Risk of Obesity in Relation to Physical Activity Tracking from Youth to Adulthood

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ABSTRACT

YANG, X., R. TELAMA, J. VIIKARI, and O. T. RAITAKARI. Risk of Obesity in Relation to Physical Activity Tracking from Youth to Adulthood. *Med. Sci. Sports Exerc.*, Vol. 38, No. 5, pp. 919–925, 2006. **Purpose:** Maintaining a high level of physical activity throughout one's lifetime may decrease the risk of obesity. We evaluated how physical activity patterns from youths (9–18 yr) to adulthood are associated with body mass index (BMI) and waist circumference (WC) in a population of young adults. **Methods:** As part of the longitudinal Cardiovascular Risk in Young Finns Study, we assessed physical activity over a 21-yr follow-up in a cohort of 1319 subjects. Physical activity was measured using a questionnaire completed in conjunction with a medical examination. **Results:** During the follow-up, 33.1% of men and 32.0% of women were classified as persistently active, and 11.5% of men and 7.4% of women as persistently inactive. Both decreasingly active and persistently inactive subjects were more likely to be obese as adults compared with persistently active subjects. In women, being decreasingly active from youth to adulthood compared with being persistently active was independently associated with the risk of being overweight (BMI = 25.0–29.9 kg·m^{-2}, odds ratio (OR) = 2.35, confidence interval (CI) = 1.16–4.78), obese (BMI ≥ 30.0 kg·m^{-2}, OR = 2.72, CI = 1.04–7.09), mildly abdominally obese (WC = 800–879 mm, OR = 2.21, CI = 1.01–4.84), and severely abdominally obese (WC ≥ 880 mm, OR = 2.19, CI = 1.03–4.67), after adjustment for several variables including childhood fatness. In men, decreasing physical activity during their lifetime was associated with mild (WC = 940–1019 mm, odds ratio (OR) = 1.78, CI = 1.00–3.19) and severe (WC ≥ 1020 mm, OR = 2.47, CI = 1.27–4.78) abdominal obesity in unadjusted analyses, but these two associations disappeared after adjustment for confounding variables (OR = 1.51, CI = 0.72–3.17 and OR = 1.62, CI 0.66–4.02, respectively). In men, changes in physical activity were not associated with obesity or overweight as defined by cut-points of BMI. **Conclusions:** Maintaining a high level of physical activity from youth to adulthood is independently associated with lower risk of abdominal obesity in among women, but not men. These findings suggest that changes in physical activity patterns during the lifetime may contribute to the development of abdominal obesity in women. **Key Words:** EXERCISE, TRACKING, COHORT STUDIES, BODY MASS INDEX, WAIST CIRCUMFERENCE

Obesity increases the risk of cardiovascular disease and type 2 diabetes. It is recognized as one of the leading worldwide health problems (8,28), as the proportion of obese adults has increased dramatically in developed countries over the past two decades (12,26). Physical activity is considered important in the prevention and treatment of obesity. Inverse relationships between adult obesity and the level of physical activity have usually been reported in cross-sectional studies (4,6,15,20). However, observations regarding the relationships between adolescent physical activity and adult obesity have been inconsistent (2,9,11,14,16,18,21,25,27). Two recent studies examined the effects of changes in physical activity from adolescence to adulthood on adult obesity (9,21). Both studies found that increased prevalence of obesity in adulthood was associated with low levels of leisure-time physical activities in adolescence. In particular, patterns of decreasing activity and persistent inactivity seemed to predict adult obesity. The purpose of the present study was to test the hypothesis that obesity indices measured in young adults are related to their level of physical activity in childhood and adolescence and especially to changes in physical activity from youth to adulthood.

METHODS

Participants. Data were obtained from the Cardiovascular Risk in Young Finns Study, which is a population-based study consisting of a series of surveys of six cohorts born in 1962, 1965, 1968, 1971, 1974, and 1977. The ages were 3, 6, 9, 12, 15, and 18 yr in 1980. All the participants were randomly selected (*N* = 4320) in the five Finnish university cities with medical schools (Helsinki, Kuopio, Oulu, Tampere, and Turku) and their surrounding communities. The same participants were followed up in 1983, 1986, 1992, and 2001. Restricted sampling was also done in 1989. Physical activity was assessed in all surveys. A more complete description of the study has been reported previously (17,29). The study was reviewed and approved by the ethics committee of each of the five participating universities.

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TABLE 1. Distribution (%) of study variables.

Variable	Males N	Males %	Females N	Females %
Age in 1980 (yr)				
9	169	51.2	161	48.8
12	156	45.1	190	54.9
15	162	47.2	181	52.8
18	139	46.3	161	53.7
Age in 2001 (yr)				
30	95	49.7	96	50.3
33	76	42.5	103	57.5
36	88	44.0	112	56.0
39	70	45.8	83	54.2
Child and adolescent physical activity[a]				
Active	245	39.1	243	35.1
Moderately active	202	32.3	300	43.3
Inactive	179	28.6	150	21.6
Adult physical activity[a]				
Active	247	39.5	281	40.5
Moderately active	189	30.2	236	34.1
Inactive	190	30.3	176	25.4
21-yr tracking physical activity				
Persistently active	207	33.1	222	32.0
Increasingly active	171	27.3	210	30.3
Decreasingly active	176	28.1	210	30.3
Persistently inactive	72	11.5	51	7.4
BMI in childhood and adolescence[b]				
Normal weight	577	92.2	647	93.4
Overweight and obesity	49	7.8	46	6.6
SSF in childhood and adolescence[c]				
< 25th percentile	153	24.4	172	24.8
25th–75th percentiles	321	51.3	347	50.1
> 75th percentile	152	24.3	174	25.1
BMI in adulthood				
Normal weight (< 25.0)	275	43.9	439	63.3
Overweight (25.0–29.9)	259	41.4	171	24.7
Obesity (≥ 30.0)	92	14.7	83	12.0
WC in adulthood[d]				
Normal	419	67.0	417	60.2
Mild abdominal obesity	116	18.5	134	19.3
Severe abdominal obesity	91	14.5	142	20.5
Confounding variables				
Place of residence				
Rural	217	34.7	256	36.9
Urban	409	65.3	437	63.1
Education				
Low	258	41.2	168	24.2
Moderate	250	39.9	378	54.5
High	118	18.9	147	21.3
Occupation				
Blue collar	32	5.1	78	11.3
Lower white collar	324	48.6	174	25.1
Upper white collar	290	46.3	441	63.6
Marital status				
Married	473	75.6	515	74.3
Unmarried	153	24.4	178	25.7
Having children				
No child	245	39.1	187	27.0
1 child	102	16.3	120	17.3
> 1 child	279	44.6	386	55.7
Smoking				
Nonsmoker	465	74.3	575	83.0
Smoker	161	25.7	118	17.0

[a] The level of youth and adult physical activity was divided into three categories: 5–7 = inactive, 8–10 = moderate, and 11–14 = active.
[b] BMI in childhood and adolescence by international age- and sex-specified cutoff points: overweight and obesity ≥ 19.10 kg·m^{-2} in boys and 19.07 kg·m^{-2} in girls at age 9 yr; ≥ 21.22 kg·m^{-2} in boys and 21.68 kg·m^{-2} in girls at age 12 yr; ≥ 23.29 kg·m^{-2} in boys and 23.94 kg·m^{-2} in girls at age 15 yr; and ≥ 25.0 kg·m^{-2} in both sexes at age 18 yr.
[c] SSF in childhood and adolescence by the age- and sex-specified cutoff points: 25th–75th percentiles between 19.10 and 28.09 mm in females and 15.50 and 23.39 mm in males at age 9 yr; between 21.60 and 34.39 mm in females and 16.80 and 28.19 mm in males at age 12 yr; between 25.70 and 39.74 mm in females and 17.40 and 25.09 mm in males at age 15 yr; and between 30.90 and 44.79 mm in females and 18.20 and 25.19 mm in males at age 18 yr.
[d] WC in adulthood: normal (< 940 mm in males and < 800 mm in females), mild abdominal obesity (940–1019 mm in males and 800–879 mm in females), and severe abdominal obesity (≥ 1020 mm in males and ≥ 880 mm in females).

We included the four oldest age cohorts (9, 12, 15, and 18 yr in 1980) in the present analysis. Thus, subjects aged 3 and 6 yr at baseline were excluded. This was due to the different method used to assess physical activity in the two youngest age groups. A total of 2889 boys and girls aged 9–18 yr were invited to participate in the study in 1980, and 2309 (80%) subjects participated and completed the physical activity questionnaire. From this sample, 1665 (72%) participated and completed the questionnaire in 2001. Due to lack of information on obesity indices, the

TABLE 2. Mean and SD of BMI ($kg \cdot m^{-2}$), SSF (mm), and WC (mm) by the level of physical activity (PA)[a] in childhood and adolescence and adulthood.

Category	N	Child and Adolescent Obesity BMI (Mean ± SD)	Child and Adolescent Obesity SSF (Mean ± SD)	Adult Obesity BMI (Mean ± SD)	Adult Obesity WC (Mean ± SD)[b]
Males					
Child and adolescent PA					
Inactive	179	19.6 ± 3.3***	23.2 ± 10.6	25.8 ± 3.9	907.3 ± 106.9
Moderately active	202	18.5 ± 3.1	22.6 ± 11.1	25.9 ± 3.6	905.0 ± 99.0
Active	245	18.5 ± 2.8	22.4 ± 9.8	26.2 ± 3.4	915.2 ± 90.6
Adult PA					
Inactive	190			26.3 ± 4.2	925.0 ± 114.3*
Moderately active	189			25.7 ± 3.2	908.3 ± 88.1
Active	247			25.9 ± 3.4	898.7 ± 90.3
Females					
Child and adolescent PA					
Inactive	150	19.4 ± 2.7**	33.9 ± 12.3***	24.4 ± 4.5	795.8 ± 116.2
Moderately active	300	18.8 ± 2.8	32.6 ± 12.6	24.7 ± 4.3	805.0 ± 104.5
Active	243	18.4 ± 2.9	29.6 ± 11.5	24.7 ± 4.7	800.5 ± 116.3
Adult PA					
Inactive	176			25.2 ± 5.0*	817.0 ± 116.2**
Moderately active	236			24.8 ± 4.4	808.3 ± 104.5
Active	281			24.1 ± 4.1	786.0 ± 116.3

[a] Cutoff points of physical activity index: 5–7 = inactive, 8–10 = moderately active, and 11–14 = active.
[b] ANOVA for the categorical variables.
* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

final sample size in this analysis was 1319 subjects (57%; 626 males and 693 females).

Physical activity index. In 1980, physical activity and participation in sports were assessed using a self-report questionnaire administered individually in conjunction with a physical examination. We assessed the frequency and intensity of leisure-time physical activities, participation in sports-club training, participation in sports competitions, usual way of spending leisure time, and the way of commuting to school (23). A physical activity index (PAI) was computed using these variables. In 2001, the questions assessed the intensity of physical activity, frequency of vigorous physical activity, hours spent on vigorous physical activity, average duration of a physical activity session, and participation in organized physical activity. The original questions relating to the variables of 1980 and 2001 and their scoring and recoding for both PAI are presented elsewhere (24,29). The questionnaires in youth and adulthood were not identical. The main difference concerned the assessment of supervised training. Activities such as sports-club training and sport competitions were assessed in detail only in childhood and adolescence, as these are common activities in young people but not in adults. Despite these differences, the tracking correlations from youth to young adulthood were of the same magnitude as the interage correlations in youth. Cronbach's alpha for the PAI in the 1980 data ranged from 0.49 to 0.76 for males and from 0.44 to 0.69 for females. In the 2001 data, Cronbach's alpha for the PAI varied from 0.74 to 0.85 for males and from 0.59 to 0.85 for females. Reliability showed a consistent improvement with advancing age. The test–retest reliabilities with the PAI values of the previous years (1980–1992), estimated by the stability coefficients of the simplex model, were > 0.70 (22).

A subsample of participants (N = 102) underwent maximal cycle ergometer exercise testing using a protocol with increments of loading of 20–25 $W \cdot min^{-1}$ in 2001. Three indicators of exercise capacity (indicating fitness) were measured: estimated maximal oxygen uptake ($\dot{V}O_{2max}$), mean workload attained during the last 4 min of the test (Wlast4), and hypothetical maximal workload sustainable for 6 min (Wmax6) (3). The validity of the physical activity measurements was studied by correlating childhood and adulthood PAI with the indicators of exercise capacity. The correlation coefficients ranged from r = 0.20 to 0.53, and were strongest between the PAI and Wmax6. In both sexes, childhood PAI correlated with Wmax6: r = 0.39 (P = 0.027) and r = 0.33 (P = 0.044) for women and men, respectively. Similarly, the correlations between adulthood PAI and Wmax6 were r = 0.49 (P =

TABLE 3. Mean and standard deviation of BMI ($kg \cdot m^{-2}$) and waist circumference (WC) (mm) in adulthood by the changes of physical activity[a] from childhood and adolescence to adulthood.

Tracking Years (1980–2001)	Males N	Males BMI (Mean ± SD)	Males WC (Mean ± SD)	Females N	Females BMI (Mean ± SD)	Females WC (Mean ± SD)[b]
Persistently active	130	25.6 ± 2.9	895.2 ± 79.3*	138	24.4 ± 3.8*	795.6 ± 099.9*
Increasingly active	216	25.9 ± 3.5	903.4 ± 94.1	225	23.9 ± 3.9	782.2 ± 097.8
Decreasingly active	139	26.6 ± 3.8	933.8 ± 103.5	187	25.3 ± 5.4	815.0 ± 129.5
Persistently inactive	141	25.8 ± 4.0	908.4 ± 110.3	143	25.1 ± 4.6	820.1 ± 112.1

[a] Physical activity groups: persistently active (active or moderately active in both 1980 and 2001), increasingly active (change 1980–2001 from inactive to moderately active or to active or from moderate to active), decreasingly active (change 1980–2001 from active to moderate or to inactive or from moderate to inactive), persistently inactive (inactive both in 1980 and 2001).
[b] ANOVA for the categorical variables.
* $P < 0.01$.

TABLE 4. Odds ratios for overweight (BMI = 25.0–29.9 kg·m^{-2}) and obesity (BMI ≥ 30.0 kg·m^{-2}) of adults according to the changes of physical activity[a] from childhood and adolescence to adulthood.

Tracking Years (1980–2001)	N	Overweight: Unadjusted OR (CI)	Overweight: Adjusted OR (CI)	N	Obesity: Unadjusted OR (CI)	Obesity: Adjusted[b] OR (CI)
Males						
Persistently active	67	1.00	1.00	19	1.00	1.00
Increasingly active	78	0.75 (0.46–1.21)	0.76 (0.42–1.38)	18	1.25 (0.63–2.49)	0.79 (0.32–1.98)
Decreasingly active	71	1.11 (0.69–1.80)	1.20 (0.67–2.18)	20	1.50 (0.75–3.00)	1.04 (0.41–2.63)
Persistently inactive	26	0.47 (0.24–0.89)	0.52 (0.22–1.23)	14	1.14 (0.50–2.60)	0.87 (0.27–2.85)
Females						
Persistently active	33	1.00	1.00	10	1.00	1.00
Increasingly active	60	1.36 (0.77–2.40)	1.25 (0.61–2.53)	18	1.12 (0.53–2.37)	0.80 (0.29–2.19)
Decreasingly active	49	1.79 (1.02–3.16)	2.35 (1.16–4.78)	32	2.09 (1.03–4.26)	2.72 (1.04–7.09)
Persistently inactive	27	2.22 (1.04–4.72)	2.18 (1.05–7.57)	15	0.96 (0.29–3.19)	1.51 (0.32–6.99)

[a] Physical activity groups: persistently active (active or moderately active in both 1980 and 2001), increasingly active (change 1980–2001 from inactive to moderately active or to active or from moderate to active), decreasingly active (change 1980–2001 from active to moderate or to inactive or from moderate to inactive), persistently inactive (inactive both in 1980 and 2001).

[b] Adjusted for age, BMI of youth, SSF of youth, place of residence, education, occupation, marital status, number of children, and smoking.

0.001) and r = 0.53 (P < 0.001) for women and men, respectively. A significant correlation was also found between adulthood PAI and waist circumference, in both sexes, r = −0.14 (P = 0.001) and r = −0.12 (P = 0.001) for women and men, respectively (24).

Participants were divided into three groups according to the distribution of the PAI values. Those who were in the 66th percentile or above were labeled "active," participants between the 34th and 65th percentiles were "moderately active," and those below the 34th percentile were "inactive." The same categories were formed in both the 1980 and 2001 data. The cutoff points of the PAI values in both measurements were 5–7 for "inactive," 8–11 for "moderately active," and 12–15 for "active." To study the effect of persistent physical activity and changes of activity on adult obesity, the participants were classified into four groups on the basis of the three activity tertiles described above. Participants who belonged to "active" or "moderately active" groups both in 1980 and 2001 were labeled "persistently active." Those who increased their activity from 1980 to 2001, either from "inactive" to "moderately active" or "active" or from "moderately active" to "active," were "increasingly active." Participants who decreased their activity either from "active" to "moderately active" or "inactive" or from "moderately active" to "inactive" were "decreasingly active." Those who belonged to the "inactive" group in both 1980 and 2001 were "persistently inactive."

Obesity indices. In 1980, weight was measured with a Seca scale (Vogel & Halke, Hamburg, Germany), and height was measured with a Seca anthropometer. Body mass index (BMI) was calculated as weight (kg)/height (m^2). Skinfold thickness was measured at biceps, triceps, and subscapular sites (7). The sum of these three skinfold measures (sum of skinfolds (SSF)) were used to estimate body fatness. In 2001, waist circumference (WC) was measured in duplicate to an accuracy of 1 mm (1,19).

Overweight and obesity in children and adolescents were defined using the international age- and sex-specific cutoff points (5): 19.10 kg·m^{-2} in boys and 19.07 kg·m^{-2} in girls at age 9 yr; 21.22 kg·m^{-2} in boys and 21.68 kg·m^{-2} in girls at age 12 yr; 23.29 kg·m^{-2} in boys and 23.94 kg·m^{-2} in girls at age 15 yr; and 25.0 kg·m^{-2} in both sexes at age 18 yr. In adults, overweight was defined as a BMI between 25.0 and 29.9 kg·m^{-2} and obesity as a BMI ≥ 30.0 kg·m^{-2} (13). Mild abdominal obesity in adults was defined as a WC of 940–1019 mm in men and 800–879 mm in women. Severe abdominal obesity was defined as a WC of ≥ 1020 mm in men and ≥ 880 mm in women. These cutoff

TABLE 5. Odds ratios for mild abdominal obesity (WC = 940–1019 mm in males and 800–879 mm in females) and severe abdominal obesity (WC ≥ 1020 mm in males and ≥ 880 mm in females) of adults according to the changes of physical activity[a] from childhood and adolescence to adulthood.

Tracking Years (1980–2001)	N	Mild Abdominal Obesity: Unadjusted OR (CI)	Mild Abdominal Obesity: Adjusted OR (CI)	N	Severe Abdominal Obesity: Unadjusted OR (CI)	Severe Abdominal Obesity: Adjusted[b] OR (CI)
Males						
Persistently active	27	1.00	1.00	19	1.00	1.00
Increasingly active	31	0.96 (0.52–1.77)	0.78 (0.36–1.67)	18	0.92 (0.47–1.83)	0.65 (0.26–1.67)
Decreasingly active	31	1.78 (1.00–3.19)	1.51 (0.72–3.17)	20	2.47 (1.27–4.78)	1.62 (0.66–4.02)
Persistently inactive	14	0.78 (0.34–1.82)	0.59 (0.19–1.89)	14	1.56 (0.71–3.39)	1.96 (0.66–5.80)
Females						
Persistently active	33	1.00	1.00	10	1.00	1.00
Increasingly active	60	1.60 (0.85–3.03)	1.45 (0.67–3.15)	18	0.99 (0.54–1.82)	0.61 (0.28–1.37)
Decreasingly active	49	2.00 (1.06–3.79)	2.21 (1.01–4.84)	32	1.80 (1.01–3.22)	2.19 (1.03–4.67)
Persistently inactive	27	1.34 (0.52–3.44)	1.25 (0.39–3.99)	15	1.53 (0.67–3.48)	1.66 (0.52–5.30)

[a] Physical activity groups: persistently active (active or moderately active in both 1980 and 2001), increasingly active (change 1980–2001 from inactive to moderately active or to active or from moderate to active), decreasingly active (change 1980–2001 from active to moderate or to inactive or from moderate to inactive), persistently inactive (inactive both in 1980 and 2001).

[b] Adjusted for age, BMI of youth, SSF of youth, place of residence, education, occupation, marital status, number of children, and smoking.

points for overweight and obesity according to BMI and WC are widely used in identifying adults with an increased risk of comorbidities (28).

Confounding variables. In adults, the self-administered questionnaire included questions on education, occupation, place of residence (urban vs rural), marital status, number of children, and smoking habits. Those smoking daily were considered smokers.

Statistical methods. The relationship between youth and adult physical activity and changes in physical activity and adult obesity were analyzed using ANOVA. To evaluate the associations between changes in physical activity and the prevalence of obesity in adults, a multinomial logistic regression analysis was applied, with persistent physical activity as the reference group. Adjustment for potential confounding variables was made to evaluate how the changes in physical activity were independently related to the prevalence of obesity. Data were analyzed for men and women separately. Level of significance level was $P < 0.05$. All the statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Inc., version 12, Chicago, IL).

RESULTS

During the 21-yr follow-up, 33.1% of men and 32.0% of women were classified as persistently active, 27.3% of men and 30.3% of women were increasingly active, 28.1% of men and 30.3% of women became decreasingly active, and 11.5% of men and 7.4% of women were classified as persistently inactive. The prevalence of overweight (BMI 25.0–29.9 $kg \cdot m^{-2}$) was 41.4% in adult men and 24.7% in adult women. The prevalence of obesity (BMI $\geq$ 30 $kg \cdot m^{-2}$) was 14.7% in adult men and 12.0% in adult women (Table 1).

Physical activity in youth was inversely associated with both measures of obesity in youth in females but only with BMI in males. Physical activity in youth was not associated with adult obesity. Adult physical activity was related to both measures of adult obesity among females but only with WC among males (Table 2).

The effects of the changes in physical activity from childhood and adolescence to adulthood on adult BMI and WC are shown in Table 3. In both sexes, the participants who were persistently or increasingly active had lower WC values than those who were decreasingly active.

The results of the multiple logistic regression analysis showing the influence of physical activity changes on overweight and obesity measured by BMI are presented in Table 4. Women who had been decreasingly active from youth to adulthood had higher probability of being overweight (OR = 1.79, CI = 1.02–3.16) and obese (OR = 2.09, CI = 1.03–4.26) than women who had been persistently active. These relationships remained significant after adjusting for confounding variables. In addition, women who had been persistently inactive had higher probability of being overweight than women who had been persistently active.

The associations between the physical activity tracking patterns and the risk of abdominal obesity are shown in Table 5. Both men and women who had been decreasingly active were more likely to have mild and severe abdominal obesity in adulthood than those who had been persistently active. In women, these associations remained significant after adjusting for potential confounders.

DISCUSSION

We found that physical activity history over 21 yr was significantly related to abdominal obesity in men and women in unadjusted analyses. Subjects who reported that their physical activity level had decreased from youth to adulthood were at increased risk of being obese in adulthood compared with subjects who reported being persistently active or increasingly active. In women, these relationships remained significant even after adjustment for potential confounders. These observations suggest that changes in physical activity patterns during the lifetime may play an important role in the development of adult obesity in women.

In general, the results support the findings of many previous cross-sectional studies (4,6,15) and longitudinal studies (9,18,21,27) on the relationship between physical activity and obesity. Two recent studies examined how changes in physical activity from youth to adulthood relate to the risk of obesity. Hasselström et al. (9) showed in an 8-yr follow-up study that a change in physical activity from ages 17 to 25 was inversely related to WC and fatness in men (9). Tammelin et al. (21) performed a 17-yr follow-up study and found that becoming inactive during the transition from ages 14 to 31 was associated with overall obesity in both sexes and with severe abdominal obesity in women (21). In the present study, being decreasingly active seemed to be a stronger risk factor for obesity than being persistently inactive. This may be related to a general adverse change in health habits associated with the reduction of physical activity level. It has been hypothesized that increasing one's physical activity might reduce weight gain through increased energy expenditure or favorable changes in adipose tissue (20), while decreasing one's physical activity might increase sedentary behaviors and reduce energy expenditure (15), especially when combined with the increased body fat distribution caused by increased energy intake and unhealthy dietary habits (12).

An unexpected result was that being persistently inactive was not associated with a higher level of adult obesity compared with the persistently active reference subjects. This finding conflicts with the results of two other studies that found that persistent inactivity predicted an increased level of obesity (9,21). In those studies, follow-up time was shorter (8 and 17 yr) and the participants were younger (25 and 31 yr as adults) than those in the present study. In the present study, however, the number of subjects in the persistently inactive group was much smaller than in other groups.

Obesity tracks significantly from youth to adulthood (13,16). We observed that physical activity in youth was inversely related to obesity in youth. Therefore, considering obesity in youth as a confounding variable was important. The relationship between activity history and adult obesity remained significant after controlling for youth obesity and other confounders in women. This suggests that changes in physical activity patterns during the lifetime may have an independent effect on the development of adult obesity in women. In men, the relationships between physical activity patterns and obesity were diluted after controlling for potential confounders. This may indicate that part of the effect of physical activity change on obesity in men is mediated by concomitant changes in sociodemographic and lifestyle habits, which in turn are known to be associated with obesity (12,18).

Physical activity patterns were related to BMI in women but not in men. This sex difference may be explained by differences in body constitution. Women have a higher percentage of body fat than men (12), and men have more skeletal muscle in the upper body, both in absolute terms and relative to body mass, than women (10). Thus, BMI may be a better marker of adipose tissue in women than in men.

There are some limitations in the present study that should be considered when interpreting the results. Diet is an important determinant of obesity. Unfortunately, detailed information on diet was not available from the majority of the study subjects. Without information on diet, it is not possible to assess whether diet could have confounded the results. In the Young Finns Study, the level of physical activity has been assessed at several time points during the follow-up. To have a large enough study sample with statistical power, only data collected in 1980 and 2001 were included in this analysis. We have previously shown, however, that the interage stability coefficients estimated at 3-yr intervals by the Simplex model (sample tracking correlations corrected by reliability coefficients) varied from 0.65 to 0.99 among males and from 0.53 to 0.97 among females (22). This indicates that physical activity behavior is rather stable in youth and suggests that one measure of physical activity during childhood and adolescence may represent the overall activity in youth reasonably well.

The questionnaires for children and adults were not identical. When measuring physical activity using a questionnaire, it is difficult to harmonize the questions targeted at different age groups. For example, the perceived intensity of equally intense physical activity may differ between children and adults. Although children participate in activities that seem very strenuous, their perceived intensity is low and only increases as they get older (23). Adults can more reliably assess the intensity of their physical activity. Therefore, in adults, questions concerning hours and frequency of intensive physical activity may be more relevant than in children. Children, on the other hand, are able to report reliably the frequency of their participation in organized sport, which plays an important role in physical activity among children. Although the questionnaires for young people and adults were different, the tracking correlations from youth to young adulthood were similar to the interage correlations in youth. This suggests that physical activity can be measured using different kinds of questions, provided that the questions are relevant.

In summary, we found that physical activity history over 21 yr was significantly related to abdominal obesity in men and women. These findings suggest that changes in physical activity patterns during the lifetime may play an important role in the development of adult obesity. Persistent participation in regular physical activity from youth to adulthood could aid in the prevention of abdominal obesity in adulthood.

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