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Longitudinal associations of participation in organized and unorganized sports in youth with physical activity in mid-adulthood: the Young Finns Study

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Abstract

We investigated the longitudinal associations between sports participation patterns in youth and physical activity (PA) in adulthood. PA was self-reported triannually between ages 9-18 (n=2550, 52% females) and measured by accelerometers in mid-adulthood (n=1002, 61% females, aged 48±4 years). Three latent classes of youth sports participation emerged for both genders: 1) “organized sports” (persistent high PA with regular sports club activities), 2) “unorganized sports” (persistent high PA without sports club activities, and 3) “low activity” (low PA with decreasing sports involvement). These groups comprised 29%, 34%, and 37% of males, and 23%, 27%, and 50% of females, respectively. Youth “organized sports” was associated with higher adult PA in both males (+1166 steps/day, p=0.012) and females (+15 min/day moderate-to-vigorous PA [MVPA], +1064 steps/day, +1066 leisure-time steps/day; p≤0.005) compared to “low activity”. In males, youth “organized sports” was associated with higher adult PA (+1103 steps/day, -26 min/day sedentary time, and +133 counts/minute higher total PA, p≤0.039) compared to “unorganized sports”. In females, "unorganized sports” in youth was related to higher adult PA (+10 min/day MVPA, p=0.034) when compared to “low activity”. Sustained participation in youth organized sports, and for females, also in unorganized sports, is positively linked with adult PA.

Keywords: Sports club, childhood, adolescence, accelerometer, follow-up

Introduction

Physical activity (PA) is one of the health habits often adopted during childhood and adolescence (Viner et al., 2012). Although it has been widely recognized that PA during this period has long-term health benefits (e.g., Hallal et al., 2006), it has been reported in recent years that there is a widespread crisis of physical inactivity among children (Aubert et al., 2022, Blomqvist et al., 2019). PA commonly declines during adolescence (Dumith et al., 2011; Farooq et al., 2019), with an average decline of seven percent per year for the total volume of PA (Dumith et al., 2011). Comprehensive reviews exploring PA trajectory classes (Lounassalo et al., 2019), as well as the trajectories of moderate-to-vigorous PA (MVPA) (Farooq et al., 2019), revealed notable declines that actually begin in childhood, as early as the age of six to seven years.

PA levels in youth have been shown to predict PA levels in adulthood, especially when activity in youth is persistent (Lenze et al., 2023; Telama et al., 2014; Yang, Kukko, Kaseva, et al., 2022). PA encompasses a variety of activities, and the context or type of PA during youth may also influence the maintenance of activity into later life. One form of PA for children and adolescents is organized sports, which refers to structured leisure-time physical activities in sports clubs or other institutions, coordinated by adults (Batista et al., 2019, Wiium & Säfvenbom, 2019). These activities encompass both individual and collective sports (e.g., ball games, dancing, or swimming), and can be pursued for competition or leisure (Batista et al., 2019). In contrast, unorganized sports during youth denotes less structured leisure-time physical activities, typically self-coordinated by the youth (Wiium & Säfvenbom, 2019). These activities (e.g., ball games, cycling, and active free play) occur outside the formal structure of a sports club and are primarily undertaken individually or within informal groups. As the settings are usually self-determined, collaboratively

supervised, and relationally process-oriented, the terms self-organized sports or self-organized PA are also used (Kemp et al., 2022; Säfvenbom et al., 2018). In this article, the term unorganized sports will be used.

In recent decades, it has been found that children in Finland are becoming involved in organized sports at a younger age than before (Blomqvist et al., 2019), and the number of participants has increased among youth (Mathisen et al., 2019). Nationwide data in Finland shows that the average age of starting participation is 6 years (Blomqvist et al., 2019). Participation in organized sports is highest during early adolescence, after which it gradually declines, with a notable decrease typically occurring after the age of approximately 14 (Howie et al., 2016; Wall et al., 2011). Participation in unorganized sports among youth is also prone to decline with age, particularly between ages 10-13 (Kemp et al., 2020). The subdomains of unorganized sports also change with increasing age, with physically active free play declining significantly at the beginning of adolescence, while other subdomains (e.g., ball sports, outdoor activities) remain relatively stable or experience minor declines in participation (Kemp et al., 2020).

Participation in organized youth sports, particularly when maintained over time, has been shown to predict PA (Telama et al., 2006; Yang, Kukko, Lounassalo, et al., 2022) and sports participation (Scheerder et al., 2006) in adulthood. In fact, sports participation during youth appears to be a better indicator of adults' involvement in sports than educational level or parental socioeconomic status (Scheerder et al., 2006). Participation in organized sports has also been associated with higher life satisfaction, healthy growth, cognitive abilities, and physical fitness compared to other forms of PA (Drenowatz et al., 2019; Eime et al., 2010), all of which may contribute to regular and sustained PA in later life. However, the continuity of unorganized sports over the life course is sparsely investigated. To our knowledge, there

are few, if any, studies that have specifically targeted unorganized youth sports and PA in later life.

Based on recent findings on the positive associations between sustained organized youth sports and PA in mid-adulthood (Yang, Kukko, Lounassalo, et al., 2022), our investigation expands its focus to encompass not only organized youth sports but also unorganized youth sports activities. This extension aims to provide a more comprehensive understanding of the long-term impact of youth sports activities on adult PA behaviors. Therefore, the purpose of this longitudinal study, with a follow-up period spanning over 40 years, was to explore the associations of longitudinal sports participation patterns in youth, both within and outside sports clubs, with accelerometer-measured PA in midlife.

Methods

Study design and participants

Data were obtained from the Cardiovascular Risk in Young Finns Study (YFS), which is an ongoing, prospective population-based cohort study commenced in 1980 (Raitakari et al., 2008). At baseline, the study sample comprised 3596 children and adolescents aged 3, 6, 9, 12, 15, and 18 years, who were randomly selected from five university hospital catchment areas in Finland. From 1980 to 1992, the participants were re-assessed every three years and were subsequently followed up at intervals of 4 to 9 years between 1992 and 2011 (Telama et al., 2014), and finally in 2018-2020 (Yang et al., 2021). The latest data collection was completed in early March 2020, before the implementation of COVID-19 restrictions in Finland. The study was approved by the ethical committees of each of the five universities, and a written informed consent was obtained from all participants in accordance with the Helsinki Declaration.

The sample for the present analysis includes data from all participants aged 9 to 18 between 1980 and 1989 who reported their participation in sports on at least two out of the four follow-up points (n = 2550). Among these participants, a total of 1001 also provided accelerometer-measured data on adult PA in 2018-2020.

Measures

Sports participation in youth

Participation in organized and unorganized sports during youth was evaluated using self-reported questionnaire data on the frequency and intensity of leisure-time PA (LTPA), and involvement in sports club activities. Data were collected in 1980, 1983, 1986, and for those aged 12-18, also in 1989. Participants aged nine were instructed to seek assistance from their parents if required. All the follow-ups were conducted during the autumn season.

The frequency of LTPA was measured with the question "*How often do you engage in leisure-time physical activity at least half an hour per time?"* The response alternatives were recoded as 0 = less than once a week, 1 = once a week, 2 = twice a week to six times per week, and 3 = daily. The question on the intensity was "*How heavily do you breathe and sweat when you engage in physical activity and sport?"* with response alternatives of 1 = not at all, 2 = moderately, and 3 = a lot. Based on a sum score for the frequency and intensity of LTPA, the participants were classified as high LTPA (a score of 4-6) or low LTPA (≤ 3).

Participation in organized sports was assessed with the question "*How many times per week do you usually engage in training sessions organized by a sport club?"* The response alternatives were recoded as 0 = no participation or participation less than once a week, and 1 = participation at least once a week.

Finally, both LTPA and organized sports participation variables were combined into a single sports participation variable and recoded as follows: 1 = low activity (low LTPA), 2 = participation in unorganized sports (high LTPA but not involved in sports club activities), and 3 = participation in organized sports (high LTPA and involved in sports club activities at least once a week). Indicators of validity and reliability of the individual PA measurements, as well as of a more comprehensive PA sum index that includes organized sports (which was not utilized in the present study) have been reported elsewhere (Hirvensalo et al., 2017; Mansikkaniemi et al., 2012; Telama et al., 1996, 1997, 2005).

Accelerometer-measured PA in adulthood

PA in adulthood was measured with a tri-axial accelerometer (ActiGraph GT3X+ and wGT3X+, FL, USA) during 2018-2020. The accelerometer assessments have been described in detail elsewhere (Yang et al., 2021; Yang, Kukko, Lounassalo, et al., 2022). Briefly, participants were instructed to wear the accelerometer in an elastic waistband over their right hip for seven consecutive days and nights except during water-related activities. Data were collected at a 60 Hz sample rate using normal filter and later averaged to 60-second epochs. Data were analyzed with Customized Visual Basic macro for Excel software. Data from participants with at least four days with ≥10 hours of wear-time during awake time were included in the analysis. Sleep time was calculated using the algorithms from Barreira et al. (2018), with a 70-minute continuous sleep limit applied for bedtime (from the diary). This sleep time was then subtracted from both sedentary and wear time. Non-wear time was defined as 60 minutes of consecutive zero counts and excluded from the data. For this study, the outcome variables included average vector magnitude counts per minute (cpm, an index of total PA), mean daily minutes of sedentary time (ST), light-intensity PA (LPA), and moderate-to-vigorous intensity PA (MVPA), and mean daily counts of total steps and leisure-time steps. Daily leisure-time hours were determined based on participants' self-reported

diary information regarding their working hours. A cut point for ≤150 cpm for the vertical axis was defined as sedentary time (Kozey-Keadle et al., 2011), whereas cut points for >151 to 2690 cpm for vector magnitude were used for LPA and >2690 cpm for MVPA (Migueles et al., 2017; Sasaki et al., 2011).

Covariates and descriptive characteristics

Body mass (kg) and height (cm) were measured at baseline and during follow-up visits, and body mass index (BMI, kg/m^2) was calculated. Residential place (urban vs. rural) was assessed with a questionnaire at baseline and during follow-up visits. Adult educational and income levels, as well as the number of children in the household in adulthood, were self-reported using a questionnaire. The response alternatives for adult education were categorized as ≤ 13 years and >13 years. Annual income levels were categorized as <25000€, 25000-45000€, and >45000€, while the number of children was categorized as having no child or at least one child in the household.

Statistical analysis

Means and standard deviations for the continuous variables and percentages for the categorical data were calculated. Differences between genders were compared with independent samples t-tests and chi-squared tests. Since youth data were utilized for each participant from follow-up points when they were between 9 and 18 years old, and at least two data points were required for inclusion in the sample, the baseline for each participant was individually set between the years 1980 and 1986.

Latent class analysis (LCA) with one to six classes was conducted on youth data to identify subgroups of participants with similar patterns of youth sports participation over time, separately for boys and girls. The indicator variables were the 3-class sports participation variables at ages 9, 12, 15, and 18 years. Logit link functions were used on the categorical

responses. Youth sports participation classes were based on four phases of YFS data, which were synchronized for cohorts by age, successively from ages 9 to 18 years. Missing data within class indicator variables were assumed to be missing at random and subsequently imputed with a relevant correlation structure.

Measures of model fit were calculated including information criteria (AIC, BIC, ABIC), likelihood-ratio tests (VLMR, LMR, BLRT), entropy, and class sizes (Tein et al., 2013). We based the decision of the number of categories on the adjusted Bayesian Information Criteria (ABIC) and class sizes such that the lowest ABIC values with minimum class sizes of 5% were chosen. The classes were nominated according to the class contents after visual and numerical inspection of the proportions of responses in the LCA classes.

Binary logistic regression analysis was used to examine the attrition from baseline until the follow-up. Remaining in the study was indicated by the presence (1) or absence (0) of valid accelerometer data in adulthood. Associations of remaining with participant age, gender, and youth sports participation classification probabilities were calculated as odds ratios.

The associations of latent classification with accelerometer-measured PA outcomes in adulthood were analyzed using linear regression models. Individual classification probability vectors were used to account for the uncertainty in the LCA modeling. The reference class was rotated to enable all desired comparisons between the classes obtained from LCA. Initially, all models were adjusted only for accelerometer wear time (at relevant domain; full week or leisure time), except for total PA provided in counts per minute. Subsequently, all models were further adjusted for follow-up age, body mass index, having children, income class, and education class.

Descriptive analyses were performed in SPSS statistics 28.0 (IBM Corp, Armonk, NY) and regression analyses were performed within the R environment (R Core Team 2020). Latent

class analyses were conducted using Mplus, version 8.8 via R software package MplusAutomation (Hallquist & Wiley, 2018). The significance was set at 5% in all analyses.

Results

Participant characteristics

Participant characteristics are summarized in Table 1 in the full study sample and according to gender. Youth data were obtained from 1226 (48%) male and 1324 (52%) female participants. No significant gender differences were observed in participant age, body mass index, or residential place at baseline. Follow-up data on youth sports participation indicated that at the ages of 9 and 12, most of the participants were physically active during leisure time but not involved in sports club activities (unorganized sports), while at the ages of 15 and 18, they were more likely to be less active. Significant gender differences were observed in the distributions of sports participation up to age 15, indicating that males were more likely to be physically active and involved in sports club activities (organized sports) during leisure time, while females were more likely to be physically less active ($p < 0.001$).

In adulthood, between years 2018 and 2020, the average age of the participants was 48 years. Females were more likely to have children in the household compared to males ($p = 0.028$), while males had lower education levels and higher income than females ($p < 0.001$). Males engaged in more total PA ($p = 0.027$) and MVPA ($p < 0.001$) compared to females. Conversely, females engaged in more LPA ($p = 0.007$) and had higher daily counts of leisure-time steps and longer accelerometer wear time for leisure activities ($p < 0.001$) than males. No gender differences were observed in sedentary time.

Table 1. Participants characteristics in the whole sample and according to gender.

		All (n = 2550)	Males (n = 1226)	Females (n = 1324)	p*
Baseline (1980-86)					
Age, years		10.7 (2.3)	10.6 (2.3)	10.8 (2.3)	0.102
BMI, kg/m^2		17.6 (2.7)	17.5 (2.6)	17.7 (2.8)	0.089
Residential place (%)					
Urban		46.6	47.1	46.3	0.356
Rural		53.4	52.9	53.7	
Baseline and follow-ups (1980-89)					
Sports participation, %					
9-years	Low activity	29.9	22.9	36.9	<0.001
	Unorganized sports	51.6	53.8	49.4	
	Organized sports	18.5	23.3	13.7	
12-years	Low activity	28.7	21.8	35.4	<0.001
	Unorganized sports	42.4	43.0	41.7	
	Organized sports	29.0	35.2	22.9	
15-years	Low activity	42.8	40.9	44.5	<0.001
	Unorganized sports	34.4	32.2	36.3	
	Organized sports	22.9	26.9	19.2	
18-years	Low activity	48.7	48.6	48.8	0.165
	Unorganized sports	36.4	34.7	37.9	
	Organized sports	14.8	16.7	13.3	
2018-2020					
Age, years		47.8 (4.2)	47.7 (4.3)	47.9 (4.1)	0.370
BMI, kg/m^2		27.8 (5.2)[a]	27.8 (4.4)[b]	27.7 (5.8)[c]	0.675
Having children (in the household), %		39.4	37.2	42.2	0.028
Adult education, %					<0.001
≤13 years		25.3	32.4	19.6	
>13 years		74.7	67.6	80.4	
Annual income, %					<0.001
<25000 €		16.4	12.9	19.2	
25000–45000 €		43.9	33.7	52.2	
>45000 €		39.7	53.4	28.6	
Accelerometer-measured PA		n = 1002	n = 394	n = 608	
Wear time, min/day		1015 (73)	1016 (79)	1013 (69)	0.860
Leisure-time wear time, min/day		569 (109)	546 (117)	583 (101)	<0.001
Total PA, cpm		1044 (378)	1078 (403)	1022 (360)	0.027
ST, min/day		695 (93)	696 (98)	695 (89)	0.591
LPA, min/day		264 (71)	256 (70)	269 (71)	0.007
MVPA, min/day		55 (31)	64 (34)	50 (27)	<0.001
Total steps, steps/day		8601 (2885)	8668 (2882)	8557 (2888)	0.551
Leisure-time steps, steps/day		4837 (2323)	4321 (2100)	5171 (2400)	<0.001

Values are mean (SD) unless otherwise noted. Abbreviations: BMI = body mass index, PA = physical activity, cpm = counts per minute, ST = sedentary time, LPA = light physical activity, MVPA = moderate and vigorous physical activity

* The p-value for the gender difference, independent samples t-test or chi-square test. [a] n = 1563, [b] n = 697, [c] n = 866

Latent classes of sports participation in youth

The selection of the final number of classes is shown in Table 2. Based on the lowest ABIC values with adequate class sizes, three latent classes were identified for both males and females. The uncertainty in the classification was high as the model entropies were 0.53 for males and 0.50 for females. The mean proportions of the observed sports participation forms within the latent classes at different ages are shown in Figures 1 and 2. Persistent participation was defined for classes where the mean observed proportions remained the largest throughout the follow-up from age 9 to 18. For males, the classes were as follows: 1) organized sports (high persistent participation in organized sports, 29%), 2) unorganized sports (high persistent but decreasing participation in unorganized sports, 34%), and 3) low activity (low activity with decreasing participation in unorganized sports, 37%) (Fig. 1). For females, the classes were: 1) organized sports (high persistent participation in organized sports, 23%), 2) unorganized sports (high persistent participation in unorganized sports 27%), and 3) low activity (low activity with decreasing participation in unorganized sports, 50%) (Fig. 2). In both genders, the proportions of participation in organized sports within the organized sports class were highest at ages 12 and 15. For males, the unorganized sports class was characterized by high participation in unorganized sports at ages 9 and 12, after which a subsequent increase in low activity was observed. Conversely, in females, participation in unorganized sports remained relatively high and stable at all ages Furthermore, in both genders, the proportions of low activity within the low activity class gradually increased, and participation in organized and unorganized sports decreased with age, with these changes being more pronounced in boys.

Table 2. The model goodness-of fit indices of latent class analyses for youth sports participation in males (n = 1226) and females (n = 1324).

Classes	AIC	BIC	ABIC	VLMR	LMR	BLTR	Entropy	Class sizes (%)
Males								
1	6854	6894	6869	<0.001	<0.001	<0.001	0.00	100
2	6452	6539	6485	<0.001	<0.001	<0.001	0.79	70.8, 29.2
3	**6395**	**6527**	**6445**	**<0.001**	**<0.001**	**<0.001**	**0.53**	**36.9, 34.5, 28.6**
4	6396	6574	6463	0.026	0.027	0.267	0.61	33.8, 29.8, 27.7, 8.7
5	6402	6627	6488	0.165	0.171	1.000	0.61	35.3, 29.7, 15.1, 13.8, 6
6	6412	6683	6515	0.381	0.386	1.000	0.60	33.4, 18.9, 16.5, 11.9, 10.1, 9.1
Females								
1	7266	7308	7282	<0.001	<0.001	<0.001	0.00	100
2	6997	7085	7031	<0.001	<0.001	<0.001	0.69	79.1, 20.9
3	**6957**	**7092**	**7009**	**0.001**	**0.001**	**<0.001**	**0.50**	**50.2, 27.3, 22.5**
4	6943	7124	7013	0.075	0.078	<0.001	0.58	44.3, 34.7, 12.3, 8.6
5	6942	7171	7031	0.167	0.171	<0.001	0.61	41.2, 32, 13.5, 6.6, 6.6
6	6952	7227	7058	1.000	1.000	1.000	0.57	31.2, 27.3, 16.1, 15.7, 5.4, 4.4

Note: Boldface indicates the class solution considered optimal. Final class proportions for the tested latent class models based on estimated posterior probabilities.
Abbreviations: AIC Akaike's information criterion; BIC Bayesian information criterion; ABIC sample-size adjusted Bayesian information criterion; VLMR Vuong-Lo-Mendell-Rubin likelihood ratio test; LMR Lo-Mendell-Rubin adjusted LRT test; BLRT Parametric bootstrapped likelihood ratio test.

Attrition analyses

Out of the 2550 participants included in the LCA analyses, a total of 1001 had valid accelerometer data in adulthood and were included in the final analyses with distal outcomes. The logistic regression analyses indicated that females were more likely to remain in the study than males (OR = 1.83, 95% CI [1.55, 2.16], p < 0.001). Participant age (OR = 1.02, 95% CI [1.00, 1.04], p = 0.105) or latent classification probabilities (organized sports vs. low activity: OR = 1.24, 95% CI [0.96, 1.62], p = 0.104; unorganized sports vs. low activity: OR = 1.11, 95% CI [0.81, 1.53], p = 0.498) were not statistically significantly associated with remaining in the study.

Associations of sports participation in youth with accelerometer-measured PA in midlife

The associations of latent classification probabilities with midlife PA outcomes are shown in Table 3. In males, organized sports in youth was associated with a higher number of daily leisure-time steps in midlife compared to low activity, after adjusting only for accelerometer wear time (B = 727.6, p = 0.030 for Model 1). However, this association did not remain statistically significant in the fully adjusted Model 2. Additionally, organized sports in youth was associated with a greater number of daily total steps in midlife compared to low activity (B = 1165.7, p = 0.012 for Model 2) in the fully adjusted model, but not in Model 1. In males, when compared to unorganized sports, organized sports was associated with higher total PA (B = 133.3, p = 0.039), a higher number of daily steps (B = 1102.9, p = 0.016), and lower sedentary time (B = -26.3, p = 0.039) in midlife in the fully adjusted model only.

In females, both organized sports and unorganized sports in youth were associated with higher MVPA (B = 15.4, p < 0.001 and B = 9.8, p = 0.034 for Model 2) in midlife compared to low activity in youth (Table 3). These associations were observed in both Models 1 and 2. In addition, organized sports in youth was associated with a higher daily step count (B =

1064.4, p = 0.005 for Model 2) and more leisure-time steps (*B* = 1165.6, p < 0.001 for Model 2) in adulthood compared to low activity in both models. Furthermore, organized sports in youth was associated with lower daily minutes of LPA (*B* = -17.8, p = 0.047 for Model 1) in midlife compared to low activity in youth, but the association did not remain statistically significant in the fully adjusted model. In females, no statistically significant associations were observed between organized sports in youth and PA outcomes in midlife when organized sports was compared to unorganized sports in youth.

Table 3. The associations of latent classification probabilities in youth (organized sports, unorganized sports, and low activity) with accelerometer-measured physical activity in midlife.

		Males				Females			
		Model 1		Model 2		Model 1		Model 2	
	Comparison	***B* (SE)**	**p**	***B* (SE)**	**p**	***B* (SE)**	**p**	***B* (SE)**	**p**
Total PA (counts/min)	Organized ≠ Low activity (ref.)	-29.3 (64.9)	0.652	61.2 (65.2)	0.349	85.6 (47.2)	0.070	91.1 (47.8)	0.057
	Unorganized ≠ Low activity (ref.)	-76.3 (75.0)	0.310	-72.1 (73.3)	0.326	67.6 (60.2)	0.262	80.4 (60.7)	0.186
	Organized ≠ Unorganized (ref.)	46.9 (65.6)	0.475	133.3 (64.4)	**0.039**	17.9 (55.8)	0.748	10.8 (55.6)	0.847
ST (min/day)	Organized ≠ Low activity (ref.)	4.0 (13.7)	0.770	-24.6 (13.5)	0.069	0.7 (10.0)	0.945	-8.8 (10.2)	0.387
	Unorganized ≠ Low activity (ref.)	5.1 (15.9)	0.747	1.8 (15.2)	0.907	-0.9 (12.8)	0.945	-9.6 (13.0)	0.459
	Organized ≠ Unorganized (ref.)	-1.1 (13.9)	0.937	-26.3 (13.3)	**0.049**	1.6 (11.9)	0.896	0.8 (11.9)	0.948
LPA (min/day)	Organized ≠ Low activity (ref.)	-2.5 (10.7)	0.818	17.6 (10.6)	0.097	-17.8 (8.9)	**0.047**	-6.5 (8.9)	0.464
	Unorganized ≠ Low activity (ref.)	-0.4 (12.4)	0.971	1.1 (11.9)	0.926	-8.2 (11.4)	0.470	-0.1 (11.3)	0.991
	Organized ≠ Unorganized (ref.)	-2.0 (10.8)	0.852	16.5 (10.4)	0.116	-9.5 (10.6)	0.369	-6.4 (10.4)	0.538
MVPA (min/day)	Organized ≠ Low activity (ref.)	-1.6 (5.4)	0.773	7.0 (5.4)	0.194	17.1 (3.5)	**<0.001**	15.4 (3.6)	**<0.001**
	Unorganized ≠ Low activity (ref.)	-4.7 (6.3)	0.457	-2.9 (6.1)	0.634	9.1 (4.5)	**0.041**	9.8 (4.6)	**0.034**
	Organized ≠ Unorganized (ref.)	3.1 (5.5)	0.571	9.9 (5.3)	0.064	8.0 (4.1)	0.055	5.6 (4.2)	0.183
Steps (per day)	Organized ≠ Low activity (ref.)	521.6 (459.1)	0.257	1165.7 (459.9)	**0.012**	1234.7 (374.6)	**0.001**	1064.4 (379.9)	**0.005**
	Unorganized ≠ Low activity (ref.)	71.7 (531.1)	0.893	62.8 (516.9)	0.903	777.1 (478.9)	0.105	746.7 (482.6)	0.122
	Organized ≠ Unorganized (ref.)	449.9 (464.4)	0.333	1102.9 (454.6)	**0.016**	457.6 (445.1)	0.304	317.7 (443.4)	0.474
Leisure-time steps (per day)	Organized ≠ Low activity (ref.)	727.6 (334.3)	**0.030**	608.5 (338.7)	0.073	1378.4 (312.7)	**<0.001**	1165.6 (314.4)	**<0.001**
	Unorganized ≠ Low activity (ref.)	187.8 (387.5)	0.628	-3.0 (383.9)	0.994	675.7 (398.9)	0.091	668.1 (397.8)	0.094
	Organized ≠ Unorganized (ref.)	539.8 (336.3)	0.109	611.5 (334.1)	0.068	702.8 (371.3)	0.059	497.5 (367.6)	0.177

Note: Model 1 is adjusted for accelerometer wear time (except for Total PA). Model 2 is adjusted for adult age, body mass index, having children, income class, education class, and accelerometer wear time. Abbreviations: PA = physical activity, ST = sedentary time, LPA = light physical activity, MVPA = moderate-to-vigorous physical activity.

Discussion

This population-based, prospective longitudinal cohort study investigated the associations of sports participation patterns in youth with accelerometer-measured PA in midlife. Three latent classes of youth sports participation were identified for both genders: organized sports (persistent high LTPA with regular sports club activities), unorganized sports (persistent high LTPA outside sports clubs), and low activity (low LTPA with decreasing participation in unorganized sports). Among females, both organized sports and unorganized sports in youth were associated with higher PA levels in midlife compared to low activity in youth. On the contrary, among males, persistent organized sports in youth was associated with higher PA in adulthood compared to both unorganized sports and low activity in youth. No significant associations with adult PA were observed among males when comparing unorganized sports with low activity in youth.

Consistent with previous findings on the positive associations between organized youth sports and PA in adulthood (Batista et al., 2019), our study revealed that sustained participation in organized sports in youth was associated with approximately 1100 more daily steps in midlife in both genders and, in females, additional 15 minutes of MVPA per day compared to those who sustained low activity. However, a novel finding was that in females, continuous participation in unorganized sports in youth also showed a similar association with higher MVPA in adulthood. These results are in line with previous findings by Sheerder et al. (2006), indicating that females involved in organized or unorganized leisure-time sports between the ages of 15-18 had higher chances of active sports participation in adulthood compared to non-participants. In males, on the contrary, we observed that only organized sports in youth was associated with higher PA levels in midlife, and interestingly, this association was more pronounced when comparing organized sports to unorganized sports

rather than low activity. In males, persistent organized sports was linked to higher total PA and approximately 30 minutes less sedentary time per day in adulthood compared to unorganized sports.

The lack of positive association between unorganized sports in youth and adult PA in males, and the overall gender differences in the associations with adult PA levels, could, in part, relate to gender differences in youth sports participation and the latent class solutions employed in our study. Specifically, in boys, the low activity class included a considerable number of those participating in organized or unorganized sports at younger ages and becoming more commonly low-active later in youth. In girls, the observed changes in low activity over time were less pronounced, and the class was considered persistently low-active. Similarly, the mean proportions of individuals participating in unorganized sports within the unorganized sports class were initially high in boys at younger ages, but the proportions of individuals with low activity increased within the class over time. In contrast, in girls, the distributions remained relatively stable, with consistently high levels of participation in unorganized sports at all ages. Additionally, it is worth noting that the average inclusion probability for the low activity class was 50% in girls, whereas in boys, the class sizes of organized, unorganized, and low activity were more similar with each other.

Several factors have also been suggested in the literature to explain the potential gender differences in the associations of youth sports participation and PA in later life (e.g., Batista et al., 2019). Participants of organized and unorganized sports settings typically differ in their motivations and goals, and, for example, the level of competition is usually higher in organized settings compared to unorganized settings (Deelen et al., 2018). Competition is a typical motivation for sports participation, especially among boys (Koski et al., 2022), and higher levels of competition have been shown to predict higher PA levels in adulthood

(Telama et al., 2006). In girls, motives for sports participation appear to be more health, fitness, and sociality related (Koski et al., 2022), which may support the continuity of PA for both organized and unorganized sports. Gender differences in the associations could also relate to possible differences in sports modalities (e.g., individual vs. collective) and disciplines during youth, which we could not assess in the present study, however. Finally, adult covariates appeared to have varying influences on the associations between youth sports participation and adult PA. In males, statistically significant associations were observed only in fully adjusted models, whereas in females, the associations were mostly independent of covariates or slightly attenuated after adjustments.

Perspectives

While positive associations with adult PA were observed more for organized than unorganized sports during youth, our results suggest that LTPA outside sports clubs also deserves attention, especially for females. Although organized sports attracts children and adolescents, many (especially females) either do not participate or drop out (Blomqvist et al., 2019). Barriers such as overly competitive environments, high costs, and lack of competence (Koski et al., 2022) should be considered. Additionally, more opportunities and affordances for non-competitive and unorganized sports, including active free play, are needed. These can include participant-controlled “lifestyle sports” that allow children to engage on their terms, free from adult-imposed schedules or rules (Säfvenbom et al., 2018). In Finland, promoting extracurricular activities after school could also serve as an effective and accessible way to engage children and adolescents in less competitive forms of PA, focusing on social aspects and basic motor skills rather than excellence in traditional sports. Promoting equality in sports settings is a key goal for the 2020s, with a priority on highlighting opportunities for all youth.

Strengths and limitations

This study has its limitations. Firstly, the measures of LTPA and organized sports participation in youth were not optimal for the present research questions and there was no specific measure for unorganized sports. Additionally, information on different sports disciplines was not available. Therefore, the latent classes of unorganized sports (persistent high LTPA outside sports clubs) may not completely reflect the definition of unorganized sports in this article. Secondly, the assessment of adult PA relied on a single follow-up point. Although accelerometers provide accurate measures, they have limitations in capturing certain activities, such as water-based activities and strength training. Thirdly, the sample size for accelerometer data was rather small compared to the original sample, particularly among males. However, potential attrition bias induced by gender could be avoided by conducting gender-stratified analyses. The latent classification probabilities were not associated with study attrition, and thereby, did not introduce bias into the results either. Fourth, while the study benefited from the use of LCA in identifying trajectories of youth sport participation, the current 3-class solution exhibited considerable amount of classification uncertainty, as indicated by the entropy values. However, instead of assigning participants to classes (modal approach), posterior classification probabilities (full posterior information) were used to estimate associations with distal outcomes. Finally, we highlight the exploratory nature of this analysis and did not adjust the p-values for multiple testing to reduce the risk of false negatives. Given the large number of statistical tests performed, caution is warranted when interpreting individual analysis results. Due to the observational design, we cannot assume a causal relationship between youth sports participation and adult PA.

This study also has several strengths. The study benefits from a prospective cohort design over a 40-year follow-up period and a representative population-based sample, which was large enough to conduct gender-stratified analyses. The study incorporated repeated measures

of self-reported LTPA and organized sports participation in youth over nine years, and accelerometer-measured PA in middle adulthood. Several potentially confounding factors were controlled in the analysis of the associations between latent classification probabilities and adult PA.

Conclusion

In this prospective follow-up study, we found that for females, persistent participation in organized and unorganized sports during youth were both associated with higher accelerometer-measured moderate-to-vigorous PA in midlife. Additionally, participation in organized sports was associated with higher daily total and leisure-time step counts in midlife for females. In contrast, for males, only organized sports showed positive associations with adult PA. These observational findings, especially those in females, provide a rationale for promoting youth sports participation, both within and outside sports clubs, as part of strategies to support a physically active lifestyle. Future research is needed on the underlying mechanisms explaining these associations, facilitating more effective promotion of lifelong PA.

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Disclosure

The authors report there are no competing interests to declare.

References

Aubert, S., Barnes, J. D., Demchenko, I., Hawthorne, M., Abdeta, C., Nader, P. A., Sala, J. C. A., Aguilar-Farias, N., Aznar, S., Bakalár, P., Bhawra, J., Brazo-Sayavera, J., Bringas, M., Cagas, J. Y., Carlin, A., Chang, C.-K., Chen, B., Christiansen, L. B., Christie, C. J.-A., … Tremblay, M. S. (2022). Global Matrix 4.0 Physical Activity Report Card Grades for Children and Adolescents: Results and Analyses From 57 Countries. *Journal of Physical Activity and Health*, *19*(11), 700–728. https://doi.org/10.1123/jpah.2022-0456

Barreira, T. V., Redmond, J. G., Brutsaert, T. D., Schuna, J. M., Mire, E. F., Katzmarzyk, P. T., & Tudor-Locke, C. (2018). Can an automated sleep detection algorithm for waist-worn accelerometry replace sleep logs? *Applied Physiology, Nutrition, and Metabolism = Physiologie Appliquee, Nutrition Et Metabolisme*, *43*(10), 1027–1032. https://doi.org/10.1139/apnm-2017-0860

Batista, M. B., Romanzini, C. L. P., Barbosa, C. C. L., Blasquez Shigaki, G., Romanzini, M., & Ronque, E. R. V. (2019). Participation in sports in childhood and adolescence and physical activity in adulthood: A systematic review. *Journal of Sports Sciences*, *37*(19), 2253–2262. https://doi.org/10.1080/02640414.2019.1627696

Blomqvist, M., Mononen, K., Koski, P., & Kokko, S. (2019). Urheilu ja seuraharrastaminen. In S. Kokko & L Martin (Eds.), *Lasten ja nuorten liikuntakäyttäytyminen Suomessa. LIITU-tutkimuksen tuloksia 2018* (pp. 47–56). Valtion liikuntaneuvosto. https://www.liikuntaneuvosto.fi/wp-content/uploads/2019/09/VLN_LIITU-raportti_web-final-30.1.2019.pdf

Deelen, I., Ettema, D., & Kamphuis, C. B. M. (2018). Sports participation in sport clubs, gyms or public spaces: How users of different sports settings differ in their

motivations, goals, and sports frequency. *PloS One*, *13*(10), e0205198. https://doi.org/10.1371/journal.pone.0205198

Drenowatz, C., Greier, K., Ruedl, G., & Kopp, M. (2019). Association between Club Sports Participation and Physical Fitness across 6- to 14-Year-Old Austrian Youth. *International Journal of Environmental Research and Public Health*, *16*(18), 3392. https://doi.org/10.3390/ijerph16183392

Dumith, S. C., Gigante, D. P., Domingues, M. R., & Kohl, H. W., III. (2011). Physical activity change during adolescence: A systematic review and a pooled analysis. *International Journal of Epidemiology*, *40*(3), 685–698. https://doi.org/10.1093/ije/dyq272

Eime, R. M., Harvey, J. T., Brown, W. J., & Payne, W. R. (2010). Does sports club participation contribute to health-related quality of life? *Medicine and Science in Sports and Exercise*, *42*(5), 1022–1028. https://doi.org/10.1249/MSS.0b013e3181c3adaa

Farooq, A., Martin, A., Janssen, X., Wilson, M. G., Gibson, A. M., Hughes, A., & Reilly, J. J. (2020). Longitudinal changes in moderate-to-vigorous-intensity physical activity in children and adolescents: A systematic review and meta-analysis. Obesity reviews : an official journal of the International Association for the Study of Obesity, 21(1), e12953. https://doi.org/10.1111/obr.12953

Hallal, P. C., Victora, C. G., Azevedo, M. R., & Wells, J. C. K. (2006). Adolescent physical activity and health: A systematic review. *Sports Medicine (Auckland, N.Z.)*, *36*(12), 1019–1030. https://doi.org/10.2165/00007256-200636120-00003

Hallquist, M. N., & Wiley, J. F. (2018). MplusAutomation: An R Package for Facilitating Large-Scale Latent Variable Analyses in Mplus. *Structural Equation Modeling: A*

Multidisciplinary Journal, *25*(4), 621–638. https://doi.org/10.1080/10705511.2017.1402334

Hirvensalo, M., Magnussen, C. G., Yang, X., Telama, R., Heinonen, I., Hutri-Kähönen, N., Salin, K., Viikari, J., Raitakari, O. T., & Tammelin, T. H. (2017). Convergent Validity of a Physical Activity Questionnaire against Objectively Measured Physical Activity in Adults: The Cardiovascular Risk in Young Finns Study. *Advances in Physical Education*, *07*(04), 457–472. https://doi.org/10.4236/ape.2017.74038

Howie, E. K., McVeigh, J. A., Smith, A. J., & Straker, L. M. (2016). Organized Sport Trajectories from Childhood to Adolescence and Health Associations. *Medicine and Science in Sports and Exercise*, *48*(7), 1331–1339. https://doi.org/10.1249/MSS.0000000000000894

Kemp, B. J., Parrish, A.-M., Batterham, M., & Cliff, D. P. (2020). Participation in Domains of Physical Activity Among Australian Youth During the Transition From Childhood to Adolescence: A Longitudinal Study. *Journal of Physical Activity and Health*, *17*(3), 278–286. https://doi.org/10.1123/jpah.2018-0705

Kemp, B. J., Parrish, A.-M., Batterham, M., & Cliff, D. P. (2022). Changes in subdomains of non-organized physical activity between childhood and adolescence in Australia: A longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity*, *19*(1), 73. https://doi.org/10.1186/s12966-022-01311-2

Koski, P., Hirvensalo, M., Villberg, J., & Kokko, S. (2022). Young People in the Social World of Physical Activities: Meanings and Barriers. *International Journal of Environmental Research and Public Health*, *19*(9), Article 9. https://doi.org/10.3390/ijerph19095466

Kozey-Keadle, S., Libertine, A., Lyden, K., Staudenmayer, J., & Freedson, P. S. (2011). Validation of Wearable Monitors for Assessing Sedentary Behavior. *Medicine &*

Science in Sports & Exercise, *43*(8), 1561. https://doi.org/10.1249/MSS.0b013e31820ce174

Lenze, L., Klostermann, C., Schmid, J., Lamprecht, M., & Nagel, S. (2023). The role of leisure-time physical activity in youth for lifelong activity—A latent profile analysis with retrospective life course data. *German Journal of Exercise and Sport Research*. https://doi.org/10.1007/s12662-023-00884-9

Lounassalo, I., Salin, K., Kankaanpää, A., Hirvensalo, M., Palomäki, S., Tolvanen, A., Yang, X., & Tammelin, T. H. (2019). Distinct trajectories of physical activity and related factors during the life course in the general population: A systematic review. *BMC Public Health*, *19*(1), 271. https://doi.org/10.1186/s12889-019-6513-y

Mansikkaniemi, K., Juonala, M., Taimela, S., Hirvensalo, M., Telama, R., Huupponen, R., Saarikoski, L., Hurme, M., Mallat, Z., Benessiano, J., Jula, A., Taittonen, L., Marniemi, J., Kähönen, M., Lehtimäki, T., Rönnemaa, T., Viikari, J., & Raitakari, O. T. (2012). Cross-sectional associations between physical activity and selected coronary heart disease risk factors in young adults. The Cardiovascular Risk in Young Finns Study. *Annals of Medicine*, *44*(7), 733–744. https://doi.org/10.3109/07853890.2011.590146

Mathisen, F. K. S., Kokko, S., Tynjälä, J., Torsheim, T., & Wold, B. (2019). Leisure-time physical activity and participation in organized sports: Changes from 1985 to 2014 in Finland and Norway. *Scandinavian Journal of Medicine & Science in Sports*, *29*(8), 1232–1242. https://doi.org/10.1111/sms.13431

Migueles, J. H., Cadenas-Sanchez, C., Ekelund, U., Delisle Nyström, C., Mora-Gonzalez, J., Löf, M., Labayen, I., Ruiz, J. R., & Ortega, F. B. (2017). Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes:

A Systematic Review and Practical Considerations. *Sports Medicine (Auckland, N.Z.)*, *47*(9), 1821–1845. https://doi.org/10.1007/s40279-017-0716-0

Raitakari, O. T., Juonala, M., Rönnemaa, T., Keltikangas-Järvinen, L., Räsänen, L., Pietikäinen, M., Hutri-Kähönen, N., Taittonen, L., Jokinen, E., Marniemi, J., Jula, A., Telama, R., Kähönen, M., Lehtimäki, T., Åkerblom, H. K., & Viikari, J. S. (2008). Cohort Profile: The Cardiovascular Risk in Young Finns Study. *International Journal of Epidemiology*, *37*(6), 1220–1226. https://doi.org/10.1093/ije/dym225

Säfvenbom, R., Wheaton, B., & Agans, J. P. (2018). 'How can you enjoy sports if you are under control by others?' Self-organized lifestyle sports and youth development. *Sport in Society*, *21*(12), 1990–2009. https://doi.org/10.1080/17430437.2018.1472242

Sasaki, J. E., John, D., & Freedson, P. S. (2011). Validation and comparison of ActiGraph activity monitors. *Journal of Science and Medicine in Sport*, *14*(5), 411–416. https://doi.org/10.1016/j.jsams.2011.04.003

Scheerder, J., Thomis, M., Vanreusel, B., Lefevre, J., Renson, R., Vanden Eynde, B., & Beunen, G. P. (2006). Sports Participation Among Females From Adolescence To Adulthood. *International Review for The Sociology of Sport*, *41*(3), 413–430. https://doi.org/10.1177/1012690207077702

Tein, J.-Y., Coxe, S., & Cham, H. (2013). Statistical Power to Detect the Correct Number of Classes in Latent Profile Analysis. *Structural Equation Modeling: A Multidisciplinary Journal*, *20*(4), 640–657. https://doi.org/10.1080/10705511.2013.824781

Telama, R., Leskinen, E., & Yang, X. (1996). Stability of habitual physical activity and sport participation: A longitudinal tracking study. Scandinavian Journal of Medicine & Science in Sports, 6(6), 371–378. https://doi.org/10.1111/j.1600-0838.1996.tb00109.x

Telama, R., Yang, X., Hirvensalo, M., & Raitakari, O. (2006). Participation in Organized Youth Sport as a Predictor of Adult Physical Activity: A 21-Year Longitudinal Study. *Pediatric Exercise Science*, *18*(1), 76–88. https://doi.org/10.1123/pes.18.1.76

Telama, R., Yang, X., Laakso, L., & Viikari, J. (1997). Physical activity in childhood and adolescence as predictor of physical activity in young adulthood. *American Journal of Preventive Medicine*, *13*(4), 317–323.

Telama, R., Yang, X., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., Viikari, J. S. A., & Raitakari, O. T. (2014). Tracking of physical activity from early childhood through youth into adulthood. *Medicine and Science in Sports and Exercise*, *46*(5), 955–962. https://doi.org/10.1249/MSS.0000000000000181

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O. (2005). Physical activity from childhood to adulthood: A 21-year tracking study. *American Journal of Preventive Medicine*, *28*(3), 267–273. https://doi.org/10.1016/j.amepre.2004.12.003

Viner, R. M., Ozer, E. M., Denny, S., Marmot, M., Resnick, M., Fatusi, A., & Currie, C. (2012). Adolescence and the social determinants of health. *The Lancet*, *379*(9826), 1641–1652. https://doi.org/10.1016/S0140-6736(12)60149-4

Wall, M. I., Carlson, S. A., Stein, A. D., Lee, S. M., & Fulton, J. E. (2011). Trends by age in youth physical activity: Youth Media Campaign Longitudinal Survey. *Medicine and Science in Sports and Exercise*, *43*(11), 2140–2147. https://doi.org/10.1249/MSS.0b013e31821f561a

Wiium, N., & Säfvenbom, R. (2019). Participation in Organized Sports and Self-Organized Physical Activity: Associations with Developmental Factors. *International Journal of Environmental Research and Public Health*, *16*(4), 585. https://doi.org/10.3390/ijerph16040585

Yang, X., Kukko, T., Kaseva, K., Biddle, S. J. H., Rovio, S. P., Pahkala, K., Kulmala, J., Hakonen, H., Hirvensalo, M., Hutri-Kähönen, N., Raitakari, O. T., & Tammelin, T. H. (2022). Associations of parental physical activity trajectories with offspring's physical activity patterns from childhood to middle adulthood: The Young Finns Study. *Preventive Medicine*, *163*, 107211. https://doi.org/10.1016/j.ypmed.2022.107211

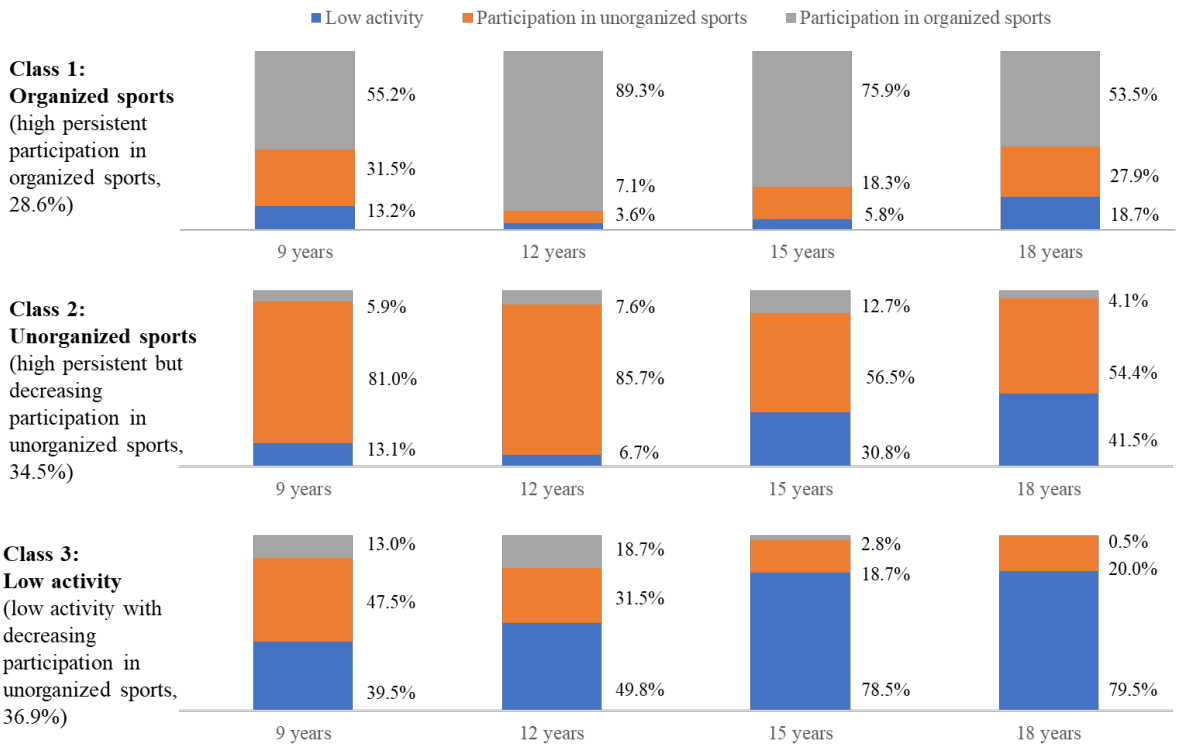
Yang, X., Kukko, T., Lounassalo, I., Kulmala, J., Hakonen, H., Rovio, S. P., Pahkala, K., Hirvensalo, M., Palomäki, S. H., Hutri-Kähönen, N., Raitakari, O. T., Tammelin, T. H., & Salin, K. (2022). Organized Youth Sports Trajectories and Adult Health Outcomes: The Young Finns Study. *American Journal of Preventive Medicine*, *63*(6), 962–970. https://doi.org/10.1016/j.amepre.2022.06.018

Yang, X., Kulmala, J., Hakonen, H., Hirvensalo, M., Rovio, S. P., Pahkala, K., Kukko, T., Hutri-Kähönen, N., Raitakari, O. T., & Tammelin, T. H. (2021). Tracking and Changes in Daily Step Counts among Finnish Adults. Medicine and science in sports and exercise, 53(8), 1615–1623. https://doi.org/10.1249/MSS.0000000000002621

Figures

Figure 1. The associations of latent classes with observed sports participation forms within latent classification analysis (C = 3) for males in probability scale.

Figure 2. The associations of latent classes with observed sports participation forms within latent classification analysis (C = 3) for females in probability scale.



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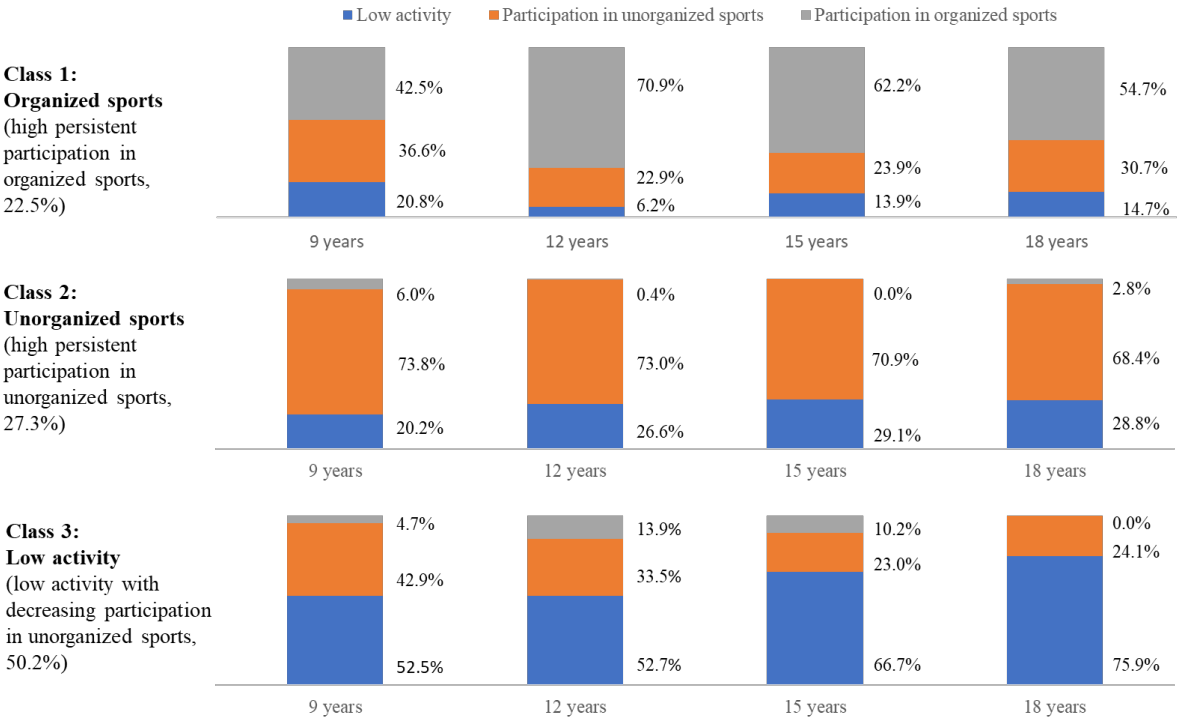

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