BMC Public Health

RESEARCH

Open Access

The prevalence and determinants of physical activity in secondary Vietnamese students: a hierarchical analysis

Tram T. N. Truong[1†], Son Trung Huynh[1*†], Vinh Nhu Nguyen[1,2] and An Le Pham[1]

Abstract

Background Physical activity (PA) levels among adolescents are low globally and in Vietnam. This study aims to assess the prevalence of PA and identify demographic, psychosocial, and behavioral factors related to PA among secondary school students in Ho Chi Minh City.

Methods A cross-sectional study was conducted from March to May 2023, involving 475 6th-grade students. Data were collected through self-reported questionnaires and anthropometric measurements. Psychosocial factors, including self-efficacy, enjoyment, family influence, and belief in PA were measured using validated scales, while teacher influence on PA was evaluated using a custom-designed questionnaire. Sedentary behavior was assessed using the Adolescent Sedentary Activity Questionnaire (ASAQ), and PA levels were determined using the Physical Activity Questionnaire for Older Children (PAQ-C). Gender differences were analyzed using chi-square tests and t-tests. Pearson's correlation coefficient and hierarchical multiple regression were applied to examine associations and factors influencing PA.

Results Only 36.8% of students met the recommended PA levels, with boys (40.7%) being more active than girls (32.9%). Boys had higher body mass index (BMI) and more screen time, while girls spent more time on cultural and social activities. Positive correlations were found between PA levels and psychosocial factors, especially in self-efficacy ($r = 0.761$, $p < 0.001$) and family influence ($r = 0.717$, $p < 0.001$). Sedentary behaviors, such as small screen recreation ($r = -0.449$, $p < 0.001$) and after-school education ($r = -0.380$, $p < 0.001$), negatively correlated with PA levels. Hierarchical analyses showed that BMI, self-efficacy, beliefs, family and teacher influence, and time spent on small screen recreation and after-school education significantly explained PA among adolescents.

Conclusion Vietnamese adolescents have low PA levels, with gender differences. Interventions should enhance support, reduce sedentary behavior, and address gender-specific barriers.

Keywords Adolescent activity, Gender differences, Psychosocial factors, Sedentary behavior, PAQ-C, ASAQ, Public health intervention

†Tram T. N. Truong and Son Trung Huynh contributed equally to this work.

*Correspondence:
Son Trung Huynh
huynhtrungson@ump.edu.vn
[1] University of Medicine and Pharmacy at Ho Chi Minh City, Ho Chi Minh City, Vietnam
[2] University Medical Center Ho Chi Minh City, Ho Chi Minh City, Vietnam

Background

Sufficient physical activity (PA), particularly in adolescence, not only helps reduce the risk of non-communicable diseases (NCDs) but also improves cardiovascular health and enhances mental well-being [1, 2]. Studies have shown that regular PA is associated with better academic performance, reduced stress levels, and improved social interactions in children and adolescents [3–5]. Despite these benefits, 80% of adolescents do not meet the PA level recommended by the World Health Organization (WHO) [6], which states that "children and adolescents should engage in at least 60 min per day of moderate-to-vigorous-intensity PA across the week" [7].

Demographic factors, for example, age, sex, and body mass index (BMI) are related to PA levels [8, 9]. In particular, boys are more physically active than girls, according to some researchers [8]. A study on PA among Filipino youth revealed that a significant proportion of girls, up to 87%, failed to adhere to the recommended guidelines for PA compared to only about 18% of boys [10]. In Vietnam, the gender gap in PA may be further exacerbated due to reduced independence among girls [11].

Psychological factors, including self-efficacy, beliefs, and social influence, play a crucial role in determining levels of PA [12]. Studies have shown that high self-efficacy and enjoyment are essential for sustaining long-term PA in children [13]. In addition, the support of parents and physical education teachers is positively associated with the activity levels of children [14, 15].

Another contributing factor to PA behavior among adolescents is their sedentary lifestyle. Previous research has mainly concentrated on monitoring sedentary behavior via multimedia technology; nonetheless, sedentary behavior occurs not only when one is utilizing technological gadgets [16]. Furthermore, differences in cultural norms and educational systems can impact the extent and nature of sedentary behaviors in children. This disparity is largely attributed to cultural values that prioritize academic achievement and place greater emphasis on academic subjects over PA [11].

Most PA studies have been conducted in developed countries, leaving a significant research gap in low- and middle-income countries. Although several studies have examined PA levels in Vietnamese children, they have primarily focused on prevalence rates rather than investigating the underlying determinants of PA participation. Furthermore, these studies lack hierarchical analytical approaches that account for the complex interactions between demographic, psychosocial, and sedentary behavior factors.

Compared to global averages, PA levels among Vietnamese adolescents remain substantially lower, with only 18.2% of students aged 13 to 15 and 21.3% of those aged 16 to 17 engaging in sufficient PA daily [17]. Addressing these gaps, this study aims to assess the prevalence of PA and the psychosocial correlates of PA and sedentary behavior among adolescents in Ho Chi Minh City, Vietnam. Findings from this study will contribute to the existing body of literature and provide insights into promoting a healthier, more active lifestyle among adolescents.

Methods

Study design and sample size

This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure comprehensive reporting (Supplementary Material 1) [18]. A cross-sectional study was conducted on 6th-grade students at Nguyen Du Secondary School in Go Vap District from March to May 2023. We selected this location because Go Vap District is the second most populous district in Ho Chi Minh City [19], and Nguyen Du Secondary School is one of the public schools with large class sizes in the district.

The sample size was calculated using the formula by Naing et al. for prevalence studies [20]. Based on previous research and recommendations for school-based cluster sampling, a design effect of 3 was applied to correct the sampling variance [21]. The sample size estimation formula for a proportion was used, with $Z = 1.96$ (Z statistic for a 95% confidence level), $P = 0.101$ (expected prevalence from the study by Ngan HTD et al. [22], $d = 0.05$ (precision), and $deff = 3$ (design effect). Therefore, the sample size calculated by the formula was 420. To minimize the effect of non-response and missing data, an additional 10% was added to the calculated sample size, following the recommended range of 10% to 20% for the non-response rate [20]. Finally, the total sample required was 466. Nguyen Du Secondary School consisted of 12 6th-grade classes with 552 students, which was similar to the required sample size; therefore, we selected all 6th-grade students from the school, with each class serving as a cluster unit.

Participants

We focused on 6th-grade students because this age group experiences rapid physical and psychological development, forming cognitive, attentional, and behavioral decisions [23]. In Vietnam, secondary high schools have four grades: 6th, 7th, 8th, and 9th, catering to students aged 11 to 15. Since 6th-grade students are the youngest in secondary high school, providing data on their PA status can help schools design appropriate educational programs for the coming years. The inclusion criteria were: (1) 6th-grade students at Nguyen Du Secondary School in Go Vap District who have lived in Ho Chi Minh City for at least 12 months. The exclusion criteria were: (1)

students with congenital disabilities or acute or chronic illnesses that could affect their participation in the study and biometric measurements, and (2) students who provided less than 75% of the required responses in the questionnaire.

Measurements

Demographic and anthropometric data

After completing the questionnaire, students' weight and height were measured using a digital weighing scale (model HD 379, Tanita Corporation, Japan) and a stadiometer (model 26SM, Tamil Nadu, India), respectively. Each measurement was taken twice by a trained collaborator in the school environment, with weight recorded to 0.1 kg and height to 0.1 cm accuracy. BMI was calculated as weight (kg) divided by height (m) squared. Crude BMI was utilized in this study as an independent variable to examine the association between anthropometric traits and PA. Though BMI classification according to WHO or Centers for Disease Control and Prevention (CDC) percentiles is recommended for age- and sex-adjusted interpretations of children's physical status [24], crude BMI remains a reliable and accepted indicator for assessing the relationship between body composition and physical fitness in pediatric populations [25, 26].

Psychosocial factors related to PA

PA self-efficacy, family influence on PA, and beliefs in PA outcomes were assessed using a modified version of the Self-Efficacy, Social Influences, and Beliefs scales developed by Saunders et al. [12]. The PA self-efficacy included 16 items rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). PA self-efficacy score was calculated using the average score of all selected responses. The family influence on PA consisted of 8 items rated on a 5-point scale ranging from 1 (never) to 5 (very often). Family influence on PA score was determined by calculating the average score of all selected responses. The beliefs in PA outcomes consisted of 16 items, including eleven positive and five negative outcomes. For positive outcomes, each response was scored from 1 (strongly disagree) to 5 (strongly agree), whereas for negative outcomes, each response was scored in reverse. Beliefs in PA outcomes score were calculated by the average score of all selected responses. The psychometric properties of these three scales in Vietnamese children have been reported elsewhere [27].

Enjoyment of PA was assessed using a modified version of the scale developed by Molt et al. [28]. The scale comprised 16 items, including nine positive and seven negative statements. For positive statements, each response was scored from 1 (strongly disagree) to 5 (strongly agree), whereas for negative statements, each response was scored in reverse. The enjoyment of the PA score was calculated as the average score of all selected responses.

Teacher influence on PA was determined based on six items rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree): i) the teacher listens to what I say in physical education class; ii) the teacher treats us fairly in PA; iii) the teacher supports me when I can't perform exercises; iv) the teacher encourages me to be physically active; v) the teacher encourages me to exercise outside the classroom; vi) the teacher exercises together with me during physical education classes (Supplementary Material 2). The teacher influence score was calculated as the average score of all selected responses.

Sedentary behavior in children

The Adolescent Sedentary Activity Questionnaire (ASAQ) was developed by Hardy et al. to measure how much time adolescents spend on sedentary behaviors like sitting or lying-down activities [29]. The tool required children to remember and note the time spent on 12 sedentary behaviors over a week. These behaviors were divided into five categories: small screen recreation (e.g., watching TV, videos, using the computer for fun), after-school education (e.g., doing homework on or off a computer, out-of-school tutoring), passive travel (e.g., using motorized transport like a motorbike, car, or bus to school or other places), cultural activities (e.g., reading for fun, hobbies, playing a musical instrument), and social activities (e.g., religious activities, sitting and chatting with friends, or using the phone). Each sedentary behavior was recorded in minutes and then converted into hours. The total time spent on sedentary behaviors for the week was calculated using the formula: [Total sedentary behavior time for (weekdays + weekends)]/7, in hours/day.

Physical activity in children

The Physical Activity Questionnaire for Older Children (PAQ-C), adapted from Kowalski et al., consists of nine items [30]. The PAQ-C has been validated against accelerometers for use in Vietnamese adolescents [31]. Item 1 included a checklist of activities children typically do in their spare time. Participants were required to respond to an activity checklist and were scored on a 5-point scale ranging from 1 (no) to 5 (7 times or more). The score for item 1 was the average score of all activities on the activity checklist. Items 2 to 8 referred to activities at different times, such as during physical education class, recess, lunch, right after school, evening, and weekends, and described the activity level for one week. Item 9 included rating the frequency of activities each day of the week from Monday to Sunday, with each day's response scored from 1 (none) to 5 (very often). The score for item 9 was

the average score for all days of the week. The PAQ-C total score was calculated based on the average scores from items 1 to 9, ranging from 1 (lowest activity) to 5 (highest activity). Further, students were considered to meet the PA guidelines when their total PAQ-C score was greater than 2.75 [32].

Procedures

Data were collected using a self-reported questionnaire, in which the scales and questionnaires were back-and-forth translated independently by two Vietnamese researchers fluent in English. Subsequently, a native English speaker and two Vietnamese experts reviewed and compared both versions to ensure linguistic and cultural equivalence. Following extensive discussions, the ASAQ was adjusted for cultural adaptation. The item related to religious activities on Saturdays and Sundays, originally phrased as "going to church or attending Saturday school", was modified to "going to temple or meditation" to reflect better the religious practices prevalent in Vietnam, particularly Buddhism. This change ensures that the questionnaire accurately captures time spent in religious settings, which often involves prolonged sitting, for example, attending services or listening to spiritual teachings. No modifications were made to the other instruments. The final version of the scales and questionnaires was derived from a reconciliation of the original, backward, and forward translations.

Before data collection, a pilot test was carried out with a sample of 35 6th-grade students. The scales and questionnaires were administered twice to this sample, with a seven-day interval between measurements, to assess test–retest reliability and evaluate the stability of self-reported responses. The pilot results demonstrated that these tools exhibited high reliability and acceptable validity, as presented in Table 1.

Table 1 Psychometric properties of scales and questionnaires related to PA from the pilot test ($n = 35$)

Name of tools	No. of main items	Test–retest (ICC)	Cronbach's alpha (α)
PA self-efficacy	16	0.88	0.84
Beliefs in PA outcomes	16	0.90	0.71
Enjoyment of PA	16	0.90	0.86
Family influence on PA	8	0.92	0.78
Teacher influence on PA	6	0.88	0.84
ASAQ questionnaire	12	0.90	–
PAQ-C questionnaire	9	0.90	0.86

Abbreviations: *ICC* Intraclass correlation coefficient, *PA* Physical activity, – not applicable

Statistical analysis

Data were analyzed using Stata Version 14.0 (StataCorp, College Station, TX, USA). Descriptive statistics including frequencies, percentages, means, and standard deviations, were calculated to describe participant characteristics. Internal consistency and test–retest reliability of the scales and questionnaires were assessed using Cronbach's alpha (α) and the ICC in a pilot study with 35 students. Gender differences were examined using the chi-square test and independent t-test. Due to positively skewed data, the mean total PAQ-C score was log-transformed. The correlation between the PAQ-C score and determinants of PA was examined using scatter plots and Pearson's coefficient. Hierarchical multiple regression analyses were conducted to determine the independent associations of demographic, anthropometric, psychosocial, and sedentary behavior variables with PA. In the first step, age and BMI were included; in the second step, psychosocial variables were added; and in the third step, sedentary behavior variables were incorporated. Potential gender differences in the activity determinants were examined by analyzing the total sample and separately for girls and boys. A p-value of less than 0.05 was considered significant.

Results

Of 552 6th-grade students, 35 were excluded for the test–retest reliability study, leaving 517 for the cross-sectional survey. Of these, 33 students declined to participate, and nine did not complete the questionnaires, resulting in 475 (91.9%) participants for the final analysis.

Table 2 presents the characteristics of participants in the total sample and by gender. Overall, boys were significantly taller and had a higher BMI than girls ($p < 0.05$). No significant gender differences were observed in the psychosocial factors related to PA. We also found that girls spent more time on cultural and social activities, whereas boys spent more time on screen-based recreation ($p < 0.05$). Only 36.8% of students had sufficient PA levels, with boys (40.7%) being more active than girls (32.9%).

We found strong positive correlations between the total PAQ-C score and psychosocial factors related to PA, while weak to moderate negative correlations were observed with sedentary behavior time, all statistically significant at $p < 0.001$. The correlations ranged from 0.652 for teacher influence on PA to 0.717 for PA self-efficacy in psychosocial factors (Fig. 1) and from -0.449 for small screen recreation to -0.129 for passive travel in terms of sedentary behavior (Fig. 2).

Table 3 presents the results of a 3-step hierarchical regression analysis to identify predictors of PA. Age and BMI were included as predictors in the first step, and

Table 2 Participant characteristics and related factors in PA

Variables	Total, $n=475$ Mean ± SD	Boys, $n=241$ Mean ± SD	Girls, $n=234$ Mean ± SD	p-value[†]
Demographic and anthropometric factors				
Age (years)	11.8 ± 0.3	11.8 ± 0.3	11.7 ± 0.3	0.230
Height (centimetres)	152.6 ± 6.2	45.4 ± 7.9	43.5 ± 6.8	**0.007**
Weight (kilograms)	44.5 ± 7.4	152.7 ± 6.4	152.5 ± 6.0	0.762
BMI (kg/m^2)	19.1 ± 2.8	19.4 ± 2.9	18.7 ± 2.5	**0.004**
Psychosocial factors related to PA				
PA self-efficacy	3.4 ± 0.8	3.5 ± 0.8	3.4 ± 0.7	0.766
Beliefs in PA outcome	3.5 ± 0.9	3.5 ± 0.9	3.5 ± 0.8	0.605
Enjoyment of PA	3.6 ± 0.9	3.6 ± 0.9	3.5 ± 0.9	0.469
Family influence on PA	3.2 ± 1.0	3.2 ± 1.0	3.1 ± 0.9	0.233
Teacher influence on PA	3.7 ± 0.8	3.6 ± 0.8	3.7 ± 0.7	0.427
Sedentary behavior time for the week (hours/day)				
Small screen recreation[a]	1.6 ± 0.9	1.7 ± 1.0	1.5 ± 0.9	0.053
After-school education[b]	1.8 ± 0.9	1.8 ± 0.9	1.9 ± 0.9	0.063
Passive travel[c]	0.3 ± 0.2	0.3 ± 0.2	0.2 ± 0.1	0.267
Cultural activities[d]	0.7 ± 0.6	0.7 ± 0.5	0.8 ± 0.7	**0.005**
Social activitiese	0.6 ± 0.4	0.5 ± 0.4	0.7 ± 0.4	**0.001**
Total sedentary behaviors[f]	5.0 ± 1.6	4.9 ± 1.6	5.2 ± 1.7	0.092
The prevalence of PA				
Total PAQ-C score	2.5 ± 0.7	2.6 ± 0.7	2.4 ± 0.6	**0.027**
PA level[(l)]				
Sufficient (PAQ-C score > 2.75)	175 (36.8)	98 (40.7)	77 (32.9)	**0.080**
Insufficient (PAQ-C score ≤ 2.75)	300 (63.2)	143 (59.3)	157 (67.1)	

Abbreviations: *BMI* Body mass index, *PA* Physical activity, *PAQ-C* Physical Activity Questionnaire for Older Children, *SD* Standard deviation

[†] Chi-square test and independent T-test were used to examine significant gender differences at p-value < 0.05

[(l)] Data expressed as frequency (percentage)

[a] Small screen recreation includes watching television/videos/DVDs and using a computer for fun (e-communications, e-games, internet surfing)

[b] After-school education includes doing homework (on or off a computer) and out-of-school tutoring

[c] Passive travel includes motorized travel (motorbike/car/bus)

[d] Cultural activities include reading for fun, doing hobbies or crafts, and playing/practicing a musical instrument

[e] Social activities include sitting and chatting with friends, hanging out, using the telephone, and religious activities (going to temple or mediation)

[f] Total sedentary behavior includes activities in[a,b,c,d,e]

the model explained 7.2% of the variance in PA for the total sample [F (2, 472) = 18.27, $p < 0.001$]. We also found that BMI was the only significant negative predictor of the PAQ-C score for both boys and girls. In the second step, the model explained 65.9% of the variance [F (7, 467) = 129.11, $p < 0.001$], and its predictive power was significantly increased when psychosocial factors related to PA were included. For boys, self-efficacy, beliefs in PA outcome, and family influence were positive predictors of the PAQ-C score. In contrast, for girls, self-efficacy, enjoyment of PA, family influence, and teacher influence were positive predictors. In the final step, variables representing time spent on sedentary behavior were added. This addition improved the predictive power of the model, explaining 68.4% of the variance in PA for the total sample [F (12, 462) = 83.40, $p < 0.001$]. Out of the five variables included, small screen recreation, after-school education, and social activities were identified as significant independent predictors. For boys, small screen recreation and after-school education were found to be positive predictors of the PAQ-C score. For girls, small screen recreation, after-school education, and social activities were identified as positive predictors.

Discussion

The purpose of this study was to examine the factors that influence PA in children using hierarchical regression analysis. The study focused on 475 6th-grade students in Ho Chi Minh City, Vietnam, and considered demographic, psychosocial, and sedentary behavior

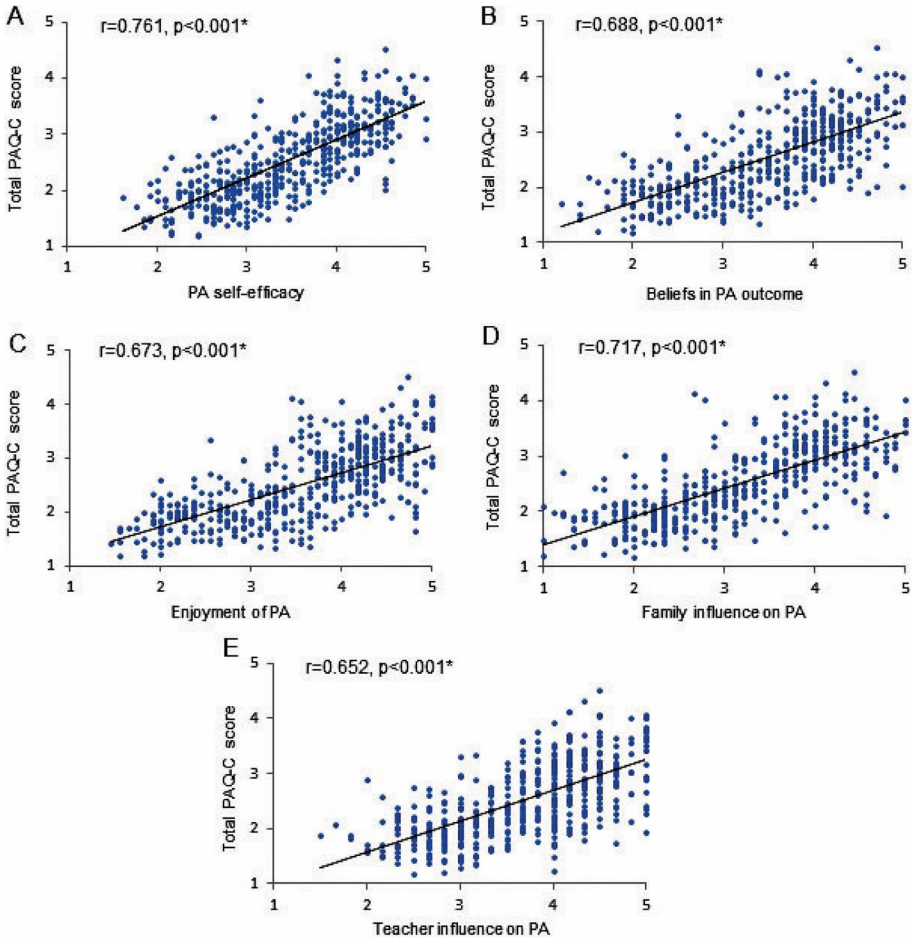

Fig. 1 Scatter plots and Pearson coefficients (r) show correlations between PAQ-C and psychosocial factors ($n = 475$). Correlations of PAQ-C with **A**: PA self-efficacy; **B**: beliefs in PA outcomes; **C**: enjoyment of PA; **D**: family influence on PA; **E**: teacher influence on PA. *Significant correlations at $p < 0.05$. PA = physical activity; PAQ-C = Physical Activity Questionnaire for Older Children

factors. The findings would better provide a comprehensive understanding of various aspects of children's PA by revealing gender-specific determinants and common elements within the group.

Prevalence of PA

Our study revealed that the average PAQ-C score was 2.5 ± 0.7, which is lower compared to a survey of 994 ethnically diverse children (3.23 ± 0.64) [33] but similar to findings in a group of adolescents in China (2.62 ± 0.68) [34]. Additionally, we discovered that 36.8% of the children met the WHO recommended PA guidelines. This percentage is significantly lower than the findings of Linh LHH et al.'s study on 318 secondary school students in urban Ho Chi Minh City, Vietnam (36.8% vs. 67.6%) [35]. On the other hand, this proportion is higher than that observed in a study assessing the prevalence of sufficient PA among students across 34 countries, which reported PA rates in several Asian countries, including the Philippines (9%), Myanmar (20.0%), Indonesia (22.0%), and China (30.0%). In comparison, the rate for Vietnam was 18.2% [36].

Our findings revealed gender differences in PA levels, with boys being more physically active than girls. Similar gender disparities have been reported in countries on other continents [8, 37, 38], as well as studies conducted in Vietnam, for example, those by Trang NH et al. and To GQ et al., which also found that boys participated in PA more frequently [11, 39]. In Vietnamese culture, academic achievement is prioritized over extracurricular activities like physical exercise. Students typically spend around 9 h at school each day (from 6:00 AM to 4:00 PM). After school, the majority of students devote their time to doing homework and attending additional tutoring sessions. This cultural emphasis on education may partly explain the lower levels of PA observed among adolescents, in particular girls, who may experience pressure to focus on pursuing grades rather than engaging

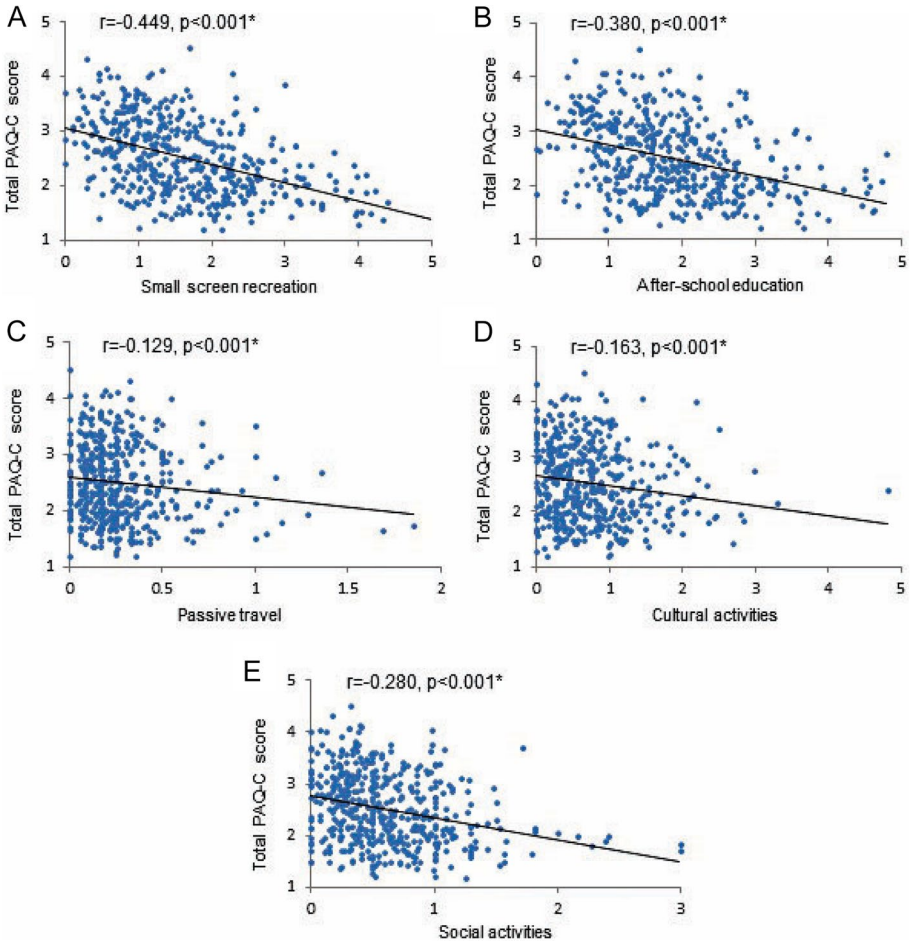

Fig. 2 Scatter plots and Pearson coefficients (r) show correlations between PAQ-C and sedentary behavior time ($n = 475$). Correlations of PAQ-C with **A**: small screen recreation (hours/day); **B**: after-school education (hours/day); **C**: passive travel (hours/day); **D**: cultural activities (hours/day); **E**: social activities (hours/day). *Significant correlations at $p < 0.05$. PAQ-C = Physical Activity Questionnaire for Older Children

in activities. As well, traditional gender roles in Vietnam tend to assign more passive roles to girls, restricting their participation in physically demanding activities such as sports. Boys are often encouraged to participate in outdoor activities; in contrast, girls may not receive the same encouragement or opportunities [40].

Demographic, anthropometric factors, and PA

We found significant differences in several anthropometric indices between boys and girls. Boys had a higher average BMI and height compared to girls, consistent with national growth standards and earlier studies on adolescent development in Vietnam [41, 42]. The higher BMI of boys may be indicative of variations in adipose distribution and muscle mass, which could influence their PA levels and preferences [43].

Age was not found to be predictive of PA levels for any group. This result contradicts other studies reporting that PA tends to decline with age during childhood and adolescence [38, 44]. Perhaps the narrow age range of our sample (mean age of 11.8 years) might not allow for detecting the age-related differences in PA. A broader age span would likely reveal more distinct trends in the behavior associated with the developmental process.

In our result, BMI was identified as a significant negative predictor of PA for the overall sample and boys but less so for girls. This inverse relationship has been supported by previous studies [45]. Nonetheless, the interaction between PA and BMI may be bi-directional, leading to a vicious cycle of low PA and obesity. Numerous studies have shown that regular PA has a positive effect on maintaining or reducing BMI, particularly in children and adolescents [46]. On the other hand, children with high BMI often face difficulties in engaging in physical activities due to mobility issues or reduced endurance [47]. Additionally, psychological factors comprising low self-esteem and social stigma related to weight may also contribute to lower participation in PA [48].

Table 3 Hierarchical regression to identify predictors of log mean PAQ-C score for boys and girls

Variables	Total, $n=475$							Boys, $n=241$							Girls, $n=234$						
	b	SE (b)	β	t	95% CI	R^2	aR^2	b	SE (b)	β	t	95% CI	R^2	aR^2	b	SE (b)	β	t	95% CI	R^2	aR^2
Step 1																					
Age	0.065	0.043	0.067	1.50	-0.20, 0.15	0.072	0.068	0.086	0.059	0.088	1.47	-0.03, 0.20	0.147	0.140	0.030	0.062	0.031	0.47	-0.09, 0.15	0.024	0.016
BMI	-0.026	0.004	-0.258	-5.82***	-0.03, -0.02			-0.036	0.006	-0.371	-6.20***	-0.05, -0.02			-0.016	0.007	-0.150	-2.31*	-0.03, -0.00		
Step 2																					
Age	0.031	0.026	0.032	1.19	-0.02, 0.08	0.659	0.654	0.046	0.037	0.048	1.25	-0.03, 0.12	0.670	0.660	0.008	0.037	0.008	0.21	-0.07, 0.08	0.668	0.657
BMI	-0.004	0.003	-0.044	-1.57	-0.01, 0.01			-0.011	0.004	-0.111	-2.77**	-0.02, -0.00			0.001	0.004	0.007	0.17	-0.01, 0.01		
PA self-efficacy	0.119	0.019	0.325	6.24***	0.08, 0.16			0.111	0.028	0.311	3.92***	0.06, 0.17			0.134	0.026	0.360	5.23***	0.08, 0.18		
Beliefs in PA outcome	0.040	0.018	0.125	2.18*	0,00, 0.08			0.067	0.026	0.214	2.56*	0.02, 0.12			0.011	0.025	0.035	0.45	-0.04, 0.06		
Enjoyment of PA	0.022	0.017	0.072	1.29	-0.01, 0.06			-0.009	0.025	-0.029	-0.34	-0.06, 0.04			0.053	0.023	0.170	2.30*	0.01, 0.10		
Family influence on PA	0.076	0.012	0.264	6.09***	0.05, 0.10			0.072	0.018	0.250	3.91***	0.04, 0.11			0.070	0.017	0.247	4.16***	0.04, 0.10		
Teacher influence on PA	0.037	0.014	0.105	2.54*	0.01, 0.07			0.035	0.021	0.101	1.67	-0.01, 0.08			0.042	0.020	0.119	2.10*	0.00, 0.08		
Step 3																					
Age	0.031	0.026	0.032	1.20	-0.02, 0.08	0.684	0.676	0.049	0.037	0.051	1.32	-0.02, 0.12	0.689	0.673	0.010	0.036	0.011	0.28	-0.06, 0.08	0.696	0.679
BMI	-0.003	0.003	-0.026	-0.93	-0.01, 0.00			-0.008	0.004	-0.085	-2.12*	-0.02, -0.00			0.002	0.004	0.018	0.46	-0.01, 0.01		
PA self-efficacy	0.097	0.019	0.265	5.12***	0.06, 0.13			0.103	0.028	0.289	3.67***	0.05, 0.16			0.100	0.026	0.271	3.82***	0.05, 0.15		
Beliefs in PA outcome	0.035	0.018	0.109	1.96*	-0.01, 0.07			0.053	0.026	0.169	2.01*	0.00, 0.11			0.014	0.025	0.043	0.57	-0.03, 0.06		
Enjoyment of PA	0.020	0.017	0.064	1.18	-0.01, 0.05			-0.006	0.025	-0.019	-0.23	-0.05, 0.04			0.048	0.023	0.154	2.10*	0.00, 0.09		
Family influence on PA	0.063	0.012	0.221	5.15***	0.04, 0.09			0.063	0.018	0.217	3.40**	0.03, 0.10			0.057	0.017	0.201	3.43**	0.02, 0.09		
Teacher influence on PA	0.038	0.014	0.108	2.68**	0.01, 0.07			0.030	0.021	0.088	1.47	-0.01, 0.07			0.048	0.020	0.135	2.43*	0.01, 0.09		
Small screen recreation[a]	-0.029	0.009	-0.097	-3.14**	-0.05, -0.01			-0.026	0.013	-0.089	-1.97*	-0.05, -0.00			-0.038	0.014	-0.123	-2.83**	-0.06, -0.01		
After-school education[b]	-0.038	0.009	-0.124	-4.26***	-0.06, -0.02			-0.031	0.014	0.007	-2.31*	-0.06, -0.01			-0.042	0.012	-0.145	-3.47**	-0.07, -0.02		
Passive travel[c]	-0.053	0.031	-0.046	-1.72	-0.11, 0.01			-0.035	0.046	-0.029	-0.76	-0.13, 0.06			-0.074	0.042	-0.066	-1.76	-0.16, 0.01		

Table 3 (continued)

Variables	Total, $n=475$							Boys, $n=241$							Girls, $n=234$						
	b	SE (b)	β	t	95% CI	R^2	aR^2	b	SE (b)	β	t	95% CI	R^2	aR^2	b	SE (b)	β	t	95% CI	R^2	aR^2
Cultural activities[d]	-0.011	0.012	-0.023	-0.87	-0.03, 0.01			-0.016	0.020	-0.030	-0.78	-0.06, 0.02			0.003	0.015	0.008	0.22	-0.03, 0.03		
Social activities[e]	-0.048	0.017	-0.078	-2.83**	-0.08, -0.01			-0.022	0.025	-0.037	-0.91	-0.07, 0.03			-0.051	0.025	-0.079	-2.05*	-0.10, -0.00		

Abbreviations: *BMI* Body mass index, *PA* Physical activity, *PAQ-C* Physical Activity Questionnaire for Older Children

[a] Small screen recreation includes watching television/videos/DVDs and using a computer for fun (e-communications, e-games, internet surfing)

[b] After-school education includes doing homework (on or off a computer) and out-of-school tutoring

[c] Passive travel includes motorized travel (motorbike/car/bus)

[d] Cultural activities include reading for fun, doing hobbies or crafts, and playing/practicing a musical instrument

[e] Social activities include sitting and chatting with friends, hanging out, using the telephone, and religious activities (going to temple or mediation)

* $p<0.05$, ** $p<0.01$, ***$p<0.001$

BMI may not be a strong predictor of PA levels among girls due to lower societal expectations for them to engage in vigorous activities, which can reduce the impact of higher BMI on their PA participation [49]. Alternatively, recent evidence suggests that body fat distribution plays a more significant role in determining PA levels in girls, as it affects mobility and self-perception in ways that BMI alone cannot capture [50]. Relying solely on BMI may overlook these complex variations in body composition that influence PA, highlighting the need for more comprehensive measures to assess PA in girls.

Psychosocial factors and PA

According to our findings, there were positive correlations between PA levels and psychosocial factors, aligning with previous research conducted among fifth-grade students in Ho Chi Minh City, Vietnam [39], as well as reports from other international studies [51, 52]. Self-efficacy appeared to have the most robust correlation to PA, as both boys and girls who exhibited higher self-efficacy engaged in greater amounts of PA. This highlights the importance of self-confidence in children's capability to engage in PA as well as social impact in promoting regular PA in youngsters, as proposed by social cognitive theory [53].

The study showed that belief in PA outcomes was significant for boys and the overall sample but not for girls. This gender difference may reflect that boys' levels of PA are more influenced by their perception of the benefits of PA, whereas girls might be affected by other factors namely enjoyment. These findings support previous studies suggesting that belief in positive outcomes is a significant motivator for PA, especially in boys [54]. Interestingly, enjoyment of PA was a significant predictor only for girls, indicating that the extent of PA is directly related to how much they enjoy the activity. This finding is consistent with the systematic review of qualitative studies about PA among children and adolescents, highlighting the importance of enjoyment in sustaining activity among female students [55].

Both family and teacher influences were significant predictors for the overall sample and girls, but teacher influence was not significant for boys. Many studies have confirmed that practical and emotional support from the family is the most fundamental type of support related to adolescents' PA [14]. Several suggestions for family influence include enrolling children in PA programs, providing transportation to recreational facilities, observing their participation in physical activities, advising their children about the benefits of PA, and offering positive reinforcement for their efforts in PA [56]. Although teacher influence was less significant, it still plays an important role, specifically for girls, underscoring the role of the school environment in promoting an active lifestyle among students [57].

Sedentary behaviors and PA

Sedentary behavior involves sitting for 3 h or more per day. It includes a variety of activities, for example, watching television, playing video games, talking on the phone, sitting and chatting with friends, using computers, doing homework, and attending additional classes after school [58]. Our study found that children spent an average of 5.0 h per day engaged in sedentary behaviors. The most popular activities were after-school education (1.8 h/day) and small screen recreation (1.6 h/day). These findings align with previous research indicating a rising trend in sedentary behaviors among Vietnamese youth, specifically television watching, video gaming, and computer use [11]. However, the duration of sedentary behavior in our results was longer than that reported in other regional studies [58, 59]. Factors contributing to sedentary behavior among adolescents may include access to electronic devices, recreational games, family conflicts, limited knowledge, inadequate parenting skills, and negative role models [60, 61]. Overall, sedentary behavior in adolescents is affected by individual factors as well as family and social environments.

We found a negative correlation between sedentary behavior and PA levels; however, this conclusion may not be applicable to the circumstances and cultures of other countries. Previous studies have shown that sedentary behavior and PA are not strictly oppositional but are instead influenced by the environment and individual habits [62]. For instance, Schmidt et al. observed that PA in children and adolescents is highly context-dependent and can coexist with recreational screen time, rather than being direct opposites [63]. Similarly, Lian et al. reported that children's participation in sports and screen time can occur alongside, with both acting as mediators in the influence of family sports attitudes on children's BMI [64]. These findings underscore the need for a comprehensive and nuanced approach to examining the relationship between sedentary behavior and PA.

When examining each gender separately, male students spent more time on small screen recreation compared to females (1.7 h per day vs. 1.5 h per day). Girls participated in social activities for an average of 0.7 h per day, in comparison, this figure for boys was 0.5 h per day. Notably, the time spent watching television in our study did not exceed three hours per day. The increase in television viewing time might be associated with the growth of cable and digital television services in Vietnam. Furthermore, internet use among younger age groups has also increased compared to previous findings. A report released in 2020 estimated that over 4.6 billion people

worldwide were using the internet, with Vietnam alone accounting for over 68 million users, primarily adolescents [65]. Consistent with the findings of Prince SA et al. [66], our hierarchical analysis showed a negative relationship between PAQ-C scores and sedentary behaviors, such as small screen recreation and after-school education for both sexes. Boys spend more time on devices, whereas girls engage more in non-physical activities.

Overall, our study highlights the need for multifaceted programs designed to meet the specific needs of both boys and girls. For boys, emphasizing the social benefits of PA, for instance, spending time with friends and participating in team sports like basketball, soccer, and swimming, can be highly effective. For girls, creating enjoyable and engaging PA programs like aerobics, dance, or jogging is necessary. Ensuring safe and accessible environments for all children is paramount. Family involvement is critical; parents should support their children's PA by providing transportation, positive reinforcement, and being active role models. Schools should promote PA through structured programs and opportunities for active play. By addressing these diverse factors, we can develop effective interventions that increase PA levels and reduce sedentary behaviors, ultimately improving the overall health and well-being of Vietnamese children.

Limitations and future directions

Several limitations of this study should be acknowledged. Firstly, the cross-sectional design captures the PA status of students only at the time of the survey, failing to establish causal relationships between associated factors. Secondly, reliance on self-reported PA measures may lead to potential response biases. Thirdly, the study involved only 6th-grade students from one secondary school, limiting the generalizability of the results across all adolescents. Fourth, the use of crude BMI as the sole measure of anthropometric characteristics may compromise the accuracy of body composition assessments, as BMI does not distinguish between fat and lean mass, particularly in children at the extremes of the growth curve [67]. Additional measures, such as waist-to-height ratio, waist circumference, or body fat percentage, would better represent physical fitness [68]. Fifth, this study did not investigate barriers to PA participation, including lack of time, lack of motivation, and limited access to facilities, which have been recognized in previous studies [69, 70]. A comprehensive examination of these factors is essential for identifying key determinants influencing children's engagement in PA. Finally, to fully capture specific PA patterns, we used several unvalidated tools for Vietnamese children (e.g., ASAQ and the enjoyment of PA scale). Despite implementing a translation process and reliability testing, the absence of full validation for these tools may introduce potential biases, limiting the generalizability and practical application of the findings.

To the best of our knowledge, this is one of the few studies examining PA levels and related factors among 6th-grade students in Vietnam. The findings of this study may have implications for Southeast Asian urban areas and other developing contexts, such as low- or middle-income countries facing similar public health challenges. Factors including cultural norms and socioeconomic conditions may influence PA behavior differently. For this reason, caution should be exercised when generalizing the findings to rural or culturally distinct settings. Addressing barriers to PA in children, such as reducing screen time and increasing social support from family and teachers, is necessary for designing effective interventions in these environments. Longitudinal studies could reveal how changes in psychosocial aspects and sedentary behaviors affect PA levels over time. Additionally, research on gender differences could inform targeted interventions to bridge the PA gap among children. Future studies may also consider using BMI classification to improve standardization and comparability across diverse populations.

Conclusion

The present study showed that the prevalence of students engaging in sufficient PA in our sample is low (36.8%), with girls being less physically active. Hierarchical regression analysis highlighted several factors influencing children's PA, including the negative correlations of BMI and time spent on sedentary behaviors, as well as the positive correlations of psychosocial factors such as self-efficacy, beliefs in PA outcomes, and the influence of family and teachers. By targeting these modifiable factors and addressing the gender disparities in PA patterns, we could foster healthier lifestyles and would reduce the risk of chronic diseases in adulthood.

Abbreviations

PA	Physical activity
NCDs	Non-communicable diseases
WHO	World Health Organization
BMI	Body mass index
CDC	Centers for Disease Control and Prevention
ASAQ	Adolescent Sedentary Activity Questionnaire
PAQ-C	Physical Activity Questionnaire for Older Children
ICC	Intraclass correlation coefficient

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22308-z.

Supplementary Material 1: STROBE statement. Checklist of items that should be included in reports of cross-sectional studies.

Supplementary Material 2: Questionnaire about teacher influence on physical activity.

Acknowledgements
The authors thank the Department of Education and Training and the University of Medicine and Pharmacy in Ho Chi Minh City, Vietnam. We also thank the principal and teachers at Nguyen Du Secondary School for their essential support in collecting samples and the parents and students who participated in the study.

Authors' contributions
TTNT and STH conceived the study. STH and ALP contributed to the study design. TTNT, STH analysed the data. TTNT, STH, VNN and ALP interpreted the data and contributed to the discussion. TTNT, STH wrote the first draft of the manuscript and revised it. TTNT and STH are equal contributors to this work and are designated as co-first authors. All authors have agreed with the results and conclusion of the study and approved the final version of the manuscript.

Funding
Not applicable.

Data availability
The datasets analyzed in the current study are available from the corresponding author, Son Trung Huynh (huynhtrungson@ump.edu.vn), upon reasonable request.

Declarations

Ethics approval and consent to participate
The study received ethical approval from the Ethics Committee of the University of Medicine and Pharmacy at Ho Chi Minh City (Number: 261/HDDD DHYD granted on 03/03/2023). Written consent forms were obtained from all students and their parents or guardians before participating in the study. Participants were fully informed about the study objectives, procedures, potential risks, and their right to withdraw at any time without consequences. Permissions for non-commercial use of all questionnaires in the study were granted by the corresponding author of those questionnaires under non-disclosure agreements. All procedures followed the National guidelines for ethics in biomedical research and the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 21 September 2024 Accepted: 12 March 2025
Published online: 07 May 2025

References

1. Melby PS, Elsborg P, Bentsen P, Nielsen G. Cross-sectional associations between adolescents' physical literacy, sport and exercise participation, and wellbeing. Front Public Health. 2023;28(10):1054482.
2. Khan A, Lee EY, Rosenbaum S, Khan SR, Tremblay MS. Dose-dependent and joint associations between screen time, physical activity, and mental wellbeing in adolescents: an international observational study. Lancet Child Adolesc Health. 2021;5(10):729–38.
3. Barbosa A, Whiting S, Simmonds P, Scotini Moreno R, Mendes R, Breda J. Physical activity and academic achievement: an umbrella review. Int J Environ Res Public Health. 2020;17(16):5672.
4. Sampasa-Kanyinga H, Colman I, Goldfield GS, Janssen I, Wang J, Podinic I, et al. Combinations of physical activity, sedentary time, and sleep duration and their associations with depressive symptoms and other mental health problems in children and adolescents: a systematic review. Int J Behav Nutr Phys Act. 2020;17(1):72.
5. Eime RM, Young JA, Harvey JT, Charity MJ, Payne WR. A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. Int J Behav Nutr Phys Act. 2013;10(1):98.
6. Sallis JF, Bull F, Guthold R, Heath GW, Inoue S, Kelly P, et al. Progress in physical activity over the Olympic quadrennium. Lancet. 2016;388(10051):1325–36.
7. World Health Organization (WHO). WHO guidelines on physical activity and sedentary behaviour. 2020. https://www.who.int/publications/i/item/9789240015128. Accessed 16 May 2023.
8. Kretschmer L, Salali GD, Andersen LB, Hallal PC, Northstone K, Sardinha LB, et al. Gender differences in the distribution of children's physical activity: evidence from nine countries. Int J Behav Nutr Phys Act 2023;20(103). https://doi.org/10.1186/s12966-023-01496-0.
9. Jago R, Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA. Association of BMI category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. Int J Obes (Lond). 2020;44(1):104–13.
10. Tudor-Locke C, Ainsworth BE, Adair LS, Popkin BM. Physical activity in Filipino youth: the Cebu longitudinal health and nutrition survey. Int J Obes Relat Metab Disord. 2003;27(2):181–90.
11. Trang NH, Hong TK, Dibley MJ, Sibbritt DW. Factors associated with physical inactivity in adolescents in Ho Chi Minh City. Vietnam Med Sci Sports Exerc. 2009;41(7):1374–83.
12. Saunders RP, Pate RR, Felton G, Dowda M, Weinrich MC, Ward DS, et al. Development of questionnaires to measure psychosocial influences on children's physical activity. Prev Med. 1997;26(2):241–7.
13. Morano M, Bortoli L, Ruiz MC, Vitali F, Robazza C. Self-efficacy and enjoyment of physical activity in children: factorial validity of two pictorial scales. PeerJ. 2019;29(7):e7402.
14. Su DLY, Tang TCW, Chung JSK, Lee ASY, Capio CM, Chan DKC. Parental influence on child and adolescent physical activity level: a meta-analysis. Int J Environ Res Public Health. 2022;19(24):16861.
15. Mak TCT, Chan DKC, Capio CM. Strategies for teachers to promote physical activity in early childhood education eettings-a scoping review. Int J Environ Res Public Health. 2021;18(3):867.
16. Li L, Moosbrugger ME. Correlations between physical activity participation and the environment in children and adolescents: a systematic review and meta-analysis using ecological frameworks. Int J Environ Res Public Health. 2021;18(17):9080.
17. Hanoi Medical University. Vietnam - Global School-Based Student Health Survey 2013. World Health Organization (WHO). 2013. https://extranet.who.int/ncdsmicrodata/index.php/catalog/482. Accessed 24 May 2023.
18. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61:344–9.
19. Statistical Office of Ho Chi Minh City. Statistical yearbook Ho Chi Minh City 2022. 2023. https://lib.hids.hochiminhcity.gov.vn/DigitalDocument/Detail?treeId=784&fileId=28765. Accessed 8 Feb 2023.
20. Naing L, Winn T, Rusli BN. Practical issues in calculating the sample size for prevalence studies. Arch Orofac Sci. 2006;1:9–14.
21. Sharma B, Chavez RC, Nam EW. Prevalence and correlates of insufficient physical activity in school adolescents in Peru. Rev Saude Publica. 2018;52:51.
22. Ngan HTD, Tuyen LD, Phu PV, Nambiar S. Childhood overweight and obesity amongst primary school children in Hai Phong City. Vietnam Asia Pac J Clin Nutr. 2018;27(2):399–405.
23. Sawyer SM, Afifi RA, Bearinger LH, Blakemore SJ, Dick B, Ezeh AC, et al. Adolescence: a foundation for future health. Lancet. 2012;379(9826):1630–40.
24. World Health Organization (WHO). Growth reference data for 5–19 years. Geneva: World Health Organization. 2006. https://www.who.int/growthref/en/. Accessed 18 Jan 2025.
25. Agata K, Monyeki MA. Association between sport participation, body composition, physical fitness, and social correlates among adolescents: the PAHL study. Int J Environ Res Public Health. 2018;15(12):2793.
26. Dewi RC, Rimawati N, Purbodjati P. Body mass index, physical activity, and physical fitness of adolescence. J Public Health Res. 2021;10(2):2230.
27. To QG, Gallegos D, Do DV, Tran HT, To KG, Wharton L, et al. Psychometric properties of questionnaires to measure social ecological influences in Vietnamese children. Sports Med Health Sci. 2019;1(1):40–3.
28. Motl RW, Dishman RK, Saunders R, Dowda M, Felton G, Pate RR. Measuring enjoyment of physical activity in adolescent girls. Am J Pre Med. 2001;21(2):110–7.

29. Hardy LL, Booth ML, Okely AD. The reliability of the adolescent sedentary activity questionnaire (ASAQ). Prev Med. 2007;45:71–4.
30. Kowalski KC, Crocker PR, Donen RM. The physical activity questionnaire for older children (PAQ-C) and adolescents (PAQ-A) manual. Coll Kinesiol Univ Sask. 2004;87:11–5.
31. Lachat CK, Verstraeten R, le Khanh NB, Hagströmer M, Khan NC, Van Ndo A, et al. Validity of two physical activity questionnaires (IPAQ and PAQA) for Vietnamese adolescents in rural and urban areas. Int J Behav Nutr Phys Act. 2008;5:37.
32. Lupo C, Boccia G, Ungureanu AN, Mulasso A, De Pasquale P, Mancini A, et al. The Cut-Off Value for Classifying Active Italian Children Using the Corresponding National Version of the Physical Activity Questionnaire. Sports (Basel). 2022;10(4):61.
33. Welk GJ, Wood K, Morss G. Parental influences on physical activity in children: an exploration of potential mechanisms. Pediatr Exerc Sci. 2003;15(1):19–33.
34. Wang JJ, Baranowski T, Lau WP, Chen TA, Pitkethly AJ. Validation of the Physical Activity Questionnaire for Older Children (PAQ-C) among Chinese children. Biomed Environ Sci. 2016;29(3):177–86.
35. Linh LHH, Minh NN, Hong TK. Physical activity and related factors among junior high school students in Ho Chi Minh City in 2022 (Vận động thể lực và các yếu tố liên quan ở học sinh trung học cơ sở tại thành phố Hồ Chí Minh). J Med Res. 2023;160(12V1).[in Vietnamese].
36. Regina G, Melanie JC, Christine SA, Laura K, Leanne MR. Physical activity and sedentary behavior among schoolchildren: a 34-country comparison. J Pediatr. 2010;157(1):43–9.
37. Brazo-Sayavera J, Aubert S, Barnes JD, González SA, Tremblay MS. Gender differences in physical activity and sedentary behavior: results from over 200,000 Latin-American children and adolescents. PLoS ONE. 2021;16(8):e0255353.
38. Marques A, Henriques-Neto D, Peralta M, Martins J, Demetriou Y, Schönbach DMI, et al. Prevalence of physical activity among adolescents from 105 low, middle, and high-income countries. Int J Environ Res Public Health. 2020;17(9):3145.
39. To QG, Gallegos D, Do DV, et al. Correlates of physical activity in fifth-grade students in Ho Chi Minh City. Vietnam Sports Med Health Sci. 2020;2(1):33–7.
40. Vella SA, Cliff DP, Okely AD. Socio-ecological predictors of participation and dropout in organised sports during childhood. Int J Behav Nutr Phys Act. 2014;11:62.
41. Phan HD, Nguyen TNP, Bui PL, Pham TT, Doan TV, Nguyen DT, et al. Overweight and obesity among Vietnamese school-aged children: national prevalence estimates based on the World Health Organization and International Obesity Task Force definition. PLoS ONE. 2020;15(10):e0240459.
42. Pham NK, Sepehri A, Le TM, Tran VT. Correlates of body mass index among primary school children in Ho Chi Minh City. Vietnam Public Health. 2020;181:65–72.
43. He H, Pan L, Du J, Liu F, Jin Y, Ma J, et al. Muscle fitness and its association with body mass index in children and adolescents aged 7–18 years in China: a cross-sectional study. BMC Pediatr. 2019;19(1):101.
44. Hafsteinsson Östenberg A, Enberg A, Pojskic H, Gilic B, Sekulic D, Alricsson M. Association between physical fitness, physical activity level and sense of coherence in Swedish adolescents; an analysis of age and sex differences. Int J Environ Res Public Health. 2022;19(19):12841.
45. Zhou Y, Wang L. Correlates of physical activity of students in secondary school physical education: a systematic review of literature. Biomed Res Int. 2019;2019:4563484.
46. Kelley GA, Kelley KS, Pate RR. Exercise and adiposity in overweight and obese children and adolescents: a systematic review with network meta-analysis of randomised trials. BMJ Open. 2019;9(11):e031220.
47. Barros WMA, da Silva KG, Silva RKP, Souza APDS, da Silva ABJ, Silva MRM, et al. Effects of overweight/obesity on motor performance in children: a systematic review. Front Endocrinol (Lausanne). 2022;12:759165.
48. Zhang BG, Qian XF. Weight self-stigma and engagement among obese students in a physical education class. Front Psychol. 2022;13:1035827.
49. O'Reilly M, Talbot A, Harrington D. Adolescent perspectives on gendered ideologies in physical activity within schools: reflections on a female-focused intervention. Fem Psychol. 2023;33(2):175–96.
50. Chen FF, Liu JT, Huang GM, Mi J, China Children and Adolescents Cardiovascular Health Research Project Group (for the CCACH Collaboration Group). Developmental characteristics on body composition in Chinese urban children and adolescents aged 3–17 years old. Zhonghua Liu Xing Bing Xue Za Zhi. 2020;41(2):213–9.
51. Dan SP, Mohd NM, Zalilah MS. Determination of factors associated with physical activity levels among adolescents attending school in Kuantan. Malaysia Malays J Nutr. 2011;17(2):175–87.
52. Lee KS, Loprinzi PD, Trost SG. Determinants of physical activity in Singaporean adolescents. Int J Behav Med. 2010;17(4):279–86.
53. Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, N.J: Prentice Hall; 1986.
54. Cachón-Zagalaz J, Carrasco-Venturelli H, Sánchez-Zafra M, Zagalaz-Sánchez ML. Motivation toward physical activity and healthy habits of adolescents: a systematic review. Children (Basel). 2023;10(4):659.
55. Allender S, Cowburn G, Foster C. Understanding participation in sport and physical activity among children and adults: a review of qualitative studies. Health Educ Res. 2006;21(6):826–35.
56. Tate EB, Shah A, Jones M, Pentz MA, Liao Y, Dunton G. Toward a better understanding of the link between parent and child physical activity levels: the moderating role of parental encouragement. J Phys Act Health. 2015;12(9):1238–44.
57. Morton KL, Atkin AJ, Corder K, Suhrcke M, van Sluijs EM. The school environment and adolescent physical activity and sedentary behaviour: a mixed-studies systematic review. Obes Rev. 2016;17(2):142–58.
58. Ahmad Bahathig A, Abu Saad H, Md Yusop NB, Mohd Shukri NH, El-Din MME. Relationship between physical activity, sedentary behavior, and anthropometric measurements among Saudi female adolescents: a cross-sectional study. Int J Environ Res Public Health. 2021;18(16):8461.
59. Kracht CL, Joseph ED, Staiano AE. Video games, obesity, and children. Curr Obes Rep. 2020;9(1):1–14.
60. Visier-Alfonso ME, Sánchez-López M, Rodríguez-Martín B, Ruiz-Hermosa A, Bartolomé-Gutiérrez R, Sequí-Domínguez I, et al. Parents' perceptions of children's and adolescents' use of electronic devices to promote physical activity: systematic review of qualitative evidence. JMIR MHealth UHealth. 2023;11:e44753.
61. Wong RS, Tung KTS, Chan BNK, Ho FKW, Rao N, Chan KL, et al et al. Early-life activities mediate the association between family socioeconomic status in early childhood and physical fitness in early adolescence. Sci Rep 2022;12(81). https://doi.org/10.1038/s41598-021-03883-8.
62. Pearson N, Braithwaite RE, Biddle SJ, van Sluijs EM, Atkin AJ. Associations between sedentary behaviour and physical activity in children and adolescents: a meta-analysis. Obes Rev. 2014;15(8):666–75.
63. Schmidt SCE, Anedda B, Burchartz A, Eichsteller A, Kolb S, Nigg C, et al. Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. Sci Rep. 2020;10(1):21780.
64. Lian Y, Peijie C, Kun W, Tingran Z, Hengxu L, Jinxin Y, et al. The influence of family sports attitude on children's sports participation, screen time, and body mass index. Front Psychol. 2021;20(12):697358.
65. Internet World Stats: Internet Usage in Asia. 2020. https://www.internetworldstats.com/stats3.htm. Accessed 26 Aug 2023.
66. Prince SA, Roberts KC, Melvin A, Butler GP, Thompson W. Gender and education differences in sedentary behaviour in Canada: an analysis of national cross-sectional surveys. BMC Public Health. 2020;20(1):1170.
67. Weber DR, Moore RH, Leonard MB, Zemel BS. Fat and lean BMI reference curves in children and adolescents and their utility in identifying excess adiposity compared with BMI and percentage body fat. Am J Clin Nutr. 2013;98(1):49–56.
68. López-Gil JF, Brazo-Sayavera J, Yuste Lucas JL, Renato CF. Weight status is related to health-related physical fitness and physical activity but not to sedentary behaviour in children. Int J Environ Res Public Health. 2020;17(12):4518.
69. Ferreira Silva RM, Mendonça CR, Azevedo VD, Raoof Memon A, Noll PRESNM. Barriers to high school and university students' physical activity: a systematic review. PLoS ONE. 2022;17(4):e0265913.

70. Martins J, Costa J, Sarmento H, Marques A, Farias C, Onofre M, et al. Adolescents' perspectives on the barriers and facilitators of physical activity: an updated systematic review of qualitative studies. Int J Environ Res Public Health. 2021;18(9):4954.

Publisher's Note