ORIGINAL ARTICLES

Leisure Time Physical Activity in Young Adults Born Preterm

Marjaana Tikanmäki, MD[1,2], Nina Kaseva, MD, PhD[1], Tuija Tammelin, PhD[3], Marika Sipola-Leppänen, MD, PhD[1,2,4], Hanna-Maria Matinolli, MHealthSci[1,2], Johan G. Eriksson, MD, DMSc[1,5,6], Marjo-Riitta Järvelin, MD, PhD[7,8,9,10], Marja Vääräsmäki, MD, PhD[4,11], and Eero Kajantie, MD, PhD[1,4,12]

Objective To evaluate the amount of self-reported physical activity in young adults born prematurely compared with those born at term.

Study design Unimpaired participants of the Preterm Birth Study (Preterm Birth and Early Life Programming of Adult Health and Disease) birth cohort study were studied at age 23.3 ± 1.2 (SD) years: 118 born early preterm (<34 weeks), 210 late preterm (34-36 weeks), and 311 born at term (≥37 weeks, controls). The participants completed a validated 30-item, 12-month physical activity questionnaire. The annual frequency and total volume of conditioning and nonconditioning leisure time physical activity and commuting physical activity were calculated and the data analyzed by means of linear regression.

Results Adults born early preterm reported a 31.5% (95% CI, 17.4-43.2) lower volume of leisure time physical activity (in metabolic equivalents [MET] h/year) and had a 2.0-fold increased OR (1.2-3.3) of being in the least active quintile than controls. Lower amounts of conditioning, nonconditioning, and commuting physical activity all contributed to the difference. In addition, early preterm participants undertook less vigorous physical activity (≥6 MET). No differences in physical activity were found between the late preterm and control groups. Adjustments for potential early life confounders and current mediating health characteristics did not change the results.

Conclusions Young adults born early preterm engage less in leisure time physical activities than peers born at term. This finding may in part underlie the increased risk factors of cardiometabolic and other noncommunicable diseases in adults born preterm. Low physical activity is a risk factor for several noncommunicable diseases and amenable to prevention. *(J Pediatr 2017;189:135-42).*

Every year, approximately 14.9 million infants worldwide (11% of all newborns) are born preterm (<37 weeks of gestation).[1] There is extensive evidence that preterm adults born at a very low birth weight (VLBW; <1500 g) or extremely low birth weight (ELBW; <1000 g) have higher levels of risk factors for chronic noncommunicable disease, including higher blood pressure, impaired glucose regulation, lower bone mineral density, and obstructive airflow.[2-5] However, these individuals constitute only a small proportion of all preterm infants. Of all preterm infants in the United States, for example, 70% are born late preterm, between 34 and 36 weeks of gestation.[6] Recent evidence suggests that many of these adverse consequences of preterm birth are present in those born late preterm and increase with the degree of prematurity.[5,7,8]

Physical inactivity is related to increased levels of risk factors for noncommunicable disease and this could in part explain them in those born preterm. Studies among children and adolescents born extremely preterm (≤28 weeks or ≤1000 g)[9,10] or with ELBW[11] or VLBW[12] suggest lower reported levels of physical activity compared with those born at term or of normal birth weight. However, some small studies among VLBW or preterm children have revealed no differences.[13,14] Adolescents and adults born preterm with VLBW or ELBW report substantially lower amounts of physical activity[15,16] and have lower levels of cardiorespiratory and muscular fitness.[12,17] We recently showed that lower fitness is also seen among the much

ELBW	Extremely low birth weight
ESTER	ESTER Preterm Birth Study (Preterm Birth and Early Life Programming of Adult Health and Disease)
GSD	Geometric standard deviation
MET	Metabolic equivalent
SGA	Small for gestational age
VLBW	Very low birth weight

From the [1]Chronic Disease Prevention Unit, Department of Health, National Institute for Health and Welfare, Oulu, Helsinki; [2]Institute of Health Sciences, University of Oulu, Oulu; [3]LIKES Research Center for Physical Activity and Health, Jyväskylä; [4]PEDEGO Research Unit (Research Unit for Pediatrics, Dermatology, Clinical Genetics, Obstetrics and Gynecology), Medical Research Center Oulu (MRC Oulu), Oulu University Hospital and University of Oulu, Oulu; [5]Department of General Practice and Primary Health Care, University of Helsinki and Helsinki University Hospital; [6]Health Research Center, Helsinki, Finland; [7]Department of Epidemiology and Biostatistics, MRC–PHE Center for Environment & Health, School of Public Health, Imperial College London, United Kingdom; [8]Center for Life Course Epidemiology, Faculty of Medicine, University of Oulu; [9]Biocenter Oulu; [10]Unit of Primary Care, Oulu University Hospital; [11]Children, Adolescents and Families Unit, Department of Welfare, National Institute for Health and Welfare, Oulu; and [12]Children's Hospital, Helsinki University Hospital, University of Helsinki, Helsinki, Finland

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larger group of early (<34 weeks) and young adults who were born late preterm.[18] Whether these adults actually perform less physical activity is uncertain.

We studied self-reported physical activity in unimpaired young adults born at early or late preterm gestational ages. We hypothesized that preterm young adults would report less physical activity than young adults who were born at term. We also hypothesized that lower physical activity among those born prematurely would not be fully explained by conditions underlying preterm birth.

Methods

The Preterm Birth and Early-Life Programming of Adult Health and Disease (ESTER) Preterm Birth Study involves 1890 young adults recruited through the Northern Finland Birth Cohort 1986 (born in 1985-1986; 49.8%) and via the Finnish Medical Birth Register (born in 1987-1989; 50.2%).[8] In 2009-2011, 753 individuals with verified durations of gestation participated in a clinical study at 23.3 ± 1.2 (SD) years of age.[19] After exclusions (**Figure 1**), 118 participants born early preterm, 210 born late preterm, and 311 controls born at term (≥37 weeks) were unimpaired (no mental or physical disability), nonpregnant, and had complete data on self-reported physical activity.

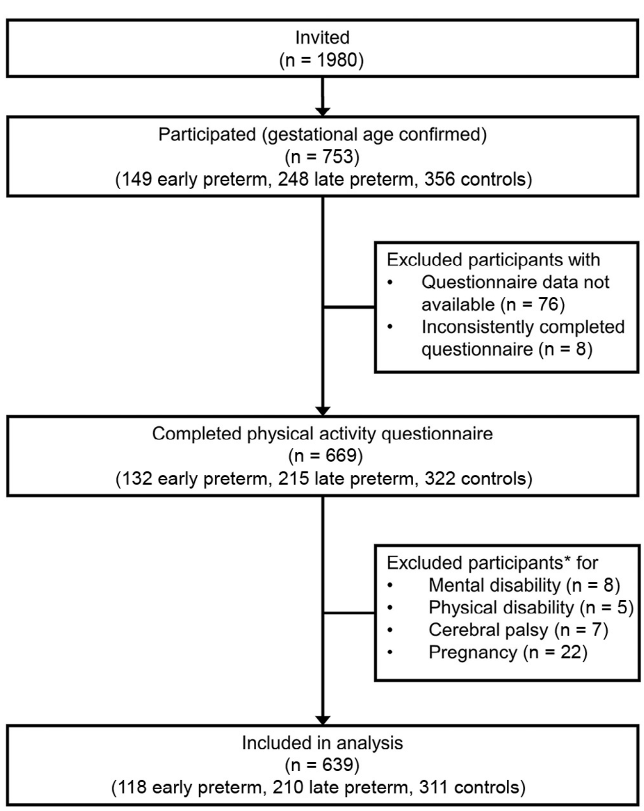

Figure 1. Flow chart of the study population. Early preterm is <34 gestational weeks; late preterm is 34-36 gestational weeks. *One person can have >1 reason for exclusion.

This study was approved by the Coordinating Ethics Committee at Helsinki and Uusimaa Hospital District. The participants provided a signed informed consent document.

For participants recruited through the Northern Finland Birth Cohort 1986, perinatal data were collected previously.[20] Corresponding data from hospital and maternal welfare clinic records were obtained for those invited through the Finnish Medical Birth Register. Through these data, the duration of gestation was confirmed (determined by ultrasonography in 62.7% and 53.1% of preterm infants and controls, respectively).[8,19] The study groups were defined by the duration of gestation as early preterm (<34 weeks), late preterm (34-36 weeks), and controls born at term (≥37 weeks). Diagnoses of maternal gestational diabetes, hypertension (gestational or chronic), or preeclampsia (including superimposed) were confirmed according to prevailing criteria.[21,22] Small for gestational age (SGA) was defined as a birth weight of >2 SD below the mean for gestational age.[23]

The mean of 3 measurements was calculated for height. Body weight and composition were assessed using segmental multifrequency bioelectrical impedance equipment (InBody 3.0, Biospace Co, Seoul, South Korea). Medical history, medication, socioeconomic status, and lifestyle data were collected via questionnaires. Childhood socioeconomic status was assessed as the education level of the more highly educated parent.[8]

Self-Reported Physical Activity

During the visit to the research clinic, the participants completed the modified Kuopio Ischemic Heart Disease Risk Factor Study questionnaire for detailed assessment of 12-month physical activity history.[24] The reproducibility and validity of the questionnaire have been confirmed.[16,25-28] The questionnaire comprises a 30-item list of types of physical activity, including conditioning leisure time physical activity (20 items; eg, running, skiing, swimming), nonconditioning leisure time physical activity (8 items; eg, household work, gardening, shoveling snow), physical activity from commuting to work (walking or cycling), and a category for other physical activity specified by the participant. The participants reported the monthly frequency and duration of each physical activity session for the previous 12 months and rated the average intensity of activities on a scale of 0 to 3 (0 = light, 1 = moderate, 2 = strenuous, 3 = very strenuous).

Data Analysis

The self-reported monthly frequency of physical activity was converted into times/year, and the average duration of each physical activity session was summed and converted into hours/year. The self-rated average physical activity intensities were converted into metabolic equivalents (METs) using the Compendium of Physical Activities.[29] An intensity of 1 MET corresponds with an energy expenditure of 1 kcal/kg/hour, equivalent to the energy cost of sitting quietly. The total volume of physical activity in conditioning and nonconditioning leisure time physical activity and commuting physical activity were calculated separately and summed as the total volume of leisure time physical activity (MET hours/year). The total amount of vigorous intensity physical activity (≥6 MET) was calculated per year in conditioning, nonconditioning, and commuting physical activity.

Statistical Analyses

Characteristics were compared using the Student *t* test and the χ^2 test, with Yates' correction for continuity in 2 × 2 tables, and outcomes using linear and logistic regression analyses. The level of significance was set at $P < .05$. Interactions between 2 variables were tested ($P < .01$) by including a product term, using these variables. Non-normally distributed outcome variables, including zero values, were log-transformed ($\log_{10}[x + 1]$) and mean differences reported as back-transformed percentages. Categorical covariates were entered as dummy variables with a separate dummy for missing values. Model 1 adjusted for sex, age, cohort, and season (December-February, March-May, June-August, September-November). Model 2 further adjusted for parental and early life factors: parental education, maternal smoking, gestational diabetes and hypertension, and birth weight SD score. Model 3 additionally adjusted for potential adult mediators including asthma,[30] height,[15,16] body fat percentage,[31] and smoking.[32] Analyses were rerun after replacement of the adjustment for body fat percentage with lean body mass.

Sensitivity analyses were performed to evaluate the effects of perinatal and neonatal factors on the associations. Analyses were rerun (1) after exclusion of participants born after a multiple pregnancy and (2) after exclusion of those born SGA. Further, among participants born early preterm, whether or not the outcomes could be predicted by multiple pregnancy or by supplementary oxygen treatment for >28 days after birth was assessed. Among all participants, prediction of outcomes by SGA status was also assessed. Analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (Armonk, New York).

Results

Gestational ages for the early preterm, late preterm, and control groups ranged from 23.9 to 33.9 weeks, 34.0 to 36.9 weeks, and 37.0 to 43.1 weeks, respectively. The respective ranges of birth weight were 655-3010 g, 1410-4440 g, and 2310-4920 g. Participant characteristics are shown in **Table I** and outcomes by exposure group in **Table II** (available at www.jpeds.com). There was no interaction between the association of sex and preterm birth with any outcomes.

The flow of participants through the study is shown in **Figure 1**. A detailed nonparticipant analysis has been published.[8] Among the participants in the overall study, the characteristics (listed in **Table I**) of those who completed the physical activity questionnaire were compared with the unimpaired nonparticipants who did not respond to the questionnaire or did not have valid questionnaire data (**Figure 1**). Similar proportions of the early and late preterm groups completed physical activity questionnaires compared with the control group. Among the late preterm group, the birth weight SD score was higher among physical activity questionnaire study participants than nonparticipants ($P = .04$), and nonparticipants were more often identified via the Finnish Medical Birth Register than the Northern Finland Birth Cohort 1986 ($P = .03$). Participation in the physical activity questionnaire study was lower in the winter among the late preterm ($P = .01$) and control groups ($P = .02$) and higher in the summer among the late preterm group ($P = .01$).

The frequency and volume for the total and all types of leisure time physical activity for women and men are detailed in **Table III** (available at www.jpeds.com).

For the total amount of leisure time physical activity, in the early preterm group, the overall frequency of physical activity was 17.2% lower and the overall total volume (MET hours/week) of physical activity was 31.5% lower compared with the control group in model 1 (adjusted for age, sex, cohort, and season) (**Table IV**). The difference in frequency was no longer significant when adjusted for socioeconomic status, pregnancy-related factors, and adult characteristics in models 2 and 3, but the difference in the total volume of physical activity persisted (**Figure 2**, **Table IV**). Young adults in the early preterm group were 2 times more likely to be classified in the least active quintile of the population compared with young adults in the control group (OR, 2.0; 95% CI, 1.2-3.3; model 1). The results remained similar after further adjustments in models 2 and 3. The frequency and total volume of physical activity (**Figure 2**, **Table IV**), and classification in the least active quintile in late preterm individuals did not differ from those in the control individuals.

For conditioning leisure time physical activity, in the early preterm group, the frequency was 31.3% lower and the total volume of conditioning physical activity was 46.6% lower than in the control group in model 1 (**Table IV**). These differences in frequency and total volume became slightly attenuated in models 2 and 3. The frequency and total amount of conditioning physical activity in the late preterm group did not differ from the control group.

For nonconditioning leisure time physical activity, in the early preterm group, the total volume was 41.6% lower than in the control group in model 1 (**Table IV**). This difference persisted after statistical adjustments. The frequency of nonconditioning physical activity in the early or late preterm groups was not different from that of the control group, and the volume of nonconditioning physical activity among late preterm individuals did not differ from that among the control individuals.

For commuting physical activity, the early preterm group reported a 46.3% lower frequency and 63.6% lower volume compared with the control group in model 1 (**Table IV**), but this difference was no longer significant after further adjustment in models 2 and 3. The late preterm group did not differ from the control group in either the frequency or volume of commuting physical activity.

For vigorous physical activity, in the early preterm group, the frequency was 43.5% lower on average and the total volume

Table I. Perinatal, neonatal, and current characteristics of the young adults born preterm and the controls born at term

	Early preterm (n = 118)				Late preterm (n = 210)				Controls (n = 311)			Missing (early preterm/late preterm/controls)
	n	%	Mean (SD)	P*	n	%	Mean (SD)	P*	n	%	Mean (SD)	
Men	57	48.3		1.00	104	49.5		.73	148	47.6		0/0/0
NFBC member	44	37.3		<.001	100	47.6		.003	190	61.1		0/0/0
Perinatal and neonatal												
Multiple pregnancy	30	25.4		<.001	29	13.8		<.001	3	1.0		0/0/0
Maternal hypertension†	17	14.4		.27	34	16.2		.08	33	10.6		0/2/2
Maternal preeclampsia‡	28	23.7		<.001	24	11.4		.005	14	4.5		0/2/2
Maternal gestational diabetes§	4	3.4		.59	11	5.2		.07	6	1.9		21/24/8
Maternal smoking during pregnancy	17	14.4		.87	41	19.5		.40	51	16.4		7/5/4
Cesarean section	73	61.9		<.001	58	27.6		<.001	36	11.6		0/0/0
Gestational age, weeks			31.9 (1.9)	<.001			35.8 (0.8)	<.001			40.1 (1.2)	0/0/0
Birth weight, g			1786 (478)	<.001			2692 (527)	<.001			3576 (482)	0/0/0
Birth weight SD score, SD			-0.8 (1.4)	<.001			-0.6 (1.3)	<.001			.0 (1.0)	0/0/0
SGA	20	16.9		<.001	25	11.9		<.001	5	1.6		0/0/0
Supplementary oxygen	85	72.0		<.001	78	37.1		<.001	6	1.9		0/0/0
Duration of supplementary oxygen, days			16.1 (12.9)	<.001			16.4 (69.6)	0.655			3.5 (1.6)	0/0/0¶
Current												
Age, y			23.1 (1.4)	.003			23.2 (1.2)	.001			23.5 (1.1)	0/0/0
Height, cm												0/0/0
Men			179 (7)	.36			177 (7)	.79			178 (7)	
Women			163 (5)	.45			165 (6)	.46			164 (6)	
BMI, kg/m^2												0/0/0
Men			24.4 (4.2)	.83			25.5 (4.8)	.03			24.3 (3.3)	
Women			24.4 (5.5)	.15			23.5 (4.1)	.62			23.2 (4.3)	
Body fat percentage, %												0/0/2
Men			17.9 (6.6)	.58			19.7 (7.7)	.01			17.4 (5.8)	
Women			30.9 (7.6)	.006			28.8 (6.9)	.26			27.8 (7.3)	
Lean body mass, kg												0/0/2
Men			63.5 (9.0)	.77			63.6 (8.6)	.65			63.1 (8.5)	
Women			44.1 (7.1)	.71			44.7 (5.7)	.66			44.4 (5.3)	
Parental education				.70				.57				
Basic or less	10	8.5			16	7.8			18	5.8		0/5/2
Secondary	71	60.2			115	56.1			189	61.0		
Lower-level tertiary	13	11.0			27	12.9			42	13.5		
Upper-level tertiary	24	20.3			47	22.4			60	19.3		
Daily smoking	32	27.1		.31	49	22.9		.77	68	21.9		0/0/0
Asthma	25	21.2		.10	34	16.2		.61	44	14.1		0/0/0
Season												0/0/0
Winter	27	22.9		.49	44	21.0		.72	60	19.3		
Spring	29	24.6		1.00	68	32.4		.05	75	24.1		
Summer	17	14.4		.19	36	17.1		.39	64	20.8		
Autumn	45	38.1		.77	62	29.5		.15	112	36.0		

NFBC, Northern Finland Birth Cohort 1986.
Early preterm includes those born at <34 weeks of gestation; late preterm, 34-36 weeks; and controls, ≥37 weeks.
**P* values refer to comparisons between preterm groups and controls with the use of Student's *t* test or Pearson's χ^2 test with Yates' continuity correction for 2 × 2 tables. *P* values < .05 were considered significant.
†Gestational or chronic hypertension.
‡Includes superimposed preeclampsia.
§Participants whose mothers' gestational diabetes data are missing include those whose mothers did not undergo an oral glucose tolerance test despite risk factors and thus have uncertain gestational diabetes status.
¶Of those who received supplementary oxygen.

54.3% lower than reported by the control group. Adjustments for covariates in models 2 and 3 did not change the results. The late preterm group undertook similar amounts of vigorous physical activity as the control group.

The total volume of physical activity was higher among women ($P = .02$; Table III), older participants ($P = .02$), nonsmokers ($P = .02$), and those with a lower body fat percentage ($P = .01$). Associations with smoking were mostly in connection with conditioning and commuting physical activity ($P < .001$), and associations with lower body fat percentage with conditioning physical activity ($P = .01$). Vigorous physical activity was more common among the offspring of parents with a higher level of education ($P = .001$) and reported especially during winter ($P = .001$), and conditioning physical activity was reported more frequently during winter ($P = .03$) and spring ($P = .04$); other outcomes did not differ according to season. Participants exposed to maternal gestational hypertension or chronic hypertension during pregnancy performed less vigorous physical activity ($P = .02$; data not shown).

For the sensitivity analysis, when only singletons were included in the analyses, the differences in total, nonconditioning, and vigorous physical activity persisted after all adjustments, as did differences in conditioning physical activity in model 1, whereas the differences in commuting physical activity decreased to statistical nonsignificance. A multiple pregnancy was

Table IV. Outcomes in preterm groups compared with term-born controls

	Controls (n = 311) Geometric mean and SD	Model*	Early preterm (n = 118) Mean difference % (95% CI)	P†	Late preterm (n = 210) Mean difference % (95% CI)	P†
Total amount of leisure time physical activity						
Frequency, times/wk	8.0 (1.9)					
		1	−17.2 (−28.5; −4.2)	.01	−3.0 (−14.0; 9.4)	.62
		2	−14.4 (−29.9; 0.3)	.06	−1.5 (−13.2; 11.7)	.81
		3	−13.0 (−25.7; 2.0)	.09	−0.9 (−12.6; 12.4)	.89
Total volume, MET h/wk‡	30.4 (2.2)					
		1	−31.5 (−43.2; −17.4)	<.001	−6.5 (−19.8; 9.1)	.39
		2	−30.1 (−42.9; −14.5)	.001	−4.0 (−18.2; 12.8)	.62
		3	−28.4 (−41.6; −12.3)	.001	−2.3 (−16.8; 14.8)	.78
Conditioning leisure time physical activity						
Frequency, times/wk	2.6 (2.8)					
		1	−31.3 (−46.7; −11.5)	.004	−8.2 (−25.5; 13.1)	.42
		2	−27.0 (−44.5; −4.1)	.02	−4.3 (−23.0; 19.0)	.69
		3	−24.6 (−42.4; −1.3)	.04	−2.9 (−21.6; 20.2)	.78
Total volume, MET h/wk‡	14.0 (4.1)					
		1	−46.6 (−63.3; −22.2)	.001	−15.1 (−37.7; 15.7)	.30
		2	−42.6 (−61.8; −13.8)	.008	−9.6 (−34.6; 24.8)	.54
		3	−39.8 (−59.8; −9.8)	.01	−7.3 (−32.8; 27.8)	.64
Nonconditioning leisure time physical activity						
Frequency, times/wk	1.5 (2.9)					
		1	−17.2 (−34.2; 4.1)	.11	−2.9 (−19.6; 17.3)	.76
		2	−20.4 (−37.9; 2.2)	.07	−1.7 (−19.4; 19.8)	.86
		3	−21.5 (−39.0; 1.1)	.06	−1.7 (−19.6; 20.1)	.86
Total volume, MET h/wk‡	4.6 (6.2)					
		1	−41.6 (−60.9; −13.0)	.008	−8.7 (−34.2; 26.8)	.66
		2	−46.8 (−65.5; −18.1)	.004	−7.3 (−34.2; 30.6)	.66
		3	−48.2 (−66.6; −19.8)	.003	−.7.7 (−34.8; 30.7)	.65
Commuting physical activity						
Frequency, times/wk	1.1 (8.2)					
		1	−46.3 (−66.6; −13.5)	.01	−17.5 (−44.5; 22.7)	.34
		2	−35.5 (−61.4; 7.9)	.44	−15.1 (−43.9; 28.3)	.44
		3	−28.0 (−57.3; 21.2)	.22	−14.9 (−43.7; 28.6)	.44
Total volume, MET h/wk‡	0.6 (41.7)					
		1	−63.6 (−84.3; −15.4)	.02	−31.9 (−66.0; 36.6)	.28
		2	−48.3 (−79.3; 28.8)	.16	−27.6 (−64.9; 49.6)	.38
		3	−42.0 (−76.8; 44.8)	.24	−24.8 (−63.6; 55.4)	.44
Vigorous§ leisure time physical activity						
Frequency, times/wk	1.3 (3.4)					
		1	−43.5 (−58.0;−24.1)	<.001	−6.2 (−26.5; 19.4)	.60
		2	−42.6 (−58.2; −21.3)	.001	−5.7 (−26.6; 21.2)	.65
		3	−41.7 (−57.6; −19.9)	.001	−5.2 (−26.3; 22.0)	.68
Total volume, MET h/wk‡	8.7 (4.6)					
		1	−54.3 (−68.4; −33.8)	<.001	−10.3 (−33.9; 21.6)	.48
		2	−52.8 (−68.2; −30.0)	<.001	−8.2 (−32.8; 25.5)	.59
		3	−52.1 (−67.8; −28.6)	<.001	−7.8 (−32.8; 26.4)	.61

The geometric mean is the *n*th root of the product of *n* individual values. Geometric SDs correspond with the percent increase in the variable corresponding to a change of 1 SD unit in the logarithm of the variable.
*Model 1 (n = 639): sex, age, cohort, season.
Model 2 (n = 639): model 1 plus socioeconomic status, maternal smoking, gestational diabetes and hypertension, and birth weight SD score.
Model 3 (n = 637): model 2 plus diagnosed asthma, adult body size (height, body fat percentage), and smoking.
†Level for statistical significance $P < .05$.
‡MET h/wk indicates MET hours of physical activity per week.
§Physical activity intensity ≥6 MET.

not associated with physical activity outcomes among the early preterm group.

Participants born early preterm who had received supplementary oxygen for >28 days after birth (n = 17) showed a lower frequency of total ($P = .01$) and conditioning ($P = .01$) physical activity than the other participants born early preterm. Being born SGA was not associated with physical activity outcomes among the participants, and the results were similar when those born SGA were excluded.

When adjustments were made for lean body mass instead of body fat percentage, the results were similar in all analyses.

Discussion

The main finding of this study is that unimpaired young adults born early preterm performed markedly less leisure time physical activity than those born at term. Lower levels were seen for conditioning and nonconditioning, commuting, and vigorous physical activity and resulted in a 31.5% lower total volume of physical activity. This difference was not explained by socioeconomic status or by pregnancy-related factors underlying preterm birth. The finding persisted when adjusted for adult characteristics including body size, current smoking, or

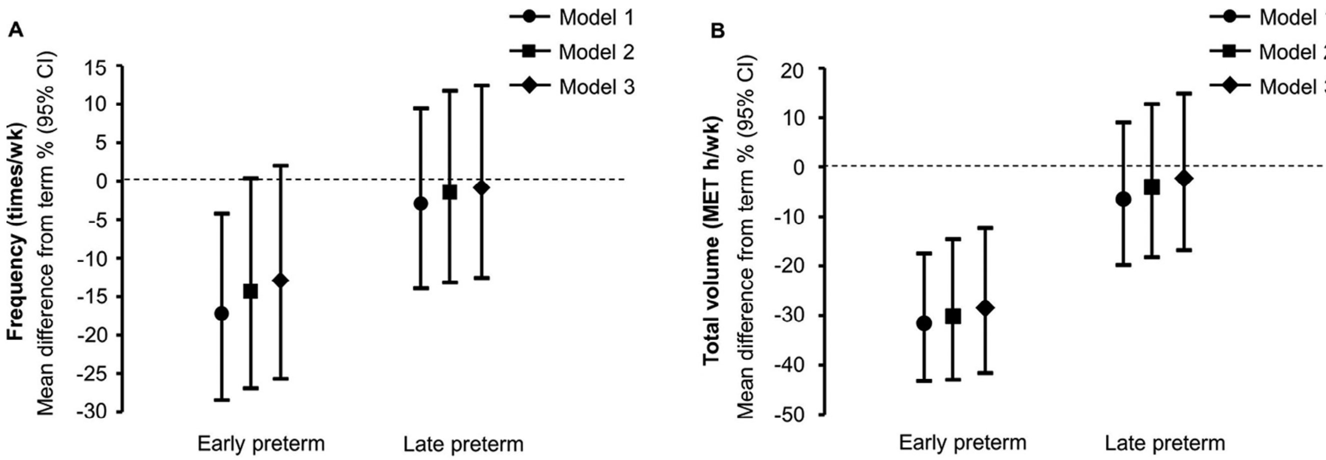

Figure 2. Mean differences in physical activity (95% CIs, error bars) consisting of conditioning and nonconditioning leisure time physical activity and commuting physical activity in preterm groups compared with controls (zero line). Model 1 was adjusted for sex, age, cohort, and season. Model 2 was adjusted as for model 1 plus socioeconomic status, maternal smoking, gestational diabetes, and hypertensive disorder during pregnancy, and birth weight SD score. Model 3 was adjusted as for model 2 plus diagnosed asthma, adult body size (height, body fat percentage), and smoking.

diagnosed asthma, suggesting that it is not mediated through these characteristics.

Previous studies focused on the smallest preterm infants, who, as adolescents or adults, have shown substantially less physical activity than those born at term. Unimpaired 17-year-old survivors with birth weights of ≤800 g have reported less frequent participation in sports.[12] Similarly, unimpaired VLBW (<1500 g) adults reported exercising less frequently, with lower intensity and shorter sessions, and performed 48.6% less conditioning leisure time physical activity compared with those born at term.[15,16] This parallels our finding of 46.6% less conditioning physical activity among those born early preterm. Although the difference we found among the late preterm group was not significant, the point estimate for conditioning physical activity was 15.1% less compared with those born at term, consistent with a dose–response relationship between shorter duration of gestation and less physical activity.

In previous studies among ELBW or VLBW adults, lower physical activity was related specifically to less conditioning leisure time physical activity or sports participation.[12,15,16] In contrast, in the present study, low-level physical activity was observed for conditioning, nonconditioning, and commuting physical activity, and also when vigorous intensity physical activity was assessed separately. The reasons for this difference remain unclear. However, our present findings suggest a general preference for a physically less active lifestyle rather than a specific aversion to conditioning physical activity sports. Adults born preterm not only undertook less conditioning and vigorous intensity activities, but also reported less commuting and nonconditioning types of activity. The reported differences could not be attributed to pregnancy conditions underlying preterm birth, or to fetal growth. This finding suggests that mostly the observed differences in physical activity are due to postnatal events or prematurity itself, rather than perinatal conditions.

Findings of lower self-reported physical activity reported in this study and in prior studies have not been replicated in adults when physical activity is assessed objectively by means of accelerometry.[33] This was also the case in a subset of the present cohort who underwent accelerometry.[34] Objective measurements during childhood have not been able to capture differences in physical activity between those born preterm and at term,[35,36] except in 1 study of 7-year-old boys born very preterm (<32 weeks).[37] One reason for this discrepancy may be that self-reporting and accelerometry capture different aspects of physical activity. Self-reporting enables the assessment of a broad range of physical activities in any circumstances and provides average figures within a longer time frame, whereas objective measurement is more precise in registering the intensity of physical activity and the amount of sedentary time within a shorter period.[38] Correlation coefficients between self-reported and objectively measured physical activity are usually low to moderate, in our cohort 0.25,[34] and according to meta-analyses approximately 0.3-0.4.[38-40] Additionally, in a relatively large sample with self-reported physical activity, those who are least active are well-represented, whereas physically more active participants may volunteer to participate in accelerometry.

Potential explanations for lower self-reported levels of leisure time physical activity among individuals born preterm include reduced muscle mass due to preterm birth,[41] poorer motor skills persisting through childhood and adolescence,[42] and lower self-efficacy, leading to reduced muscular fitness in young adulthood,[18] and this, combined with poorer visual acuity[43] and reduced pulmonary function, could discourage undertaking conditioning, nonconditioning, and commuting physical activity.[4] Children and adults born prematurely have reduced cognitive abilities[44,45] and although the direction of causality has been debated, it has been shown that those with lower cognitive abilities undertake less physical activity.[46,47] A previous study in men showed that the association between low exercise capacity and low cognitive function was particularly strong among those born preterm,[45] suggesting that adults born preterm who have lower cognitive abilities could be a particular risk group. We had no comprehensive assessment of cognitive abilities and could not assess this suggestion. Another explanation could be more protective parenting, which we reported in a previous study,[48] where we compared adults born preterm with VLBW with their term-born controls. However, a recent meta-analysis[48] did not reveal any systematic difference in maternal parenting behavior.[49]

A low level of leisure time physical activity among individuals born early preterm may predispose them to cardiometabolic diseases and their risk factors, including elevated blood pressure, impaired glucose regulation,[2,5,8] and reduced muscular fitness.[18] A low level of physical activity is also associated with other noncommunicable diseases,[50] and it predicts mortality in late adulthood.[51] According to current recommendations from the US Department of Health and Human Services[52] and World Health Organization,[53] 150 minutes of moderate intensity (3-6 MET) physical activity or 75 minutes of vigorous intensity (>6 MET) physical activity per week provides substantial health benefits. For comparison, the 30% (approximately 8.8 MET hours/week at mean levels) less total amount of physical activity found among young adults born early preterm corresponds with the equivalent of more than 120 minutes of brisk walking (at an intensity of 4.3 MET) per week.

The strengths of this study include assessment of self-reported 12-month leisure time physical activity using a validated detailed questionnaire.[25,27] A limitation of the method is the potential for recall bias that could differ between groups. Potentially lower physical self-efficacy among those born preterm[54] may affect self-rating of physical activity. However, individuals born preterm also tend to respond to questionnaires in a socially more acceptable manner,[55] which could result in reporting of higher levels of physical activity. This effect would diminish rather than exaggerate the differences. The distributions of the subcomponents of physical activity, particularly commuting physical activity, were skewed even after log-transformation. However, the distribution of total physical activity, on which the main conclusions are based, was less skewed. This study population enabled the evaluation of leisure time physical activity across the full range of preterm birth. We had access to reliable and diverse perinatal data, including verified length of gestation. Most participants (86.0%) in the clinical examination phase of the ESTER study also responded to the physical activity questionnaire (**Figure 1**). Detailed nonparticipation analyses presented in a previous publication[8] and the present paper raised little concern about participation bias. Also, residual confounding cannot be excluded.

The lack of physical activity noted in this study in adults who were born preterm may contribute to a higher risk of chronic noncommunicable diseases in later life and offers a target for prevention. Healthcare professionals should be encouraged to actively support children born preterm and their families in finding physical activities suitable for each individual. Regular participation in various forms of physical activity and avoidance of a physically inactive lifestyle in childhood and adolescence are effective in decreasing risk factors of several chronic noncommunicable diseases in a life course perspective.[50] Accordingly, participation in physical activities should be strongly encouraged by pediatricians, other health professionals, and parents. ■

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Reprint requests: Marjaana Tikanmäki, MD, Department of Public Health Solutions, Chronic Disease Prevention Unit, National Institute for Health and Welfare, Kastelli Research Centre, PO Box 310, Oulu 90101, Finland. E-mail: marjaana.tikanmaki@thl.fi

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Table II. Outcomes in early preterm, late preterm, and control groups by sex

	Early preterm (n = 118)	Late preterm (n = 210)	Controls (n = 311)
Total amount of leisure time physical activity			
Frequency, times/wk			
Men	5.6 (2.4)*	7.3 (2.0)	7.5 (2.0)
Women	8.1 (2.0)	8.4 (1.9)	8.4 (1.8)
All	6.8 (2.2)	7.8 (2.0)	8.0 (1.9)
Total volume, MET h/wk†			
Men	18.1 (3.4)**	28.9 (2.3)	30.8 (2.5)
Women	25.3 (2.5)	29.0 (2.2)	30.1 (2.0)
All	21.5 (2.9)**	28.9 (2.3)	30.4 (2.2)
Conditioning leisure time physical activity			
Frequency, times/wk			
Men	1.7 (4.0)*	2.3 (3.9)	2.6 (2.7)
Women	2.0 (3.8)	2.7 (3.1)	2.6 (2.9)
All	1.8 (3.9)*	2.5 (3.5)	2.6 (2.8)
Total volume, MET h/wk†			
Men	7.0 (8.7)*	11.8 (8.7)	15.2 (4.3)
Women	8.7 (7.1)	13.0 (5.9)	13.1 (4.0)
All	7.8 (7.8)**	12.4 (7.2)	14.0 (4.1)
Nonconditioning leisure time physical activity			
Frequency, times/wk			
Men	0.9 (4.4)	1.3 (3.1)	1.3 (3.7)
Women	1.8 (2.3)	1.7 (2.2)	1.7 (2.2)
All	1.3 (3.5)	1.5 (2.6)	1.5 (2.9)
Total volume, MET h/wk†			
Men	1.5 (19.3)*	3.0 (8.5)	3.6 (10.6)
Women	4.8 (3.0)	5.5 (2.6)	5.7 (3.0)
All	2.7 (9.7)*	4.1 (5.3)	4.6 (6.2)
Commuting physical activity			
Frequency, times/wk			
Men	0.3 (14.1)*	0.7 (12.0)	0.9 (9.3)
Women	1.2 (8.7)	1.2 (8.2)	1.4 (7.1)
All	0.7 (11.9)	0.9 (10.1)	1.1 (8.2)
Total volume, MET h/wk†			
Men	0.1 (108.5)*	0.2 (78.7)	0.3 (50.4)
Women	0.7 (47.0)	0.7 (38.9)	0.9 (30.2)
All	0.2 (83.0)	0.4 (57.9)	0.6 (41.7)
Vigorous‡ leisure time physical activity			
Frequency, times/wk			
Men	0.6 (5.0)**	1.2 (3.9)	1.2 (3.3)
Women	0.9 (5.1)	1.3 (4.5)	1.3 (3.5)
All	0.7 (5.1)**	1.2 (4.2)	1.3 (3.4)
Total volume, MET h/wk†			
Men	3.7 (8.2)**	9.1 (5.3)	9.6 (4.7)
Women	4.6 (7.9)	7.5 (6.5)	8.0 (4.6)
All	4.1 (8.0)***	8.3 (5.9)	8.7 (4.6)

The geometric mean is the *n*th root of the product of *n* individual values. Geometric SDs correspond with the percent increase in the variable corresponding to a change of a 1-SD unit in the logarithm of the variable. Values are geometric mean (SD).
Levels of statistical significance for differences between the preterm group and the control group in *t* tests: ***<.001, **<.01, *<.05.
†MET h/wk indicates MET hours of physical activity per week.
‡Physical activity intensity ≥6 MET.

Table III. Physical activity

	Women (n = 330)	Men (n = 309)
Total amount of leisure time physical activity		
Frequency, times/wk	8.3 (1.9)	7.0 (2.1)
Total volume, MET h/wk*	28.8 (2.2)	27.3 (2.6)
Conditioning leisure time physical activity		
Frequency, times/wk	2.5 (3.2)	2.3 (3.4)
Volume, MET h/wk*	12.1 (5.2)	12.1 (6.5)
Nonconditioning leisure time physical activity		
Frequency, times/wk	1.7 (2.2)	1.2 (3.6)
Volume, MET h/wk*	5.4 (2.9)	2.9 (11.3)
Commuting physical activity		
Frequency, times/wk	1.3 (7.7)	0.7 (11.1)
Volume, MET h/wk*	0.8 (35.4)	0.2 (69.9)
Vigorous† leisure time physical activity		
Frequency, times/wk	1.2 (4.1)	1.1 (3.9)
Volume, MET h/wk*	7.1 (5.7)	7.9 (5.8)

The geometric mean is the *n*th root of the product of *n* individual values. Geometric SDs correspond with the percent increase in the variable corresponding to a change of a 1-SD unit in the logarithm of the variable. Values are geometric mean (SD).
*MET h/wk indicates MET hours of physical activity per week.
†Physical activity intensity ≥6 MET.