



OPEN ACCESS

EDITED BY

Sandeep Bhupendra Maharaj,
The University of the West Indies St.
Augustine, Trinidad and Tobago

REVIEWED BY

Mahlagha Dehghan,
Kerman University of Medical Sciences, Iran
Darren Dookeeram,
The University of the West Indies St.
Augustine, Trinidad and Tobago

*CORRESPONDENCE

Zhongfei Tian
✉ tzf52825250@126.com

RECEIVED 18 August 2025

ACCEPTED 26 September 2025

PUBLISHED 16 October 2025

CITATION

Xu Q, Zhou Z and Tian Z (2025) Mental health
and health-related behaviors in Chinese
college students: the role of physical
education.

Front. Public Health 13:1688244.
doi: 10.3389/fpubh.2025.1688244

COPYRIGHT

© 2025 Xu, Zhou and Tian. This is an
open-access article distributed under the
terms of the [Creative Commons Attribution
License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or
reproduction in other forums is permitted,
provided the original author(s) and the
copyright owner(s) are credited and that the
original publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or reproduction
is permitted which does not comply with
these terms.

Mental health and health-related behaviors in Chinese college students: the role of physical education

Qing Xu¹, Zan Zhou² and Zhongfei Tian^{3*}

¹Business School, Shaoxing University, Shaoxing, Zhejiang, China, ²Institute of Physical Education, Shaoxing University, Shaoxing, Zhejiang, China, ³Beijing Health Vocational College, Beijing, China

Background: University physical education (PE) class may promote healthier behaviors and better mental health, yet evidence on their impact in higher education is limited. This study examined associations between PE participation, mental health, health-related behaviors, and sleep quality among Chinese university students.

Methods: A cross-sectional survey was conducted among 2,117 s-year undergraduate students, using proportional stratified sampling in 2024. Validated instruments were used to collect data: demographics and anthropometrics (self-report height and weight to calculate BMI); International Physical Activity Questionnaire–Short Form (IPAQ-SF) for total weekly physical activity; General Health Questionnaire–12 (GHQ-12) for mental health; Pittsburgh Sleep Quality Index (PSQI) for sleep quality; and self-reported screen time. To objectively assess activity levels during PE lessons, ActiGraph wGT3X-BT accelerometers were used. Logistic and multiple linear regression analyses identified associations and predictors of mental health, health-related behaviors, and MVPA proportion during PE class.

Results: In linear models, total physical activity ($\beta = 0.17$, $p = 0.003$), greater MVPA during PE ($\beta = 0.19$, $p = 0.003$), and shorter screen time ($\beta = -0.14$, $p = 0.009$) predicted better mental health. On average, students spent 48.6% of PE lesson time in MVPA. A higher MVPA proportion was associated with lower odds of obesity (OR = 0.41, $p < 0.001$), physical inactivity (OR = 0.38, $p < 0.001$), and poor sleep quality (OR = 0.72, $p = 0.004$). Male students had greater odds of obesity (OR = 3.14, $p < 0.001$) and smoking (OR = 2.02, $p = 0.001$), while females reported poorer sleep. Predictors of MVPA proportion in PE included higher BMI ($\beta = -0.11$, $p < 0.001$), female gender ($\beta = -0.14$, $p < 0.001$), poorer sleep quality ($\beta = -0.09$, $p = 0.003$), and lower mental health ($\beta = 0.11$, $p = 0.002$).

Conclusion: PE class may provide an important context for promoting health-related behaviors and mental health among university students. However, given the cross-sectional design, causal relationships cannot be inferred. Longitudinal and intervention studies are needed to confirm these findings and clarify underlying mechanisms.

KEYWORDS

mental health, physical education, students, physical activity, obesity, sleep

1 Introduction

Mental health during young adulthood is a critical public health concern, influencing long-term well-being, academic performance, and social functioning. University students face unique stressors, including heavy academic workloads, social pressures, and the transition to independent living, which can increase their vulnerability to anxiety, depression, and sleep disorders (1). Recent studies suggest that these problems are highly prevalent among Chinese students. For example, a 2024 national survey found that 16.3% of undergraduates had positive psychological symptoms, and the prevalence of these symptoms was higher among girls (17.5%) than boys (14.7%) (2). Sleep quality is also of concern: in a large sample of 6,363 university students in China, more than 60% reported having poor sleep, and poor sleep was significantly associated with an increased risk of psychological symptoms (3). In addition to mental health and sleep, lifestyle behaviors such as screen time, physical activity, and weight status are increasingly recognized as important determinants of student health. Excessive screen time is common in this population, with students spending an average of more than 5 h per day using digital devices (4). Long screen time combined with inadequate physical activity has been associated with a significantly increased risk of psychological symptoms compared with students who are more physically active and use screens less (5). Increasing rates of overweight and obesity among Chinese youth and adolescents also exacerbate these concerns, indicating a shift toward a sedentary lifestyle and unhealthy behaviors (5). The combination of these factors highlights the urgent need for interventions that simultaneously target the physical and mental health of university students.

Physical activity is a well-established contributor to psychological well-being, with evidence suggesting that regular engagement can enhance mood, reduce stress, alleviate anxiety and depressive symptoms, and improve cognitive functioning (6, 7). Within the university context, structured physical education (PE) classes provide an organized setting that may encourage such activity. Although PE primarily targets physical fitness, it can also create opportunities for students to engage in moderate-to-vigorous physical activity (MVPA), experience social interaction, and develop self-efficacy, all of which may indirectly support mental health (8, 9).

Beyond its potential effects on psychological outcomes, PE participation may influence healthy lifestyle behaviors such as sleep patterns, sedentary screen time, and body weight management (10). These behaviors can act as mediators or moderators in the relationship between physical activity and mental health, highlighting the multifaceted role of PE in promoting holistic well-being.

Guided by Social Cognitive Theory (11), this study considers how engagement in PE classes might strengthen students' confidence to maintain an active lifestyle, facilitate observational learning from peers, and provide positive reinforcement through physical and mental health benefits. These psychosocial mechanisms may extend beyond the classroom, influencing sleep, sedentary behavior, and other lifestyle factors that collectively contribute to mental health outcomes.

1.1 Objectives

The present study was designed with three main objectives:

- 1 To examine the association between participation in PE classes—measured by the proportion of time spent in MVPA—and mental health among Chinese university students.
- 2 To assess the associations between participation in PE classes and a range of health-related behaviors, including sleep quality, screen time, BMI, obesity, and smoking.
- 3 To identify predictors of the proportion of MVPA during PE sessions, focusing on demographic, psychological, and behavioral variables.

2 Methods and materials

2.1 Study design and setting

This cross-sectional study was conducted between October and December, 2024, in universities of Zhejiang Province, China.

2.2 Sampling and sample size

A total of 18 universities were randomly selected from the provincial list of accredited higher education institutions using proportional stratified sampling according to enrollment size. Within each selected university, cluster sampling at the class level was applied: classes comprising second-year undergraduates were randomly chosen, and all students from these years present in the selected classes were invited to participate. Second-year undergraduate students were selected as the study population for several reasons. At this stage, students have completed their first year of university, allowing them to be familiar with the academic environment and campus routines, yet they are still enrolled in mandatory PE courses, ensuring consistent exposure to structured activity. This makes them an ideal group for objectively assessing activity levels during PE lessons. Additionally, selecting second-year students minimizes self-selection bias that may occur in later years when PE participation becomes voluntary, allowing for a more representative assessment of typical student behavior. Moreover, second-year students are generally available and present in scheduled classes, facilitating accurate data collection and high response rates.

The minimum required sample size was estimated using G*Power (3.1.9.7) for regression (fixed model, $R^2 \neq 0$), with $\alpha = 0.05$, power = 0.95, assumed small effect size $f^2 = 0.02$. This calculation yielded 1,341 participants, which was increased to 1,610 to account for an anticipated 20% non-response/missing data rate.

Eligibility criteria included enrollment in the second year of undergraduate study. To reduce confounding, students in health-related majors (e.g., medicine, nursing, public health, PE) were excluded. Additional exclusion criteria were: severe mobility limitations (e.g., inability to participate in moderate physical activity for at least 10 min), and attendance at university fewer than 3 days per week.

2.3 Data collection instruments

Financial status was self-rated on a five-point Likert scale ranging from “very poor” (1) to “very good” (5). Due to low frequency in extreme categories, responses were collapsed into three categories: good (very good and good), acceptable (acceptable), and poor (very poor and poor) (12). Self-perceived financial condition has been widely used in youth health research as a valid proxy for actual socioeconomic status (13), especially where objective financial data is difficult to obtain.

BMI categories were recalculated based on the China CDC guidelines (underweight: <18.5; normal: 18.5–23.9; overweight: 24.0–27.9; obese: ≥ 28) (14). Height and weight were measured by using standardized procedures, and BMI was subsequently calculated. For regression analyses, BMI was dichotomized as “non-obese” (BMI < 28.0 kg/m²) and “obese” (BMI $\geq$ 28.0 kg/m²).

To objectively assess activity levels during PE lessons, ActiGraph wGT3X-BT accelerometers were used. Given that longer epoch lengths can underestimate vigorous activity and potentially overestimate MVPA by merging structured activity bouts, data were collected using 1-s epochs (15–17). Following each measurement session, the raw ActiGraph files were downloaded and processed using ActiLife software (version 6.5). Time spent at or above the moderate-intensity threshold ($\geq 2,800$ counts per minute) was classified as MVPA (18). The proportion of each PE lesson spent in MVPA was calculated by dividing the average MVPA time (in minutes) by the total lesson duration and expressing it as a percentage.

Physical activity was measured using the short version of the International Physical Activity Questionnaire (IPAQ-SF), which includes items on the frequency and duration of walking, MVPA, and screen time during the past 7 days. Each activity was assigned a metabolic equivalent (MET) value: 3.3 for walking, 4.0 for moderate-intensity, and 8.0 for vigorous-intensity activity. Total physical activity was calculated in MET-minutes/week. Participants were classified as physically inactive if they reported <600 MET-minutes/week, in line with previous studies (19, 20). Screen time was assessed via the IPAQ-SF item on time spent sitting during a typical weekday. The Chinese version of the IPAQ-SF has demonstrated acceptable test-retest reliability ($r > 0.70$) (21), and in the current study, it showed good internal consistency (Cronbach's $\alpha = 0.82$).

Sleep quality was assessed using the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI), a 19-item self-report questionnaire (22). The 19 items are combined to form seven component scores, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, sleep medication use, and daytime dysfunction (22). Each component score ranges from 0 to 3. Specifically, item 6 and item 4 contribute to the components subjective sleep quality and sleep duration, respectively; sleep latency is formed by items 2 and 5a; habitual sleep efficiency is formed by items 1, 3, and 4; sleep disturbance is formed by items 5b–j; sleep medication use is formed by item 7; and daytime dysfunction is formed by items 8 and 9 (22). The seven component scores are summed to yield a global PSQI score ranging from 0 to 21. In Chinese populations, a cutoff of 8 is commonly used to indicate poor sleep quality, with higher scores reflecting worse sleep (23). The Chinese version of PSQI has demonstrated good reliability among undergraduate students (23, 24). In the current study, Cronbach's α for

the scale was 0.702, and composite reliability for the total PSQI score was 0.79.

Mental health was assessed using the Chinese Mental Health Value Scale (CMHVS), a culturally-informed self-report instrument developed and validated to capture attitudes, beliefs, and values related to psychological well-being in Chinese populations (25). The CMHVS consists of 35 items organized into seven subscales: Expected Self, Relating to Others, Life Principles, Family, Purpose and Meaning, Achievement, and Communication. Each item is rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Subscale scores are calculated by summing the relevant items, and a total score is computed by summing all 35 items. Total scores thus range from 35 to 175, with higher scores indicating stronger endorsement of health-promoting psychological values. The scale has demonstrated excellent internal consistency (Cronbach's $\alpha = 0.96$) and strong construct validity, supporting its use as a reliable measure of culturally-relevant mental health among Chinese university students (25).

Smoking status was evaluated using a four-category item: (1) never smoked regularly, (2) former smoker, (3) occasional smoker, and (4) daily smoker. This classification is supported by prior behavioral health surveys (26). For regression model, responses were further recoded into two categories: current smokers (occasional or daily) and non-smokers (never and former smokers) (26).

2.4 Data collection

Data were collected using structured self-administered questionnaires and objective accelerometer measurements. All participants provided written informed consent. Ethical approval was obtained from the Medical Research Ethics Committee of Zhejiang University (No. ZHU-20240209-51).

2.5 Statistical methods

Quantitative variables, including BMI, proportion of PE lesson spent in MVPA, total physical activity (MET-minutes/week), total CMHVS score, and PSQI global score, were summarized as means and standard deviations ($M \pm SD$). Categorical variables, including gender, self-perceived financial condition, smoking status, and BMI category, were expressed as frequencies and percentages. To compare differences between female and male students, independent-sample t-tests were used for continuous variables, while Pearson's chi-square tests were applied for categorical variables.

To address the primary research aim, regression analyses were conducted in two stages. First, multiple linear and logistic regression models were used to examine predictors of key health-related outcomes, including obesity (BMI ≥ 28 , logistic regression), physical inactivity (total PA < 600 MET-min/week, logistic regression), poor sleep quality (PSQI >5, logistic regression), smoking status (current smoker, logistic regression), and mental health (CMHVS total score, linear regression). To minimize confounding, all models were adjusted for relevant covariates, including gender, BMI, financial condition, sleep quality, and mental health, depending on the outcome under study.

Second, to identify determinants of MVPA proportion in PE, a multiple linear regression model was conducted with MVPA proportion in PE lessons as the dependent variable. Potential predictors included BMI, gender, financial condition, sleep quality (PSQI score), and mental health (CMHVS score). A stepwise method was applied, with entry and removal criteria of $p < 0.05$ and $p > 0.10$, respectively. For linear regression models, assumptions of normality, homoscedasticity, and multicollinearity (tolerance >0.1 , VIF < 10) were tested. For logistic regression models, the Hosmer–Lemeshow test was used to assess goodness-of-fit. The use of both objective accelerometer measures and validated self-report instruments further reduced the risk of measurement bias.

All analyses were conducted using SPSS version 26.0 (IBM Corp., Armonk, NY, United States), with a two-tailed p -value <0.05 considered statistically significant.

3 Results

A total of 2,117 valid questionnaires were collected from 2,953 distributed, yielding a response rate of 71.68% (age: 20.59 ± 0.62 years; female: 57.96%). Figure 1 shows the characteristics of the participants. 15.77% of students rated their financial status as good. 31.22% of students were overweight and obese ($BMI \geq 24$) and 55.41% met the recommended physical activity level. The proportion of PE lesson time spent in MVPA was $48.62\% \pm 12.31\%$. Most students were non-smokers (91.87%) and 38.5% of students classified as having poor sleep quality. The mean daily screen time was 5.28 ± 1.12 h and mental health score was 137.47 ± 16.73 , indicating generally positive mental health values in this population.

Gender-based comparisons revealed significant differences across several variables (Table 1). Male students reported higher mental health scores and had a higher mean BMI than females ($p < 0.001$). They were also more physically active than females, both in meeting activity guidelines and in the proportion of PE class time spent in MVPA ($p < 0.001$). Also, smoking was far more common among males and they reported longer daily screen exposure ($p < 0.001$). Females, however, exhibited significantly poorer sleep quality ($p < 0.001$).

Multiple linear regression was used to examine predictors of mental health (CMHVS total score; Table 2). The overall model was statistically significant, $F(5, 1,167) = 25.65, p < 0.001$, explaining 9.9% of the variance in mental health ($R^2 = 0.099$). Among the predictors, higher total physical activity ($\beta = 0.17, p = 0.003$) and greater MVPA during PE lessons ($\beta = 0.19, p = 0.003$) were associated with better mental health, while longer screen time ($\beta = -0.14, p = 0.009$) was associated with poorer mental health.

The univariate and multivariate logistic regression analyses were conducted to examine predictors of obesity ($BMI \geq 28$), physical inactivity (total physical activity <600 MET-min/week), poor sleep quality ($PSQI \geq 8$), and current smoking status (Table 3). In the multivariate models, a higher proportion of MVPA during PE lessons was significantly associated with lower odds of obesity (adjusted OR = 0.41, 95% CI: 0.31–0.59, $p < 0.001$), physical inactivity (adjusted OR = 0.38, 95% CI: 0.27–0.52, $p < 0.001$), and poor sleep quality (adjusted OR = 0.72, 95% CI: 0.57–0.91, $p = 0.004$). Also, male students had higher odds of obesity (OR = 3.14, 95% CI: 2.22–4.43, $p < 0.001$) and smoking (OR = 2.02, 95% CI: 1.36–3.01, $p = 0.001$).

Also, to identify determinants of MVPA proportion in PE lessons, a multiple linear regression analysis was performed with MVPA proportion as the dependent variable (Table 4). The overall model was

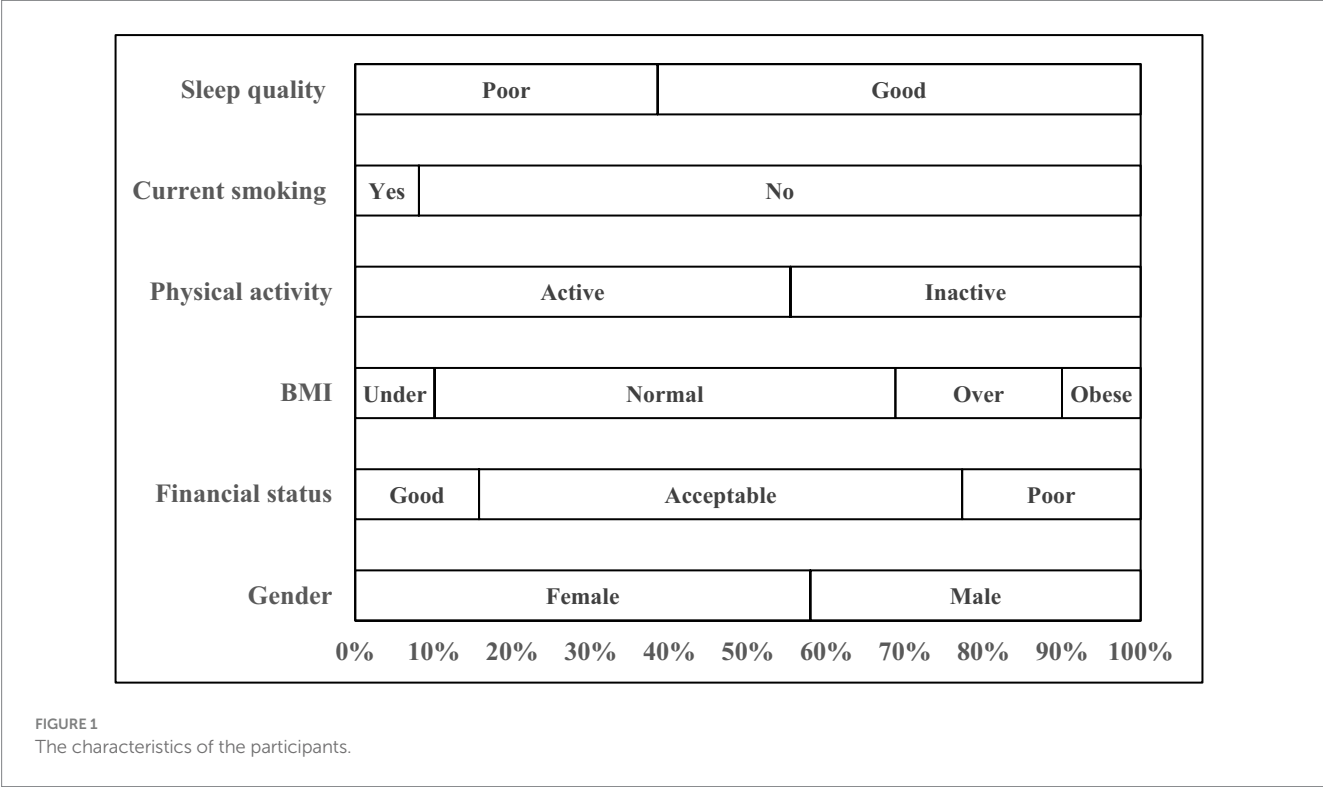


TABLE 1 Gender differences in study variables.

Variable	Male (<i>n</i> = 890)	Female (<i>n</i> = 1,227)	Test statistic	<i>p</i>
BMI (kg/m ²) (Mean ± SD)	23.78 ± 3.47	21.63 ± 3.25	12.53	< 0.001
Physically active (%, <i>n</i>)	62.92%, <i>n</i> = 560	49.96%, <i>n</i> = 613	35.22	< 0.001
MVPA proportion during PE (Mean ± SD)	52.1 ± 12.7	46.1 ± 11.8	10.02	< 0.001
Current smoking (%, <i>n</i>)	14.6%, <i>n</i> = 130	3.42%, <i>n</i> = 42	102.71	< 0.001
Daily screen time (hours), (Mean ± SD)	5.56 ± 1.18	5.06 ± 1.06	9.18	< 0.001
Sleep quality (Mean ± SD)	7.32 ± 3.08	8.12 ± 3.2	−6.47	< 0.001
Mental health (Mean ± SD)	138.9 ± 16.4	136.4 ± 16.9	5.82	< 0.001

TABLE 2 Multiple linear regression analysis predicting mental health scores from physical activity, screen time, MVPA during PE, gender, and financial status.

Predictors	Dependent variable: mental health			
	<i>B</i>	SE	<i>T</i>	<i>p</i>
Gender	0.03	0.04	1.01	0.309
Financial status	−0.01	0.03	−0.63	0.527
Total physical activity	0.17	0.06	3.14	0.003*
Screen time	−0.14	0.06	−2.57	0.009*
MVPA proportion in PE lessons	0.19	0.07	3.02	0.003*

Model summary: $R^2 = 0.099$, Adjusted $R^2 = 0.093$, $F(5, 1,167) = 25.65$, $p < 0.001$.

significant ($F(5, 2,330) = 18.62$, $p < 0.001$), explaining 9.5% of the variance in MVPA proportion ($R^2 = 0.095$). Among the predictors, higher BMI ($\beta = -0.11$, $p < 0.001$), female gender ($\beta = -0.14$, $p < 0.001$), poorer sleep quality (PSQI score, $\beta = -0.09$, $p = 0.003$), and lower mental health scores ($\beta = 0.11$, $p = 0.002$) were associated with a significantly lower proportion of MVPA during PE. Financial condition was not a significant predictor ($p = 0.163$).

4 Discussion

University PE programs have long been recognized as a strategic platform for promoting the physical and mental health of students. However, evidence regarding their effectiveness in shaping sustainable health-related behaviors among university populations, especially in China, remains. This study aimed to address this gap by examining the association between participation in PE classes and mental health and some health-related behaviors, including physical inactivity, obesity, and smoking. These findings may indicate the importance of evaluating PE classes not only in terms of physical outcomes, but also as a means of promoting students' overall health.

This study found that higher total physical activity and a greater proportion of MVPA during PE lessons were associated with better mental health, whereas longer screen time showed a negative association. Gender and self-perceived financial status did not appear to influence mental health in this sample. Therefore, implementing strategies to increase MVPA in PE classes and reduce screen time may help improve students' mental health.

Although causality cannot be inferred from this cross-sectional study, several plausible mechanisms may explain these relationships. Regular physical activity can enhance mood and emotional regulation through neurobiological pathways, including increased release of endorphins and neurotransmitters such as serotonin and dopamine (27, 28). Active participation during PE lessons may further promote self-efficacy, social engagement, and a sense of accomplishment, which can contribute to psychological well-being (29, 30). Conversely, prolonged screen time may replace opportunities for physical activity, limit social interactions, and induce mental fatigue or stress, potentially detracting from mental health (31, 32). The mechanisms suggested suggest that PE classes may be able to be purposefully designed to help foster self-efficacy and social interactions, while broader academic programs could also play a role in more effectively managing students' screen use.

Our findings show that a higher proportion of MVPA during PE lessons was associated with lower odds of obesity, physical inactivity, and poor sleep quality. Specifically, students engaging in more MVPA appeared less likely to be obese, less likely to report physical inactivity, and less likely to experience poor sleep. While causality cannot be inferred from this observational study, several mechanisms may help explain these patterns. Higher MVPA during PE could reflect greater overall activity levels, which may contribute to energy balance and body weight regulation (33), consistent with prior research linking active university-based physical activity to lower obesity prevalence (34, 35). Likewise, students who are more active during PE might be more inclined to maintain other forms of daily activity, thereby reducing sedentary behavior and inactivity. These results may indicate that PE programs can be used as preventive strategies against obesity and inactivity while also helping to improve sleep hygiene among students.

The observed association between higher MVPA and better sleep quality could be mediated through multiple physiological and behavioral pathways. Physical activity may enhance sleep homeostasis by increasing sleep drive, improving circadian rhythm regulation, and reducing stress or anxiety, all of which can positively influence sleep efficiency (36, 37). These pathways are supported by previous studies demonstrating links between regular physical activity and improved sleep metrics in university students (38–40). Encouraging more intense activities in PE classes may be a practical approach to improving students' sleep quality and academic performance.

No significant association was found between MVPA proportion and smoking status, suggesting that the behavioral patterns influencing substance use may be distinct from those shaping physical activity (41). Social and environmental influences, peer behaviors, and personality traits may play stronger roles in smoking behaviors than participation in PE (42). This may indicate that smoking status in universities requires targeted interventions in the areas of public health and social issues that go beyond the framework of PE programs.

Gender differences were evident for obesity and smoking, with male students showing higher odds of both outcomes. This aligns with prior literature reporting sex-based differences in body composition (43, 44), activity preferences, and risk-taking tendencies during

TABLE 3 Logistic and linear regression analyses predicting health-related outcomes.

Outcome	Predictor	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-value
Obesity	MVPA proportion in PE	0.46 (0.34–0.62)	0.41 (0.31–0.59)	<0.001
	Male (vs Female)	3.27 (2.31–4.62)	3.14 (2.22–4.43)	<0.001
	Financial status (acceptable and poor vs. good)	0.95 (0.71–1.28)	0.97 (0.72–1.31)	0.85
		0.97 (0.73–1.25)	0.95 (0.70–1.21)	0.119
Physical inactivity	MVPA proportion in PE	0.40 (0.29–0.55)	0.38 (0.27–0.52)	<0.001
	Male (vs Female)	0.91 (0.73–1.15)	0.88 (0.70–1.11)	0.30
	Financial status (acceptable and poor vs. good)	1.08 (0.82–1.42)	1.06 (0.80–1.40)	0.68
		1.1 (0.85–1.41)	1.07 (0.81–1.4)	0.23
Poor sleep	MVPA proportion in PE	0.75 (0.60–0.93)	0.72 (0.57–0.91)	0.004
	Male (vs Female)	1.12 (0.88–1.43)	1.09 (0.85–1.40)	0.48
	Financial status (acceptable and poor vs. good)	0.97 (0.73–1.29)	0.96 (0.72–1.28)	0.78
		0.95 (0.72–1.28)	0.93 (0.7–1.24)	0.322
Smoking (current)	MVPA proportion in PE	0.92 (0.59–1.43)	0.94 (0.60–1.46)	0.78
	Male (vs Female)	2.08 (1.40–3.08)	2.02 (1.36–3.01)	0.001
	Financial status (acceptable and poor vs. good)	0.88 (0.53–1.46)	0.90 (0.54–1.49)	0.67
		0.91 (0.57–1.48)	0.89 (0.53–1.46)	0.209

TABLE 4 Multiple linear regression analysis predicting MVPA proportion in PE lessons from BMI, sleep quality, mental health, gender, and financial status.

Predictors	Dependent variable: MVPA proportion in PE lessons			
	B	SE	T	p
BMI	−0.11	0.03	−6.14	<0.001
Gender (female)	−0.14	0.03	−7.32	<0.001
Financial condition	0.02	0.02	1.38	0.163
Sleep quality (PSQI)	−0.09	0.03	−2.87	0.003
Mental health (CMHVS)	0.11	0.03	3.09	0.002

Model summary: R² = 0.095, Adjusted R² = 0.092, F(5, 2,330) = 18.62, p < 0.001.

university (45–47). However, gender was not significantly associated with physical inactivity or poor sleep, indicating that the potential benefits of MVPA during PE lessons may be experienced similarly by both sexes in these domains. Gender-specific interventions, particularly in the areas of obesity and smoking among male students, may be necessary, while the benefits of PE classes could be promoted equally among both sexes.

Self-perceived financial status did not significantly predict any of the examined outcomes, suggesting that the relationships between MVPA and health-related behaviors operate independently of students’ perceived economic resources. Overall, these results highlight that higher engagement in MVPA during PE is consistently associated with favorable patterns in weight status, activity levels, and sleep, while emphasizing the need for cautious interpretation due to the cross-sectional design of the study.

One of the findings of the present study was that higher BMI, female gender, poorer sleep quality, and lower mental health were associated with a lower proportion of MVPA during PE lessons among university students. These associations suggest that multiple interrelated factors may influence students’ engagement in

moderate-to-vigorous activity. Higher BMI may reduce participation through both physiological and psychological pathways: excess body weight can increase fatigue and perceived exertion during activity (48), while also lowering perceived physical competence and self-efficacy (49). Female students may engage in lower MVPA due to sociocultural influences, gender norms, and differences in motivation or enjoyment during PE classes, as observed in previous studies among young adults (49). Poor sleep quality can impair alertness, energy metabolism, and physical performance, potentially reducing activity intensity, while suboptimal mental health may affect motivation, emotional regulation, and the ability to cope with physical challenge (50, 51). These findings may indicate that interventions should not only focus on promoting MVPA in general, but also need to provide more targeted supports for students with higher BMI, girls, and those experiencing sleep or mental health problems.

These findings align with prior research indicating that physical, psychological, and social factors jointly shape activity behaviors in higher education settings. Understanding these determinants can inform targeted strategies, such as tailored PE programs, supportive interventions for students with higher BMI, initiatives to improve sleep hygiene, and mental health support programs, all aimed at enhancing engagement in MVPA among university students.

Several limitations of the present study should be acknowledged. First, the cross-sectional design precludes causal inferences; although significant associations were observed, the directionality of relationships cannot be established. Second, some measures relied on self-report, which may introduce reporting bias, particularly for physical activity, screen time, and mental health. Objective measurements could enhance accuracy in future studies. Third, the sample consisted solely of university students from a single region, limiting the generalizability of findings to other populations or cultural contexts. Fourth, while multiple relevant predictors were included, unmeasured factors such as dietary habits, academic stress, or social support could also influence both MVPA participation and mental health. Finally, the proportion of variance explained in the models was modest, suggesting that other

determinants remain unaccounted for. Although we adjusted for several potential confounders, such as gender, BMI, sleep quality, and financial status, residual confounding from unmeasured variables (e.g., dietary habits, academic stress, or social support) cannot be ruled out. Future research should employ longitudinal and interventional designs, incorporate more objective measures, and explore additional contextual and behavioral variables to build stronger evidence.

5 Conclusion

In conclusion, the present study shows that both overall physical activity and participation in MVPA in PE classes are positively associated with better mental health among university students. In contrast, higher BMI, female gender, poor sleep quality, and poor mental health are associated with reduced participation in MVPA in PE classes. These findings emphasize the multifactorial nature of physical activity-related behaviors in higher education settings and suggest that interventions aimed at improving mental health and physical activity should simultaneously address physical, psychological, and behavioral factors. Targeted strategies—such as promoting inclusive PE environments, supporting students with higher BMIs, improving sleep quality, and providing mental health resources—may help optimize physical activity participation and health promotion in the university population.

At the same time, this study suggests avenues for future research. Longitudinal, intervention-based designs are essential to determine causal relationships, and the use of more objective instruments to measure health behaviors can reduce the limitations of self-reported data. Also, larger studies across multiple educational centers can help increase the generalizability of the results, and examining additional factors such as dietary habits, academic stress, and social support also merits further consideration.

From an educational perspective, the results of this study emphasize the potential of PE classes as a platform for comprehensive health promotion on campus. Designing PE curricula that maximize opportunities for MVPA, enhance enjoyment, and address barriers for students with high BMI or mental health challenges may lead to greater participation. Incorporating educational elements such as sleep hygiene and stress management into PE programs can also improve outcomes. By aligning PE classes with campus-wide health initiatives, we can create supportive environments that promote both physical activity and mental health.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

References

1. Shan Y, Ji M, Xie W, Li R, Qian X, Zhang X, et al. Interventions in Chinese undergraduate students' mental health: systematic review. *Interactive J Medical Res.* (2022) 11:e38249. doi: 10.2196/38249
2. Deng G-f, Wen Y, Cheng J, Huang B, Liu N. Analysis of the associations between moderate-to-vigorous physical activity and screen time on psychological symptoms among university students: a cross-sectional survey based on six geographic regions in China. *BMC Psychiatry.* (2024) 24:504. doi: 10.1186/s12888-024-05945-3

Ethics statement

The studies involving humans were approved by Medical Research Ethics Committee of Zhejiang University (No. ZHU-20240209-51). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

QX: Writing – original draft, Project administration, Data curation, Conceptualization. ZZ: Conceptualization, Writing – original draft, Data curation, Project administration. ZT: Writing – review & editing, Writing – original draft, Project administration, Data curation, Conceptualization, Methodology.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

5. Zhu Z, Yin P. Overweight and obesity: the serious challenge faced by Chinese children and adolescents. *J Glob Health*. (2023) 13:03036. doi: 10.7189/jogh.13.03036
6. Fletcher GF, Landolfo C, Niebauer J, Ozemek C, Arena R, Lavie CJ. Promoting physical activity and exercise: JACC health promotion series. *J Am Coll Cardiol*. (2018) 72:1622–39. doi: 10.1016/j.jacc.2018.08.2141
7. Miller KJ, Mesagno C, McLaren S, Grace F, Yates M, Gomez R. Exercise, mood, self-efficacy, and social support as predictors of depressive symptoms in older adults: direct and interaction effects. *Front Psychol*. (2019) 10:2145. doi: 10.3389/fpsyg.2019.02145
8. Li B, Jiang W, Han S-s, Ye Y-p, Li Y-x, Lou H, et al. Influence of moderate-to-high intensity physical activity on depression levels: a study based on a health survey of Chinese university students. *BMC Public Health*. (2024) 24:1023. doi: 10.1186/s12889-024-18433-w
9. Qiu W, Wang X, Cui H, Ma W, Xiao H, Qu G, et al. The impact of physical exercise on college students' physical self-efficacy: the mediating role of psychological resilience. *Behav Sci*. (2025) 15:541. doi: 10.3390/bs15040541
10. Benaich S, Mehdad S, Andaloussi Z, Boutayeb S, Alamy M, Aguenau H, et al. Weight status, dietary habits, physical activity, screen time and sleep duration among university students. *Nutr Health*. (2021) 27:69–78. doi: 10.1177/0260106020960863
11. Montcalm DM. Applying bandura's theory of self-efficacy to the teaching of research. *J Teach Soc Work*. (1999) 19:93–107.
12. Nédó E, Paulik E. Association of smoking, physical activity, and dietary habits with socioeconomic variables: a cross-sectional study in adults on both sides of the Hungarian-Romanian border. *BMC Public Health*. (2012) 12:1–10. doi: 10.1186/1471-2458-12-60
13. Williams VF, Smith AA, Villanti AC, Rath JM, Hair EC, Cantrell J, et al. Validity of a subjective financial situation measure to assess socioeconomic status in US young adults. *J Public Health Manag Pract*. (2017) 23:487–95. doi: 10.1097/PHH.0000000000000468
14. Pan Q, Zhang W, Chen X, Li Y, Tu C. A study of trends in body morphology, overweight, and obesity in Chinese adults aged 40–59 years. *BMC Public Health*. (2025) 25:833. doi: 10.1186/s12889-025-21890-6
15. Santos-Lozano A, Santin-Medeiros F, Cardon G, Torres-Luque G, Bailon R, Bergmeir C, et al. Actigraph GT3X: validation and determination of physical activity intensity cut points. *Int J Sports Med*. (2013) 34:975–82. doi: 10.1055/s-0033-1337945
16. Edwardson CL, Gorely T. Epoch length and its effect on physical activity intensity. *Med Sci Sports Exerc*. (2010) 42:928–34. doi: 10.1249/MSS.0b013e3181c301f5
17. Aibar A, Chanal J. Physical education: the effect of epoch lengths on children's physical activity in a structured context. *PLoS One*. (2015) 10:e0121238. doi: 10.1371/journal.pone.0121238
18. Zhu Z, Chen P, Zhuang J. Intensity classification accuracy of accelerometer-measured physical activities in Chinese children and youth. *Res Q Exerc Sport*. (2013) 84:S4–S11. doi: 10.1080/02701367.2013.850919
19. Craig C, Marshall A, Sjostrom M, Bauman A, Lee P, Macfarlane D, et al. International physical activity questionnaire-short form. *J Am Coll Heal*. (2017) 65:492–501. doi: 10.1080/07448481.2017.1359249
20. Amini H, Isanejad A, Chamani N, Movahedi-Fard F, Salimi F, Moezi M, et al. Physical activity during COVID-19 pandemic in the Iranian population: a brief report. *Heliyon*. (2020) 6:e05411. doi: 10.1016/j.heliyon.2020.e05411
21. Qu N, Li K. Study on the reliability and validity of international physical activity questionnaire (Chinese version, IPAQ). *Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi*. (2004) 25:265–8.
22. Zhang C, Zhang H, Zhao M, Li Z, Cook CE, Buysse DJ, et al. Reliability, validity, and factor structure of Pittsburgh sleep quality index in community-based centenarians. *Front Psychol*. (2020) 11:573530. doi: 10.3389/fpsyg.2020.573530
23. Shi S, Xiong D, Yan Q. Sleep quality among college students and associated factors. *Chin J Sch Health*. (2013) 34:1462–4.
24. Zheng B, Li M, Wang K, Lv J. Analysis of the reliability and validity of the Chinese version of Pittsburgh sleep quality index among medical college students. *Beijing da xue xue bao Yi xue ban= J Peking University Health Sci*. (2016) 48:424–8.
25. Lei Y, Duan C, Shen K. Development and validation of the Chinese mental health value scale: a tool for culturally-informed psychological assessment. *Front Psychol*. (2025) 16:1417443. doi: 10.3389/fpsyg.2025.1417443
26. Haddad C, Sacre H, Hajj A, Lahoud N, Akiki Z, Akel M, et al. Comparing cigarette smoking knowledge and attitudes among smokers and non-smokers. *Environ Sci Pollut Res Int*. (2020) 27:19352–62. doi: 10.1007/s11356-020-08162-z
27. Cabral DF. Changes in neurotransmission during exercise In: C Karageorghis and E Pappous, Editors. Sport and exercise psychophysiology. Cham: Springer Nature Switzerland. (2025). 141–79.
28. Di Liegro CM, Schiera G, Proia P, Di Liegro I. Physical activity and brain health. *Gene*. (2019) 10:720. doi: 10.3390/genes10090720
29. Sánchez-García C, Reigal RE, Hernández-Martos J, Hernández-Mendo A, Morales-Sánchez V. Engagement in transformational leadership by teachers influences the levels of self-esteem, motor self-efficacy, enjoyment, and intention to be active in physical education students. *Sports*. (2024) 12:191. doi: 10.3390/sports12070191
30. Morales-Sánchez V, Hernández-Martos J, Reigal RE, Morillo-Baro JP, Caballero-Cerbán M, Hernández-Mendo A. Physical self-concept and motor self-efficacy are related to satisfaction/enjoyment and boredom in physical education classes. *Sustainability*. (2021) 13:8829. doi: 10.3390/su13168829
31. Nakshine VS, Thute P, Khatib MN, Sarkar B. Increased screen time as a cause of declining physical, psychological health, and sleep patterns: a literary review. *Cureus*. (2022) 14:e30051. doi: 10.7759/cureus.30051
32. Devi KA, Singh SK. The hazards of excessive screen time: impacts on physical health, mental health, and overall well-being. *J Educ Health Promot*. (2023) 12:413. doi: 10.4103/jehp.jehp_447_23
33. Bourdier P, Simon C, Bessesen DH, Blanc S, Bergouignan A. The role of physical activity in the regulation of body weight: the overlooked contribution of light physical activity and sedentary behaviors. *Obes Rev*. (2023) 24:e13528. doi: 10.1111/obr.13528
34. Edelmann D, Pfirrmann D, Heller S, Dietz P, Reichel JL, Werner AM, et al. Physical activity and sedentary behavior in university students—the role of gender, age, field of study, targeted degree, and study semester. *Front Public Health*. (2022) 10:821703. doi: 10.3389/fpubh.2022.821703
35. Herbert C. Enhancing mental health, well-being and active lifestyles of university students by means of physical activity and exercise research programs. *Front Public Health*. (2022) 10:849093. doi: 10.3389/fpubh.2022.849093
36. Rutkowska M, Bieńko M, Król T, Toborek M, Marchaj M, Korta K, et al. Sleep cycles and health: role of sleep stages, circadian rhythms, and lifestyle factors on optimizing physical performance and mental well-being—a literature review. *Quality in Sport*. (2024) 18:53398. doi: 10.12775/QS.2024.18.53393
37. Healy KL, Morris AR, Liu AC. Circadian synchrony: sleep, nutrition, and physical activity. *Front Network Physiol*. (2021) 1:732243. doi: 10.3389/fnnet.2021.732243
38. Mahfouz MS, Ali SA, Bahari AY, Ajeebi RE, Sabei HJ, Somaily SY, et al. Association between sleep quality and physical activity in Saudi Arabian university students. *Nat Sci Sleep*. (2020) 12:775–82. doi: 10.2147/NSS.S267996
39. Ge Y, Xin S, Luan D, Zou Z, Liu M, Bai X, et al. Association of physical activity, sedentary time, and sleep duration on the health-related quality of life of college students in Northeast China. *Health Qual Life Outcomes*. (2019) 17:124. doi: 10.1186/s12955-019-1194-x
40. Li B, Han S-s, Ye Y-p, Li Y-x, Meng S-q, Feng S, et al. Cross sectional associations of physical activity and sleep with mental health among Chinese university students. *Sci Rep*. (2024) 14:31614. doi: 10.1038/s41598-024-80034-9
41. Brellenthin AG, Lee D-c. Physical activity and the development of substance use disorders: current knowledge and future directions. *Progress Preventive Med*. (2018) 3:e0018. doi: 10.1097/pp9.0000000000000018
42. Liu J, Zhao S, Chen X, Falk E, Albarracín D. The influence of peer behavior as a function of social and cultural closeness: a meta-analysis of normative influence on adolescent smoking initiation and continuation. *Psychol Bull*. (2017) 143:1082–115. doi: 10.1037/bul0000113
43. Jiang S, Peng S, Yang T, Cottrell RR, Li L. Overweight and obesity among Chinese college students: an exploration of gender as related to external environmental influences. *Am J Mens Health*. (2018) 12:926–34. doi: 10.1177/1557988317750990
44. Du C, Adjepong M, Zan MCH, Cho MJ, Fenton JJ, Hsiao PY, et al. Gender differences in the relationships between perceived stress, eating behaviors, sleep, dietary risk, and body mass index. *Nutrients*. (2022) 14:1045. doi: 10.3390/nu14051045
45. Zhang Y-Y, Lei Y-T, Song Y, Lu R-R, Duan J-L, Prochaska JJ. Gender differences in suicidal ideation and health-risk behaviors among high school students in Beijing, China. *J Glob Health*. (2019) 9:010604. doi: 10.7189/jogh.09.010604
46. Yang X, Chen W, Peng X, Wei C, Xin J, Tang J, et al. The prevalence of smoking in male medical students from 16 Chinese medical colleges and the associated factors. *Ann Palliat Med*. (2020) 9:4054065. doi: 10.21037/apm-20-1136
47. Wu Y, Fan H, Guo Z, Wei L. Factors associated with smoking intentions among Chinese college students. *Am J Mens Health*. (2019) 13:1557988318818285. doi: 10.1177/1557988318818285
48. Martinez-Amezcu P, Simonsick EM, Wanigatunga AA, Urbanek JK, Chiles Shaffer N, Ferrucci L, et al. Association between adiposity and perceived physical fatigability in mid-to late life. *Obesity*. (2019) 27:1177–83. doi: 10.1002/oby.22500
49. Latino F, Tafuri F, Saraiello E, Tafuri D. Classroom-based physical activity as a means to improve self-efficacy and academic achievement among Normal-weight and overweight youth. *Nutrients*. (2023) 15:2061. doi: 10.3390/nu15092061
50. Sejbuk M, Mironczuk-Chodakowska I, Witkowska AM. Sleep quality: a narrative review on nutrition, stimulants, and physical activity as important factors. *Nutrients*. (2022) 14:1912. doi: 10.3390/nu14091912
51. Craven J, McCartney D, Desbrow B, Sabapathy S, Bellinger P, Roberts L, et al. Effects of acute sleep loss on physical performance: a systematic and meta-analytical review. *Sports Med*. (2022) 52:2669–90. doi: 10.1007/s40279-022-01706-y