American Journal of
Preventive Medicine

RESEARCH ARTICLE

Organized Youth Sports Trajectories and Adult Health Outcomes: The Young Finns Study

Xiaolin Yang, PhD,[1,2] Tuomas Kukko, MS,[2] Irinja Lounassalo, PhD,[1] Janne Kulmala, MS,[2] Harto Hakonen, MS,[2] Suvi P. Rovio, PhD,[3,4] Katja Pahkala, PhD,[3,4,5] Mirja Hirvensalo, PhD,[1] Sanna H. Palomäki, PhD,[1] Nina Hutri-Kähönen, PhD,[6] Olli T. Raitakari, PhD, MD,[3,4,7] Tuija H. Tammelin, PhD,[2] Kasper Salin, PhD[1]

Introduction: This study identified the trajectories of organized youth sports over 9 years in youths aged 9–18 years and examined whether the trajectories predicted physical activity, sedentary behavior, and obesity in midlife.

Methods: Self-reported organized youth sports trajectories were identified for participants between 1980 and 1989 (N=3,474). Accelerometer-derived physical activity was quantified for participants (n=1,349) in 2018–2020. Sociodemographic, physical activity, and TV viewing data were collected through questionnaires either at baselines or follow-up. Adult BMI was calculated to clarify obesity. Associations of organized youth sports trajectories with adult physical activity, sedentary behavior, and obesity were evaluated using mixture models, which were stratified by sex and conducted in 2022.

Results: Three organized youth sports trajectories were identified for boys and girls (sustained high-sports participation, 12.0%/7.5%; sustained moderate-sports participation, 14.0%/13.3%; and low-sports/nonparticipation, 74.0%/79.2%). Boys sustaining both moderate- and high-sports participation had higher levels of adult self-reported physical activity (β=0.59, p=0.007; β=0.69, p<0.001) than low-sports/nonparticipating boys. Girls sustaining both moderate- and high-sports participation accumulated more total physical activity (β=113.4, p=0.009; β=144.3, p=0.002), moderate-to-vigorous physical activity (β=7.86, p=0.016; β=14.01, p<0.001), step counts (β=1,020, p=0.003; β=1,045, p=0.005), and self-reported physical activity (β=0.79, p<0001; β=0.63, p=0.003) in midlife than their low-sports/nonparticipating counterparts. Girls sustaining moderate-sports participation accumulated more light-intensity physical activity (β=19.79, p=0.012) and less sedentary time (β= −27.65, p=0.002), and those sustaining high-sports participation had lower obesity prevalence (OR=0.41, p=0.009) 40 years later than low-sports/nonparticipating girls.

Conclusions: Sustained participation in organized youth sports is independently predictive of physical activity patterns, sedentary time, and obesity in midlife, especially in girls, thus contributing to the development of a healthy and active lifestyle across the life course.
Am J Prev Med 2022;63(6):962–970.

From the [1]Faculty of Sport and Health Sciences, University of Jyväskylä, Jyväskylä, Finland; [2]Likes, School of Health and Social Studies, Jamk University of Applied Sciences, Jyväskylä, Finland; [3]Research Centre of Applied and Preventive Cardiovascular Medicine, Faculty of Medicine, University of Turku, Turku, Finland; [4]Centre for Population Health Research, University of Turku and Turku University Hospital, Turku, Finland; [5]Paavo Nurmi Centre & Unit for Health and Physical Activity, University of Turku, Turku, Finland; [6]Department of Pediatrics, Tampere University of Hospital, University of Tampere, Tampere, Finland; and [7]Department of Clinical Physiology and Nuclear Medicine, Turku University Hospital, Turku, Finland

Address correspondence to: Xiaolin Yang, PhD, Faculty of Sport and Health Sciences, University of Jyväskylä, P.O. Box 35, Jyväskylä 40014 Finland. E-mail: xiaolin.yang@jamk.fi.

0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2022.06.018

INTRODUCTION

Participation in organized youth sports (OYS) is important for children and adolescents to meet the recommended levels of physical activity (PA), which is ≥60 minutes of moderate-to-vigorous PA (MVPA) per day.[1,2] A recent systematic review has shown that intensive participation in OYS predicts higher PA levels in adulthood, particularly among those involved in OYS at least for 3 years.[3] Sustained OYS participation has also been found to predict later health outcomes in terms of reduced obesity and metabolic syndrome,[4,5] better cardiometabolic health,[6] and healthy habits.[7] Most evidence regarding the associations of participation in OYS with adult PA and health outcomes is based on the assessment of OYS between 2 time points.

In epidemiologic research, trajectory modeling has been applied to identify homogeneous subgroups within a given population rather than to assume the existence of subgroups at 2 different intervals.[8] A recent systematic review was conducted to identify distinct trajectories of PA and related factors during the life course.[9] In this review, only 3 of the 27 studies reported the impact of group-based OYS on health profiles in young adulthood such as less smoking,[10] decreased TV viewing,[11] lower BMI and better physical health,[12] and cardiometabolic and mental health profiles.[13] However, some studies found no clear patterns of association between OYS and obesity in cross-sectional designs[14] and long-term prospective studies.[15,16] These mixed results could be due to contextual differences between studies or the lack of repeated longitudinal data in the analysis.

Despite the increased interest in the trajectories of OYS as it relates to obesity and TV viewing in young adulthood, there is a lack of cohort studies of this kind that have assessed such associations in midlife using a longitudinal design. Of various sedentary behaviors (SBs), watching TV remains the most prevalent in Finland despite the proliferation of other electronic devices.[17] Understanding the associations of OYS trajectories in youth with PA, SB, and obesity in midlife is important for assessing the significance of OYS behavior for physical health, especially from a preventive point of view, because adherence to a healthy lifestyle is a central target for prevention efforts. Thus, this study identified OYS trajectories and examined their associations with accelerometer-derived and self-reported PA, SB (i.e., sedentary time and TV viewing), and obesity in midlife, considering the baseline and follow-up characteristics of participants in the Young Finns Study (YFS). Because a few studies previously found that OYS trajectories were associated with adult health profiles in a relatively short period,[10–12] this study specifically analyzed the associations of OYS trajectories with 3 distinct adult health outcomes over a longer period. It was hypothesized that children and adolescents who participated in OYS over 9 years would have higher levels of PA and lower levels of SB and obesity in midlife than low-sports/nonparticipants.

METHODS

Study Population

Data were obtained from the YFS of children and adolescents aged 3–18 years with 6 age cohorts in 1980.[18] From 1980 to 1992, 3,596 participants have been remeasured triennially and then followed up in 4- to 9-year intervals from 1992 to 2011[19] and in 2018–2020.[20] Participants were randomly selected from the 5 Finnish university cities with medical schools (Helsinki, Kuopio, Oulu, Tampere, and Turku) and their surrounding rural communities. For this study, participants (N=3,474) who had at least 1 nonmissing measure of OYS over time were included in trajectory analyses. Adult participants (*n*=1,349) who wore an accelerometer were included in regression analyses. The study was evaluated by the local ethics committees, and written informed consent was obtained from all participants in accordance with the Helsinki Declaration.

Measures

Self-reported OYS was assessed in youth aged 9–18 years in 1980, 1983, and 1986 as well as in those aged 12–18 years in 1989. The youngest children aged 9 years were instructed to ask for the assistance of their parents if needed. Between 1980 and 1989, 3 of the questions were used to measure OYS.[21] The first question was *How many times per week do you usually engage in training sessions of a sport club?* The response alternatives were recoded into 4 scales: 1=no participation, 2=less than once a week, 3=once a week, and 4=many hours and times per week. The second question was *How heavily do you breathe and sweat when you engage in physical activity and sport?* The responses to the question were 1=not at all, 2=moderately, and 3=a lot. The third question asked, *Do you participate in sport competitions in (a) sports clubs, (b) at the regional level, and (c) at the national level?* These were simple yes–no (1,2) responses for each item, which were combined into a sports competition scale from 1 to 4. All questions were then summed to create an OYS index ranging from 3 to 11, with higher scores indicating higher levels of sports participation. Details of the reliability and validity of the PA index, including OYS have been reported elsewhere.[21]

PA in adulthood was measured with a self-administered questionnaire in 2018 and consisted of the intensity of PA, frequency of vigorous PA, hours spent on vigorous PA, average duration of a PA session, and participation in organized PA, all with acceptable-to-good internal consistency (Cronbach's α=0.73). The items were based on the average number of hours/times per week. Each item was coded from 1=low to 3=high and summed to generate a PA index ranging from 5 to 15.[19] The PA index has been found to be reliable and valid to measure PA across the lifespan.[19,21] Simultaneously, the participants were asked to report how much time on average they spent daily on TV viewing. The daily TV viewing was measured in minutes separately for weekdays and weekend days, and those self-reports were calculated by (5 × weekday +2 × weekend)/7 as a mean daily TV viewing.[17]

PA and sedentary time in adulthood were also objectively measured using a triaxial accelerometer (ActiGraph GT3X+ and wGT3X+, FL, USA) in 2018−2020. Briefly, participants were instructed to wear the accelerometer for 7 consecutive days and nights but to remove it for bathing and water activities. Data were collected at a 60 Hz sample rate using normal filter and later averaged to 60-second epochs. Individual-level data from at least ≥10 hours for ≥4 days during awake time were required for inclusion in the analysis. *A total of 60 minutes of consecutive zero counts* were defined as nonwearing time and excluded from data. The accelerometer measures have been recently described in detail elsewhere.[20] For this study, the outcome variables included average vector magnitude counts per minute (cpm) as an index of total PA, steps/day, time spent on sedentary, light-intensity PA, and MVPA. *Cut-points ≤150 cpm for vertical axis* were defined as sedentary time,[22] whereas *cut-points >2,690 cpm for vector magnitude* were defined as MVPA.[23,24]

The participants' height and weight were measured at the baseline and follow-up study visits, and BMI was calculated as weight (kg)/height (m^2). Adult BMI was categorized as follows: normal weight (<25 kg/m^2), overweight (≥25 and <30), and obese (≥30).

Statistical Analyses

Descriptive characteristics are expressed as mean (SD) for continuous variables and as percentages for categorical variables. Sex differences in all variables were analyzed using independent *t*-tests or chi-square tests. Latent profile analysis (LPA) with 2–6 classes was fitted on boys' and girls' OYS on the basis of the data in the first 4 phases, which were synchronized using at least 1 OYS observation at successive ages 9 −18 years. The flexibility of the LPA approach enables the classification of incompletely observed indicators. Classification of OYS was conducted by adjusting for baseline age; BMI; residential place; having siblings; and parental PA, education, and occupation.[25] Several measures of model fit, including information theoretic criteria (Akaike's Information Criterion, Bayesian Information Criterion, Sample-size adjusted Bayesian Information Criterion), likelihood-ratio −based tests (Vuong-Lo-Mendell-Rubin [VLMR], Lo-Mendell-Rubin [LMR], bootstrapped likelihood-ratio test), entropy values, and average posterior probabilities describing the classification uncertainty, were calculated and evaluated to determine the optimal number of classes. To select the most parsimonious adequate model, the lowest values of information criteria, specifically adjusted Bayesian Information Criterion, were favored within the range of class sizes suggested by likelihood-ratio tests.[26] In addition, class sizes with <5% of the total sample were not accepted. In the posthoc analysis, linear regressions were used for all outcome variables representing unstandardized β-coefficients (95% CI). Logistic regressions were used to estimate OR (95% CI) for obesity (category). Both unadjusted and adjusted models were estimated, adjusting for adult participants' age, having children, and own education and income. Models for accelerometer-derived PA were additionally adjusted for wear time. All analyses were conducted in R environment[27] and Mplus, Version 7.0,[28] by R software package MplusAutomation[29] in 2022. Missing data were assumed to be missing at random and were considered missing as a function of observed covariates and observed outcomes.[28] Full information maximum likelihood estimation with robust SEs was used to handle the missing at random assumption to reduce potential bias in the parameter estimates and statistical power to detect statistically significant effects.

RESULTS

Of the 3,474 participants (48.8% males), 10.7% completed all the 4 OYS assessments, 26.6% completed 3, 35.8% completed 2, and 26.9% completed 1. In youth, boys were younger (p=0.004) and had higher OYS at all study phases (all p<0.001) than girls (Table 1). In adulthood, males engaged more in total PA (p=0.005) and MVPA (p<0.001), had higher income (p<0.001), spent more time watching TV (p=0.006), had higher BMI (p=0.048), had lower levels of light-intensity PA (p=0.001), and were less educated (p<0.001) than females. Fathers had higher PA (p<0.001) and manual work (p<0.001) and lower educational attainment (p=0.007) than mothers. No other sex differences were observed.

The 3-class model of boys' and girls' OYS was the most appropriate model according to the goodness-of-fit criteria (Table 2). VLMR and LMR were significant (all p<0.0001), and the highest entropy values were displayed (≥83%) in both sexes. Three trajectory groups were identified for boys and girls: sustained high-sports participation (12.0%/7.5%) subjects generally participated in high-intensity training several hours and times a week and competitions at regional and/or national levels; sustained moderate-sports participation (14.0%/13.3%) subjects typically participated in moderate-intensity training at least once a week and competitions at local sport-club level; and low-sports/nonparticipation (74.0%/79.2%) subjects were either nonparticipants (those not participating in sports at all for the study period), occasional participants (those participating in sports less than once a week), or dropouts/decreasers (those quitting organized sports after the first 2 phases). Boys and girls had age-related increases in the levels of OYS in high- and moderate-sports participation classes from childhood to adolescence (Figure 1A and B).

Sustained moderate- and high-sports participation were associated with higher levels of adult self-reported PA than low-sports/nonparticipation in boys (β=0.59, p=0.007; β=0.69, p<0.001) and girls (β=0.79, p<0001; β=0.63, p=0.003) (Table 3). Girls sustaining both

Table 1. Comparison of Participant Characteristics by Sex

Variables	All (N=3,474),	Males (*n*=1,697),	Females (*n*=1,777),	
	mean (SD)	mean (SD)	mean (SD)	*p*-value
Youth age, years[a]	13.6 (3.2)	13.5 (3.2)	13.7 (3.2)	**0.004**
Adult age, years	48.6 (4.9)	48.5 (4.9)	48.6 (4.9)	0.382
Youth BMI, kg/m^2	17.9 (3.1)	17.9 (3.1)	17.9 (3.1)	0.915
Having siblings, %	85.1	84.6	85.6	0.420
Organized youth sports, index				
1980	5.1 (1.5)	5.3 (1.6)	4.9 (1.5)	**<0.001**
1983	5.2 (1.9)	5.5 (2.1)	4.9 (1.7)	**<0.001**
1986	5.2 (1.9)	5.5 (2.1)	4.9 (1.6)	**<0.001**
1989	5.1 (1.9)	5.4 (2.1)	4.9 (1.7)	**<0.001**
Place of residence, %				
Urban	52.8	52.1	53.5	0.441
Rural	47.2	47.9	46.5	
Adult PA index	9.0 (1.9)	9.0 (1.9)	9.0 (1.9)	0.663
Adult TV viewing, minutes/day	119.8 (70.6)	124.7 (72.5)	115.8 (68.7)	**0.006**
Adult BMI, kg/m^2	27.5 (5.3)	27.7 (4.7)	27.3 (5.8)	**0.048**
Adult education, year, %				
Low (≤13)	28.4	37	21.2	**<0.001**
High (>13)	71.6	63	78.8	
Adult income, annual, %				
<€25,000	17.5	14.4	20.0	**<0.001**
€25,000–€45,000	43.6	33.5	51.8	
>€45,000	38.9	52.1	28.2	
Having children, %	48.3	49.8	47.1	0.262
Adult accelerometer PA	*n*=1,349	*n*=544	*n*=805	
Total PA, cpm	1,034.5 (395.2)	1,072.1 (431.8)	1,009.0 (366.4)	**0.005**
MVPA, minutes/day	54.9 (32.0)	63.0 (36.0)	49.4 (27.6)	**<0.001**
Light-intensity PA, minutes/day	265.1 (72.8)	257.3 (73.4)	270.3 (72.1)	**0.001**
Sedentary time, minutes/day	699.3 (96.0)	699.6 (103.1)	699.2 (91.0)	0.939
Total steps, step/day	8,527 (2,957)	8,520 (3,033)	8,532 (2,907)	0.943
Wear time, minutes/day	1,019 (76)	1,020 (82)	1,019 (72)	0.821
Parental variables				
PA, %		[b]	[c]	
A little	27.0	23.2	30.4	**<0.001**
Occasionally	54.5	55.9	53.2	
Regular	18.5	20.9	16.4	
Education, year, %				
Low (≤9)	55.0	57.9	52.3	**0.007**
Moderate (10–12)	24.9	22.1	27.4	
High (>12)	20.1	20.0	20.3	
Occupation, %				
Manual	36.3	40.3	32.7	**<0.001**
Lower non-manual	29.7	19.6	38.7	
Upper non-manual	34.0	40.1	28.6	

Note: Boldface indicates statistical significance ($p<0.05$).
The *p*-value is determined from Student's *t*-test or chi-square test.
[a]Average age at the youth study occasions.
[b]Fathers.
[c]Mothers.
cpm, count per minute; MVPA, moderate-to-vigorous intensity physical activity; PA, physical activity.

Table 2. The Model Goodness-of-Fit Indices of Latent Profile Analysis for Organized Youth Sports

Class	AIC	BIC	ABIC	VLMR	LMR	BLRT	Entropy	Class sizes, %
Boys (*n*=1,697)								
2	14,476	14,552	14,507	0	0	0	0.82	78.5, 21.5
3	**14,115**	**14,223**	**14,160**	**0**	**0**	**0**	**0.83**	**74, 14, 12**
4	14,010	14,152	14,069	0.277	0.284	0	0.77	66.1, 12.7, 11.3, 9.9
5	13,815	13,989	13,888	0.137	0.142	0	0.77	59.6, 15, 10.5, 8.2, 6.7
6	13,709	13,916	13,795	0.028	0.029	0	0.77	57.5, 15.8, 7.3, 6.8, 6.7, 5.9
Girls (*n*=1,777)								
2	14,247	14,324	14,279	0	0	0	0.85	83.8, 16.2
3	**13,791**	**13,900**	**13,837**	**0**	**0**	**0**	**0.85**	**79.2, 13.3, 7.5**
4	13,581	13,723	13,641	0.715	0.718	0	0.81	72.1, 11.2, 10, 6.6
5	13,463	13,639	13,537	0.038	0.039	0	0.71	59.6, 13.9, 11.2, 8.8, 6.5
6	13,332	13,540	13,420	0.734	0.735	0	0.74	56.3, 18.6, 10.2, 5.8, 4.8, 4.2

Note: Boldface indicates statistical significance ($p<0.05$) and the best model.
Final models were adjusted for baseline age, BMI, parental physical activity, education, place of residence, having siblings, and occupation.
ABIC, adjusted Bayesian Information Criterion; AIC, Akaike's Information Criterion; BIC, Bayesian Information Criterion; BLRT, bootstrapped likelihood-ratio test; LMR, Lo-Mendell-Rubin adjusted likelihood-ratio; VLMR, Vuong-Lo-Mendell-Rubin likelihood-ratio test.

moderate- and high-sports participation accumulated more daily MVPA (β=7.86, p=0.016; β=14.01, p<0.001), step counts (β=1,020, p=0.003; β=1,045, p=0.005), and total PA (β=113.4, p=0.009; β=144.3, p=0.002) 40 years later than their low-sports/nonparticipating counterparts. Girls who maintained high-sports participation also had 59% lower odds of obesity than those who maintained low-sports/nonparticipation (OR=0.41, p=0.009), and those who maintained moderate-sports participation had higher light-intensity PA (β=19.79, p=0.012) and lower sedentary time (β= −27.65, p=0.002) in midlife. These associations were independent of covariates. High- or moderate-sports participating girls had less TV viewing time or lower overweight rates in midlife than low-sports/nonparticipating girls, but this disappeared after multivariable adjustments.

DISCUSSION

This study is the first to examine the association of distinct trajectories of OYS with accelerometer-derived and self-reported PA, SB, and obesity in midlife. Three OYS trajectory classes (sustained high-sports participation, sustained moderate-sports participation, and low-sports/nonparticipation) were identified for boys and

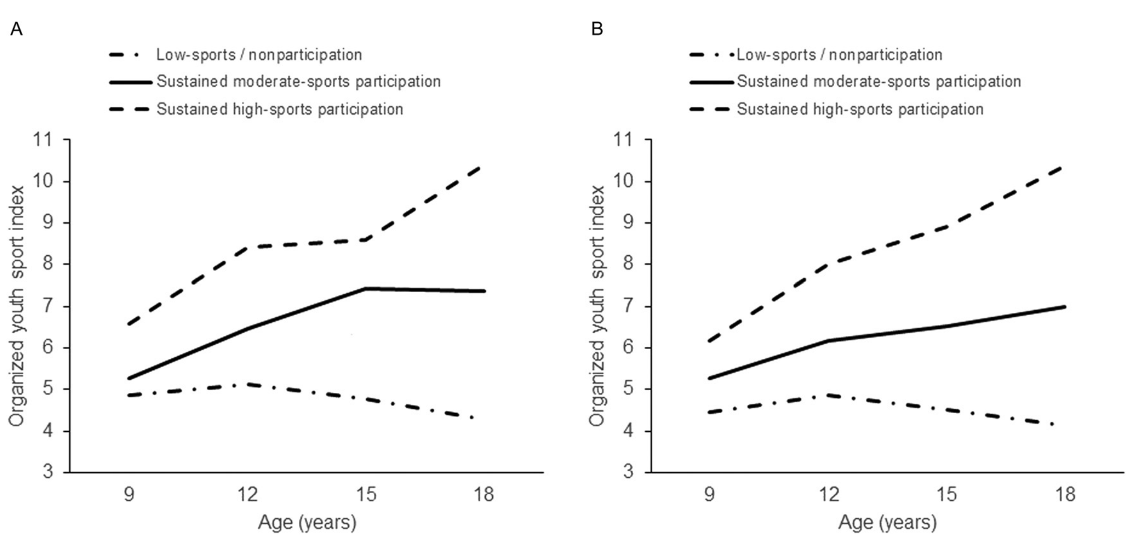

Figure 1. Mean profile lines for latent organized youth sports classes (*C*=3) of (A) boys and (B) girls.

Table 3. Regression Coefficients of Organized Sports Trajectories in Youth on Physical Activity, Sedentary Behavior, and Obesity in Midlife

	Unadjusted model[a]				Adjusted model[b]			
	Sustained high-sports participation in youth (*n*=226 boys/131 girls)		Sustained moderate-sports participation in youth (*n*=166 boys/182 girls)		Sustained high-sports participation in youth (*n*=226 boys/131 girls)		Sustained moderate-sports participation in youth (*n*=166 boys/182 girls)	
Outcome measures in midlife	**β (95% CI)**	***p*-value**	**β (95% CI)**	***p*-value**	**β (95% CI)**	***p*-value**	**β (95% CI)**	***p*-value**
Males								
Total PA (cpm)	60.51 (−49.47, 170.5)	0.280	8.55 (−104.9, 122.0)	0.882	105.4 (−9.98, 220.8)	0.073	1.86 (−114.9, 118.6)	0.975
MVPA (min/day)	3.69 (−5.36, 12.75)	0.423	−3.31 (−12.66, 6.04)	0.487	7.54 (−1.97, 17.05)	0.120	−4.91 (−14.57, 4.75)	0.319
Light−intensity PA (min/day)	−1.28 (−18.97, 16.41)	0.887	7.61 (−10.65, 25.87)	0.413	11.29 (−6.68, 29.26)	0.218	12.55 (−5.70, 30.80)	0.177
Sedentary time (min/day)	−2.42 (−25.29, 20.46)	0.836	−4.30 (−27.91, 19.31)	0.721	−18.83 (−42.40, 4.74)	0.117	−7.64 (−31.58, 16.30)	0.531
Total steps (step/day)	508.1 (−257.5, 1,274)	0.193	−102.9 (−893.2, 687.3)	0.798	707.8 (−105.4, 1,521)	0.088	−258.7 (−1,084, 567.1)	0.538
Self-reported PA (score)	**0.91 (0.56, 1.27)**	**<0.001**	**0.61 (0.19, 1.03)**	**0.005**	**0.69 (0.33, 1.06)**	**<0.001**	**0.59 (0.16, 1.02)**	**0.007**
TV viewing (min/day)	3.16 (−10.49, 16.82)	0.649	−0.88 (−16.84, 15.09)	0.914	15.94 (1.70, 30.18)	0.028	−5.49 (−21.83, 10.85)	0.510
Overweight[c]	1.04 (0.72, 1.52)	0.823	1.47 (0.94, 2.36)	0.099	1.11 (0.69, 1.80)	0.682	1.27 (0.70, 2.38)	0.437
Obese[c]	0.94 (0.61, 1.44)	0.774	1.45 (0.87, 2.43)	0.154	0.90 (0.50, 1.58)	0.703	1.39 (0.72, 2.72)	0.333
Females								
Total PA (cpm)	**148.1 (57.78, 238.3)**	**0.001**	**87.62 (5.22, 170.0)**	**0.037**	**144.3 (52.62, 236.0)**	**0.002**	**113.4 (28.72, 198.1)**	**0.009**
MVPA (min/day)	**15.13 (8.43, 21.84)**	**<0.001**	5.97 (−0.16, 12.11)	0.056	**14.01 (7.13, 20.90)**	**<0.001**	**7.86 (1.48, 14.23)**	**0.016**
Light−intensity PA (min/day)	−3.31 (−20.19, 13.57)	0.700	**18.58 (3.14, 34.02)**	**0.018**	0.81 (−15.94, 17.56)	0.924	**19.79 (4.28, 35.30)**	**0.012**
Sedentary time (min/day)	−11.82 (−30.96, 7.32)	0.226	**−24.55 (−42.06, −7.05)**	**0.006**	−14.83 (−34.10, 4.45)	0.131	**−27.65 (−45.50, −9.80)**	**0.002**
Total steps (step/day)	**1,058 (348.4, 1,768)**	**0.004**	**893.2 (244.2, 1,542)**	**0.007**	**1,045 (312.1, 1,778)**	**0.005**	**1,020 (341.0, 1,698)**	**0.003**
Self-reported PA (score)	**0.76 (0.35, 1.17)**	**<0.001**	**0.70 (0.34, 1.05)**	**<0.001**	**0.63 (0.21, 1.05)**	**0.003**	**0.79 (0.43, 1.16)**	**<0.001**
TV viewing (min/day)	**−18.19 (−33.10, −3.28)**	**0.017**	6.59 (−6.27, 19.46)	0.315	−7.77 (−22.79, 7.26)	0.310	3.93 (−8.99, 16.84)	0.551
Overweight[c]	0.76 (0.49, 1.16)	0.206	**0.64 (0.42, 0.97)**	**0.039**	0.97 (0.58, 1.61)	0.908	0.62 (0.38, 1.01)	0.059
Obese[c]	**0.39 (0.22, 0.68)**	**0.001**	1.07 (0.72, 1.58)	0.744	**0.41 (0.20, 0.78)**	**0.009**	0.93 (0.58, 1.48)	0.758

Note: Boldface indicates statistical significance (p<0.05).
[a]Sports nonparticipation (*n*=1,193 boys/1,361 girls) serves as the reference group for each.
[b]Adjusted for participants' adult age, having children, own education and income, and accelerometer wear time (special for the device).
[c]ORs from regression models with normal weight probands (BMI<25 kg/m^2) coded as a reference level (0) and overweight (≥25 and <30) or obese (≥30) probands coded as 1 in corresponding models.
cpm, count per minute; min, minute; MVPA, moderate-to-vigorous intensity physical activity; PA, physical activity.

girls. This study found that OYS trajectory classes over 9 years were differentially associated with PA, SB, and obesity prospectively. However, no associations were found between OYS trajectories and adult TV viewing in either sex.

The results indicated that the proportion of boys and girls sustaining both moderate- and high-sports participation over 9 years was 26.0% and 20.8%, respectively, which was lower than that of boys (55.2%) and girls (47.5%) in previous research.[12] Changes in OYS over time were also found in previous research[10–12] but not in this study. There are several methodologic aspects that may explain this seemingly inconsistent finding. The first is that this study used 3 items to create an index for OYS, especially sports competitions, which may affect the form of the OYS trajectories. The results, combined with previous studies,[10–12] may provide additional information on OYS trajectories for future investigations. This study confirms previous findings that intensive training and competitive sports in youth tend to increase with age, although the number of participants decreases gradually over time.[30] Second, the LPA approach was used to divide participants into homogenous classes; classification was based on the level of the index on 4 occasions. Most of these participants engaged in OYS on some occasions or even all occasions, but their indices still tended to be low. In this case, the most probable class in the 3-class solution could be the low-sports/nonparticipation. Further research is needed to determine the best method for integrating data from multiple OYS for trajectory evaluation. Finally, this study identified OYS trajectories over relatively longer periods than for previous tracking[3–7] and trajectory[10–12] research. This may emphasize the importance of paying attention to the analytical approach used in this study when analyzing trajectories of sport-specific participation over a longer time.

The findings are not in line with previous studies in which the dropout class was identified (e.g., those who initially participated in OYS and then chose to withdraw from the sport during follow-up periods).[11,12] Although the 4-class model of OYS displayed a dropout trajectory for both sexes, it was dismissed because of its nonsignificance in both VLMR and LMR. This led to the selection of the 3-class solution for OYS, which may attenuate some relevant relationships between classification and outcomes because the actual dropouts were grouped into the low-sports/nonparticipation class. It is therefore possible that dropout from OYS is commonly seen as the result of a long-term process of low-intensity PA or disengagement. Given its importance, future studies should consider the multivariate statistical methods to model and evaluate the assessment of single sport participation in youth by highlighting the interaction of frequency, intensity, and length of time across subgroups during the transition to young adulthood.

The results supported the hypothesis that sustained moderate- and high-sports participation classes were associated with higher levels of adult self-reported PA than low-sports/nonparticipation class in both sexes. Girls sustaining moderate- and high-sports participation accumulated more total PA, MVPA, step counts, and light-intensity PA after 40 years than their low-sports/nonparticipating counterparts. These results are consistent with findings of previous research that found high-intensity exercise and competitions in youth to be associated with higher levels of PA in adulthood.[3] However, not all studies support this point. Some studies revealed that consistent sports participation was not significantly associated with the maintenance of MVPA in young adulthood[11] and found no significant association for females.[12] The differing findings may partially be explained by different samples, the assessments of sports participation, length of follow-up time, and different statistical methods. Another possible explanation could be that girls sustaining OYS participation may have favored accelerometer to improve the accuracy of daily PA in midlife.

This study did not observe any association of OYS trajectories with adult TV viewing, in contrast to previous research, which has found that the consistently active trajectory is associated with low TV viewing over time.[11] However, the study found that girls sustaining moderate-sports participation accumulated less sedentary time in midlife than their low-sports/nonparticipation counterparts. One explanation for this may be that TV viewing is a marker of sedentary activity that may not adequately reflect the total sedentary time in adults.[31,32] This suggests that sustained moderate-sports participation in youth, particularly in girls, should be considered a basis for total sedentary time prevention later in life.

This prospective study found an inverse association between sustained high-sports participation and BMI in females but not in males. It is plausible that athletic activity increases muscle mass, and athletes with intensive training and competitions may have increased relative weight because of increased muscle mass, particularly in male athletes. This is because BMI did not distinguish between fat mass and fat-free mass in youth athletes. For example, Etchcison et al.[33] reported that 13.31% of the 33,896 student athletes (aged 11−19 years) were classified as obese, whereas only 5.95% were classified as obese using skinfold measures. More research is needed to provide an adjustment method for BMI[34] and additional insight into body composition assessment in athletes.[35]

Limitations

This study had several limitations. First, the study assessed trajectories of the index of frequency, intensity, and competition levels of sports participation, but sports specialization was not included in the study owing to incomplete data. Further YFS examinations, including the type of sports and years of training, would enable us to explore the metabolic equivalent task, which is utilized to quantify sports activities at different competitive levels. Second, although the assessments of PA were not comparable between the accelerometer-derived and self-reported methods,[36] the data have shown a modest positive association between the 2 assessments in adults. Third, the study included only TV viewing during leisure-time but did not capture domain-specific (i.e., occupational, transport-related, and domestic) sitting time and other leisure sitting activities. Future studies should take into account a wide range of SBs assessed by accelerometry and self-report. Fourth, the study opted to use classification thresholds for MVPA (>2,690 cpm) and sedentary time (≤150 cpm). These cut-points might influence the amount of MVPA and sedentary time, which could potentially affect the outcomes of the LPA approach. Finally, the trajectory models did not address the change of OYS in both sexes over a 9-year follow-up, which might misclassify the participants who dropped out of sport or decreased sports activities with those who were actually part of the nonparticipation. The dropout/decreasing experiences may either enhance or undermine the influence of compliance with PA, SB, and obesity on adults' health.

CONCLUSIONS

This study identified multiple patterns of OYS from childhood to adolescence over 9 years in both sexes. Sustained moderate- and high-sports participation may contribute to the development of a healthy, physically active lifestyle from childhood to adulthood, particularly in girls. The implication of this finding is that parents, teachers, trainers, health professionals, and policymakers should strive to not only enhance children's athletic experience but also optimize environmental variables toward increasing children's sports participation. More evidence is needed regarding children's involvement in different sports contexts.

ACKNOWLEDGMENTS

The Young Finns study was financially supported by the Academy of Finland (Grants 322098, 286284, and 134309 [EYE]; 126925, 121584, 124282, and 129378 [SALVE]; 117787 [GENDI]; and 41071 [SKIDI]); the Social Insurance Institution of Finland; Finnish Ministry of Education and Culture (Grant 36/626/2020, KS); Jenny and Arttu Wihuri Foundation (KS); Competitive State Research Financing of the Expert Responsibility area of Kuopio, Tampere and Turku University Hospitals (Grant X51001); Juho Vainio Foundation (XY); Paavo Nurmi Foundation; Finnish Foundation for Cardiovascular Research; Finnish Cultural Foundation; Sigrid Juselius Foundation; Tampere Tuberculosis Foundation; Emil Aaltonen Foundation; Yrjö Jahnsson Foundation; Signe and Ane Gyllenberg Foundation; Diabetes Research Foundation of Finnish Diabetes Association; EU Horizon 2020 (Grant 755320 for TAXINOMISIS and Grant 848146 for To Aition); European Research Council (Grant 742927 for MULTIEPIGEN project); and Tampere University Hospital Supporting Foundation. KP is funded by an Academy of Finland research fellowship (Number 322112).

No financial disclosures were reported by the authors of this paper.

CREDIT AUTHOR STATEMENT

Xiaolin Yang: Conceptualization, Methodology, Writing - original draft. Tuomas Kukko: Data curation, Formal analysis, Writing - review and editing. Irinja Lounassalo: Writing - review and editing. Janne Kulmala: Data curation, Investigation, Software. Harto Hakonen: Data curation, Software. Suvi P. Rovio: Data curation, Investigation, Resources, Writing - review and editing. Katja Pahkala: Resources, Visualization, Writing - review and editing. Mirja Hirvensalo: Data curation, Writing - review and editing. Sanna H. Palomäki: Writing – review and editing. Nina Hutri-Kähönen: Investigation, Resources. Olli T. Raitakari: Supervision, Visualization, Writing - review and editing. Tuija H. Tammelin: Funding acquisition, Project administration, Writing - review and editing. Kasper Salin: Funding acquisition, Project administration, Writing - original draft.

REFERENCES

1. Kokko S, Martin L, Geidne S, et al. Does sports club participation contribute to physical activity among children and adolescents? A comparison across six European countries. *Scand J Public Health.* 2019;47(8):851–858. https://doi.org/10.1177/1403494818786110.
2. Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for Americans. *JAMA.* 2018;320(19):2020–2028. https://doi.org/10.1001/jama.2018.14854.
3. Batista MB, Romanzini CLP, Barbosa CCL, Blasquez Shigaki G, Romanzini M, Ronque ERV. Participation in sports in childhood and adolescence and physical activity in adulthood: a systematic review. *J Sports Sci.* 2019;37(19):2253–2262. https://doi.org/10.1080/02640414.2019.1627696.
4. Yang X, Telama R, Viikari J, Raitakari OT. Risk of obesity in relation to physical activity tracking from youth to adulthood. *Med Sci Sports Exerc.* 2006;38(5):919–925. https://doi.org/10.1249/01.mss.0000218121.19703.f7.
5. Yang X, Telama R, Hirvensalo M, Viikari JSA, Raitakari OT. Sustained participation in youth sport decreases metabolic syndrome in adulthood. *Int J Obes (Lond).* 2009;33(11):1219–1226. https://doi.org/10.1038/ijo.2009.171.
6. Logan K, Lloyd RS, Schafer-Kalkhoff T, et al. Youth sports participation and health status in early adulthood: a 12-year follow-up. *Prev Med Rep.* 2020;19(101107). https://doi.org/10.1016/j.pmedr.2020.101107.
7. Palomäki S, Hirvensalo M, Smith K, et al. Does organized sport participation during youth predict healthy habits in adulthood? A 28-year longitudinal study. *Scand J Med Sci Sports.* 2018;28(8):1908–1915. https://doi.org/10.1111/sms.13205.

8. Nguena Nguefack HL, Pagé MG, Katz J, et al. Trajectory modelling techniques useful to epidemiological research: a comparative narrative review of approaches. *Clin Epidemiol.* 2020;30(12):1205–1222. https://doi.org/10.2147/CLEP.S265287.
9. Lounassalo I, Salin K, Kankaanpää A, et al. Distinct trajectories of physical activity and related factors during the life course in the general population: a systematic review. *BMC Public Health.* 2019;19(1):271. https://doi.org/10.1186/s12889-019-6513-y.
10. Rodriguez D, Audrain-Mcgovern J. Team sport participation and smoking: analysis with general growth mixture modeling. *J Pediatr Psychol.* 2004;29(4):299–308. https://doi.org/10.1093/jpepsy/jsh031.
11. Kwon S, Janz KF, Letuchy EM, Burns TL, Levy SM. Developmental trajectories of physical activity, sports, and television viewing during childhood to young adulthood: Iowa bone development study. *JAMA Pediatr.* 2015;169(7):666–672. https://doi.org/10.1001/jamapediatrics.2015.0327.
12. Howie EK, Mcveigh JA, Smith AJ, Straker LM. Organized sport trajectories from childhood to adolescence and health associations. *Med Sci Sports Exerc.* 2016;48(7):1331–1339. https://doi.org/10.1249/MSS.0000000000000894.
13. Howie EK, Mcveigh JA, Smith AJ, et al. Physical activity trajectories from childhood to late adolescence and their implications for health in young adulthood. *Prev Med.* 2020;139:106224. https://doi.org/10.1016/j.ypmed.2020.106224.
14. Nelson TF, Stovitz SD, Thomas MM, LaVoi NM, Bauer KW, Neumark-Sztainer D. Do youth sports prevent pediatric obesity? A systematic review and commentary. *Curr Sports Med Rep.* 2011;10(6):360–370. https://doi.org/10.1249/JSR.0b013e318237bf74.
15. Yang X, Telama R, Leskinen E, Mansikkaniemi K, Viikari J, Raitakari OT. Testing a model of physical activity and obesity tracking from youth to adulthood: the cardiovascular risk in Young Finns Study. *Int J Obes (Lond).* 2007;31(3):521–527. https://doi.org/10.1038/sj.ijo.0803459.
16. Cairney J, Veldhuizen S. Organized sport and physical activity participation and body mass index in children and youth: a longitudinal study. *Prev Med Rep.* 2017;6:336–338. https://doi.org/10.1016/j.pmedr.2017.04.005.
17. Yang X, Kankaanpää A, Biddle SJH, et al. Tracking of television viewing time during adulthood: the Young Finns Study. *Med Sci Sports Exerc.* 2017;49(1):71–77. https://doi.org/10.1249/MSS.0000000000001072.
18. Raitakari OT, Juonala M, Rönnemaa T, et al. Cohort profile: the cardiovascular risk in Young Finns Study. *Int J Epidemiol.* 2008;37(6):1220–1226. https://doi.org/10.1093/ije/dym225.
19. Telama R, Yang X, Leskinen E, et al. Tracking of physical activity from early childhood through youth into adulthood. *Med Sci Sports Exerc.* 2014;46(5):955–962. https://doi.org/10.1249/MSS.0000000000000181.
20. Yang X, Kulmala J, Hakonen H, et al. Tracking and changes in daily step counts among Finnish adults. *Med Sci Sports Exerc.* 2021;53(8):1615–1623. https://doi.org/10.1249/MSS.0000000000002621.
21. Telama R, Yang X, Viikari J, Välimäki I, Wanne O, Raitakari O. Physical activity from childhood to adulthood: a 21-year tracking study. *Am J Prev Med.* 2005;28(3):267–273. https://doi.org/10.1016/j.amepre.2004.12.003.
22. Kozey-Keadle S, Libertine A, Lyden K, Staudenmayer J, Freedson PS. Validation of wearable monitors for assessing sedentary behavior. *Med Sci Sports Exerc.* 2011;43(8):1561–1567. https://doi.org/10.1249/MSS.0b013e31820ce174.
23. Sasaki JE, John D, Freedson PS. Validation and comparison of ActiGraph activity monitors. *J Sci Med Sport.* 2011;14(5):411–416. https://doi.org/10.1016/j.jsams.2011.04.003.
24. Migueles JH, Cadenas-sanchez C, Ekelund U, et al. Accelerometer data collection and processing criteria to assess physical activity and other outcomes: a systematic review and practical considerations. *Sports Med.* 2017;47(9):1821–1845. https://doi.org/10.1007/s40279-017-0716-0.
25. Yang X, Kukko T, Hirvensalo M, et al. Longitudinal associations between parental and offspring's leisure-time physical activity: the Young Finns Study. *Scand J Med Sci Sports.* 2022;32(1):223–232. https://doi.org/10.1111/sms.14066.
26. Tein JY, Coxe S, Cham H. Statistical power to detect the correct number of classes in latent profile analysis. *Struct Equ Modeling.* 2013;20(4):640–657. https://doi.org/10.1080/10705511.2013.824781.
27. R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2020. https://www.r-project.org/index.html. Accessed August 4, 2022.
28. Muthén LK, Muthén BO. *Mplus User's Guide*. Eighth Edition Los Angeles, CA: Muthén & Muthén, 1998 −2017 .
29. Hallquist MN, Wiley JF. MplusAutomation: an R package for facilitating large-scale latent variable analyses in M plus. *Struct Equ Modeling.* 2018;25(4):621–638. https://doi.org/10.1080/10705511.2017.1402334.
30. Telama R, Yang X, Hirvensalo M, Raitakari O. Participation in organized youth sport as a predictor of adult physical activity: a 21-year longitudinal study. *Pediatr Exerc Sci.* 2006;18(1):76–88. https://doi.org/10.1123/pes.18.1.76.
31. Biddle SJH, Gorely T, Marshall SJ. Is television viewing a suitable marker of sedentary behavior in young people? *Ann Behav Med.* 2009;38(2):147–153. https://doi.org/10.1007/s12160-009-9136-1.
32. Clark BK, Healy GN, Winkler EAH, et al. Relationship of television time with accelerometer-derived sedentary time: NHANES. *Med Sci Sports Exerc.* 2011;43(5):822–828. https://doi.org/10.1249/MSS.0b013e3182019510.
33. Etchison WC, Bloodgood EA, Minton CP, et al. Body mass index and percentage of body fat as indicators for obesity in an adolescent athletic population. *Sports Health.* 2011;3(3):249–252. https://doi.org/10.1177/1941738111404655.
34. Nevill AM, Winter EM, Ingham S, Watts A, Metsios GS, Stewart AD. Adjusting athletes' body mass index to better reflect adiposity in epidemiological research. *J Sports Sci.* 2010;28(9):1009–1016. https://doi.org/10.1080/02640414.2010.487071.
35. Mazić S, Lazović B, Delić M, Lazić JS, Aćimović T, Brkić P. Body composition assessment in athletes: a systematic review. *Med Pregl.* 2014;67(7−8):255–260. https://doi.org/10.2298/MPNS1408255M.
36. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *Int J Behav Nutr Phys Act.* 2008;5:56. https://doi.org/10.1186/1479-5868-5-56.