptin resistance in the hypothalamus [35]. In studies on rodents, these changes have led to lower physical activity [36].

This study has several strengths. Physical activity was device-measured instead of being based on self-administered questionnaires. The correlation between objectively-measured and self-reported physical activity varies, but is generally low to moderate [37]. Body-worn monitoring devices give a more reliable estimation of physical activity especially in older participants, since older participants are less physically active overall and because the physical activity they attend is generally lower in intensity, which is often inaccurately measured by questionnaires [38]. The analyses were based on 5 monitored days, including at least one weekend day, and the SWA was worn at least 90% of the time each day. In older adults, 3-4 days of monitoring with a wearable device or an activity log have been found to accurately estimate PA [39]. A high SWA wear time was chosen because a low accelerometer wear time has been found to cause bias [40]. Another strength is an exceptionally long follow-up period. A follow-up period of 73 years enables us to study changes in participants' health from birth to late in life. Furthermore, maternal, neonatal and childhood characteristics were obtained from reliable sources; hospital birth records, child healthcare records and school health records. Thorough clinical examinations at two time points in late adulthood provide trustworthy data and allow us to study changes in health in late adulthood.

The study also has some limitations. We do not have information about the participants in early- or mid-adulthood and we were consequently unable to consider any changes in weight status during that time. We used sample-specific cut points for childhood overweight because overweight was not as common in the 1930s and 1940s as it is today and because there were no accepted definitions for overweight and obesity in children at the time. The sample specific cut points for childhood overweight do, however, limit the repeatability of the study. Further, we do not possess information about participants' physical activity earlier in life and are thus unable to study changes in physical activity. The limited amount of data inhibited us from studying the more detailed associations of weight status with specific intensities and types of physical activity. As this study was observational, causality cannot be inferred. Moreover, we cannot tell whether overweight in adulthood may at least partly be a consequence of low physical activity.

In conclusion, we have studied the longitudinal associations of maternal BMI, childhood and late adulthood overweight and device-measured physical activity in older men and women. Our main finding was that overweight in childhood, especially in women, was associated with lower physical activity in older age and that, in participants with childhood overweight, reaching normal weight after childhood was associated with a higher level of physical activity in older age. A remission of overweight after childhood was, however, quite rare. As the causal relationship of overweight and physical activity is likely to be reciprocal, an increased focus on weight control in overweight children could, consequently, improve physical activity in older people and, in turn, contribute to improved weight control and active aging.

Perspective

Physical activity decreases the risk of several noncommunicable diseases [1,2]. Despite its acknowledged health-benefits, a fourth of all adults are physically inactive [7].

Overweight and obesity are linked to physical activity and the causality may be bidirectional. The current study adds to existing research by studying the longitudinal associations of maternal BMI, childhood and late adulthood weight status and physical activity in older age in a cohort with a long follow-up period, clinical measurements of weight in childhood and late adulthood and device-measured physical activity in older adults. The main finding was that childhood overweight, particularly in women, was associated with lower physical activity in older age and that reaching a normal weight after childhood was associated with higher physical activity level in older age. The findings emphasize the benefit of weight loss and maintenance of normal weight.

Maternal obesity may be linked to lower physical activity in the offspring in childhood [21]. We found a slightly U-shaped association between maternal BMI and offspring physical activity in older women, while there was no association in men. Furthermore, the associations of changes in weight status and physical activity in older age were not modified by maternal BMI.

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Table 1. Maternal and participant characteristics according to change in weight status from childhood (7 years) to late adulthood (61 years). Data reported as mean and standard deviations (SD) or number (n) and percentages (%).

	Not overweight in childhood or adulthood (n=168)		**Overweight only in childhood (n=14)**		**Overweight only in adulthood (n=309)**		**Overweight in childhood and adulthood (n=69)**		**P for difference between groups**
Maternal	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	
Overweight, n (%)	87	(51.8)	6	(42.9)	148	(47.9)	43	(62.3)	0.16
Parity	2.0	(1.3)	1.6	(0.7)	1.9	(1.1)	2.0	(1.2)	0.69
Neonatal									
Female, n (%)	104	(61.9)	8	(57.1)	153	(49.5)	37	(53.6)	0.076
Gestational age, days	279.3	(14.1)	277.6	(8.9)	279.9	(13.8)	279.1	(13.2)	0.88
Childhood									
BMI† at age 7, kg/m²	15.0	(0.9)	18.0	(2.0)	15.3	(0.8)	17.5	(0.8)	<0.001
Childhood SES‡, n									0.96
Highest	25		2		43		9		
Middle	39		2		64		17		
Lowest	103		10		202		42		
Adulthood									
BMI at age 61, kg/m²	23.0	(1.5)	24.0	(0.8)	29.1	(3.6)	30.2	(4.1)	<0.001
Smoking, n (%)	94/167	(56.2)	8	(57.1)	155/307	(50.5)	34/68	50.0%	0.63
Time from first clinical examination to PA§ measurements, years	9.8	(0.9)	9.9	(0.8)	9.8	(0.9)	9.8	(0.8)	0.85
Age at PA	70.6	(2.6)	69.7	(1.6)	70.9	(2.8)	70.0	(1.6)	0.017

measurements, years									

†Body Mass Index

‡Socioeconomic status

§Physical activity

Table 2. Total physical activity in older age (70 years) in metabolic equivalent of task-hours/day (METh/d) according to maternal body mass index (BMI,) childhood BMI at 7 years of age and late adulthood BMI at 61 years of age. Values are presented as means, standard error (SE), mean difference and 95% confidence interval (95% CI). Models are adjusted for gestational age, parity, childhood social class, age at second clinical examination, follow-up time from first clinical examination to total physical activity (TPA) measurement, month of TPA measurement, smoking status, chronic diseases and and sex in the analyses with both sexes combined.

	Total physical activity (METh/d)				
Variable	**Mean (SE)**		**Mean difference (95% CI)**		**p**
High maternal BMI					
All					
No	29.6	(0.3)	-0.3	(-1.1–0.5)	0.41
Yes	29.3	(0.3)			
Women					
No	28.5	(0.4)	0.3	(-0.9–1.4)	0.65
Yes	28.8	(0.4)			
Men					
No	30.9	(0.4)	-1.0	(-2.0–0.06)	0.066
Yes	29.9	(0.4)			
Childhood overweight					
All					
No	29.7	(0.2)	-1.8	(-2.7– -0.9)	0.001
Yes	27.9	(0.5)			
Women					
No	29.1	(0.3)	-3.2	(-4.6– -1.9)	<0.001
Yes	25.9	(0.6)			
Men					
No	30.5	(0.3)	-0.3	(-1.5–0.9)	0.65
Yes	30.2	(0.5)			
Adulthood overweight					
All					

No	32.5	(0.3)	-4.6	(-5.4– -3.8)	<0.001
Yes	28.0	(0.2)			
Women					
No	32.5	(0.5)	-6.2	(-7.2– -5.1)	<0.001
Yes	26.4	(0.3)			
Men					
No	32.3	(0.5)	-2.6	(-3.7– -1.5)	<0.001
Yes	29.7	(0.3)			

Table 3. Odds ratio (OR) and 95% confidence interval (95% CI) for performing moderate to vigorous intensity (≥ 3 METs) physical activities for at least 30 minutes for 5 days according to high maternal body mass index (BMI,) childhood overweight at 7 years of age, late adulthood overweight at 61 years of age and change in weight status. Adjusted for sex, gestational age, parity, childhood social class, age at second clinical examination, follow-up time from first clinical examination to total physical activity (TPA) measurement, month of TPA measurement, smoking status and chronic diseases.

Variable	OR	(95% CI)	p
High maternal BMI			
No	Ref.		
Yes	0.90	(0.62 – 1.30)	0.57
Childhood overweight			
No	Ref.		
Yes	0.53	(0.31–0.91)	0.021
Adulthood overweight			
No	Ref.		
Yes	0.30	(0.20 – 0.46)	<0.001
Change in weight status			
Not overweight in childhood or adulthood	Ref.		
Overweight only in childhood	0.31	(0.08–1.15)	0.081
Overweight only in adulthood	0.32	(0.21 – 0.49)	<0.001
Overweight in childhood and adulthood	0.25	(0.13 – 0.49)	<0.001

Figure 1. Flowchart of the study cohort and data collection.

Figure 2. Change in overweight from childhood (7 years) to late adulthood (61 years) and mean total physical activity (TPA) in metabolic equivalent of task-hours/day (METh/d) in older age (70 years). P value for difference in TPA compared to the normal weight-group. Adjusted for sex, gestational age, parity, childhood social class, age at second clinical examination, follow-up time from first clinical examination to TPA measurement, month of TPA measurement, smoking status and chronic diseases.

Figure 3. Change in overweight from childhood (7 years) to late adulthood (61 years) and mean total physical activity (TPA) in metabolic equivalent of task-hours/day (METh/d) in older age (70 years), according to maternal body mass index (BMI). Adjusted for sex, gestational age, parity, childhood social class, age at second clinical examination, follow-up time from first clinical examination to TPA measurement, month of TPA measurement, smoking status and chronic diseases.

Appendix 1. Comparison analysis of the analytic cohort (n=552) and the rest of the baseline cohort from the first clinical examination (n=1,451). Data reported as mean and standard deviations (SD) or number (n) and percentages (%).

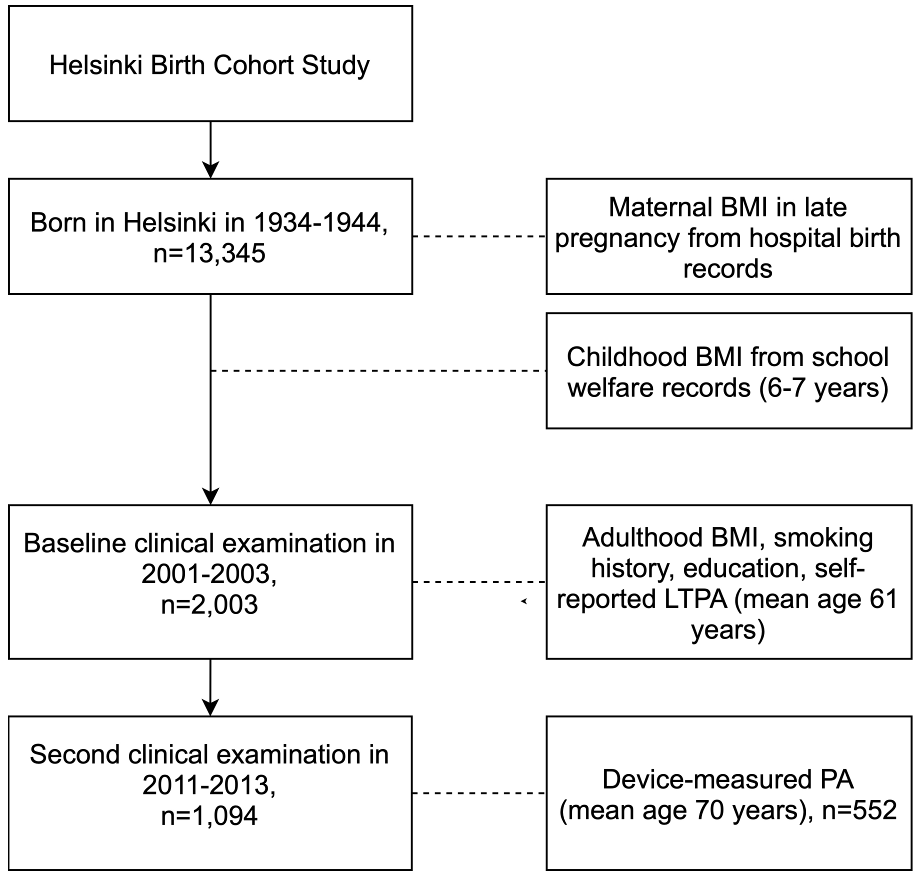
	Analytic cohort, n=552	**Baseline cohort from first clinical examination (excluding analytic cohort), n=1,451**	**P for difference between groups**
	Mean or n (SD or %)	Mean or n (SD or %)	
Maternal			
BMI†, kg/m^2	26.6	26.5	0.40
Parity	1.9 (1.3)	2.0 (1.2)	0.79
Neonatal			
Female, n (%)	297/552 (53.8%)	778/1,451 (53.6%)	0.96
Gestational age, days	279.6	279.3	0.67
Childhood			
BMI† at age 7, kg/m^2	15.6 (1.4)	15.7 (1.3)	0.41
Childhood SES‡, n (%)	n=552	n=1,437	0.059
Highest	79 (14.3%)	264 (18.4%)	
Middle	122 (22.1%)	331 (23.0%)	
Lowest	351 (63.6%)	842 (58.6%)	
Adulthood			
BMI† at age 61, kg/m^2	27.3	27.8	0.046
Smoking, n (%)	290/552	721/1,193	0.002

	(52.5%)	(60.4%)	

†Body Mass Index

‡Socioeconomic status

Appendix 2. The association between maternal body mass index (BMI) in late pregnancy and offspring total physical activity (TPA) at the age of 70 year. Adjusted for sex, gestational age, parity, childhood social class, age at second clinical examination, follow-up time from first clinical examination to TPA measurement, month of TPA measurement, smoking status and chronic diseases.



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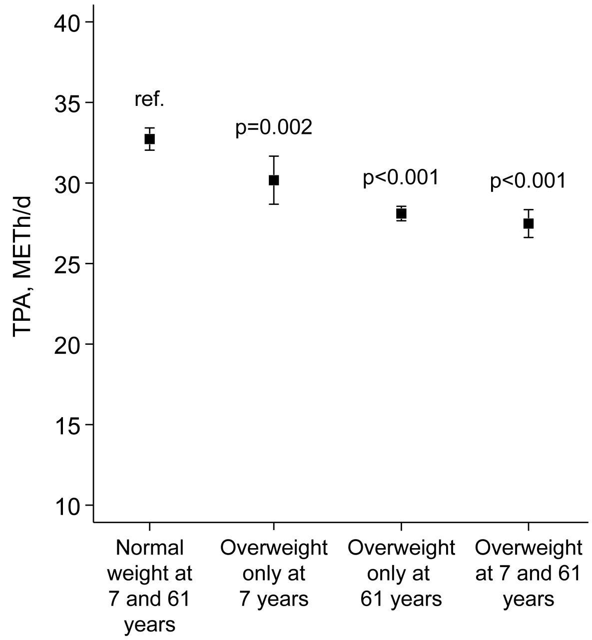

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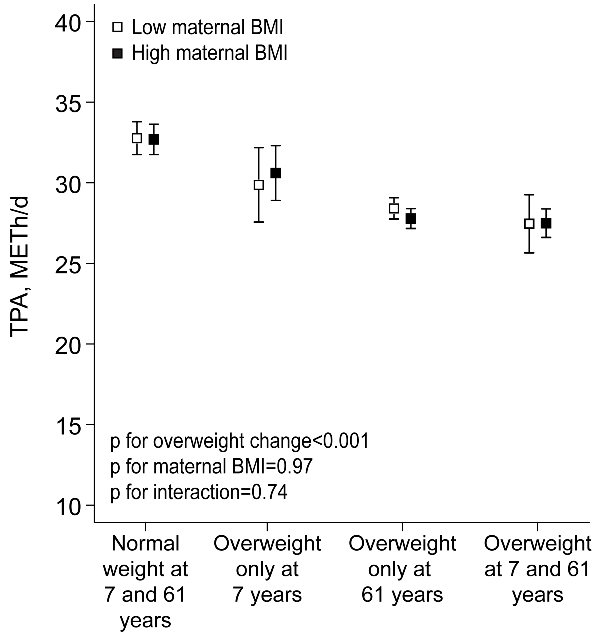

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