Sex differences in the trajectories of and factors related to extracurricular exercise: A cohort study spanning 13 years

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Abstract

Background Extracurricular exercise (ECE) refers to regular exercise/sports participation in addition to the normal physical exercise education in school among a school-aged population. Rather than general physical activity, ECE is typically deliberately initiated and presents an efficient target for interventions. However, relatively few studies have investigated sex differences in the development of ECE from childhood to emerging adulthood. This study aimed to examine the latent trajectories of ECE from childhood to emerging adulthood across sexes and to identify the associated sex-specific individual (i.e., body mass index, body dissatisfaction, stress, and screen behavior) and parental factors (i.e., parental exercise and parental screen behavior).

Methods This study used data from part of the Child and Adolescent Behavior in Long-term Evolution (CABLE) project, which comprised 2,072 fourth graders (aged 9 years) in Northern Taiwan followed from 2001 to 2013. Repeated-measures latent class analysis was used to identify the trajectories of ECE for males and females, respectively. Multinomial logistic regression was further used to identify sex-specific factors related to ECE after controlling for the parental education level, family monthly income, and parental marital status.

Results Four trajectories of ECE were identified for males and females. For males, these trajectories were Rarely-to-Never, Often-to-Rarely, Always-to-Never, and Always. For females, these trajectories were Rarely-to-Never, Rarely, Always-to-Rarely, and Always. We observed that the developmental patterns of ECE varied by sex such that there was an earlier decline in the trajectories of ECE in females than in males and that, compared with males, fewer females maintained exercise habits in young adulthood. Furthermore, we found several sex-specific factors related to ECE, namely, stress, BMI, and parental exercise. Body dissatisfaction and individual screen behavior were associated with trajectories of ECE for both sexes.

Conclusions We found distinct trajectories of ECE from childhood to emerging adulthood for both sexes. The trajectories of ECE for males and females, however, differ in terms of patterns and associated factors. Our findings suggest that efforts to increase ECE should be initiated early and may be made more effective by considering sex differences.

Introduction

The World Health Organization (WHO) identifies physical inactivity as the fourth leading cause of global mortality [1]. Enhancing physical activity can yield substantial benefits for physical health, mental health, academic achievement, and cognitive outcomes [2–4]. Despite recognition that engagement in regular physical activity should be developed early in life, namely during childhood and adolescence, 81% of adolescents across the world do not meet WHO recommendations regarding physical activity [5, 6]. Instead of targeting physical activity, exercise may be a more efficient area in which to intervene [7]. Exercise is “a subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the

objective [8, 9].”. In general, exercise is the primary source of activities that are of sufficient intensity and duration to yield moderate-to-vigorous energy expenditure for most of the populace [7]. Thus, increasing the quantity of exercise will inevitably escalate the overall level of physical activities.

Extracurricular exercise (ECE), referring to regular exercise/sports participation in addition to the normal physical exercise course in school, is a significant form of health-promoting physical activity [10]. Normal physical exercise course in school is typically disciplined and ruled by school and government policies. For instance, in Taiwan, every school is required to provide at least two hours of physical exercise courses for each student per week. However, given the tight school schedule, there is typically no other free time in which to exercise. Most students participate in physical exercise courses and fulfill school requirements. However, these requirements may not be sufficient to meet the recommendation of at least 60 minutes of moderate-to-vigorous physical activity each day [4]. Thus, increasing the level of ECE is a means to compensate for this deficit.

Although numerous longitudinal studies have identified a declining pattern of exercise and physical activity during adolescence [11–14], not everyone has reduced the frequency with which they exercise. For example, Farooq et al.’s [13] longitudinal study found that a significant minority of boys (18.8%) maintained a level of moderate-to-vigorous intensity physical activity from the age of 7 to 15 years, whereas the level for the remaining boys and all the girls decreased. Another study found that a third of Canadian boys and girls continued high-frequency exercise from age 4 to 17 years [15]. Based on previous findings, it is likely that adolescents may follow different developmental patterns of exercise and that segmenting a population according to latent ECE trends can depict this development more precisely. However, no existing study has examined the distinct long-term patterns of ECE. Moreover, understanding the factors involved in increasing or maintaining ECE may highlight future intervention strategies that can be designed to develop exercise habits.

Sex differences in exercise have been well-established by scholars [16]. However, mixed findings in the existing literature suggest that the role of sex in the development of exercise still requires further investigation. For instance, a longitudinal study monitoring British adolescents from the age of 7 to 11 years found that exercise among girls decreased more rapidly than among boys [17]. Another longitudinal study following a group of American adolescents from the age of 10 to 12 years found that girls increased exercise during after-school hours, whereas boys maintained exercise; however, no sex differences were found in school-time exercise [14]. These inconsistent results substantiate the need to understand the effects of sex differences in the distinct developmental patterns of ECE and factors that contribute to such disparities.

There is also evidence of sex differences in the important psychosocial determinants of exercise, including body mass index (BMI), body dissatisfaction, perceived stress, screen time, and parental behaviors. Specifically, females with a lower BMI were found to have a higher probability of exercising, whereas body mass had no significant association with exercise in males [18]. Similarly, higher body dissatisfaction (indicated by greater body shame and higher appearance anxiety) was associated with

decreased rates of participation in physical activities by females [19]. By contrast, males with a higher level of stress and less screen time were more likely to exercise than females [20, 21]. Parental behavior, an essential social factor associated with exercise [22, 23], has also been found to have differential influences on exercise across sexes [23, 24]. However, whether these factors have sex-specific associations with trajectories of ECE is yet to be explored.

To fill these gaps in the literature, this study aimed to (1) depict the trajectories of ECE in males and females from childhood to emerging adulthood and (2) identify sex differences in factors associated with ECE trajectories. To the best of our knowledge, this is the first longitudinal study focusing on the sex-specific developmental patterns of ECE over a long lifespan (i.e., 13 years) and further examining whether factors related to these distinct patterns vary by sex. Establishing the developmental patterns of ECE, such as whether they are increasing, decreasing, or maintaining, and their associated factors can help facilitate the development of effective exercise-enhancing programs.

Methods

Participants, Design and Setting

Data for this secondary analysis were obtained from the Child and Adolescent Behaviors in Long-term Evolution (CABLE) project. The study commenced in 2001 and followed participants annually until 2016. The CABLE project aimed to investigate the development of healthy behaviors from childhood to adolescence based on a socioecological model. Participants were cluster-sampled from all public elementary schools in Taipei City and Hsinchu County in Taiwan based on a list of names provided by the Ministry of Education in 2001. Nine schools from each area were selected. Two cohorts, first and fourth graders in each school, were followed. Further details regarding the sampling process, sample size calculations, and instrument development are described elsewhere [25]. Signed informed consent was provided by the parents or primary caregivers of all participating students.

In the CABLE project, data were collected from students and their parents. Regarding the students, first to ninth graders completed their questionnaires in the classroom under the supervision of trained instructors. From the 10th grade onwards, students were interviewed individually by trained interviewers. In the first four annual assessments, primary caregivers also completed parent-version questionnaires, which inquired about the parental education level, family income, marital status, and parental behaviors. The project was approved by the Human Research Medical Ethics Committee of the National Health Research Institutes in Taiwan (EC9009003).

In this study, we analyzed data from the second cohort (fourth graders), who were followed annually from 2001 to 2013 (aged 9 to 21 years). The completion rate ranged from 81.6% to 98.1% during the study period. The final analytical sample comprised 2,072 participants (1,075 males and 997 females) who were enrolled in 2001 and provided at least one wave of data on the measure of ECE. Overall, 46.53% of participants provided ECE data in all 13 waves, and 13.61%, 7.53%, 7.92%, 6.03%, 4.01%, 2.12%, 3.47%,

1.69%, 1.30%, 1.88%, 0.97%, and 2.94% of participants provided ECE data in twelve waves to one wave, respectively. Reasons for the attrition rate included moving, refusal to be interviewed, health issues, and loss of contact.

Measures

ECE. The measurement of ECE was assessed annually by asking participants “Not counting normal physical exercise courses in school, have you exercised/participated in sports in the past week?”. The possible responses were “1 = never,” “2 = rarely (one or two days),” “3 = often (three to six days),” and “4 = always (every day).”

Related factors. This study examined the sex-specific effects of several individuals and parental factors on the trajectories of ECE. Specific measures for each factor were as follows.

Individual factors. All individual factors were measured from 2001 (aged 9 years) to 2006 (aged 14 years), and scores at each wave were averaged to reflect the mean levels of each factor. BMI was measured by self-reported weight (kg) divided by the square of height (m^2). *Body dissatisfaction* was measured using four items, namely self-perceived satisfaction with appearance, figure, height, and weight [26], all of which were rated on a 5-point scale ranging from 1 (very satisfied) to 5 (very unsatisfied). The body dissatisfaction score was obtained by summing the four items, with higher scores indicating a higher level of body dissatisfaction (Cronbach’s alpha of 0.68 to 0.72). *Stress* was assessed using questions adapted from a previous study [27] that asked participants to rate their perceived levels of stress from eight different sources (e.g., academic performance, relationships with friends, and relationships with parents). All items were rated on a 5-point scale ranging from 0 (absolutely no stress) to 4 (extremely high-level stress) and were summed to create an overall stress score (Cronbach’s alpha of 0.79 to 0.84). *Screen behavior* was assessed using two items: “Have you used a computer or played video games continuously for more than two hours in the past week?” and “Have you watched television continuously for more than two hours in the past week?” All responses were rated on a four-point scale ranging from 1 (never) to 4 (every day). The level of screen behavior was computed by summing the frequencies of these two items.

Parental factors. *Parental* exercise was measured by one item asking parents “Have you exercised in the past week?” and was dichotomized as “regular exercise” (defined as at least one parent had often or always exercised) and “irregular exercise or none exercise.” *Parental screen behavior* was measured at each wave from 2001 to 2004 by using the same two items that assessed students’ screen behavior. Response categories for these two items, which ranged from 1 (never) to 5 (always), were summed and averaged across 4 years to reflect the level of parental screen behavior.

Control variables. Parental education, household income, and marital status were included as control variables based on the previous evidence of associations between these social demographic variables and exercise [18]. All control variables were collected between 2001 and 2004 and reported by parents or primary caregivers. *Parental education* was measured as the highest level of education attained by either

parent and was coded as low (less than or equal to 12 years) or high (more than or equal to 13 years). *Monthly household income* was averaged across 4 years and categorized as low (less than 59,999 new Taiwan dollars (NTD; 1 NTD ≈ 0·03 $US), medium (60,000–119,999 NTD), or high-income (more than 120,000 NTD) groups. *Parental marital status* was dichotomized as married or not married.

Analytic Procedure

Descriptive statistics included means, standard deviations, and study variables' distribution. Student's t-test and chi-square test were used to identify associations between the study variables and sex. Repeated-measures latent class analysis (RMLCA) was used to identify distinct ECE trajectories from childhood to young adulthood [28]. RMLCA is a statistical method that can be used to cluster individuals into a number of latent classes based on the pattern of responses to ECE questions at discrete time points [28]. All models were estimated using SAS version 9.4 (SAS Institute Inc., Cary, NC) via Proc LCA. The number of latent patterns was determined using 1) fit indices, namely the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample size-adjusted BIC, where a lower value indicates a better model; 2) average classification probability (ACP), where a higher value indicates better classification; and 3) interpretation of latent groups. According to a recent simulation study, BIC was preferred when comparing models [29]. We performed multiple group comparisons to determine potential sex differences [30] and found that the latent classes of exercise varied by sex. RMLCA and subsequent analyses were therefore stratified by sex. Finally, multinomial logit models were used to examine associations between related factors and different trajectories of ECE across sex.

Missing Data

In RMLCA, missing data were addressed using the maximum likelihood estimation [28]. For the multinomial logistic model, only complete data were used (n = 1701, 82.09%). We compared the analytic sample with those that had missing data and found no differences between the two samples in terms of sex, body dissatisfaction, stress, screen behavior, parental education, parental exercise, and parental screen behavior. However, those with missing data were significantly more likely to have a lower level of BMI (18.9 vs. 19.6), parents who were not married (18.6% vs. 12.8%), or parents with low education (32.7% vs. 29.16%). A sensitivity analysis was performed to assess the robustness of findings. This involved comparing results by using a multiple imputation strategy with results applying a list-wise deletion technique [31]. Twenty sets of missing values were imputed when conducting multiple imputations by using Markov Chain Monte Carlo methods, and the results of each data set were then combined to perform multinomial logistic regressions.

Results

Sample Characteristics

The descriptive statistics are presented in Table 1. Sex differences were evident in individual factors. For instance, males had higher BMI and engaged in more frequent screen behavior than females. By contrast,

females were more dissatisfied with their body and expressed a higher level of stress than males. Among parental factors, no sex differences were identified. Most of the parents reported having exercised irregularly or not exercised in the past week (n = 1195, 62.57%). The average frequency of parental screen behavior ranged from rarely to sometimes. In terms of control variables, a greater proportion of males had parents with high-level education (41.46%) than did females (36.03%). There were no significant differences in other control variables across sex. The majority of parents were married (n = 1716, 86.14%) and had a monthly household income between 60,000 to 120,000 NTD (equals to 2,000 to 4,000 USD) (n = 983, 49.62%).

Trajectories of ECE from Ages of 9 to 21 Years

Table 2 displays the results of fit indices for LCA models with different numbers of latent groups. In males, the log-likelihood statistic fell substantially when the number of latent classes increased to four. The four-class model also had the lowest BIC (14627.51) and high ACP (0.83), indicating that it was the best-fitting model. For females, the model with four groups was also the best-fitting, with the lowest value of BIC (12953.44) and a relatively high ACP (0.84).

Table 3 shows the item-response probabilities for males. Class 1 was the largest class (32% of males) and was labeled as “Often-to-Rarely.” Children who belonged to the Often-to-Rarely class had a high probability of often engaging in ECE from the age of 9 years, but this changed to rarely engaging in ECE after they entered high school (age of 14 years). Class 2 was labeled “Rarely-to-Never” (20%) and consisted of participants who rarely engaged in ECE from the age of 9 years and then never engaged in ECE when they were 17 years old. Class 3 accounted for 21% of males and was labeled as “Always-to-Never.” This included participants with a high probability of always engaging in ECE from the age of 9 to 14 years and a high probability of never engaging in ECE after the age of 18 years. Class 4 was labeled as “Always” (27%) and consisted of participants with the highest probability of always engaging in ECE over time. The average probability of correctly classifying participants into each latent class was 0.79, 0.86, 0.81, and 0.83 for classes 1, 2, 3, and 4, respectively.

Regarding the four latent classes of ECE in females, Class 1 was labeled as “Always-to-Rarely” and accounted for 33% of females. Females in this class had a high probability of always engaging in ECE from the age of 9 to 11 years and an increasing probability of rarely engaging in ECE from the age of 14 years. Class 2 (34%) was labeled as “Rarely-to-Never” and included female participants who had a high probability of rarely engaging in ECE at the beginning of the study and a high probability of never engaging in ECE from the age of 14 years onwards. Class 3 was the smallest class (10%) and labeled as “Always,” as they had the highest probability of always engaging in ECE over time. However, although the pattern of the “Always” class for females was similar to that for males, the proportion of females was much smaller (10% of females vs. 27% of males). Class 4 was labeled as “Rarely” and included females who had the highest probability of rarely engaging in ECE over time. The average probability of correctly classifying female participants into each latent class was 0.82, 0.85, 0.89, and 0.82 for classes 1, 2, 3, and 4, respectively

Factors Associated with Trajectories of ECE

Table 4 shows the results of multinomial logistic regressions for males and females. Similar results were observed in the sensitivity analysis with complete data based on a multiple imputation strategy (Additional files 1). We use the “Rarely-to-Never” class, the lowest level of ECE, as the reference group, because we can investigate the factors which can promote participants’ ECE. The results indicated that males who had higher levels of body dissatisfaction were significantly less likely to be categorized in the “Often-to-Rarely,” “Always-to-Never,” and “Always” classes. Furthermore, males who had higher stress were significantly less likely to be categorized in the “Always-to-Never” and “Always” classes. In addition, males who reported more frequent screen behavior had a lower probability of being categorized in the “Often-to-Rarely” class, but a higher probability of being categorized in the “Always-to-Never” class. Regarding parental factors, males with regularly exercising parents had higher probabilities of being categorized in the “Always-to-Never” class and “Always” class than did their counterparts.

In females, again using the “Rarely-to-Never” class as the reference group, those with a higher BMI level had a higher probability of being categorized in the “Always-to-Rarely,” “Always,” and “Rarely” classes (Table 4). Females who were more dissatisfied with their body were less likely to be categorized in the “Always” and “Rarely” classes. Females who reported more frequent screen behavior were also significantly less likely to be categorized in the “Always-to-Rarely” and “Rarely” classes. No parental behavioral factor was found to be associated with trajectories of ECE in females.

Discussion

This study identified four trajectories of ECE from childhood to emerging adulthood (age of 9 to 21 years) for males and females. For males, these trajectories were Rarely-to-Never, Often-to-Rarely, Always-to-Never, and Always. For females, these trajectories were Rarely-to-Never, Rarely, Always-to-Rarely, and Always. Sex differences emerged in patterns and factors related to ECE. Specifically, compared with males, fewer females maintained relatively high frequencies of ECE during the study period (10% < 27%), and a decline in regular exercise occurred much earlier. Regarding related factors, stress and parental exercise were significantly associated with trajectories of ECE in males but not in females. By contrast, BMI was only significantly associated with ECE trajectories in females.

Extending previous findings on sex differences regarding trends in physical exercise [32, 33], we found that the age of decline in regular ECE was earlier for females (age 11) than males (age 14) when comparing trajectories of ECE with similar patterns across sexes (“Always-to-Never” in males and “Always-to-Rarely” in females). In addition, the proportion of females with decreasing patterns of exercise was almost 1.5 times higher than that of males (67% vs. 41%). Moreover, although more than a quarter of males frequently exercised over 13 years, only a tenth of females maintained exercise habits from adolescence to young adulthood. All these observations indicate that females may be more likely to have an inactive lifestyle than males when entering young adulthood. Despite these observed sex differences, we still found a substantial number of individuals with regular ECE, which was similar to previous

findings [13, 15], indicating that exercise habits can be developed and sustained in this age group. Therefore, it is essential to develop effective health promotion strategies to encourage ECE and help young people develop regular exercise habits, especially females.

We also observed sex differences in factors related to ECE. First, stress and parental exercise were only associated with ECE trajectories in males. Specifically, males with a higher level of stress had a higher chance of developing chronically low frequencies of ECE ("Rarely-to-Never" compared with "Always-to-Never" and "Always"). Despite the surprising and counterintuitive nature of the observed direction of the association between stress and ECE, it is likely that males who belonged to the "Rarely-to-Never" class were those who initially had a higher level of stress. Given that our study cannot infer causality, future research should further investigate causal relationships between stress and exercise among males. In addition, we found that males with parents who regularly exercise were more likely to engage in high-frequency ECE (i.e., "Always-to-Never" and "Always" compared with "Rarely-to-Never"). This finding supports social-learning theory in that it shows parental behavior has a modeling effect on offspring's behavior [23, 24]. The reasons as to why the observed association between parental exercise and ECE in offspring was only significant in males; however, merits further examination.

We found that BMI was only associated with trajectories of ECE in females. The observed sex differences may be due to the fact that females are more concerned about their weight and are more likely to use exercise to control this than males [34, 35]. Prior studies have also found that the association between BMI and exercise was more apparent among females than males [18, 36]. The nature of the observed association between BMI and ECE trajectories in females, however, was inconsistent with previous research. Specifically, although other studies have indicated that females with higher BMI were less likely to exercise [18, 36], we found that females with higher BMI were more likely to initiate and maintain ECE. Factors that may have contributed to these discrepancies include differences in the study design, sample characteristics, analytical strategy, and exercise measurement. Because there are currently no other studies exploring the association between BMI and ECE trajectories, further research is needed to clarify these relationships.

There are also similarities in factors related to ECE for both sexes. For example, we found that body dissatisfaction was significantly associated with low frequencies of ECE (i.e., Rarely-to-Never in males and females). In a Chinese society that emphasizes the face-conscious (Mianzi) nature of social life [37], adolescents in our sample who had high body dissatisfaction may be unwilling to exercise because they feel embarrassed when doing so [19]. Screen behavior was the other factor that was associated with low ECE in both sexes. Extending previous findings on the negative association between screen behavior and physical activity (e.g., Sisson et al., 2010), we demonstrated that screen behavior in childhood could have lasting effects on the initiation and maintenance of ECE. Therefore, it is vital for both sexes to reduce screen behavior in the early stages of life to increase the likelihood of exercise in the future.

Our study has some notable strengths. First, the use of longitudinal data allowed us to delineate the sex-specific development of ECE across multiple stages of life. Second, by applying a sophisticated data

analysis, we could capture distinct developmental patterns and factors associated with ECE. Specifically, we identified important sex differences in both the timing of the decline and factors associated with the trajectories of ECE in males and females. Therefore, our findings not only provide important information regarding the identification of potential high-risk groups, they also help develop sex-specific strategies for intervention.

Several limitations in the study also need to be addressed. For instance, exercise was measured using a single retrospective self-reported question that may be subject to recall bias. Second, because our sample was drawn from northern Taiwan, the generalizability of our findings may be limited. Thus, caution should be exercised when applying the current results to other populations. Third, CABLE project did not measure the duration of ECE, therefore, the trajectories can only represent the frequencies of exercise. Finally, constrained by the use of secondary data, we were not able to investigate the effects of other potentially important factors, including exercise knowledge, attitudes, the motivations of family members and friends, and the availability of exercise facilities.

Conclusions

This study enhances the existing understanding of the development of ECE from childhood to young adulthood by revealing sex differences in patterns of ECE and factors associated with ECE. The earlier timing of a decline in the trajectories of ECE in females suggests that interventions to promote ECE should be initiated earlier. Additionally, because factors associated with ECE are different for males and females, interventions should be tailored accordingly to increase their effectiveness.

Declarations

Abbreviations

ECE: Extracurricular exercise; BMI: Body mass index

Ethical approval and consent to participate

The project was approved by the Human Research Medical Ethics Committee of the National Health Research Institutes (approval code EC9009003). All parents or guardians in the study signed the informed consent form at baseline to allow their children to participate

Consent for publication

Not applicable

Availability of data and materials

The data used in the present study can be made available on request to the correspondence authors.

Competing interests

The authors declare no competing interests.

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Authorship Contribution

WCH, LYC and HYC designed the research, had full access to all the data in the study, and take primary responsibility for the integrity of the data and accuracy of the analysis. WCW performed the statistical analysis and wrote the first draft of the manuscript. LYC supervised the study and revised the draft. HYC supervised the conceptualization and statistical analysis, and gave valuable comments. DLL provided valuable comments about exercise. CCW coordinated and supervised the field work. FS critically revised and reviewed the manuscript, and gave valuable comments during the study period. LLY acted as the guarantor of the paper and vouched for its validity.

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Tables

Table 1. Descriptive statistics for multi-faceted related factors across sex

	Total (n=2072)			Male (n=1075)			Female (n=997)			P-value
ated Factors	n	mean or %	SE	n	mean or %	SE	n	mean or %	SE	
ividual factors										
ly Mass Index (averaged)	1952	19.56	0.08	1013	20.04	0.12	939	19.03	0.10	<0.001
ly dissatisfaction (Range: 4-20, averaged)	1791	11.92	0.07	924	11.15	0.10	867	12.74	0.10	<0.001
ess (Range: 0-32, averaged)	1792	10.10	0.12	924	9.24	0.17	868	11.01	0.17	<0.001
een behavior (Range: 2-8, averaged)	2011	3.91	0.03	1043	4.19	0.04	968	3.60	0.03	<0.001
ental Factors										
ental screen behavior (Range: 2-10, averaged)	1995	4.84	0.03	1035	4.87	0.04	960	4.79	0.04	0.165
ental exercise										
egular	715	37.43%		366	37.12%		349	37.77%		0.769
regular or no exercise	1195	62.57%		620	62.88%		575	62.23%		
ntrol variables										
ental highest education level										
ow (<= 12 years)	1256	61.15%		624	58.54%		632	63.97%		0.012
igh (>=13 years)	798	38.85%		442	41.46%		356	36.03%		
nily monthly income (averaged)										
ow	584	29.48%		287	27.92%		297	31.16%		0.083
edium	983	49.62%		508	49.42%		475	49.84%		
igh	414	20.90%		233	22.67%		181	18.99%		
ental marriage status										
ot married	276	13.86%		147	14.22%		129	13.47%		0.628
arried or living together	1716	86.14%		887	85.78%		829	86.53%		

ividual-level factors were averaged based on available data from 2001 to 2006.

ental level factors and control variables were averaged based on available data from 2001 to 2004.

Table 2. Determining the number of latent groups

Number of latent classes	Log-likelihood	AIC	BIC	Adjusted BIC	ACP
Males (n=1075)					
1	-14883.36	15712.29	15906.51	15782.64	1.00
2	-14170.26	14366.09	14759.51	14508.59	0.92
3	-13968.68	14042.93	14635.56	14257.59	0.86
4	**-13825.06**	**13835.68**	**14627.51**	**14122.50**	**0.83**
5	-13718.09	13701.75	14692.79	14060.72	0.83
6	-13619.73	13585.02	14775.26	14016.14	0.81
Females (n=997)					
1	-13383.32	13826.91	14018.19	13894.33	1.00
2	-12776.92	12694.10	13081.58	12830.67	0.91
3	-12586.32	12392.91	12976.58	12598.63	0.85
4	**-12436.66**	**12173.58**	**12953.44**	**12448.44**	**0.84**
5	-12337.51	12055.29	13031.33	12399.30	0.82
6	-12257.19	11974.65	13146.89	12387.81	0.82

AIC, Akaike Information Criterion; BIC, the Bayesian Information Criterion; Adjusted BIC, sample size-adjusted BIC. ACP, average classification probability.

Bolded letters indicate selected models.

Table 3. Item-response probabilities for a four-class model of exercise from ages 9 through 21 by gender.

Latent class and membership probability	Male: Class 1				Male: Class 2				Male: Class 3				Male: Class 4			
	Often-to-Rarely				Rarely-to-Never				Always-to-Never				Always			
	32%				20%				21%				27%			
age	Never	Rarely	Often	Always	Never	Rarely	Often	Always	Never	Rarely	Often	Always	Never	Rarely	Often	Always
9	0.06	0.32	**0.35**	0.28	0.14	**0.51**	0.22	0.14	0.09	0.19	0.27	**0.44**	0.04	0.11	0.24	**0.61**
10	0.03	0.27	**0.35**	0.36	0.12	**0.45**	0.27	0.16	0.00	0.14	0.31	**0.55**	0.01	0.04	0.16	**0.78**
11	0.00	0.21	**0.46**	0.34	0.16	**0.45**	0.28	0.11	0.03	0.07	0.29	**0.61**	0.01	0.03	0.08	**0.87**
12	0.02	0.27	**0.41**	0.30	0.27	**0.57**	0.12	0.04	0.02	0.17	0.33	**0.48**	0.02	0.04	0.19	**0.74**
13	0.04	0.28	**0.44**	0.25	0.21	**0.59**	0.15	0.05	0.04	0.20	0.28	**0.48**	0.01	0.04	0.24	**0.71**
14	0.02	**0.34**	**0.34**	0.30	0.29	**0.47**	0.16	0.08	0.09	0.24	0.26	**0.41**	0.00	0.08	0.17	**0.75**
15	0.08	**0.41**	0.35	0.15	0.44	**0.41**	0.07	0.08	0.22	**0.38**	0.19	0.20	0.08	0.14	0.23	**0.55**
16	0.02	**0.43**	0.41	0.15	0.37	**0.48**	0.08	0.06	0.34	**0.37**	0.17	0.12	0.03	0.09	0.25	**0.63**
17	0.07	**0.48**	0.29	0.16	**0.45**	0.38	0.06	0.12	0.36	**0.40**	0.14	0.10	0.05	0.15	0.29	**0.51**
18	0.04	**0.44**	0.35	0.17	0.32	**0.50**	0.14	0.04	**0.44**	0.36	0.10	0.09	0.06	0.20	**0.40**	0.34
19	0.07	0.39	**0.41**	0.13	0.38	**0.43**	0.13	0.07	**0.47**	0.33	0.04	0.16	0.08	0.26	**0.35**	0.31
20	0.04	**0.43**	0.41	0.11	**0.44**	0.36	0.12	0.08	**0.61**	0.29	0.06	0.03	0.13	0.30	**0.36**	0.21
21	0.11	**0.45**	0.35	0.09	**0.48**	0.38	0.11	0.02	**0.64**	0.25	0.08	0.03	0.17	0.29	**0.40**	0.13

Latent class and membership probability	Female: Class 1				Female: Class 2				Female: Class 3				Female: Class 4			
	Always-to-Rarely				Rarely-to-Never				Always				Rarely			
	33%				34%				10%				23%			
age	Never	Rarely	Often	Always	Never	Rarely	Often	Always	Never	Rarely	Often	Always	Never	Rarely	Often	Always
9	0.02	0.17	0.35	**0.46**	0.10	**0.41**	0.27	0.22	0.04	0.23	0.28	**0.46**	0.10	**0.51**	0.25	0.13
10	0.01	0.06	0.41	**0.52**	0.12	**0.36**	0.32	0.21	0.04	0.26	0.18	**0.52**	0.06	**0.55**	0.33	0.07
11	0.00	0.07	0.42	**0.51**	0.11	**0.42**	0.32	0.15	0.04	0.22	0.27	**0.47**	0.09	**0.56**	0.31	0.05
12	0.00	0.15	**0.47**	0.38	0.26	**0.46**	0.21	0.07	0.04	0.18	0.27	**0.51**	0.16	**0.60**	0.21	0.03
13	0.03	0.33	**0.35**	0.29	0.37	**0.45**	0.12	0.05	0.00	0.18	0.25	**0.56**	0.06	**0.72**	0.19	0.03
14	0.06	**0.46**	0.27	0.21	**0.46**	0.39	0.06	0.08	0.00	0.24	0.18	**0.58**	0.12	**0.60**	0.17	0.11
15	0.29	**0.38**	0.24	0.09	**0.69**	0.22	0.03	0.06	0.04	0.11	0.31	**0.53**	0.21	**0.54**	0.15	0.10
16	0.18	**0.53**	0.22	0.07	**0.65**	0.25	0.03	0.07	0.00	0.05	0.30	**0.65**	0.15	**0.62**	0.12	0.12
17	0.25	**0.49**	0.18	0.08	**0.70**	0.22	0.03	0.04	0.00	0.18	0.30	**0.52**	0.18	**0.60**	0.10	0.12
18	0.28	**0.46**	0.22	0.04	**0.70**	0.22	0.06	0.02	0.10	0.15	0.32	**0.43**	0.20	**0.56**	0.17	0.08
19	0.32	**0.48**	0.13	0.08	**0.73**	0.22	0.05	0.01	0.16	0.29	**0.37**	0.18	0.21	**0.59**	0.13	0.07
20	0.40	**0.48**	0.10	0.02	**0.74**	0.19	0.06	0.01	0.04	**0.39**	0.35	0.21	0.27	**0.56**	0.12	0.04
21	0.36	**0.39**	0.22	0.03	**0.68**	0.24	0.08	0.01	0.12	0.28	**0.40**	0.20	0.34	**0.48**	0.15	0.03

Bold numbers indicate the highest probability among the four responses in the specific age of each class.

Table 4. Results of the multinomial logit model examining factors related to exercise trajectories

Males (n=874)	1. Often-rarely / 2. Rarely-Never			3. Always-Never / 2. Rarely-Never			4. Always / 2. Rarely-Never		
Factors	OR	95% C. I.		OR	95% C. I.		OR	95% C. I.	
Individual factors									
Body Mass Index	1.047	(0.993 - 1.105)		0.967	(0.909 - 1.028)		1.030	(0.972 - 1.091)	
Body dissatisfaction	0.913	(0.842 - 0.989)	*	0.894	(0.820 - 0.974)	*	0.844	(0.777 - 0.918)	*
Stress	0.994	(0.955 - 1.034)		0.952	(0.910 - 0.997)	*	0.955	(0.914 - 0.997)	*
Screen behavior	0.800	(0.682 - 0.937)	*	1.184	(1.001 - 1.402)	*	0.909	(0.772 - 1.070)	
Parental Factors									
Parental exercise									
Regular / unregularly or no exercise	1.459	(0.965 - 2.208)		1.600	(1.011 - 2.532)	*	1.583	(1.025 - 2.444)	*
Parental screen behavior	1.020	(0.870 - 1.195)		1.123	(0.942 - 1.338)		1.094	(0.925 - 1.295)	

Females (n=827)	1. Always-Rarely / 2. Rarely-Never			3. Always/ 2. Rarely-Never			4. Rarely/ 2. Rarely-Never		
Factors	OR	95% C. I.		OR	95% C. I.		OR	95% C. I.	
Individual factors									
Body Mass Index	1.080	(1.012 - 1.152)	*	1.214	(1.110 - 1.327)	*	1.074	(1.001 - 1.152)	*
Body dissatisfaction	0.945	(0.875 - 1.020)		0.846	(0.755 - 0.949)	*	0.913	(0.841 - 0.991)	*
Stress	0.984	(0.947 - 1.023)		0.999	(0.942 - 1.059)		1.008	(0.967 - 1.050)	
Screen behavior	0.717	(0.598 - 0.860)	*	0.838	(0.645 - 1.089)		0.729	(0.598 - 0.887)	*
Parental Factors									
Parental exercise									
Regular / unregularly or no exercise	1.272	(0.888 - 1.822)		1.150	(0.668 - 1.980)		1.184	(0.804 - 1.745)	
Parental screen behavior	1.033	(0.897 - 1.191)		1.190	(0.970 - 1.459)		0.998	(0.856 - 1.163)	

The multinomial logistic model used “Rarely-Never” class as a reference group. Parental highest education, family monthly income, and parental marital status were controlled in the model.

*: $p < .05$, , OR: Odds Ration, C.I.: Confidence Interval

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