

Influencing Factors of Disordered Eating Behavior Among Chinese University Students: The Moderating Role of Physical Activity in the Body Status Chain Mediation Model

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Purpose: To explore the impact and mechanism of weight status on the disordered eating behavior of university students, this study conducted a moderated chain mediation model based on the Escape Theory and the Strength Model of Self-Control.

Methods: This was a cross-sectional online study conducted at a university in Shanghai. The questionnaire was distributed via communication tools such as WeChat from March 6 to 15, 2022, receiving 2618 valid responses. The moderated chain mediation model was empirically examined with 10,000 Bootstrap samples using AMOS software.

Results: (1) Weight status can indirectly predict disordered eating behavior through the mediating effect of body dissatisfaction ($\beta = 0.24$, 95% CI: 0.22–0.26, $p < 0.001$); (2) Body dissatisfaction and negative affect play a chain mediation role in the positive impact of weight status on disordered eating behavior ($\beta = 0.01$, 95% CI: 0.01–0.02, $p < 0.001$); (3) Physical activity moderates the positive impact of negative affect on disordered eating behavior (Diff = -0.11 , $t = 2.20$, $p < 0.05$) and further plays a moderating role in the chain mediation model (Diff = -0.01 , $t = 2.30$, $p < 0.05$). Specifically, the higher the level of physical activity among university students, the weaker the impact of negative affect on disordered eating behavior, and the weaker the chain mediation effect; (4) The level of physical activity moderates the relationship between weight status, body dissatisfaction, and disordered eating, suggesting that the higher the level of physical activity, the stronger the mediating role of body dissatisfaction between weight status and abnormal eating (Diff = 0.12, $t = 2.74$, $p < 0.05$).

Conclusion: These findings revealed the pathways through which weight status affects the eating behavior of university students and how physical activity might weaken or strengthen this impact. This research supplements prior studies and offers insight into health promotion for university students.

Keywords: body shape, body dissatisfaction, disordered eating behavior, university students, physical activity level

Introduction

Disordered eating behavior refers to a subclinical state that does not fully meet the diagnostic criteria for an eating disorder, but exhibits certain symptoms. It is considered an early warning sign of potential eating disorders.¹ Disordered eating behavior has garnered considerable attention in recent years, as the population that falls between normal eating and eating disorders is larger than expected, and the phenomenon continues to increase,² particularly among high-risk groups such as middle school and university students. This behavior can adversely affect individuals' psychological, physiological, and social functioning.^{3,4} Partial previous research demonstrated that weight status is an effective predictor of disordered eating behaviors, which is crucial in forming and developing such abnormal eating behaviors.⁵ Research

evidence suggests that an elevated body mass index (BMI) correlates with an increased risk of disordered eating behaviors.⁶ Similarly, some studies targeting university students have found a positive correlation between weight status and disordered eating habits, implying that weight status may directly affect the likelihood of developing problematic eating patterns.^{7,8} The correlation between weight and disordered eating behavior may stem from the stigmatizing effects of weight, which are intricately associated with mental health, including a series of cognitive and emotional changes that precipitate disordered eating behavior.⁹

However, the relationship between weight status and eating behavior varies due to different theoretical frameworks used in research, leading to differing conclusions and pathways. Some studies have also found that the direct predictive power of weight status on disordered eating behavior is insufficient.^{10,11} According to previous research, risk factors for disordered eating behaviors include cognitive and emotional factors. First, from a cognitive perspective, body dissatisfaction is a subjective negative evaluation of one's body image, and serves as an effective indicator for predicting the occurrence of disordered eating behaviors. Weight is one of the most relevant factors associated with body dissatisfaction.^{12,13} Additionally, from an emotional perspective, negative cognition about one's weight status can trigger negative affect, which in turn can influence an individual's eating behavior.¹³

Moreover, regular participation in physical activity not only improves weight status but also alleviates negative effects. In most cases, consistent engagement in physical activity is an effective strategy for promoting physical and mental health. However, some studies have found that factors such as the mode of participation, exercise intensity, and the purpose of engagement can influence participants' exercise experience. According to the strength model, self-control is a finite resource, once depleted, it results in diminished performance on self-control tasks, a phenomenon termed ego depletion. This condition can provoke disinhibited behaviors, such as binge eating, specifically, excessive exercise may deplete psychological resources, potentially inciting disordered eating behaviors.^{14,15}

In summary, while there is controversy regarding the direct impact of weight status on disordered eating behavior, the complex relationship between the two cannot be denied. This study primarily focused on potential mediating variables that may exist between them and the moderating factors influencing how weight status affects eating behavior. Based on this, the study posed three main research questions: 1. Does being overweight or obese increase body dissatisfaction, thereby leading to increased disordered eating behavior among university students? 2. If being overweight or obese exacerbates body dissatisfaction among university students, does this negative cognition trigger negative affect, consequently leading to an increase in disordered eating behavior? 3. Does regular physical activity level play a moderating role in the relationships within this study's model?

This study attempts to examine the relationship between weight status and disordered eating behaviors in-depth, based on theoretical frameworks and empirical data. Furthermore, we incorporate physical activity as a moderating variable, an element frequently overlooked in prior research, thus offering novel theoretical insights and intervention suggestions to enhance university students' physical and mental well-being.

Literature Review and Research Hypotheses

The Mediating Role of Body Dissatisfaction

Body dissatisfaction refers to an individual's subjective negative evaluation of their weight status or a specific part of their body.¹⁶ The causes of body dissatisfaction are complex and primarily include social, cultural, and biological factors,¹⁷ with weight being the most relevant biological factor associated with body dissatisfaction.¹⁸ Compared to peers with a normal BMI, overweight and obese individuals tend to be more dissatisfied with their weight status. Therefore, this study proposed the hypothesis:

H₁: Weight status has a positive impact on body dissatisfaction.

Body dissatisfaction is prevalent among university students. For example, a study by Alruwayshid found that 71.1% of the 204 university students surveyed expressed dissatisfaction with their weight status.¹⁹ Previous research has found that the sense of disparity created by comparing oneself to an "ideal" weight status makes individuals more susceptible to negative affect and negative self-awareness.^{20,21} According to Escape Theory, to avoid negative self-awareness,

individuals often adopt cognitive avoidance strategies to escape negative stimuli in their environment, thereby entering a lower level of self-awareness. In this state, individuals become less sensitive to the discrepancies between themselves and the ideal standards. Typical strategies for cognitive avoidance include drinking, distraction, eating, and dissociation of thoughts or behaviors.²² Thus, this study posited that university students who are consistently exposed to an environment that idealizes thinness, due to the internalization of societal appearance standards and excessive comparison of appearance, experience a significant gap between their self-perceived weight status and their ideal weight status. This gap leads to the emergence of body dissatisfaction among university students, which in turn predicts the occurrence of subsequent disordered eating behaviors. Therefore, this study proposed the hypothesis:

H₂: Body dissatisfaction has a positive impact on disordered eating behavior.

Combining the relationships predicted in this study's hypotheses H1 and H2, it is believed that overweight and obese university students are more likely to experience dissatisfaction with their weight status. Based on Escape Theory, in order to evade this negative self-awareness associated with body dissatisfaction, individuals may engage in disordered eating behavior as a cognitive avoidance strategy, allowing them to focus on immediate, concrete, and low-level thoughts, thus escaping the negative self-awareness brought about by body dissatisfaction. Therefore, this study proposed the hypothesis:

H₃: Body dissatisfaction serves as a mediating factor between weight status and disordered eating behavior.

The Chain Mediation Effect of Body Dissatisfaction and Negative Affect

Negative affect is considered a subjective state of distress or unpleasant feelings, such as anger, disgust, guilt, fear, and anxiety.²³ Previous research has found that emotional frustration caused by body dissatisfaction is an effective predictor of negative emotions, which include anxiety, depression, stress, and low self-esteem.^{13,24} Therefore, this study proposed the hypothesis:

H₄: Body dissatisfaction has a positive impact on negative affect.

According to the Strength Model of Self-Control, self-control is the conscious and effortful ability to overcome impulses or automatic responses and to direct one's behaviors. It is a core function of the self, representing the ability to say "no" to impulses.²⁵ Negative affect are one of the primary factors that trigger self-control failures because self-control requires adequate psychological resources to sustain it. However, negative affect deplete these limited psychological resources, leading to a decline in self-control and resulting in impulsive behaviors, such as binge eating, smoking, and excessive drinking.²⁶ Previous research supports that negative affect can induce disordered eating behaviors.^{27,28} Stice et al found that after conducting a three-year longitudinal study with 135 adolescents, negative affect were closely associated with the occurrence of disordered eating behaviors over the subsequent three years, even after controlling for baseline BMI levels.²⁹ Therefore, this study proposed the hypothesis:

H₅: Negative affect has a positive impact on disordered eating behavior.

Based on the relationships predicted by hypotheses H1, H4, and H5, this study posited that the gap between body status and ideal weight status increases college students' dissatisfaction with their own weight status. This negative self-perception can trigger negative affect such as stress, anxiety, and depression, which in turn deplete psychological resources, leading to a decrease in self-control and the subsequent emergence of disordered eating behaviors. Therefore, this study further proposed the hypothesis:

H₆: There is a chain mediating effect of body dissatisfaction and negative affect between weight status and disordered eating behaviors.

The Moderating Role of Physical Activity

According to the theory of self-control, self-control helps individuals make better behavioral choices and maintain long-term healthy behaviors patterns, while the success or failure of self-control depends on the reserve of psychological resources.³⁰ Due to the finite nature of psychological resources, each act of self-control consumes a certain amount of these resources, a phenomenon known as the “ego-depletion effect”.³¹ However, studies have shown that regular physical activity can effectively enhance psychological resources and improve an individual’s self-control.³² Therefore, this study posited that regular physical activity can interact with negative affect, profoundly influencing college students’ cognitive, emotional, and behavioral performance.

Specifically, regular physical activity can mitigate the impact of negative affect on abnormal eating behaviors. Previous research has indicated that the relationship between negative affect and abnormal eating behaviors varies with changes in physical activity levels. Regular physical activity serves as a behavioral strategy that can buffer the effects of negative affect on abnormal eating behaviors.^{33,34} Additionally, regular physical activity can also indirectly regulate the chain-mediated effects of body image dissatisfaction and negative affect between weight status and abnormal eating behaviors by moderating the impact of negative affect on abnormal eating behaviors. Specifically, when college students engage in consistent moderate to high-intensity physical activity, their psychological resources are continually replenished, thereby offsetting the psychological resource depletion caused by negative affect. As a result, when faced with abnormal eating impulses, college students can maintain sufficient self-control and avoid falling into a vicious cycle of negative affect and binge eating behaviors. Therefore, this study hypothesized that regular moderate to high-intensity physical activity can not only weaken the negative impact of negative affect on eating behaviors but also diminish the chain-mediated effects of body image dissatisfaction and negative affect between weight status and abnormal eating behaviors.

Second, the relationship between physical activity, body dissatisfaction, and abnormal eating behaviors has yielded inconsistent results in previous studies. Some research supports a positive correlation among body satisfaction, eating behaviors, and levels of regular physical activity.³⁵ Conversely, other studies have found that while physical activity is an essential component of a healthy lifestyle, variations in participation purposes and exercise modalities can sometimes pose risks to psychological well-being. Under the influence of body dissatisfaction, such differences may increase the likelihood of engaging in abnormal eating behaviors.^{36,37} Therefore, this study posited that the level of physical activity serves as a moderating factor in the relationship between body dissatisfaction and abnormal eating behaviors. However, based on previous research, the direction of this moderating effect is contentious. Consequently, this study proposed the following hypothesis:

H₇: The level of physical activity has a moderating effect on the model of this study.

In summary, based on the literature discussed above, we constructed a foundational model illustrating how weight status affects eating behaviors through body dissatisfaction, using the escape theory as a framework. Furthermore, we explored the chain mediating effects of body dissatisfaction and negative affect in the relationship between weight status and abnormal eating behaviors, following the logic of the self-control model. Lastly, the study incorporated the level of physical activity among college students as a moderating variable to examine its varying impacts on the model’s pathways. Thus, building on existing research, this study proposed the following hypothesized model (Figure 1).

Research Method

Research Design and Implementation Procedure

This study adopted a cross-sectional design and constructed a moderated chain mediation model based on relevant theories. The study was conducted primarily in 2022, with data collection taking place from March 6 to March 15 at a university in Shanghai. Online questionnaires were distributed through WeChat and QQ platforms, employing a combination of convenience sampling and snowball sampling methods. The target population consisted of enrolled university students aged 18 years or older who were able to complete the questionnaire independently. Participants were required to read and agree to an online informed consent form before participating in the survey. To ensure participant

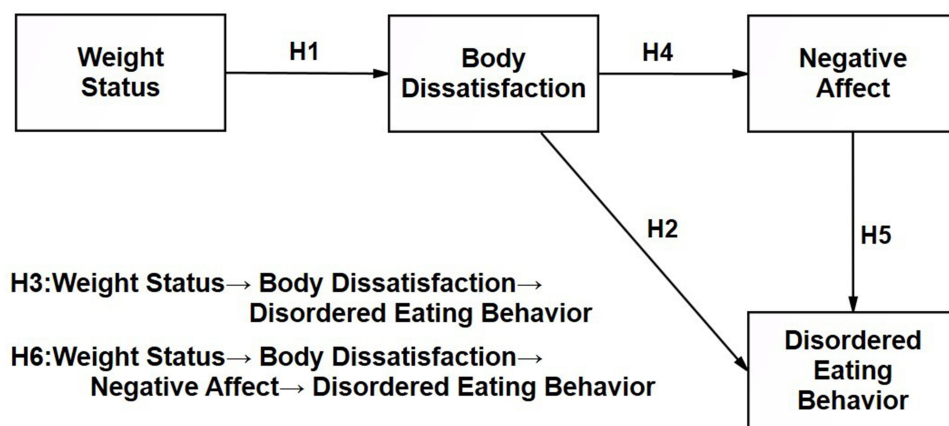


Figure 1 Hypothesized Model of the Intrinsic Relationships Between Weight Status, Body Dissatisfaction, and Disordered Eating Behavior.

privacy, no personally identifiable information (eg, student ID numbers or national identification numbers) was collected. The study received ethical approval from the Committee on Ethics of Medicine at Shanghai Gongli Hospital on March 5; however, the approval document did not include an ethics reference number. The study strictly adhered to the ethical principles outlined in the Declaration of Helsinki. All research procedures complied fully with current Chinese regulations for biomedical research, ensuring participants' rights to information, privacy, safety, and welfare. Data were entered and cleaned using IBM SPSS 26.0, with duplicate and incomplete responses removed. A total of 2618 valid questionnaires were obtained for analysis.

Data Analysis

This study aimed to investigate the roles of body dissatisfaction and negative affect in the relationship between weight status and disordered eating behaviors. Prior to the analysis, data quality was assessed to identify any entry errors, and the internal consistency of the scales was verified to meet academic standards. Normality tests and multicollinearity checks were conducted to ensure that the data satisfied the basic assumptions required for regression analysis. To test mediation effects, the bootstrap method was employed, which has been shown to provide greater statistical power compared to causal path methods and the Sobel Z test product coefficient method.^{38–42} Hayes recommended the bootstrap approach for more accurate verification of indirect effects.⁴³ Path analyses were conducted using AMOS 24.0 to evaluate the hypothesized direct and indirect effects. The bootstrap method was applied with 10,000 resamples to address potential estimation biases. Both Bias-corrected and Percentile estimation methods were used, with a 95% confidence interval that did not include 0 considered indicative of statistical significance. Additionally, participants were divided into high and low physical activity groups based on their activity levels. Multi-group analyses were then performed to compare path and mediation effects between the two groups, examining the moderating role of physical activity levels in the research model.

Measurements

Demographic Variables

Basic demographic information about participants, including gender, age, grade, height, and weight, was collected through self-reporting.

Weight Status

The Body Mass Index (BMI) was utilized as the measure of weight status for college students in this study. BMI was calculated using the standard formula: $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$.

Body Dissatisfaction

The study used the Fatness dimension of the Negative Physical Self Scale (NPSS-F) revised by Chen et al⁴⁴ to assess college students' satisfaction with their weight status. The NPSS consists of 48 items divided into five subscales: overall,

appearance, fatness, height, and thinness. Since this study focused only on college students' negative perceptions, emotions, and behaviors regarding their weight, it selected 11 items from the fatness dimension. These items include the cognitive-affective (eg, "I am quite concerned about my weight"), projection of others' views (eg, "I think I am fat in others' eyes"), and behavioral regulation (eg, "I lost weight through dieting") sub-dimensions, scored on a 0–4 scale, where higher scores indicate a more negative body self-concept regarding fatness. The test-retest reliability of the original total scale after three weeks was 0.89 ($p < 0.001$), with an alpha coefficient of 0.86 and a split-half reliability of 0.83. The criterion-related validity of the Body Esteem Scale was 0.49. The alpha coefficient for the fatness dimension subscale was 0.88, with a split-half reliability of 0.85 and criterion-related validity of the Body Esteem Scale (weight dimension) of 0.46. In this study, the Cronbach's alpha was 0.91.

Disordered Eating Behaviors

The study used the Eating Attitudes Test with 26 items (EAT-26)⁴⁵ to investigate college students' eating attitudes and behaviors. The test-retest reliability of the EAT-26 in a Chinese sample was 0.82 ($p < 0.001$), with an alpha coefficient of 0.91 and a criterion-related validity of EDI-1 of 0.74 ($p < 0.001$), demonstrating good reliability and validity.⁴⁶ The scale consists of 26 items that include three dimensions: dieting, bulimia and food preoccupation, and food oral control. It uses a 6-point Likert scale, where a higher total score indicates a greater deviation from normal eating attitudes and behaviors. In this study, the Cronbach's alpha was 0.86.

Negative Affect

The study utilized the Simplified Chinese version of the 21-item Depression Anxiety and Stress Scale (DASS-21)⁴⁷ to assess college students' negative affect. This scale consists of 21 items, including three subscales measuring emotional states, each containing seven items. Participants rated their experiences over the past week, focusing on three dimensions: depression (items 3, 5, 10, 13, 16, 17, 21), anxiety (items 2, 4, 7, 9, 15, 19, 20), and stress (items 1, 6, 8, 11, 12, 14, 18). Scoring ranged from 0 (not applicable) to 3 (very applicable). The scores of the items in each subscale were summed and multiplied by 2 to obtain the subscale scores. The Cronbach's alpha for the total scale of DASS-21 for Chinese college students was 0.89, with subscale alpha coefficients ranging from 0.76 to 0.79. Structural indicators included the Goodness-of-Fit Index (GFI = 0.92), Adjusted Goodness-of-Fit Index (AGFI = 0.90), Incremental Fit Index (IFI = 0.88), Tucker-Lewis Index (TLI = 0.86), Comparative Fit Index (CFI = 0.88), and Root Mean Square Error of Approximation (RMSEA = 0.07). All indices met the psychometric standards, demonstrating acceptable reliability and validity.⁴⁸ In this study, the Cronbach's alpha was 0.92.

The Level of Physical Activity

The International Physical Activity Questionnaire (IPAQ) was used to assess the physical activity levels of college students. IPAQ, one of the widely used questionnaires for measuring physical activity levels internationally, has two versions: the short form (IPAQ-SF) and the long form (IPAQ-LF), both of which have been validated with Chinese populations, demonstrating good reliability and validity.^{49,50} This study utilized the short form (IPAQ-SF), consisting of seven items, with six questions regarding individuals' physical activity levels. Students were asked to report their participation in physical activities over the past week. In this study, the calculation method for the frequency of physical activity at varying intensities among college students is as follows: Metabolic Equivalent of Task (MET) \times weekly frequency (days per week) \times daily duration (minutes per day), where the MET value for walking is 3.3, for moderate-intensity activity is 4.0, and for vigorous-intensity activity is 8.0.

According to the data cleaning and physical activity level grouping principles published by the reference questionnaire development group,⁵¹ this study categorized college students into high, medium, and low physical activity level groups. The criteria for the high physical activity level group were: a total of high-intensity physical activities ≥ 3 days and a weekly total physical activity level ≥ 1500 MET-min/week, or a total of activities across all intensities ≥ 7 days and a weekly total physical activity level ≥ 3000 MET-min/week. The criteria for the medium physical activity level group were: at least 20 minutes of high-intensity physical activity ≥ 3 days, or at least 30 minutes of moderate-intensity and/or walking activities ≥ 5 days, or a total of activities across all intensities ≥ 5 days with a weekly total physical activity level ≥ 600 MET-min/week. The criteria for the low physical activity level group were: reporting no activity or reporting some activity but not meeting the above

medium or high grouping standards. The questionnaire had a criterion-related validity of 0.41 ($p < 0.001$) when correlated with a three-dimensional accelerometer (ActiGraph wGT3X-BT), and a test-retest reliability of 0.59 ($p < 0.001$).⁵⁰

Results

The study employed a cross-sectional design, sampling 2887 university students from a local university in Shanghai. Data collection was conducted through a questionnaire survey between March 6 and 15, 2022. After excluding incomplete or invalid responses, a total of 2618 valid questionnaires were retained, yielding an effective response rate of 90.7%.

Descriptive Analysis

Among the 2618 participants, 1557 were male (59.5%) and 1061 were female (40.5%). Most participants were aged 18–20 years, with the largest proportion being 19 years old (37.1%). Freshmen and sophomores constituted the majority, representing 46.0% and 53.4% of the sample, respectively. Over half of the participants (53.6%) majored in engineering. Only 29.3% reported regular physical activity, with 29.3% classified as high activity levels, 32.3% as medium, and 38.4% as low. Table 1 provides a detailed summary of demographic characteristics and physical activity levels.

Data Inspection

Table 2 presents the descriptive statistics and correlation analysis for the research constructs. The mean Body Mass Index (BMI) of the sample was 21.50 (SD = 3.39), which falls within the normal weight range according to the World Health Organization (WHO) classification (18.5–24.9). The skewness (1.21) and kurtosis (2.33) values indicate a symmetric BMI distribution with no extreme outliers. Body dissatisfaction had a mean of 21.58 (SD = 8.88), while negative affect had

Table 1 Summary of Research Background Variables (N = 2618)

Variable	Number	Percentage
1. Gender		
(1) Male	1557	59.5
(2) Female	1061	40.5
2. Age		
(1) Under 17 years old	18	0.7
(2) 18 years old	505	19.3
(3) 19 years old	972	37.1
(4) 20 years old	893	34.1
(5) 21 years old	210	8.0
(6) Over 22 years old	20	0.8
3. Grade		
(1) Freshman	1208	46.0
(2) Sophomore	1398	53.4
(3) Junior and above	12	0.5
4. Major		
(1) Engineering	1404	53.6
(2) Science	260	9.9
(3) Literature	296	11.3
(4) Arts	191	7.3
(5) Management	465	17.8
(6) Philosophy	2	0.1

(Continued)

Table 1 (Continued).

Variable	Number	Percentage
5. Regular Physical Activity		
(1) Yes	767	29.3
(2) No	1851	70.7
6. Levels of Physical Activity		
(1) High	767	29.3
(2) Medium	845	32.3
(3) Low	1006	38.4

Notes: Physical Activity Levels. **High:** Vigorous ≥ 3 days (1500+ MET-min) or any activity ≥ 7 days (3000+ MET-min). **Medium:** Vigorous ≥ 3 days (20+ min/day), moderate/walking ≥ 5 days (30 + min/day), or any activity ≥ 5 days (600+ MET-min). **Low:** Less than the above.

Table 2 Summary of Descriptive Statistics and Correlation Analysis of Research Constructs

Dimension	Descriptive Statistics				VIF	Pearson Correlation		
	Min/Max	Mean(SD)	Skewness	Kurtosis		Weight Status	Body Dissatisfaction	Negative Affect
Weight Status	13.86/ 41.62	21.50(3.39)	1.21	2.33	1.39	1.00		
Body Dissatisfaction	11.00/ 55.00	21.58(8.88)	0.70	-0.27	1.06	0.52	1.00	
Negative Affect	0.00/ 56.00	10.98(8.96)	1.09	1.42	1.46	0.05	0.22	1.00
Disordered Eating Behavior	0.00/ 56.00	8.61(7.49)	1.57	3.62	1.31	0.07	0.48	0.21

a mean of 10.98 (SD = 8.96). Disordered eating behavior reported the lowest mean ($M = 8.61$, $SD = 7.49$). The correlation analysis revealed moderate associations between weight status and body dissatisfaction ($r = 0.52$), and between body dissatisfaction and disordered eating behavior ($r = 0.48$), suggesting significant interrelationships among these constructs.

This study ensured the rigor of the analysis by checking for normality and the Variance Inflation Factor (VIF) to confirm that the data met the assumptions of normality and did not have multicollinearity issues. The skewness values between the variables ranged from 0.70 to 1.57, and the kurtosis values ranged from -0.27 to 3.62, which aligns⁵² with the standards proposed by previous research, indicating that the absolute values of skewness were less than 2 and the values of kurtosis were less than 7. Additionally, the VIF values for each variable ranged from 1.06 to 1.46, all below the recommended threshold of 3.3.⁵³ Overall, these findings indicate that the data in this study met the assumptions of univariate normality and lacked multicollinearity issues, making them suitable for regression path analysis. Please refer to Table 2 for a summary of the descriptive statistics and correlation analysis of the research constructs.

Hypothesis Testing

According to the research objectives, this study used AMOS 24.0, employing the bootstrapping method with 10,000 iterations to sequentially conduct path analysis and mediation effect testing. This confirmed the significance of the path effects of independent variables on the dependent variables within the research model. Subsequently, the sample was divided into two groups based on physical activity levels: high-intensity and low-intensity activity. Group comparisons were conducted to further validate the moderating effects of physical activity levels in the research model. The relevant results are described in this section.

Path Analysis

The hypothesis tests for each path in the research model are explained as follows:

Hypothesis H₁: The standardized regression coefficient of “weight status” on “body dissatisfaction” was 0.53, $p < 0.001$, and the confidence interval did not include 0 [0.49, 0.56]. Therefore, this study’s Hypothesis 1 that “weight status” positively influences “body dissatisfaction” was supported.

Hypothesis H₂: The standardized regression coefficient of “body dissatisfaction” on “disordered eating behavior” was 0.45, $p < 0.001$, and the confidence interval did not include 0 [0.42, 0.49]. Thus, this study’s Hypothesis 2 that “body dissatisfaction” positively influences “disordered eating behavior” was supported.

Hypothesis H₄: The standardized regression coefficient of “body dissatisfaction” on “negative affect” was 0.23, $p < 0.001$, and the confidence interval did not include 0 [0.18, 0.27]. Hence, this study’s Hypothesis 4 that “body dissatisfaction” positively influences “negative affect” was supported.

Hypothesis H₅: The standardized regression coefficient of “Negative Affect” on “Disordered Eating Behavior” was 0.11, $p < 0.001$, and the confidence interval did not include 0 [0.07, 0.15]. Therefore, this study’s Hypothesis 5 that “Negative Affect” positively influences “Disordered Eating Behavior” was supported.

Finally, the explanatory power (R squared) values of the three dependent variables—body dissatisfaction, negative affect, and disordered eating behavior—were 0.28, 0.05, and 0.24, respectively. A higher R² value indicates that the independent variables explain the dependent variables better. According to the recommendations from scholars,⁵⁴ the suggested R² values are 0.19, 0.33, and 0.67, arranged from low to high. In other words, the explanatory power of this study’s model generally met the scholars’ recommendations for small to medium explanatory strength. Please refer to Table 3 for a summary of the research hypothesis paths.

Mediation Effect Analysis

This study aimed to explore the mediating roles of body dissatisfaction and negative affect in the relationship between weight status and disordered eating behaviors. The mediation effects in Hypotheses 3 and 6 were tested using the

Table 3 Summary of the Research Hypothesis Paths

Independent Variable → Dependent Variable		Point Estimate				Bootstrap 10,000 times			
						Percentile 95%		Bias-corrected 95%	
		Standardized Regression Coefficient	Standard Error	t-value	p-value	Lower Bound	Upper Bound	Lower Bound	Upper Bound
H ₁	Weight Status → Body Dissatisfaction	0.53	0.02	33.35	***	0.49	0.56	0.49	0.56
H ₂	Body Dissatisfaction → Disordered Eating Behavior	0.45	0.02	26.29	***	0.42	0.49	0.42	0.49
H ₃	Weight Status → Body Dissatisfaction → Disordered Eating Behavior	0.24	0.01	20.52	***	0.22	0.26	0.22	0.26
H ₄	Body Dissatisfaction → Negative Affect	0.23	0.02	10.68	***	0.18	0.27	0.18	0.27
H ₅	Negative Affect → Disordered Eating Behavior	0.11	0.02	5.54	***	0.07	0.15	0.07	0.15
H ₆	Weight Status → Body Dissatisfaction → Negative Affect → Disordered Eating Behavior	0.01	0.00	4.92	***	0.01	0.02	0.01	0.02

Note: *** $p < 0.001$.

bootstrap method, and the results indicated significant mediation effects, supporting the hypothesized relationships. Detailed results of the indirect effects are presented in Table 3. The analysis is described as follows:

Hypothesis H₃: The standardized regression coefficient of “weight status” affecting “disordered eating behavior” through “body dissatisfaction” was 0.24, $p < 0.001$, and the confidence interval did not include 0 [0.22, 0.26]. Therefore, this study’s Hypothesis 3 that “weight status” influences “disordered eating behavior” through “body dissatisfaction” was supported.

Hypothesis H₆: The standardized regression coefficient of “weight status” affecting “negative affect” and subsequently leading to “disordered eating behavior” was 0.01, $p < 0.001$, and the confidence interval did not include 0 [0.01, 0.02]. Therefore, this study’s Hypothesis 6 that “weight status” influences “negative affect”, which in turn leads to “disordered eating behavior”, was supported as a chain mediation effect.

Moderating Effect: Comparison of Two Different Groups of Physical Activity Levels

This study aimed to further explore the impact of regular exercise and physical activity levels on the research model. A total of 767 students who engaged in regular exercise and had high levels of physical activity were selected as the high activity level group (H), while another group of 1006 students with irregular exercise and low levels of physical activity was identified as the low activity level group (L). The two groups of students were compared to verify whether physical activity levels had a moderating effect in the research model (see Table 4 and Figure 2). This study found that physical activity levels significantly moderated certain pathways in the research model, with the main results described as follows.

First, in the effect of body dissatisfaction on disordered eating behaviors, the regression coefficient difference was 0.12, with a t -value of 2.74 and $p = 0.01 < 0.05$. Further examination revealed that the coefficient for the high activity group was 0.49 ($t = 15.42$, $p < 0.01$), which was higher than the low activity group at 0.37 ($t = 12.26$, $p < 0.01$). In other words, students with higher levels of physical activity exhibited more disordered eating behaviors compared to those with lower levels of physical activity.

Second, in the effect of negative affect on disordered eating behaviors, the regression coefficient difference was -0.11 , $p < 0.05$, indicating that regular physical activity significantly moderated the relationship between negative affect and disordered eating behaviors among college students. The results showed that when college students had lower levels of physical activity, the positive impact of negative affect on disordered eating behaviors was stronger, with a coefficient of 0.18 ($t = 5.62$, $p < 0.01$). Conversely, when college students had higher levels of physical activity, the impact of negative affect on disordered eating behaviors was weaker and did not reach significance, with a coefficient of 0.07 ($t = 1.96$, $p = 0.05$). This suggests that regular engagement in high levels of physical activity can weaken the positive influence of negative affect on disordered eating.

Third, in the chain mediation where weight status affects disordered eating behavior through body dissatisfaction and negative affect, the regression coefficient difference was -0.01 ($t = -2.30$, $p < 0.05$), reaching a significant level, indicating that the chain mediation effect was moderated by physical activity levels. As can be seen in Table 4,

Table 4 Summary of Moderating Effects by Different Levels of Physical Activity

Independent Variable → Dependent Variable		High			Low			Difference sig. test		
		Path	t	p	Path	t	p	diff	t	p
H ₁	Weight Status → Body Dissatisfaction	0.45	13.86	0.00	0.53	20.53	***	-0.08	1.92	0.06
H ₂	Body Dissatisfaction → Disordered Eating Behavior	0.49	15.42	0.00	0.37	12.26	***	0.12	2.74	0.01**
H ₃	Weight Status → Body Dissatisfaction → Disordered Eating Behavior	0.22	10.27	0.00	0.20	10.27	***	0.02	0.87	0.38
H ₄	Body Dissatisfaction → Negative Affect	0.23	5.69	0.00	0.23	7.00	***	-0.01	0.15	0.88
H ₅	Negative Affect → Disordered Eating Behavior	0.07	1.96	0.05	0.18	5.62	***	-0.11	2.20	0.03*
H ₆	Weight Status → Body Dissatisfaction → Negative Affect → Disordered Eating Behavior	0.01	1.87	0.06	0.02	4.35	***	-0.01	2.30	0.02*

Notes: * $p < 0.05$ ** $p < 0.001$ *** $p < 0.001$.

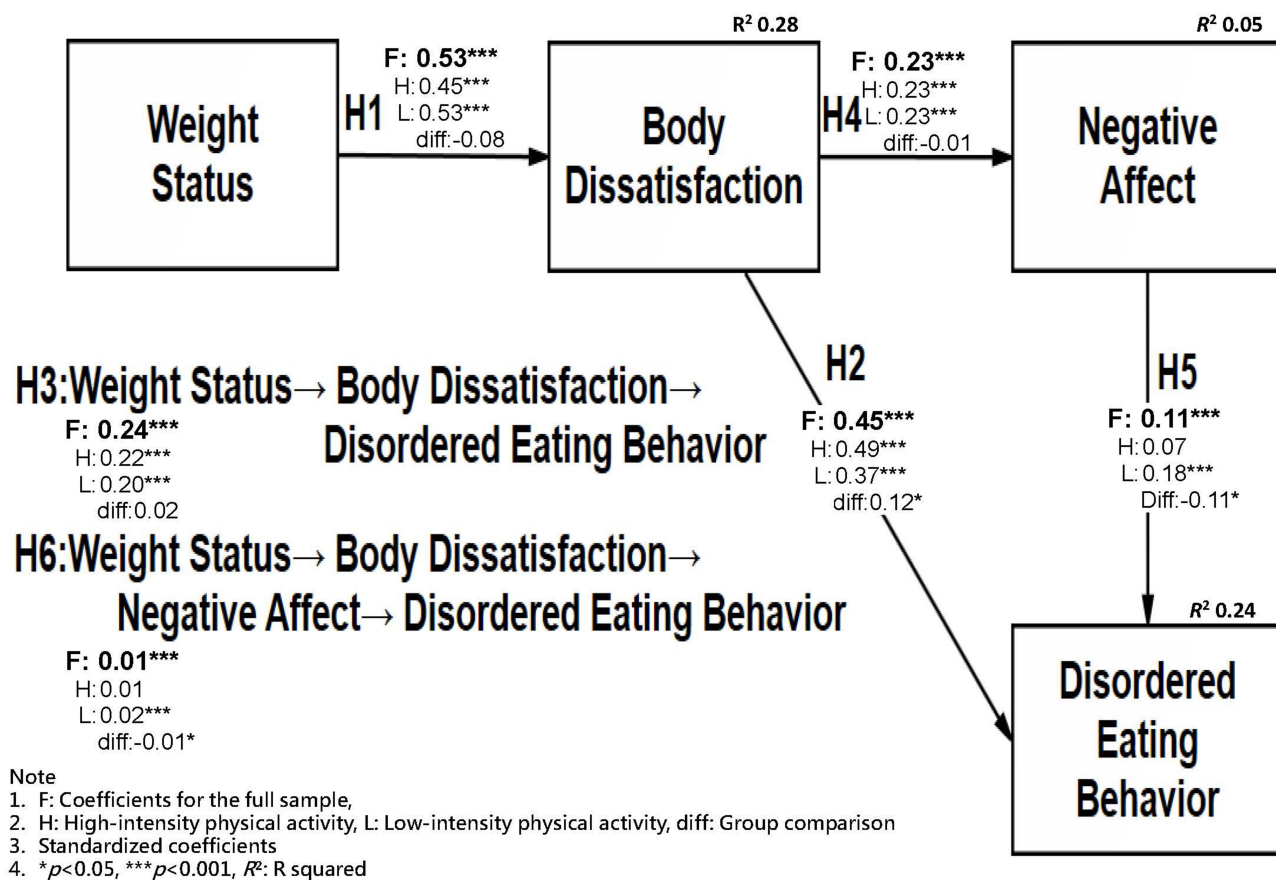


Figure 2 Validation of the research model.

comparing the two groups, the high activity group's coefficient was 0.01 ($t = 1.87$, $p = 0.06$) and the low activity group's coefficient was 0.02 ($t = 4.35$, $p < 0.01$). It is evident that students with lower activity levels were more affected by their weight status, leading to body dissatisfaction and negative affect, resulting in more instances of disordered eating behaviors. In contrast, students with higher activity levels did not exhibit statistically significant effects along this pathway. This indicates that when college students engaged in regular physical activity, the chain mediation effect of body dissatisfaction and negative emotions between weight status and disordered eating behaviors was significantly weakened.

In summary, as the level of physical activity increases, the positive influence of negative affect on disordered eating behaviors continues to weaken. The chain mediation effect of body dissatisfaction and negative affect between weight status and disordered eating behaviors also diminishes. Regular physical activity significantly moderates the size of the chain mediation effect by alleviating the positive impact of negative affect of disordered eating behaviors. Therefore, this study's hypothesis H_7 was supported. Additionally, the level of physical activity significantly moderates the relationship between body dissatisfaction and disordered eating behaviors, with the results indicating that compared to low physical activity levels, high physical activity levels enhance the impact of body dissatisfaction on disordered eating behaviors.

Discussion

This study systematically examined the potential relationships among weight status, body dissatisfaction, negative affect, and abnormal eating behaviors. The results of the constructed model reveal that weight status influences college students' eating behaviors through body dissatisfaction and negative affect. This influence includes two pathways: 1. Weight status positively affects college students' disordered eating behaviors by increasing body dissatisfaction; 2. Body dissatisfaction

and negative affect play a chain-mediated role in the positive impact of weight status on disordered eating behaviors. Therefore, the research results support hypotheses H1-H6.

Mediating Effect of Body Dissatisfaction

First, consistent with previous studies, being overweight or obese positively predicts body dissatisfaction,^{55,56} which leads to abnormal eating behaviors such as dieting and binge eating among college students.^{57,58} To explain the mediating role of body dissatisfaction in the relationship between weight status and disordered eating behaviors, the escape theory suggests that individuals compare themselves to high standards (which may stem from self-requirements or external references). Body dissatisfaction arises from the gap between one's self-perceived weight status and one's ideal weight status. Higher standards lead to lower body satisfaction, resulting in higher levels of negative self-awareness. Individuals may escape this negative self-awareness through cognitive constriction strategies, which typically include drinking, distraction, dissociation, and abnormal eating behaviors. Those prone to abnormal eating are more likely to engage in binge eating as a means to eliminate unpleasant thoughts and meaningful reflections, entering a state of low self-awareness that facilitates disinhibited eating behaviors (for example, a tendency to consume high-calorie foods).²²

The Chain Mediating Effect of Body Dissatisfaction and Negative Affect

Additionally, there exists a chain mediating effect of body dissatisfaction and negative affect in the positive influence of weight status on disordered eating behaviors. Previous studies have shown that being overweight or obese exacerbates individuals' subjective negative evaluations of their weight status,⁵⁹ which further activates negative affect, leading to an increasing level of psychological distress.⁶⁰ According to the self-control strength model, self-control is the ability to say "no" to temptations, and it requires limited psychological capital. Negative affect can deplete psychological capital, thereby weakening self-control. Research has found that when in a state of negative emotion, self-control is diminished, making individuals more likely to engage in disinhibited eating behaviors (such as binge eating and overeating).^{61,62}

The Moderating Role of Physical Activity Level

The level of physical activity moderates the chain mediation path of "weight status → body dissatisfaction → negative affect → disordered eating behavior", supporting research hypothesis H7. Group comparisons revealed that when college students had a low level of physical activity, the chain mediation effect of body dissatisfaction and negative affect between weight status and disordered eating behavior was significant. However, this chain mediation effect was not significant in the high physical activity group, suggesting that engaging in physical activity may have a protective effect against disordered eating behaviors. This finding aligns with previous research, indicating that negative affect lead to the depletion of psychological resources and a decrease in self-control, resulting in the occurrence of disordered eating behaviors,⁶³ therefore, enhancing college students' self-control seems to be an effective strategy in combating disordered eating behaviors, and according to research in the field of cognitive function, regular physical activity can enhance self-control. Studies have found that physical activity levels are closely related to negative affect and cognitive function. Physical activity can promote self-control and self-regulation by improving negative affect and increasing arousal levels, ultimately enhancing psychological resources and self-control, thereby weakening the impact of negative affect on disordered eating behaviors.⁶⁴

Finally, this study further examined the moderating role of physical activity levels in the process by which body dissatisfaction affects disordered eating behaviors. The results revealed that, compared to low levels of physical activity participation, body dissatisfaction has a more significant positive predictive effect on disordered eating behaviors under conditions of high physical activity levels. Previous research⁶⁵ has found that body dissatisfaction is related to excessive exercise, especially when individuals exercise with the goal of improving their appearance or losing weight, as higher levels of physical activity may more easily trigger disordered eating behaviors (such as dieting and binge eating) among those with body dissatisfaction.

Additionally, another perspective for interpreting this result is that recent studies support the idea of "compensatory eating behaviors after exercise",^{66,67} suggesting that high levels of physical activity may also serve as a "placebo" for individuals with body dissatisfaction when it comes to unhealthy eating. Research has shown that the weight loss and

health benefits gained from regular physical activity are often offset by compensatory eating behaviors after exercise, which are typically characterized by overeating or unhealthy food choices. The underlying factors behind compensatory eating behaviors include reward for effort and reduced self-control.

It is evident that the results of this study support research hypothesis 7, indicating that physical activity levels have a moderating effect in the model. However, physical activity appears to be a “double-edged sword” in the pathway from weight status to disordered eating behaviors. While appropriate levels of physical activity can help enhance psychological resources, excessive physical activity may also weaken self-control, which may depend on the characteristics of the physical activity itself and the purposes of the exercise. Physical activity can be a very pleasurable or very strenuous experience, influenced by factors such as exercise intensity, duration, type of exercise, and past exercise experiences. Notably, exercises that require more effort (non-hedonic) consume more psychological capital, leading to a decline in self-control and self-regulation abilities when performing subsequent tasks.

Therefore, it is suggested that when individuals seek to make changes due to body dissatisfaction, they may adopt high levels of physical activity as a coping strategy. However, prolonged high-intensity exercise aimed at weight loss or altering weight status requires significant self-control resources (psychological capital). According to the model of self-control strength, the willpower expended in maintaining such exercise routines can lead to psychological capital depletion during subsequent tasks requiring self-control (such as inhibiting eating), resulting in a decline in self-control and uncontrollable disordered eating behaviors.⁶⁸ Furthermore, compensatory eating behaviors after exercise are not only associated with unhealthy eating habits but also help explain the phenomenon where weight loss outcomes in some interventions utilizing exercise as a strategy do not meet expected goals.

Conclusion

Disordered eating behaviors are prevalent among college students in recent years. Due to the socio-cultural influences, the percentage of individuals showing unhealthy eating behaviors has increasingly surged. As subclinical eating disorder symptoms, students with disordered eating behaviors might suffer from severe physical and mental threats if the preventive measures are not implemented promptly. Gaining a deeper understanding of antecedents of disordered eating is an effective strategy for preventing such behaviors among college students, thus the purpose of this study is to utilize a cross-sectional survey method and conduct empirical analysis, grounded in the Escape Theory and the Strength Model of Self-Control, to clarify the mechanisms in developing the harmful disordered eating behavior. Based on the findings of this study, the following conclusions are drawn: (1) Weight status affects college students' eating behavior through the mediating effect of body dissatisfaction; (2) Body dissatisfaction and negative affect play a chain mediation role between weight status and abnormal eating; (3) Physical activity moderates the chain mediation path by mitigating the positive influence of negative affect on disordered eating behavior; (4) There is an interaction between body dissatisfaction and high levels of physical activity in triggering disordered eating behavior among college students. These findings offer new insight into understanding the cause of disordered eating behavior, particularly revealing the complex interactions between weight status, cognitive and psychological factors, and the level of physical activity. Additionally, these findings provide valuable references for future studies and intervention approaches, which are intended to improve college students' eating behavior and mental health. The following sections will elaborate on the deeper implications and potential impacts of these findings.

Theoretical Implications

This study, viewed through the lens of Escape Theory, offers a new insight into understanding the formation and development of disordered eating behaviors among university students. This study identifies a dual pathway of cognitive and emotional changes as antecedents of disordered eating behaviors, demonstrating that body dissatisfaction and negative affect collaboratively contribute to the occurrence of disordered eating behaviors. This finding offers the theoretical basis for future research to investigate the diverse triggering mechanisms of disordered eating behaviors from various viewpoints, in addition, it is beneficial for designing more effective strategies for intervention.

Practical Implications

Schools should pay more attention to the detrimental effects of disordered eating behaviors on students' health condition, and focus on improving the school environment to reduce triggering factors. Firstly, schools should encourage students to express and discuss negative emotions by offering communication platforms including group counseling and individualized support, which could help them overcome mental distress associated with body dissatisfaction and enhance their body image and self-esteem, resulting in the interrupting of the mechanisms of developing disordered eating behaviors. Moreover, schools should form a vibrant campus by organizing various types of physical activities, including but not limited to sports organizations, physical education courses, and sports-related events, which could effectively encourage students to participate in physical activities. Apart from this, educators should find some ways, such as lectures, to promote health concepts, which could enhance students' physical literacy and help them properly comprehend the health benefits associated with physical activity. Lastly, schools should evaluate the efficiency of such interventions regularly, and follow up modifications of students' body image, body esteem, and dietary behaviors via questionnaires and psychological assessments, and then improve these intervention strategies based on the assessment outcomes.

Research Limitations and Future Outlook

When exploring the mechanisms influencing college students' abnormal eating behaviors, previous studies have rarely considered physical activity levels as a moderating variable. Although this study has yielded preliminary results, the constraints of the research sample might limit the generalizability of the findings to the entire population of college students. This study was conducted at a university primarily focused on engineering, and used convenience sampling to gather data, which may have hindered the generalizability of the findings due to sample homogeneity. As a result, we recommend future studies should explore this finding in universities with a broad range of academic disciplines and utilize random sampling to enhance the external validity and generalizability of the results. Additionally, this study cannot make rigorous statements about the causal relationships between variables, making it difficult to reflect the dynamic processes through which body image affects college students' cognition, emotions, and behaviors. Future research could consider using longitudinal tracking methods with a time span to explore the mechanisms of action between body image and abnormal eating behaviors in greater depth. Finally, since this study was cross-sectional, it could not verify the interactions between physical activity levels, body image dissatisfaction, and negative affect in enhancing or weakening the pathways to abnormal eating behaviors. Subsequent studies are encouraged to conduct randomized controlled trials to manipulate physical activity levels (including the purpose of exercise, type of exercise, intensity, and duration) to further clarify the recommended amount of physical activity aimed primarily at reducing abnormal eating behaviors.

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