

Temporal Associations Between Restrained Eating and Physical Activity Among Male University Students: A Cross-Lagged Panel Study

Mengxuan Liu

liumengxuan@aliu.scu.edu.cn

Jiangxi Institute of Technology

Research Article

Keywords: restrained eating, physical activity, eating behavior, male university students, longitudinal study, emerging adulthood

Posted Date: September 8th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10625874/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Purpose

This study investigated the bidirectional temporal relationship between restrained eating (RE) and physical activity (PA) in male university students using data from three assessments.

Methods

Male undergraduates from eight universities in China were followed for 12 months, with surveys administered in March 2025, September 2025, and March 2026. The analysis included 808 participants with valid data at all three assessments. RE was measured using the restrained-eating subscale of the Dutch Eating Behavior Questionnaire, whereas PA was calculated from the Physical Activity Rating Scale-3. Reciprocal longitudinal associations were examined using a cross-lagged panel model that incorporated autoregressive paths and concurrent covariances.

Results

PA and RE were moderately stable across waves and negatively correlated within waves ($p < .01$). Earlier PA predicted lower subsequent RE ($\beta = -0.233$ and -0.262 , both $p < .001$), whereas earlier RE predicted lower subsequent PA ($\beta = -0.253$ and -0.183 , both $p < .001$).

Conclusion

RE and PA showed inverse reciprocal prospective associations. These findings support joint consideration of eating and activity behaviors in male university students but do not establish causal effects or imply that changing one behavior will necessarily change the other.

Level of Evidence:

Level III, well-designed cohort study.

1 Introduction

Restrained eating (RE) refers to deliberate efforts to limit food intake to influence body weight or shape [11, 27, 37, 57]. Although restraint may be adopted for health or weight-management purposes, sustained or rigid restriction has also been associated with problematic eating patterns [39]. University students may be particularly susceptible because increased autonomy over food, disrupted routines, and appearance-related pressures often accompany the transition to independent living. RE is common in university populations [18, 49, 57], but research has focused largely on women. Men also engage in dietary restraint for goals related to leanness, muscularity [23], athletic performance, and self-discipline [1, 12], which may shape its relationship with other health behaviors.

Physical activity (PA) also changes substantially during university. Although regular activity benefits physical and psychological health, participation may decline or fluctuate with academic demands, unstructured schedules, screen exposure, and changing social environments [8, 13, 15]. Among young men, PA may additionally serve appearance- and performance-related goals involving strength, fitness, and bodily control [5, 6, 29, 41]. Thus, both RE and PA may

represent health-promoting behaviors, weight-management strategies, or components of broader eating- and body-related regulation [52].

Self-regulation provides a framework for understanding their potential temporal relationship. Both behaviors involve goal setting, monitoring, and behavioral adjustment in response to health [35], appearance, or performance standards [3, 9, 54]. RE and PA may reinforce one another when used as complementary weight-management strategies. Alternatively, dietary restriction may be followed by lower activity through fatigue, reduced energy, or diminished motivation [24, 26], whereas PA may either increase dietary control [7, 14, 50] or reduce reliance on restrictive eating through more flexible regulation and greater perceived competence [22, 31, 32]. These competing pathways suggest that the direction of the RE–PA association requires empirical examination.

Most previous studies have examined RE and PA cross-sectionally [17, 28], limiting conclusions about temporal ordering or reciprocal associations [36, 42]. This gap is particularly important among male university students, whose eating and exercise behaviors may be influenced by expectations concerning muscularity, fitness, and self-control [16, 45]. Findings derived primarily from female samples therefore may not generalize directly to men.

The present study used three assessments over 12 months to examine prospective bidirectional associations between RE and PA among male university students. A cross-lagged panel model (CLPM) estimated reciprocal cross-wave paths while accounting for prior levels of each construct and within-wave associations [10, 55]. As shown in Fig. 1, paths from PA to subsequent RE and from RE to subsequent PA were tested across adjacent waves without prespecifying that the associations would necessarily be positive or negative [25, 34].

2 Methods

2.1 Participants and Procedure

Participants were assessed at baseline in March 2025 (T1) and followed up in September 2025 (T2) and March 2026 (T3). Male undergraduates aged 17–25 years were recruited by convenience sampling from eight universities across five Chinese provinces. Students unable to complete the survey independently, reporting conditions or medical restrictions affecting eating or physical activity, or providing incomplete or invalid responses were excluded.

An a priori G*Power analysis indicated a minimum of 142 participants [40]. An SEM-based estimate suggested approximately 150, which increased to 180 after allowing for 20% attrition; recruitment exceeded this target.

Written informed consent was obtained at baseline. Participation was voluntary, uncompensated, and anonymous, with withdrawal permitted at any time. Unique study codes linked responses across waves. Baseline data were collected during regular teaching weeks, while follow-up surveys were administered online with reminders distributed through class-based group chats.

At T1, 900 undergraduate students completed the baseline survey; 874 participated at T2 and 834 at T3. After excluding incomplete or invalid responses, 808 participants who completed all three waves and met the data-quality criteria were included in the longitudinal analyses (Table 1). Because the available data did not permit a formal comparison between retained participants and those lost to follow-up, attrition bias cannot be excluded. The study received ethics approval from Jiangxi Institute of Technology and complied with the Declaration of Helsinki.

Table 1
Participant characteristics (N = 808)

Characteristics	Categories	N(%)	M ± SD
Grade	freshman	318 (39.4)	
	sophomore	319 (39.5)	
	junior	171 (21.2)	
Family residence	Rural	341 (42.2)	
	Urban	467 (57.8)	
Age			19.31 ± 0.92

2.2 Measures

2.2.1 Physical Activity

Physical activity was measured with Liang's Physical Activity Rating Scale-3 (PARS-3) [30]. The instrument assesses exercise intensity, session length, and participation frequency, each through five response categories. Consistent with the original scoring method, an overall activity score was derived as intensity × (duration – 1) × frequency. Scores can range from 0 to 100, with higher values reflecting greater activity. Previous studies have applied the PARS-3 in university samples [54, 58]. As its three dimensions form a multiplicative index rather than a reflective scale, Cronbach's alpha was not considered an appropriate primary indicator of reliability.

2.2.2 Restrained Eating

Restrained eating was evaluated with the 10-item restraint subscale of the Dutch Eating Behavior Questionnaire (DEBQ) [43], using the Chinese version validated by Wu et al. [53]. The items capture deliberate regulation of food consumption for weight control in everyday contexts. Responses were recorded on a Likert-type scale and averaged, with higher mean scores denoting greater restraint. One example item asks, "Do you deliberately eat less in order not to become heavier?" The subscale has demonstrated satisfactory psychometric properties in nonclinical and university populations. In the present sample, Cronbach's alpha was .923 at T1, .925 at T2, and .917 at T3.

2.3 Statistical Analysis

Analyses were conducted in SPSS 26.0 and Mplus 8.3 using the 808 complete cases. SPSS was used to calculate means, standard deviations, skewness, kurtosis, and Pearson correlations for PA and RE at each wave. Longitudinal measurement invariance was examined separately for PA and RE using configural, metric, and scalar models. Successive models constrained factor loadings and then intercepts to equality across waves. Invariance was evaluated from absolute fit indices and changes in CFI and TLI, with absolute changes below .010 interpreted as evidence that the additional equality constraints did not materially worsen fit [48, 60].

The cross-lagged panel model was estimated in Mplus with maximum likelihood using the observed PA composite and mean RE score at T1, T2, and T3. The model included autoregressive paths for each construct, reciprocal cross-lagged paths between adjacent waves, and within-wave covariances between PA and RE. Standardized coefficients and two-sided p values are reported. The analysis estimates between-person prospective associations after accounting for prior scores; it does not isolate within-person change or establish causal effects. Statistical significance was evaluated at alpha = .05.

3 Results

3.1 Measurement Invariance

Longitudinal measurement invariance results are presented in Table 2. For PA, the configural model was just identified ($\chi^2/df = 0$); therefore, its perfect fit indices are a mathematical property and were not interpreted as evidence of model fit. The constrained PA models retained acceptable absolute fit. The RE configural, metric, and scalar models also showed acceptable fit.

For both PA and RE, changes in CFI and TLI between successive models were smaller than .010 (Table 2), indicating that equality constraints on loadings and intercepts did not materially reduce fit [51]. Metric and scalar invariance were therefore considered supported, while the just-identified PA configural model was interpreted cautiously.

Table 2
Longitudinal measurement invariance tests for PA and RE

Variable	Model	χ^2/df	CFI	TLI	SRMR	RMSEA	Model comparison	ΔCFI	ΔTLI
PA	M1	0	1	1	0	0			
	M2	1.829	0.998	0.996	0.021	0.032	M2-M1	-0.002	-0.004
	M3	2.39	0.995	0.994	0.03	0.041	M3-M2	-0.003	-0.002
RE	M1	2.117	0.989	0.986	0.018	0.041			
	M2	2.051	0.99	0.989	0.021	0.036	M2-M1	0.001	0.003
	M3	1.955	0.99	0.990	0.023	0.034	M3-M2	0	0.001
Note: M1 = configural invariance; M2 = metric invariance; M3 = scalar invariance. ΔCFI and ΔTLI values < .010 indicate acceptable longitudinal measurement invariance.									

3.2 Descriptive Statistics

Descriptive statistics and bivariate correlations are presented in Table 3. PA and RE were positively correlated with their respective scores at later waves, and PA was negatively correlated with RE in all concurrent and cross-wave comparisons (all $p < .01$). Across the six variables, skewness ranged from 0.00 to 0.91 and kurtosis from - 1.26 to - 0.53, providing no indication of severe univariate nonnormality.

Table 3
Descriptive Statistics and Correlations of PA and RE Across Three Time Points

Correlations	M	SD	Skewness	Kurtosis	T1 PA	T2 PA	T3 PA	T1 RE	T2 RE	T3 RE
T1 PA	28.15	30.62	0.81	-0.73	1					
T2 PA	28.15	30.55	0.79	-0.76	.424**	1				
T3 PA	27.97	29.86	0.91	-0.53	.416**	.340**	1			
T1 RE	2.91	1.10	0.02	-1.17	-.398**	-.381**	-.311**	1		
T2 RE	2.93	1.12	0.00	-1.26	-.395**	-.341**	-.278**	.500**	1	
T3 RE	2.99	1.03	0.02	-0.98	-.398**	-.399**	-.324**	.510**	.493**	1

Note: **p < 0.01.

3.3 Cross-Lagged Panel Analysis

Standardized coefficients from the cross-lagged panel model are shown in Fig. 2. Autoregressive paths were positive for PA from T1 to T2 ($\beta = .324$, $p < .001$) and T2 to T3 ($\beta = .277$, $p < .001$). RE also showed positive autoregressive paths from T1 to T2 ($\beta = .407$, $p < .001$) and T2 to T3 ($\beta = .404$, $p < .001$). These coefficients indicate moderate rank-order stability rather than within-person stability.

After prior scores were included, all four cross-lagged paths were negative. PA was prospectively associated with lower RE at the next wave (T1→T2: $\beta = -.233$; T2→T3: $\beta = -.262$; both $p < .001$). RE was likewise prospectively associated with lower subsequent PA (T1→T2: $\beta = -.253$; T2→T3: $\beta = -.183$; both $p < .001$). The direction of the associations was consistent across intervals; these coefficients should not be interpreted as causal or exclusively within-person effects.

4 Discussion

This three-wave study examined the longitudinal associations between RE and PA among male university students. Three findings warrant attention. First, both behaviors showed moderate temporal stability across the 12-month follow-up. Second, RE and PA were negatively correlated at each wave. Third, after accounting for prior levels, each behavior was prospectively associated with lower levels of the other across both six-month intervals. These reciprocal paths indicate that RE and PA were temporally linked rather than independent health behaviors, although the observational design does not permit causal inference [2].

The autoregressive paths indicate moderate rank-order stability in RE and PA during university, consistent with emerging adulthood as a period in which health-related routines consolidate [21, 38]. These patterns may persist long enough to warrant early identification while remaining potentially modifiable.

The consistent inverse correlations extend previous evidence that eating and activity may function as alternative rather than necessarily complementary weight-management strategies [56]. Greater PA was associated with lower RE at each wave. This should not imply that PA is uniformly protective or that restraint is inherently maladaptive, because both behaviors vary in function and intensity. PA may be recreational or compulsive, while restraint may

range from flexible monitoring to rigid restriction. Nevertheless, the findings suggest that weight-related behaviors in male students may be better understood when eating and activity are considered jointly.

Higher PA was prospectively associated with lower subsequent RE across both intervals. Regular activity may support energy balance, mood regulation, stress management, and perceived body competence, thereby reducing reliance on restrictive eating strategies [23, 46]. These mechanisms remain speculative because they were not directly assessed [19, 59]. Residual confounding is also possible; students with more adaptive self-regulation or fewer body-image concerns may simultaneously be more active and less restrictive. Future research should therefore test these mechanisms directly rather than assuming that increasing PA alone reduces RE.

The reverse pathway was also significant, with higher RE predicting lower subsequent PA. Sustained restriction may coincide with reduced energy availability, fatigue, or lower motivation, potentially making regular activity more difficult to maintain [20, 47]. Psychological processes such as rigid self-control, body dissatisfaction, or shifts between competing weight-management strategies may also contribute. Because energy intake, fatigue, and related mechanisms were not measured, these interpretations remain tentative.

The negative RE-to-PA association differs from findings in some female university samples, where greater restraint has been associated with greater PA [33]. One explanation may involve population differences in body-related goals. Thinness-oriented regulation may encourage restriction and exercise to co-occur, whereas male body ideals may place greater emphasis on muscularity, strength, and performance [4]. Restriction that conflicts with these goals could therefore be associated with less sustained activity [44]. However, exercise motives, drive for muscularity, body-image concerns, and sex or gender differences were not directly assessed, so a male-specific mechanism cannot be established.

Together, the reciprocal negative paths suggest that greater reliance on one regulatory strategy was followed by less engagement in the other. Because the effects were modest, RE and PA should not be treated as interchangeable, and the average pattern may not characterize all students. Within-person and person-centered approaches are needed to identify underlying temporal states and subgroups.

These findings may inform health promotion for male university students. Assessment may benefit from considering eating behavior, activity level, and the motives underlying both. Strict dietary restriction without attention to fatigue, body image, or exercise patterns may be inappropriate for some students, while PA promotion should not assume that all exercise is adaptive. Programs could emphasize adequate nutrition, flexible self-regulation, and sustainable activity. Students displaying marked restriction, compulsive exercise, or substantial weight and shape concerns may require broader assessment for eating-disorder risk.

Several limitations should be acknowledged. First, RE and PA were assessed using self-report measures and may therefore be affected by recall and social-desirability bias. The measures also did not distinguish flexible from rigid restraint or recreational from compulsive activity. Second, complete-case analysis was used, and a formal comparison between retained participants and those lost to follow-up could not be conducted; therefore, attrition bias cannot be excluded. Third, the models were not adjusted for potential confounders. Although age, grade, and family residence were recorded, BMI and other potentially relevant factors, including energy intake, body composition, exercise motives, body-image concerns, socioeconomic status, and health conditions, were unavailable. Residual confounding may therefore have influenced the observed associations. Fourth, participants were recruited through convenience sampling from eight universities, and potential clustering by university was not modeled, limiting representativeness and generalizability. Finally, the traditional CLPM combines stable between-person differences

with within-person variation. Accordingly, the observed paths do not represent individual-level change processes and cannot establish causality.

Future studies should combine objective PA assessment with measures of dietary restraint, energy intake, BMI, body image, exercise motives, stress, and fatigue. Random-intercept cross-lagged models could distinguish within-person from between-person processes. Replication should differentiate flexible from rigid restraint and recreational from compulsive exercise across more diverse samples.

Strength and limits

Strengths include the three-wave design, large multi-site sample, longitudinal measurement invariance testing, and focus on an underrepresented male population. Limitations include convenience sampling, complete-case analysis, self-report measures, unmeasured confounding, lack of site-level modeling, and use of a traditional CLPM that does not isolate within-person change.

What is already known on this subject?

Restrained eating and physical activity are both relevant to weight-related self-regulation, but previous research has largely relied on cross-sectional designs and female samples. Their temporal relationship among male university students therefore remains unclear.

What this study adds?

Across three waves over 12 months, restrained eating and physical activity showed reciprocal negative prospective associations among male university students. These findings support considering eating and activity jointly in this population while recognizing that the observed temporal associations do not establish causality.

5 Conclusions

In this three-wave study, restrained eating and physical activity showed reciprocal negative prospective associations among male university students over 12 months. Higher levels of each behavior were associated with lower subsequent levels of the other after accounting for prior scores. The findings support considering eating and activity jointly in weight-related assessment, but the observational, self-report design precludes causal inference. University health initiatives may consider adequate nutrition, flexible eating regulation, and sustainable physical activity within an integrated framework while identifying rigid restriction, compulsive exercise, and related risk.

Declarations

Funding: The author declares that no funds, grants, or other support were received during the preparation of this manuscript.

Competing interests: The author has no relevant financial or non-financial interests to disclose.

Author contributions: Mengxuan Liu conceived and designed the study, collected and analyzed the data, prepared the figures and tables, and wrote and revised the manuscript. The author approved the final manuscript.

Ethics approval: The study was performed in accordance with the Declaration of Helsinki. Approval was granted by the Ethics Committee of Jiangxi Institute of Technology (8 January 2025; IRB-JXUT-PEC-20250108).

Consent to participate: Informed consent was obtained from all individual participants included in the study.

Consent to publish: Not applicable; the manuscript contains no identifiable individual participant data.

Data availability: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Abdella HM, Elmabsout AA, Abdullatif A et al (2023) Influence of gender on the relationship between eating behaviors, age and BMI in people in Benghazi, Libya. *Eur J Theor Appl Sci* 1:57–65. [https://doi.org/10.59324/ejtas.2023.1\(2\).05](https://doi.org/10.59324/ejtas.2023.1(2).05)
2. van Allen Z, Presseau J (2024) A multiple behaviour temporal network analysis for health behaviours during COVID-19. *British Journal of Health Psychology* 29:1049–1063. <https://doi.org/10.1111/bjhp.12750>
3. Anderson ES, Wojcik JR, Winett RA, Williams DM (2006) Social-cognitive determinants of physical activity: The influence of social support, self-efficacy, outcome expectations, and self-regulation among participants in a church-based health promotion study. *Health Psychology* 25:510–520. <https://doi.org/10.1037/0278-6133.25.4.510>
4. Anschutz DJ, Van Strien T, Van De Ven MOM, Engels RCME (2009) Eating styles and energy intake in young women. *Appetite* 53:119–122. <https://doi.org/10.1016/j.appet.2009.03.016>
5. Brown CEB, Richardson K, Halil-Pizzirani B et al (2024) Key influences on university students' physical activity: a systematic review using the Theoretical Domains Framework and the COM-B model of human behaviour. *BMC Public Health* 24:418. <https://doi.org/10.1186/s12889-023-17621-4>
6. Buková A, Tomková P, Uher I et al (2024) Selected lifestyle factors as students transition from secondary school to university in Slovakia. *Front Public Health* 12:1461989. <https://doi.org/10.3389/fpubh.2024.1461989>
7. Capó X, Martorell M, Ferrer M et al (2020) Calorie restriction improves physical performance and modulates the antioxidant and inflammatory responses to acute exercise. *Nutrients* 12:930. <https://doi.org/10.3390/nu12040930>
8. Chaabna K, Mamtani R, Abraham A et al (2022) Physical Activity and Its Barriers and Facilitators among University Students in Qatar: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health* 19:7369. <https://doi.org/10.3390/ijerph19127369>
9. Chen B, Hua S, Tu Z et al (2026) An investigation of the relationship between grit, physical activity, and self-efficacy: a variable-centered and person-centered approach. *Front Psychol* 16:1742211. <https://doi.org/10.3389/fpsyg.2025.1742211>
10. Chen B, Huang W, Hu C (2025) The relationship between positive exercise experiences and mobile phone addiction tendencies in older adults: a cross-lagged study. *Front Public Health* 13:1710048. <https://doi.org/10.3389/fpubh.2025.1710048>
11. D'Adamo L, Christian C, Jebeile H et al (2026) Facets of dietary restraint associated with disordered eating behaviors among children and adolescents with higher weight. *Obesity* 34:219–227. <https://doi.org/10.1002/oby.70073>
12. Du C, Adjepong M, Zan MCH et al (2022) Gender Differences in the Relationships between Perceived Stress, Eating Behaviors, Sleep, Dietary Risk, and Body Mass Index. *Nutrients* 14:1045. <https://doi.org/10.3390/nu14051045>

13. Edelmann D, Pfirrmann D, Heller S et al (2022) Physical activity and sedentary behavior in university students—the role of gender, age, field of study, targeted degree, and study semester. *Front Public Health* 10:821703. <https://doi.org/10.3389/fpubh.2022.821703>
14. Emakpor O, Edo G, Yousif E et al (2024) The interplay of nutrition, exercise, and dietary intervention for enhanced performance of athletes and general well-being of non-athletes: a review. *OBM Integr Complement Med* 9(2):038. <https://doi.org/10.21926/obm.icm.2402038>
15. García-Lorenzo E, Visos-Varela I, Pintos-Rodríguez S et al (2024) Physical activity and sedentarism among university students: an approach using a real-life survey. *Eur J Public Health* 34:ckae144.1297. <https://doi.org/10.1093/eurpub/ckae144.1297>
16. Hanick C, Jamshed H, Bryan D et al (2020) Effects of time-restricted eating on appetite, eating behaviors, and physical activity in adults. *Obesity* 28(Suppl 2):91. <https://doi.org/10.1002/oby.23063>
17. Hao M, Fang Y, Yan W et al (2022) Relationship between body dissatisfaction, insufficient physical activity, and disordered eating behaviors among university students in southern China. *BMC Public Health* 22:2054. <https://doi.org/10.1186/s12889-022-14515-9>
18. He D, Gilcharan Singh HK, Alavi M et al (2025) Body image dissatisfaction and disordered eating behaviors in Chinese female undergraduate students: the mediating role of emotional regulation strategies. *J Eat Disord* 13:104. <https://doi.org/10.1186/s40337-025-01287-x>
19. Herbert C (2022) Enhancing mental health, well-being and active lifestyles of university students by means of physical activity and exercise research programs. *Front Public Health* 10:849093. <https://doi.org/10.3389/fpubh.2022.849093>
20. Hu C, Bin J, Zhang W, Huang W (2025) How sports-implied packaging of protein powder products enhances the purchase intention of Generation Z: evidence from multiple experiments. *Front Nutr* 12:1645614. <https://doi.org/10.3389/fnut.2025.1645614>
21. Hu C, Huang W, Zhang W (2025) Childhood emotional abuse and suicidal ideation in college students: exploring the mediating role of alexithymia and the moderating effect of physical exercise. *Front Psychiatry* 16:1660164. <https://doi.org/10.3389/fpsyt.2025.1660164>
22. Hu C, Zhang W, Gary J (2026) Associations of physical activity and psychological resilience with non-suicidal self-injury among Chinese adolescents: a combined variable- and person-centered approach. *Behav Sci (Basel)* 16:785. <https://doi.org/10.3390/bs16050785>
23. Hu C, Zhang W, Huang W (2025) The Role of Self-Objectification and Physical Exercise in Social Appearance Anxiety and Restrained Eating Among Female College Students. *Behavioral Sciences* 15:1300. <https://doi.org/10.3390/bs15101300>
24. Hu C, Zhang W, Huang W, Jin C (2025) How grit enhances physical exercise in college students: mediating roles of personal growth initiative and self-efficacy. *Front Psychol* 16:1652984. <https://doi.org/10.3389/fpsyg.2025.1652984>
25. Huang B, Chen X, Hu C et al (2026) Relationship among physical activity, social anxiety, and autistic traits in female college students: a variable- and person-centered analysis. *Front Psychiatry* 17:1786160. <https://doi.org/10.3389/fpsyt.2026.1786160>
26. Huang W, Chen B, Hu C (2025) The latent profile structure of negative emotion in female college students and its impact on eating behavior: the mediating role of physical exercise. *Front Public Health* 13:1663474. <https://doi.org/10.3389/fpubh.2025.1663474>
27. Jeżewska-Zychowicz M, Małachowska A, Sajdakowska M, Żybula Z (2025) Experiencing Food Restrictions for Health and Weight Control in Childhood and Their Links to Restrained Eating and Excessive Body Weight in

Polish Young Adults—A Cross-Sectional Study. *Nutrients* 17:87. <https://doi.org/10.3390/nu17010087>

28. Kong X, Deng M, Xiong S et al (2026) Short-form video overuse and adolescents' restrained eating: the roles of body shame and physical exercise. *BMC Psychol* 14:86. <https://doi.org/10.1186/s40359-025-03805-7>
29. Kwan MYW, Graham JD, Healey C et al (2020) Stopping the Drop: Examining the Impact of a Pilot Physical Literacy-Based Intervention Program on Physical Activity Behaviours and Fitness during the Transition into University. *International Journal of Environmental Research and Public Health* 17:5832. <https://doi.org/10.3390/ijerph17165832>
30. Liang DQ (1994) Stress levels and their relationship to physical activity among college students [in Chinese]. *Chin Ment Health J* 8:5–6. <https://doi.org/10.3321/j.issn:1000-6729.1994.03.018>
31. Liu M (2026) The relationship between physical activity and subjective wellbeing in infertile women: the mediating role of positive feedback and self-efficacy. *Front Public Health* 14:1723969. <https://doi.org/10.3389/fpubh.2026.1723969>
32. Liu M (2026) Physical activity, regulatory emotional self-efficacy, and suicidal ideation in adolescents: a variable-centered and person-centered approach. *Front Psychol* 17:1775139. <https://doi.org/10.3389/fpsyg.2026.1775139>
33. Hu C, Huang W, Liu Y (2026) The relationship between restrained eating and physical activity among female university students: a cross-lagged study. *Front Nutr* 13:1804133. <https://doi.org/10.3389/fnut.2026.1804133>
34. Liu Y, Huang W, Zhang W, Hu C (2026) The relationship between physical activity, social support, and life satisfaction among female college students: a variable- and person-centered analysis. *Behav Sci (Basel)* 16:1040. <https://doi.org/10.3390/bs16061040>
35. Mann T, De Ridder D, Fujita K (2013) Self-regulation of health behavior: Social psychological approaches to goal setting and goal striving. *Health Psychology* 32:487–498. <https://doi.org/10.1037/a0028533>
36. Mason C, Tapsoba J de D, Duggan C et al (2019) Eating behaviors and weight loss outcomes in a 12-month randomized trial of diet and/or exercise intervention in postmenopausal women. *Int J Behav Nutr Phys Act* 16:113. <https://doi.org/10.1186/s12966-019-0887-1>
37. Miguët M, Masurier J, Chaput JP et al (2019) Cognitive restriction accentuates the increased energy intake response to a 10-month multidisciplinary weight loss program in adolescents with obesity. *Appetite* 134:125–134. <https://doi.org/10.1016/j.appet.2018.12.015>
38. Neumark-Sztainer D, Wall MM, Chen C et al (2018) Eating, Activity, and Weight-related Problems From Adolescence to Adulthood. *American Journal of Preventive Medicine* 55:133–141. <https://doi.org/10.1016/j.amepre.2018.04.032>
39. Paiva U, Cortese S, Flor M et al (2025) Prevalence of mental disorder symptoms among university students: An umbrella review. *Neuroscience & Biobehavioral Reviews* 175:106244. <https://doi.org/10.1016/j.neubiorev.2025.106244>
40. Park I, Schutz RW (1999) "Quick and easy" formulae for approximating statistical power in repeated measures ANOVA. *Meas Phys Educ Exerc Sci* 3:249–270. https://doi.org/10.1207/s15327841mpee0304_5
41. Romero-Blanco C, Rodríguez-Almagro J, Onieva-Zafra MD et al (2020) Physical Activity and Sedentary Lifestyle in University Students: Changes during Confinement Due to the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health* 17:6567. <https://doi.org/10.3390/ijerph17186567>
42. Roy SK, Jahan K, Alam N et al (2021) Perceived stress, eating behavior, and overweight and obesity among urban adolescents. *J Health Popul Nutr* 40:54. <https://doi.org/10.1186/s41043-021-00279-2>

43. van Strien T, Frijters JER, Bergers GPA, Defares PB (1986) The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders* 5:295–315. [https://doi.org/10.1002/1098-108X\(198602\)5:2%3C295::AID-EAT2260050209%3E3.0.CO;2-T](https://doi.org/10.1002/1098-108X(198602)5:2%3C295::AID-EAT2260050209%3E3.0.CO;2-T)
44. van Strien T, Koenders P (2010) How Do Physical Activity, Sports, and Dietary Restraint Relate to Overweight-Associated Absenteeism? *J Occup Environ Med* 52:858–864. <https://doi.org/10.1097/JOM.0b013e3181ef7ef0>
45. Sutin AR, Stephan Y, Robinson E et al (2020) Body-related discrimination and dieting and substance use behaviors in adolescence. *Appetite* 151:104689. <https://doi.org/10.1016/j.appet.2020.104689>
46. Tsartsapakis I, Trigonis I, Zafeiroudi A et al (2025) The Role of Recreational Physical Activity in Adherence to the Mediterranean Diet in the Greek Population: Public Health and Sustainability Implications. *Sports* 13:95. <https://doi.org/10.3390/sports13040095>
47. Wan H, Huang W, Zhang W, Hu C (2025) Exploring adolescents' social anxiety, physical activity, and core self-evaluation: a latent profile and mediation approach. *Int J Ment Health Promot* 27:1611–1626. <https://doi.org/10.32604/ijmh.2025.070457>
48. Wang K, Qiu F (2025) Longitudinal Association Between Physical Activity and School Bullying in Adolescents: A Cross-Lagged Panel Model. *Behavioral Sciences* 15:1236. <https://doi.org/10.3390/bs15091236>
49. Wang Y, Wu C, Wang Q et al (2025) Exploring the relations between body dissatisfaction, rumination, physical activity, and restrained eating: a latent moderated structural equation approach. *J Eat Disord* 13:49. <https://doi.org/10.1186/s40337-025-01229-7>
50. Guo Q, Liu T, Yin Z, Li M (2026) The cross-sectional study on the association between physical exercise and restrained eating among Chinese college students: the chain mediating roles of emotional intelligence and perceived stress. *Front Psychol* 17:1805606. <https://doi.org/10.3389/fpsyg.2026.1805606>
51. Watkins MW (2006) Orthogonal higher order structure of the Wechsler Intelligence Scale for Children–Fourth edition. *Psychological Assessment* 18:123–125. <https://doi.org/10.1037/1040-3590.18.1.123>
52. White J, Halliwell E (2010) Examination of a sociocultural model of excessive exercise among male and female adolescents. *Body Image* 7:227–233. <https://doi.org/10.1016/j.bodyim.2010.02.002>
53. Wu S, Cai T, Luo X (2017) Validation of the Dutch Eating Behavior Questionnaire (DEBQ) in a sample of Chinese adolescents. *Psychology, Health & Medicine* 22:282–288. <https://doi.org/10.1080/13548506.2016.1173712>
54. Xiang L, Gou H, Hu C (2025) The impact of weight self-stigma on appearance anxiety among female college students: a variable-centered and person-centered analysis. *Front Public Health* 13:1709480. <https://doi.org/10.3389/fpubh.2025.1709480>
55. Xiang L, Gou H, Yang J et al (2026) Dynamic interactions between physical activity, exercise adherence, and adverse psychological states in Chinese older adults: a cross-lagged network analysis. *Front Public Health* 14:1744350. <https://doi.org/10.3389/fpubh.2026.1744350>
56. Yang C, Huang W, Hu C et al (2026) Negative life events and problematic smartphone use among university students: the mediating role of self-efficacy and the moderating role of physical activity. *Front Public Health* 13:1704120. <https://doi.org/10.3389/fpubh.2025.1704120>
57. Yong C, Liu H, Yang Q et al (2021) The Relationship between Restrained Eating, Body Image, and Dietary Intake among University Students in China: A Cross-Sectional Study. *Nutrients* 13:990. <https://doi.org/10.3390/nu13030990>
58. Yuan Y, Yang J, Huang W et al (2025) Relationships among anxiety, psychological resilience, and physical activity in university students: variable-centred and person-centred perspectives. *Front Psychol* 16:1694344. <https://doi.org/10.3389/fpsyg.2025.1694344>

59. Zhang W, Huang W, Hu C et al (2025) The impact of physical activity and dietary behavior on depression in college students: a study on mediation effects and network analysis. *Front Public Health* 13:1683468. <https://doi.org/10.3389/fpubh.2025.1683468>

60. Mund M, Nestler S (2019) Beyond the cross-lagged panel model: next-generation statistical tools for analyzing interdependencies across the life course. *Adv Life Course Res* 41:100249. <https://doi.org/10.1016/j.alcr.2018.10.002>

Figures

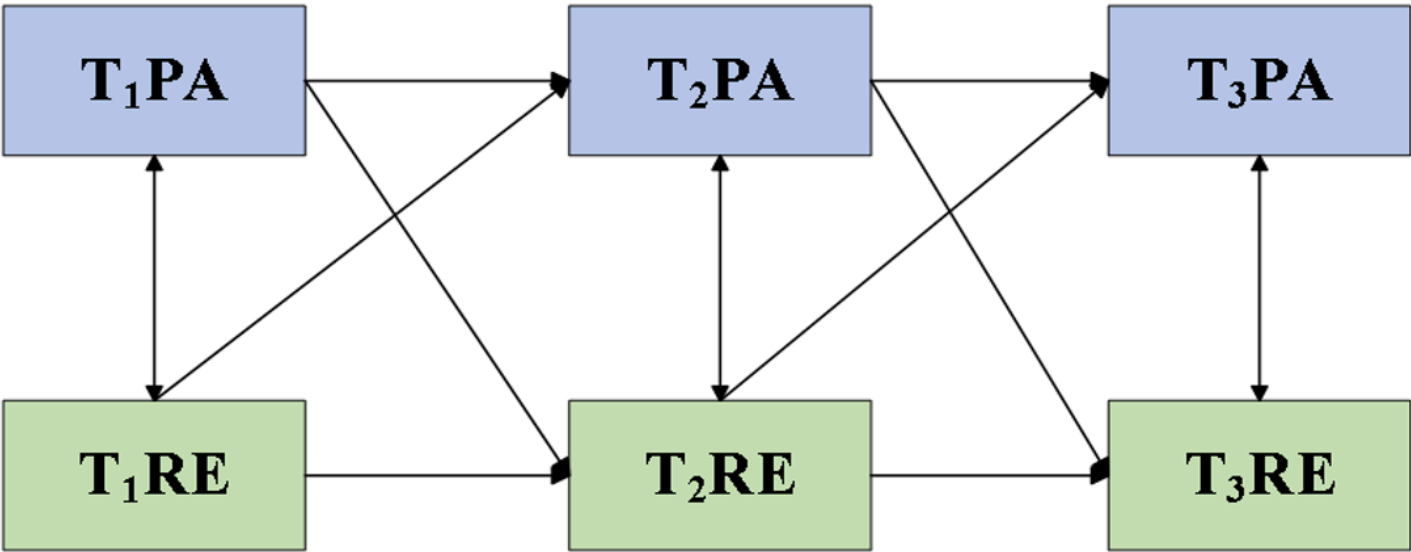


Figure 1

Cross-lagged panel model. PA = physical activity; RE = restrained eating.

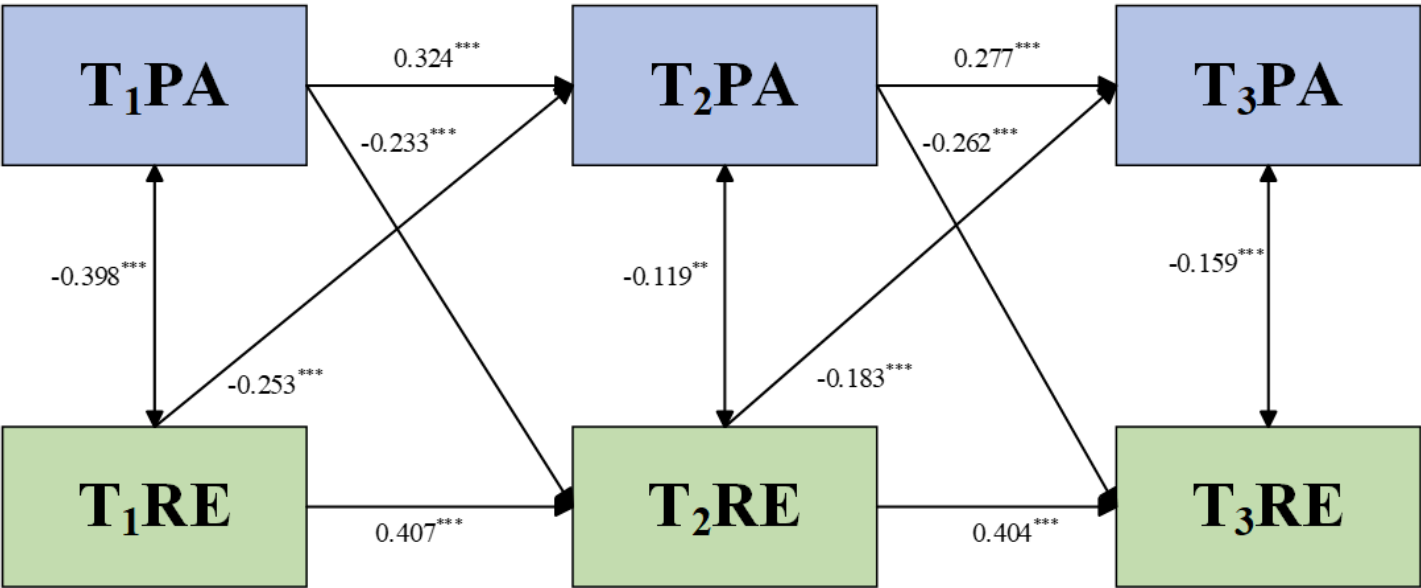


Figure 2

Standardized path coefficients of the three-wave cross-lagged model between PA and RE. **p < .01, ***p < .001.