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Research article

The association between appetite and eating behaviors among Chinese female university students

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ABSTRACT

Background: Young females are at a higher risk of developing unhealthy eating behaviors. This study investigated the relationship between appetitive traits and eating behaviors among female university students.

Methods: The study participants were 520 female university students from a public university in Eastern China. Appetitive traits were assessed using the Chinese version of the Adult Eating Behavior Questionnaire (C-AEBQ). Data on eating behaviors, including food intake frequency, meal regularity, and dieting behavior, were collected using self-administered questionnaires. The body mass index (BMI) was calculated using self-reported data. Pearson's and Spearman's correlations were used to correlate appetitive traits with BMI and eating behaviors. Latent profile analysis (LPA) was used to identify different appetitive patterns, and logistic regression was used to analyze the relationship between different appetitive patterns and eating behaviors.

Results: Two food-approach traits (food enjoyment and emotional over-eating) were positively correlated with BMI, while two food-avoidance traits (slowness in eating and satiety responsiveness) showed negative correlations. Food responsiveness was linked to a higher intake of delivered food, spicy food, and sugar-sweetened beverages, whereas satiety responsiveness was correlated with more frequent meal skipping. The LPA identified four appetitive patterns: food approachers, food approachers with emotional under-eating, food avoiders, and food avoiders with emotional over-eating. Food avoiders had significantly lower BMI than the other groups. Compared to food approachers, food avoiders skipped breakfast more frequently, and food avoiders with emotional over-eating skipped both breakfast and lunch more often. After adjusting for BMI, appetitive patterns showed no significant relationship with dieting behavior.

Conclusion: Among female university students, appetitive patterns correlated with eating behaviors, and students with food-avoidance patterns had a higher risk of meal irregularity. These

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findings emphasize the importance of implementing trait- and pattern-specific approaches to promote healthy eating behaviors among female university students.

1. Introduction

1.1. Eating behaviors of Chinese female university students

Unhealthy diets are a major modifiable lifestyle risk factor for non-communicable diseases, accounting for more than 70 % of global deaths [1]. Dietary or nutrient intake is a comprehensive consequence of multiple factors related to eating behaviors, including food choice, food preference, eating frequency, and eating occasions [2]. University and college students are in a critical period of establishing stable eating behaviors that usually persist in later life. Various factors, including personal food beliefs and taste preferences, high academic pressure, active social interaction, and the specific food environment on campus, can increase the risk of developing unhealthy eating behaviors [3] that lead to over-eating [4] and excess weight gain during academic years [5,6].

In China, many studies have reported that university students often engage in unhealthy eating behaviors. These include skipping meals, overconsumption of sugar-sweetened beverages, not eating enough milk/dairy products and fruits, frequently eating takeout fast food, and following irrational diets [7–10]. While male students tend to engage in more unhealthy eating behaviors, female students pay more attention to diet quality, eat more regular meals, and have lower overweight and obesity rates than male students [11–14]. However, they face additional sociocultural pressure that requires women to maintain a thin appearance, which can lead to body dissatisfaction and anxiety about their body image [15–18]. This can eventually increase the risk of unhealthy eating behaviors and eating disorders [15,19]. Numerous studies have found that a significant proportion of female students are dissatisfied with their body image and take action to lose weight even if they are underweight or in the normal-weight range [15,20]. Data have reported a continuous increase in the incidence rates of eating disorders among young Chinese females over the last three decades [21]. Therefore, understanding the factors that influence eating behaviors in this specific population is crucial for developing a targeted approach to improve dietary intake.

1.2. Appetitive traits and their relationship with eating behaviors

Appetitive traits are a set of innate inherited predispositions that shape an individual's response to external food cues and internal satiety signals [22,23]. These traits are typically categorized as food-approach traits, which are associated with the onset of eating, and food-avoidance traits, which are related to the termination of eating. The four food-approach traits include hunger, food responsiveness, emotional over-eating, and enjoyment of food, while four food-avoidance traits are satiety responsiveness, food fussiness, emotional under-eating, and slowness in eating [24–26]. According to the behavioral susceptibility model of obesity, appetitive traits interact with environmental factors to influence eating behaviors, ultimately impacting body weight and nutritional status. Individuals with high responsiveness to food cues and low satiety responsiveness are particularly susceptible to over-eating and excessive weight gain in today's obesogenic environment [27,28].

Several studies have differentially related appetitive traits to eating behaviors across various age stages. A study among children aged 3–4 years found that enjoyment of food was positively correlated with vegetable preference and food fussiness was negatively associated with fruit intake [29]. Another study among younger children demonstrated that higher food responsiveness was linked to higher eating frequency, whereas lower satiety responsiveness was associated with lower food intake [30]. Only one study reported a relationship among adults, showing that in young adults, enjoyment of food was positively related to fruit and vegetable consumption and food fussiness was negatively related to fruit intake [31], which is consistent with the findings in children [29]. The study also found that appetitive traits were related to dietary patterns; specifically, enjoyment of food was positively linked to a healthy dietary pattern and a protein-rich pattern, but was negatively related to an unhealthy beverage-rich dietary pattern; conversely, food fussiness was negatively associated with the healthy pattern but positively correlated with the less healthy beverage-rich pattern and high-energy pattern [31]. Despite this, the relationship between appetitive traits and eating behaviors remains poorly investigated.

It is important to recognize that existing studies have primarily focused on the connection between individual appetitive traits and eating behaviors. However, this approach may overlook the intricate nature of these traits in a population. An individual's eating behaviors can be influenced by several traits and cannot be fully explained by any single trait. Therefore, person-centered approaches, such as latent profile analysis (LPA), have been applied in some studies to cluster people into more homogenous subgroups based on the similarity in their scores across appetitive traits [32–34]. These LPA-identified appetitive patterns have been linked to anxiety [33] and stress [34] in young adults. It would be interesting to examine how these person-centered appetitive patterns affect an individual's eating behaviors.

1.3. The current study

Few studies have been conducted to investigate appetitive traits in Chinese adults, owing to the lack of a reliable measurement tool. Typically, appetitive traits in adults are assessed using the Adult Eating Behavior Questionnaire (AEBQ) developed by Hunot et al., in 2016 [35] based on the Child Eating Behavior Questionnaire (CEBQ) [23]. In 2021, He et al. validated the Chinese version of the AEBQ (C-AEBQ) in a group of Chinese university students [36]. Since then, this instrument has been utilized in several studies to evaluate

appetitive traits in young Chinese adults [34,37]. However, no study has specifically focused on female Chinese students, a population group with unique eating issues, despite the differences in some appetitive traits between male and female students, as demonstrated using the C-AEBQ [37].

In this study, we used the C-AEBQ to explore the relationship between appetitive traits and eating behaviors among female students from a university in eastern China and to compare variations in eating behaviors across appetitive patterns identified by the LPA method. Our hypotheses were as follows: 1) appetitive traits are linked to eating behaviors, including food choice, eating habits, and dieting behavior, among female Chinese university students, and 2) female students with distinct appetitive patterns differ in their eating behaviors.

2. Materials and methods

This cross-sectional study was approved by the ethics committee of Hangzhou Normal University and conducted in early 2022.

2.1. Participants and the recruitment Procedure

Female students enrolled as full-time undergraduate or graduate students at a public university in Eastern China who were willing to participate in the study were eligible for recruitment. Between January and February 2022, the investigators recruited 45 eligible female students at the entrance of each 12 campus dormitory buildings. In total, 540 participants were recruited for this study. The self-administered paper questionnaires were filled out by the participants under the guidance of the investigators. Of these, 532 questionnaires were recovered and 520 participants were included in the analysis after excluding 12 with incomplete information. The participants received no payments for the study.

2.2. Data collection

2.2.1. Appetitive traits

Appetitive traits were measured using the Chinese version of the Adult Eating Behavior Questionnaire (C-AEBQ) [36]. The AEBQ is a self-rating scale containing 35 questions measuring four food-approach traits (hunger, food responsiveness, emotional over-eating, and enjoyment of food) and four food-avoidance traits (satiety responsiveness, emotional under-eating, food fussiness, and slowness in eating) [35]. The C-AEBQ was validated by He et al. in a group of Chinese university students with sufficient internal consistency and test-retest reliability [36]. In this study, the Cronbach's alphas of the eight subscales ranged from 0.70 to 0.96, which was comparable to that of the original AEBQ (0.76–0.97) [36].

2.2.2. BMI and eating behaviors

Body mass index (BMI) was calculated based on the self-reported height and weight. Weight status was categorized as underweight, normal weight, or overweight/obese if BMI was less than 18.5 kg/m^2, 18.5 kg/m^2 to 24 kg/m^2, or higher than 24 kg/m^2, respectively, according to the criteria for the Chinese population [38]. Data on the participants' eating behaviors, including food intake frequency, meal regularity, and dieting experience, were collected using questionnaires. For food intake frequencies, participants were required to indicate the frequencies of intake (once or none per week, 2–3 times per week, 4–6 times per week, 7 times or more per week) on the questions "What was the frequency of eating fruits/dairy products/sugar-sweetened beverages/spicy meal/spicy snacks/delivered food in the last month?"; for meal regularity, participants responded to the questions "What is the frequency of eating breakfast/lunch/dinner in the last month?" for items including 6–7 times per week, 4–5 times per week, 2–3 times per week and 0–1 time per week, respectively. For the dieting experience, participants responded with yes or no to the question, "Did you have any dieting behavior to lose or maintain your body weight in the past six months?". Frequencies of less than or equal to once a week were defined as rare, 2–3 times a week as occasional, and more than three times a week as often.

2.3. Data analysis

2.3.1. The latent profile analysis

To identify clusters with similar appetitive characteristics, latent profile analysis (LPA) [39] was performed based on the scores of eight appetitive traits using Mplus 8.3 software with a robust Maximum Likelihood Estimator (MLR). Analyses were performed with one to five cluster models that were run until the best-fitting number of profiles was found. Model fit was assessed using the Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size-adjusted BIC (aBIC), Lo–Mendell–Rubin (LMR) likelihood ratio test, bootstrapped likelihood ratio test (BLRT), and entropy value. Lower AIC, BIC, and aBIC values indicate better fit, while significant P-values (<0.05) for LMR and BLRT suggest a superior model fit for the k-profile model over the k-1 profile model. Entropy values (0–1) measure classification precision, with higher scores indicating greater accuracy. The final model was selected based on goodness-of-fit indices, parsimony, and interpretability. Participants were assigned to profiles based on their highest likelihood.

2.3.2. Statistical analysis

Descriptive statistics and tests for differences were conducted using IBM SPSS 23.0 software. Pearson's correlation coefficient was used to correlate the appetitive traits with BMI. Spearman's correlation was used to test the association between appetitive traits and eating behaviors. The chi-square test or analysis of variance (ANOVA) with post hoc test was used to test the differences among

appetitive patterns clustered by LPA, and effect sizes (Cramer's V for chi-square test and η^2 for ANOVA) were calculated as below to indicate the magnitude of associations.

$$\text{Cramer's V} = \sqrt{\frac{\chi^2}{n \times [min(r,c) - 1]}}$$

χ^2, chi-square test statistic; n, total sample size; c and r, number of columns and rows in the contingency table, respectively.

$$\eta^2 = \frac{SS_{between}}{SS_{total}}$$

$SS_{between}$, sum of squares between groups; SS_{total}, total sum of squares.

Logistic regression was used to analyze the relationship between different appetitive patterns and eating behaviors. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Characteristics of study participants

A total of 520 female university students were recruited for the study. Table 1 shows the demographic characteristics and eating behaviors of the participants. The mean age of the participants was 21.2 ± 1.7 years (range 18–29 years), and 89.0 % were undergraduate students. Participants' self-reported BMIs ranged from 14.0 kg/m^2 to 29.4 kg/m^2, with 27.1 % of participants being underweight and 7.3 % overweight or obese. There was a high proportion of participants liking spicy food (31.54 % for often eating a spicy meal and 17.88 % for spicy snacks) and a substantially high proportion of participants often eating delivered food (30.58 %); on contrast, only 11.73 % and 13.08 % of participants often consumed fruits and dairy products, two classes of food regarded as healthy, respectively. A total of 21.35 % of the participants had dieting experience in the past six months.

3.2. Appetitive traits and their correlation with BMI

Among eight appetitive traits, enjoyment of food scored highest (4.37 ± 0.70), while average scores of other traits ranged from 2.46 ± 0.71 (food fussiness) to 3.08 ± 0.73 (food responsiveness) (Table 2). Positive inter-correlations (r ranged from 0.21 to 0.51) existed among the four food-approach traits (enjoyment of food, emotional over-eating, food responsiveness, and hunger). For food-avoidance traits, only satiety responsiveness was significantly related to the other three traits, namely, food fussiness ($r = 0.10$), emotional under-eating ($r = 0.12$), and slowness in eating ($r = 0.31$). Significant negative correlations were found between most of the food-approach and food-avoidance traits, except for slowness in eating (Table 2).

BMI was positively associated with two food-approach traits, food enjoyment ($r = 0.16$, $P < 0.01$) and emotional over-eating ($r = 0.11$, $P = 0.01$), and negatively associated with two food-avoidance traits, slowness in eating ($r = -0.20$, $P < 0.01$) and satiety responsiveness ($r = -0.24$, $P < 0.01$). No significant associations were found between BMI and other appetitive traits, including hunger, food responsiveness, emotional under-eating, or food fussiness (Table 2).

Table 1
Demographic characteristics and eating behaviors of participants (n = 520). [a].

Variables		Value Mean ± sd or n (%)	Variables		Value n (%)
Age, yrs		21.21 ± 1.68	Fruit intake	Rare	227 (43.65)
BMI, kg/m^2		20.11 ± 2.39		Occasional	232 (44.62)
Weight status	Underweight	141 (27.12)		Often	61 (11.73)
	Normal weight	341 (65.58)	Dairy intake	Rare	254 (48.85)
	Overweight or obese	38 (7.31)		Occasional	198 (38.08)
Eating behaviors				Often	68 (13.08)
Eating delivered food	Rare	148 (28.46)	Skipping breakfast	Rare	224 (43.08)
	Occasional	213 (40.96)		Occasional	184 (35.38)
	Often	159 (30.58)		Often	112 (21.54)
Eating spicy meals	Rare	124 (23.85)	Skipping lunch	Rare	486 (93.46)
	Occasional	232 (44.62)		Occasional	34 (6.54)
	Often	164 (31.54)		Often	0 (0.00)
Eating spicy snacks	Rare	248 (47.69)	Skipping dinner	Rare	409 (78.65)
	Occasional	179 (34.42)		Occasional	82 (15.77)
	Often	93 (17.88)		Often	29 (5.58)
Sugar-sweetened beverage intake	Rare	202 (38.85)	On diet in the past six months	No	409 (78.65)
	Occasional	225 (43.27)		Yes	111 (21.35)
	Often	93 (17.88)			

[a] Data were expressed as mean ± standard deviation (sd) or count (%); underweight, BMI <18.5 kg/m^2; normal weight, 18.5 kg/m^2 ≤ BMI <24 kg/m^2; overweight and obesity, BMI ≥24 kg/m^2; rare, ≤1 time/week; occasional, 2–3 times/week; Often, >3 times/week.

Table 2
Description and the Pearson's correlation coefficient (*r*) among appetitive traits and BMI among female university students (n = 520).[a].

C-AEBQ scales	Value (mean ± sd)	Correlation Coefficient (*r*)								
		EF	EOE	FR	H	FF	EUE	SE	SR	BMI
EF	4.37 ± 0.70	1								0.16[c]
EOE	2.74 ± 1.10	0.24[c]	1							0.11[c]
FR	3.08 ± 0.73	0.41[c]	0.30[c]	1						0.01
H	2.57 ± 0.74	0.21[c]	0.25[c]	0.51[c]	1					−0.05
FF	2.46 ± 0.71	−0.23[c]	0.02	−0.12[c]	0.08	1				−0.07
EUE	3.05 ± 1.04	−0.10[b]	−0.57[c]	−0.03	0.02	−0.037	1			−0.06
SE	2.56 ± 0.90	−0.05	0.03	0.05	0.13[c]	−0.04	0.07	1		−0.20[c]
SR	2.82 ± 0.80	−0.17[b]	−0.09[b]	−0.03	−0.03	0.10[b]	0.12[c]	0.31[c]	1	−0.24[c]

[a] EF, enjoyment of food; EOE; emotional over-eating; FR, food responsiveness; H, hunger; FF, food fussiness; EUE, emotional under-eating; SE, slowness in eating; SR, satiety responsiveness.
[b] $P < 0.05$.
[c] $P < 0.01$.

3.3. Correlation of appetitive traits with eating behaviors

Table 3 shows Spearman's correlation between appetitive traits and eating behaviors. Among the food-approach traits, food responsiveness was positively associated with higher intake frequency of delivered food ($\rho = 0.16$, $P < 0.01$), spicy meals ($\rho = 0.24$, $P < 0.01$), spicy snacks ($\rho = 0.24$, $P < 0.01$), and sugar-sweetened beverages ($\rho = 0.11$, $P = 0.01$); enjoyment of food was positively related to spicy meals ($\rho = 0.14$, $P < 0.01$); emotional over-eating was positively related to spicy snacks ($\rho = 0.09$, $P = 0.04$); and hunger was associated with a higher frequency of spicy food intake (meals: $\rho = 0.11$, $P = 0.01$; snacks: $\rho = 0.12$, $P = 0.01$). Among the food-avoidance traits, food fussiness was associated with a lower intake frequency of fruits ($\rho = -0.13$, $P < 0.01$) and dairy products ($\rho = -0.09$, $P = 0.05$), emotional under-eating was negatively related to the intake frequency of dairy products ($\rho = -0.10$, $P = 0.03$), and satiety responsiveness was positively correlated with a higher intake of sugar-sweetened beverages ($\rho = 0.10$, $P = 0.02$). For meal regularity, a higher frequency of skipping breakfast and lunch was positively related to satiety responsiveness (breakfast, $\rho = 0.12$, $P = 0.01$; lunch, $\rho = 0.15$, $P < 0.01$) and negatively related to enjoyment of food (breakfast, $\rho = -0.12$, $P = 0.01$; lunch, $\rho = -0.20$, $P < 0.01$), whereas the frequency of skipping dinner was significantly associated with satiety responsiveness only ($\rho = 0.11$, $P = 0.02$). Emotional over-eating was the only trait correlated with dieting behavior ($\rho = 0.10$, $P = 0.02$).

3.4. Latent profile analysis of appetitive traits

3.4.1. Selection of best-fit model

Table 4 presents the model fit indices. The AIC, BIC, and aBIC values decreased as the number of clusters increased from one to five. Entropy reached its maximum when five clusters were fitted in the model; however, in this model, the LMR was not significant ($P = 0.545$). According to the comprehensive judgment of all the fitting indicators, the four-cluster model provided the most optimal model-to-data fit to the sample data. Individual cases were then assigned to latent profile groups using a standard modal classification.

3.4.2. Characteristics of the latent patterns

Clusters identified by LPA were labeled as four different appetitive patterns: food approachers (Cluster 1), food approachers with emotional under-eating (Cluster 2), food avoiders (Cluster 4), and food avoiders with emotional over-eating (Cluster 3). The

Table 3
The Spearman's correlation coefficient (ρ) between appetitive traits and eating behaviors among female university students (n = 520).[a].

Appetitive traits	Intake frequency of						Frequency of skipping			on diet
	delivered food	spicy meals	spicy snacks	Sugar-sweetened beverages	fruits	Dairy products	breakfast	lunch	dinner	
EF	0.08	0.14[c]	0.04	0.03	0	0.09[b]	−0.12[c]	−0.20[c]	−0.06	0.03
EOE	0.06	0.04	0.09[b]	0.06	0.06	0.03	−0.09	−0.02	0.05	0.10[b]
FR	0.16[c]	0.24[c]	0.24[c]	0.11[b]	0.02	0.07	−0.01	−0.05	−0.01	0.03
H	0.01	0.11[b]	0.12[b]	0.06	−0.04	−0.05	−0.13[c]	−0.03	−0.08	0.02
FF	0.02	−0.02	−0.01	−0.03	−0.13[c]	−0.09[b]	0.02	0.11[b]	−0.01	0.01
EUE	−0.02	0.07	0.03	0	−0.01	−0.10[b]	0.06	0.06	−0.02	−0.03
SE	0.07	0.03	0.01	0.03	0.04	0.06	0.02	0.08	−0.03	−0.05
SR	0.07	0.03	0.07	0.10[b]	0.07	−0.07	0.12[b]	0.15[c]	0.11[b]	−0.08

[a] EF, enjoyment of food; EOE; emotional over-eating; FR, food responsiveness; H, hunger; FF, food fussiness; EUE, emotional under-eating; SE, slowness in eating; SR, satiety responsiveness.
[b] $P < 0.05$.
[c] $P < 0.01$.

Table 4
Fit indices for 1–5 clusters of appetitive traits analyzed by LPA.[a].

Clusters	AIC	BIC	aBIC	Entropy	LMRT *P*-value	BLRT *P*-value
1	12390.272	12458.333	12407.546	–	–	–
2	12010.789	12117.135	12037.779	0.848	0.000	0.000
3	11901.253	12045.883	11937.960	0.820	0.000	0.000
4	11649.905	11832.819	11696.328	0.916	0.000	0.000
5	11554.569	11775.768	11610.709	0.963	0.545	0.000

[a] AIC, the Aikake Information Criterion; BIC, the Bayesian Information Criterion; aBIC, sample-size-adjusted Bayesian information criterion; LMRT, Lo–Mendell–Rubin likelihood ratio test, BLRT, bootstrapped likelihood ratio test. Low values on AIC, BIC, and aBIC suggested a better model fit, a higher score of entropy indicated greater accuracy of classification, and significant *P*-values (<0.05) for the LMRT and BLRT indicated a better model fit for the k profile model than the k-1 profile model.

distribution of participants among the four appetitive patterns is shown in Fig. 1A and the differences in the average scores of the eight traits between each pattern and the full sample are shown in Fig. 1B. For the food approachers pattern (n = 137, 26.35 %), the mean scores for all four food-approach traits were higher than the average scores for those traits in the full sample and the mean scores for all four food-avoidance traits were lower than those in the full sample. For the pattern of food approachers with emotional under-eating (n = 102, 19.62 %), the mean score for emotional over-eating was lower, and the mean score for emotional under-eating was higher than the mean scores in the full sample, while other characteristics were similar to those of the food approachers. For the food avoiders pattern (n = 167, 32.12 %), the mean scores for all four food-avoidance traits were higher than the average scores for those traits in the full sample, and the mean scores for all four food-approach traits were lower than those in the full sample. For the pattern of food avoiders with emotional over-eating (n = 114, 21.92 %), the mean score for emotional under-eating was lower and the mean score for emotional over-eating was higher than that for the full sample, while other characteristics were similar to those of food avoiders. Table 5 shows a comparison of the scores of the eight appetitive traits among the participants in different patterns. Except for slowness

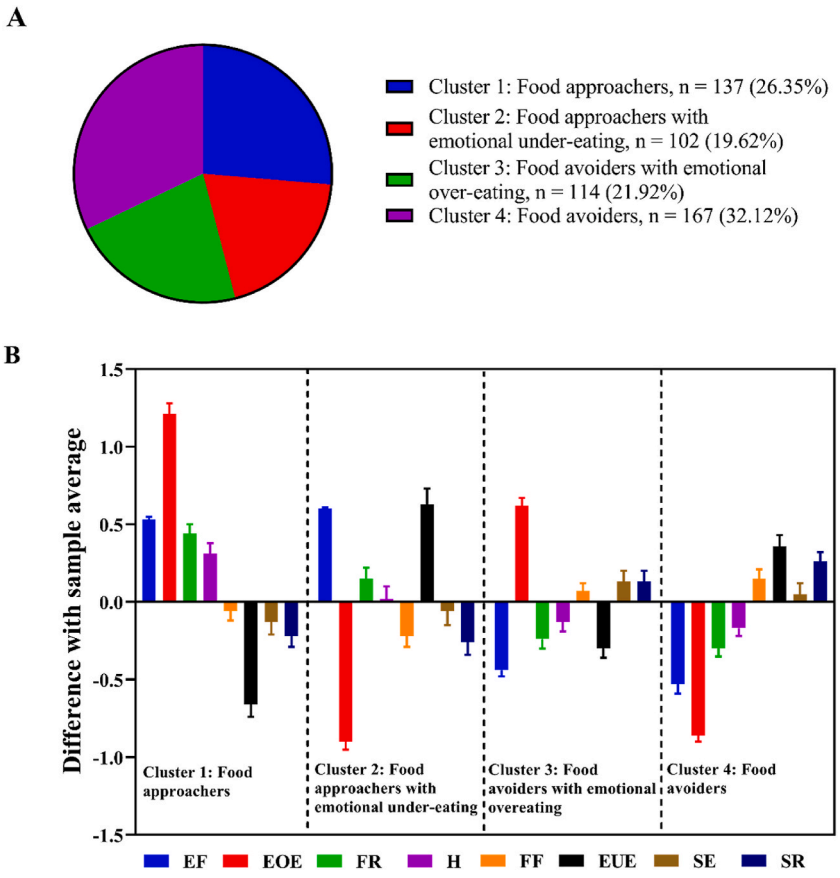

Fig. 1. Appetitive patterns identified by LPA. A, the distribution of participants among four appetitive patterns identified by LPA. B, the comparison of scores of eight traits between participants with different LPA-identified appetitive patterns and the average scores of the full sample (mean ± standard error). EF, enjoyment of food; EOE; emotional over-eating; FR, food responsiveness; H, hunger; FF, food fussiness; EUE, emotional under-eating; SE, slowness in eating; SR, satiety responsiveness.

in eating ($P = 0.10$), the average scores for other appetitive traits were significantly different among the patterns ($P < 0.01$).

3.5. Comparison of BMI across appetitive patterns

As shown in Table 6, no significant differences in BMI were found among food approachers, food approachers with emotional under-eating, and food avoiders with emotional over-eating, whereas food avoiders were weakly but significantly associated with a lower BMI ($\eta^2 = 0.032$, $P < 0.01$). Appetitive patterns were also shown to be weakly associated with weight status (Cramer's V = 0.117), as food avoiders had a higher proportion of underweight (35.9 %) and a lower proportion of overweight/obesity (3.4 %) than participants in the other three pattern groups ($P = 0.02$).

3.6. Comparison of eating behaviors across appetitive patterns

No significant differences in the intake frequency of fruits, dairy products, beverages, spicy food, or delivered food, as well as in the frequency of skipping dinner, were found among the four appetitive patterns (data not shown). However, there were significant differences in the frequency of skipping breakfast (Cramer's V = 0.108, $P = 0.05$), lunch (Cramer's V = 0.098, $P = 0.01$), and dieting behavior in the past six months (Cramer's V = 0.128, $P = 0.04$) among the four appetitive patterns, although the associations were relatively weak (Table 7).

Logistic regression analysis was performed to examine the association between appetitive patterns and behaviors related to skipping meals (Table 8). After adjusting for BMI, food avoiders had an 88 % higher frequency of occasionally or often skipping breakfast than food approachers (*OR* = 1.88, *95 % CI*: 1.19–2.97; $P = 0.01$). Similarly, food avoiders with emotional over-eating had a higher frequency of occasionally or often skipping breakfast (*OR* = 1.90, *95 % CI:* 1.14–3.15; $P = 0.01$) and lunch (*OR* = 3.11, *95 % CI*: 1.06–9.10; $P = 0.04$) than food approachers.

Logistic regression analysis showed that BMI was positively correlated with recent dieting behavior (*OR* = 1.19, *95 % CI*: 1.09–1.30; $P = 0.01$), and food avoiders had a lower risk of dieting than food approachers (*OR* = 0.52, *95%CI*: 0.29–0.91; $P = 0.02$). However, after adjusting for BMI, the difference in dieting behavior was no longer significant between food avoiders and food approachers (*OR* = 0.61, *95%CI*: 0.34–1.10; $P = 0.10$) (Table 9).

4. Discussion

In this cross-sectional study, we assessed the appetitive traits of a group of female students from a university in Eastern China. Our results revealed that two food-approach traits, enjoyment of food and emotional over-eating, were positively correlated with BMI, while two food-avoidance traits, slowness in eating and satiety responsiveness, were inversely correlated with BMI. Moreover, we demonstrated that individual traits were differentially associated with eating behaviors. Specifically, food-approach traits were more strongly associated with food choice, whereas food-avoidance traits, particularly satiety responsiveness, were more closely linked to meal regularity. Using the LPA method, we categorized these students into four appetitive patterns and found that those with different patterns varied in BMI and meal regularity. However, appetitive patterns may not affect dieting behavior, which is largely influenced by an individual's perceived body shape. Our findings provide valuable insights into this underexplored area and highlight the significance of appetitive traits as intervention targets.

The AEBQ was initially developed to assess appetitive traits among British adults, and it was demonstrated that, with the exception of hunger and food fussiness, food-approach traits were positively correlated with BMI, while food-avoidance traits were negatively correlated with BMI [35]. The C-AEBQ was validated in students from two Chinese universities, and it was found that none of the four food-approach traits were associated with BMI, while food-avoidance traits, including satiety responsiveness, food fussiness, and slowness in eating, were negatively correlated with BMI [36]. Using the C-AEBQ, we discovered a positive correlation between enjoyment of food and emotional over-eating and BMI, as well as a negative correlation between slowness in eating and satiety responsiveness with BMI in female university students. Although there were discrepancies in the associations between food-approach

Table 5
Comparisons of appetitive traits among four appetitive patterns identified by LPA.[a].

	Food approachers (n = 137)	Food approachers with emotional under-eating (n = 102)	Food avoiders with emotional over-eating (n = 114)	Food avoiders (n = 167)	*P*
EF	4.91 ± 0.20[a]	4.98 ± 0.11[a]	3.94 ± 0.44[b]	3.85 ± 0.71[b]	<0.01
EOE	3.95 ± 0.79[a]	1.84 ± 0.55[c]	3.36 ± 0.50[b]	1.88 ± 0.47[c]	<0.01
FR	3.52 ± 0.69[a]	3.23 ± 0.72[b]	2.84 ± 0.59[b]	2.78 ± 0.65[b]	<0.01
H	2.88 ± 0.81[a]	2.59 ± 0.81[b]	2.44 ± 0.59[b]	2.40 ± 0.66[b]	<0.01
FF	2.40 ± 0.68 [ab]	2.24 ± 0.75[b]	2.53 ± 0.58[a]	2.61 ± 0.74[a]	<0.01
EUE	2.39 ± 0.99[c]	3.68 ± 1.02[a]	2.75 ± 0.65[b]	3.41 ± 0.95[a]	<0.01
SE	2.43 ± 0.97	2.50 ± 0.94	2.69 ± 0.74	2.61 ± 0.89	0.10
SR	2.60 ± 0.77[b]	2.56 ± 0.80[b]	2.95 ± 0.76[a]	3.08 ± 0.77[a]	<0.01

[a] Data were expressed as mean ± sd. EF, enjoyment of food; EOE; emotional over-eating; FR, food responsiveness; H, hunger; FF, food fussiness; EUE, emotional under-eating; SE, slowness in eating; SR, satiety responsiveness. For the same row, values among groups with different superscripts were significantly different, $P < 0.05$, one-way ANOVA.

Table 6
Comparisons of BMI across four appetitive patterns among female university students (n = 520) [a].

	Food approachers (n = 137)	Food approachers with emotional under-eating (n = 102)	Food avoiders with emotional over-eating (n = 114)	Food avoiders (n = 167)	Effect size (Cramer's V or η^2)[b]	*P*
BMI, kg/m^2	20.5 ± 2.6[a]	20.5 ± 2.5[a]	20.2 ± 2.3[a]	19.5 ± 2.2[b]	0.032	<0.01[c]
Weight status, n (%)						
Underweight	34 (24.8)	20 (19.6)	27 (23.7)	60 (35.9)	0.117	0.02[d]
Normal weight	89 (65.0)	74 (72.5)	77 (67.5)	101 (60.5)		
Overweight or obese	14 (10.2)	8 (7.8)	10 (8.8)	6 (3.4)		

[a] Data were expressed as mean ± sd or count (%), one-way ANOVA and χ^2 test were used to compare the difference in BMI and weight status among appetitive patterns, respectively.
[b] Cramer's V for χ^2 test and η^2 for one-way ANOVA.
[c] For BMI, values among groups with different superscripts were significantly different, $P < 0.05$, one-way ANOVA.
[d] For weight status, $P < 0.05$, χ^2 test.

Table 7
Comparison of meal regularity and dieting behavior across four appetitive patterns among female university students (n = 520).[a].

Eating behaviors	n	Food approachers, n (%)	Food approachers with emotional undereating, n (%)	Food avoiders with emotional over-eating, n (%)	Food avoiders, n (%)	Cramer's V	*P*
Skipping breakfast							
Rare	224	72 (52.6)	48 (47.1)	42 (36.8)	62 (37.1)	0.108	0.05[b]
Occasional	184	37 (27.0)	38 (37.3)	43 (37.7)	66 (39.5)		
Often	112	28 (20.4)	16 (15.7)	29 (25.4)	39 (23.4)		
Skipping lunch							
Rare	486	132 (96.4)	100 (98.0)	102 (89.5)	152 (91.0)	0.098	0.01[b]
Occasional	34	5 (3.6)	2 (2.0)	12 (10.5)	15 (9.0)		
Skipping dinner							
Rare	409	108 (78.8)	85 (83.3)	81 (71.1)	135 (80.8)	0.104	0.08
Occasional	82	20 (14.6)	9 (8.8)	27 (23.7)	26 (15.6)		
Often	29	9 (6.6)	8 (7.8)	6 (5.3)	6 (3.6)		
Dieting behavior							
No	409	101 (73.7)	84 (82.4)	83 (72.8)	141 (84.4)	0.128	0.04[b]
Yes	111	36 (26.3)	18 (17.6)	31 (27.2)	26 (15.6)		

[a] Rare: ≤1 time/week, occasional: 2–3 times/week, Often: >3 times/week.
[b] $P < 0.05$, χ^2 test.

traits and BMI, consistent negative correlations were found between BMI and two food-avoidance traits, namely, slowness in eating and satiety responsiveness, in all three studies. It is possible that difference in age and gender distributions may be important factors accounting for the differences observed across the three studies. Our study was limited to female students, whereas the other two studies included both male and female [35,36], and Hunot's study had a wider age range [35]. In addition, the correlation between appetitive traits and BMI may also be influenced by the BMI distribution. Most participants in our study were normal weight or underweight, with only 7.3 % classified as overweight or obese; in contrast, over 45 % of Hunot's study population were categorized as overweight or obese [35].

Although there have been some reports, the relationship between appetitive traits and eating behaviors remains largely unknown [29–31]. In this study, we focused on several food types that are considered healthy, such as fruits and dairy products, or unhealthy, such as sugar-sweetened beverages, as well as foods that are frequently consumed by female university students in China. Our finding indicated that food-approach traits were more strongly associated with food choice than food-avoidance traits among female university students. Specifically, we observed a negative association between fruit intake and food fussiness, which is consistent with previous findings in children [29,40] and young adults [31]. Furthermore, we found that the intake of sugar-sweetened beverages was positively related to food responsiveness and satiety responsiveness, and the intake of dairy products was positively related to enjoyment of food but negatively related to food fussiness and emotional under-eating. These findings warrant further investigation,

Table 8
BMI-adjusted Odds ratio (OR) and 95 % confidential interval (CI) of skipping meals across different appetitive patterns among female university students (*OR, 95%CI; P*).

Appetitive pattern	Skipping breakfast	Skipping lunch	Skipping dinner
Food approachers	1.00	1.00	1.00
Food approachers with emotional under-eating	1.25, 0.75–2.08; 0.40	0.53, 0.10–2.78; 0.45	0.74, 0.38–1.45; 0.38
Food avoiders with emotional over-eating	1.90, 1.14–3.15; 0.01	3.11, 1.06–9.10; 0.04	1.52, 0.85–2.70; 0.16
Food avoiders	1.88, 1.19–2.97; 0.01	2.61, 0.92–7.36; 0.07	0.88, 0.50–1.55; 0.66

Table 9
Odds ratio (OR) and 95 % confidential interval (CI) of dieting behavior across different appetitive patterns among female university students (*OR, 95%CI; P*).

Appetitive pattern	Unadjusted	BMI-adjusted
Food approachers	1.00	1.00
Food approachers with emotional under-eating	0.60, 0.32–1.14; 0.12	0.60, 0.31–1.14; 0.12
Food avoiders with emotional over-eating	1.05, 0.60–1.84; 0.87	1.13, 0.64–2.00; 0.68
Food avoiders	0.52, 0.29–0.91; 0.02	0.61, 0.34–1.10; 0.10

particularly in light of the influence of dietary culture on specific populations.

Intriguingly, we found that the consumption of spicy food (including spicy meals and snacks) and delivered food were both positively associated with food-approach traits. Spicy food has gained popularity in China in the recent years. The impact of spicy food on dietary intake and body weight remains a topic of debate [41], but several studies on the Chinese population have indicated a positive correlation between spicy food consumption and the risk of obesity [42–45]. Similarly, online food delivery services have rapidly developed in China and have become very popular on university campuses in recent years [8,10]. It is worth noting that fast food delivered in China usually contains more oil and fewer vegetables, and is often spicy-flavored. These correlations suggest that individuals with higher food-approach traits may be at a higher risk of gaining excessive weight in this particular food environment.

LPA is an individual-centered analytical method that considers both group and individual heterogeneity. With LPA, subjects are grouped into homogenous subgroups based on a combination of several individual characteristics [39]. This analytic method has been widely used in studies on dietary intake and eating behaviors [33,34,46]. In this study, female students were categorized into four appetitive patterns using LPA: food approachers, food avoiders, food approachers with emotional under-eating, and food avoiders with emotional over-eating. These subgroups reflected two clusters of individuals who were highly responsive to food cues and easy to start eating (food approachers), and who were highly responsive to satiety signals and easy to stop eating (food avoiders), as well as two clusters of individuals whose eating behaviors were susceptible to being affected by emotion. We also found that food avoiders were weakly, but significantly, associated with a lower average BMI and had a higher proportion of underweight, whereas there were no differences in BMI or proportion of underweight among the other three patterns. Food avoiders were characterized by the lowest scores on food-approach traits and the highest scores on food-avoidance traits, suggesting that this group had a lower appetite, which might result in less energy intake and, therefore, a lower BMI. Chen et al. established a three-profile classification (no-approaching moderate eaters, approaching eaters, and approaching-and-avoidant eaters) in Chinese young adults and found that approaching eaters, who had higher scores for food-approach traits and lower scores on food-avoidance traits, had a higher proportion of overweight and obesity [34]. The differences in cluster classification and their association with BMI in these two studies may be attributed to the different distributions of sex. Our study was limited to female students. In our study, emotional eating, which is characterized by the over-consumption of food in response to negative emotions [47], was an important factor for cluster classification. This difference underscores the pivotal role of emotion in shaping female students' eating behaviors, as suggested by previous studies [48,49].

Appetite has been well recognized as the primary determinant of eating behaviors [25]. In this cross-sectional study of Chinese female students, we revealed the relationships between appetitive traits and food choices as well as meal regularity. Specifically, individuals with higher food responsiveness consumed more unhealthy foods, those with higher food fussiness scores consumed fewer healthy foods, and those classified as food avoiders were more likely to skip their meals. However, these associations were relatively weak, as indicated by correlation coefficients and effect sizes. These weak associations underscore the complex interplay of multiple factors that shape eating behaviors during a person's development [50]. Indeed, factors other than hunger and satiety, such as genetic traits, socioeconomic standing, food availability, and food environment, all have significant impacts on eating [51,52]. Therefore, a longitudinal study is warranted to further examine the extent to which appetitive traits shape a person's eating behaviors.

Although earlier studies have related single appetitive traits to eating behaviors, to the best of our knowledge, this is the first study to provide a comprehensive analysis of the impact of these traits on eating behaviors. Our results indicated that the frequency of specific food consumption did not differ among individuals with different appetitive patterns. However, we found that female university students with food-avoidance patterns (food avoiders and food avoiders with emotional over-eating) had a higher risk of skipping breakfast or lunch than those with food-approach patterns. This risk was not modulated by adjusting for BMI. These results suggest that appetitive patterns characterized by high satiety responsiveness might be a decisive factor for an individual's meal skipping, whereas BMI might not be a factor related to meal regularity. BMI appears to play a more crucial role in shaping female students' dieting habits [16,20,53,54], as evidenced by the results showing that the negative correlation between food avoiders and dieting behaviors weakened after taking BMI into account.

The results of this study have several practical applications. First, the link between appetitive traits and BMI suggests that trait-specific interventions for body weight management may be effective in female university students. For example, a positive correlation between food enjoyment and BMI implies that reducing pleasure-based eating could be helpful in maintaining a healthy weight [55], while a negative correlation between satiety responsiveness and BMI indicates that programs aimed at increasing satiety signals, such as consuming more fiber-rich foods [56], could be particularly effective. Second, the varied eating behaviors across appetitive patterns underscores the need for pattern-specific interventions to promote healthy eating. For instance, an intervention designed to lower satiety responsiveness may be beneficial for individuals with food-avoidance patterns to reduce meal skipping and minimize the risk of being underweight. However, education focused on promoting accurate body image recognition may be vital for those with dieting behaviors to avoid unhealthy dieting practices.

The findings of this study were strengthened by using a validated instrument for appetitive trait measurement and the application of a person-centered analysis method. However, this study has certain limitations. First, it is impossible to rule out the potential for self-report bias, particularly regarding sensitive information, such as dieting behaviors and BMI. Second, despite similarities in participants' age, common food environment, and relatively inexpensive food prices on campus, the potential confounding effects of other sociodemographic factors, such as taste preference due to regional variations and personal economic conditions, were not controlled but could not be eliminated in the study. Third, participants with eating disorders including anorexia nervosa and bulimia nervosa were not excluded during recruitment. Although the prevalence is relatively low among female Chinese students [57], those with eating disorders may have significant differences in appetitive traits, which could impact the results. Fourth, the study sample was limited to women from a single university with a generally low BMI, which restricts the generalizability of the findings to other populations. Finally, the cross-sectional design of the study could only infer the correlation between appetitive patterns and BMI. It is not possible to determine the dynamic effects of appetitive patterns on BMI or weight change during university years, which have a more significant impact on health. Nonetheless, these findings offer valuable insights that warrant further research.

5. Conclusion

The cross-sectional study conducted among female university students revealed a correlation between appetitive patterns and eating behaviors. In particular, female students who exhibited food-avoidance traits were more likely to having irregular meals, which may contribute to their low BMI. These findings underscore the importance of implementing interventions tailored to specific appetitive traits or patterns in order to promote healthy eating behaviors among female university students and reduce the risk of developing unhealthy body weight in this population.

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Institutional review board statement

The study was approved by the ethics committee of Hangzhou Normal University School of Public Health in January 2022 (protocol code 2022008), and was conducted in accordance with the Declaration of Helsinki.

Informed consent statement

Informed consent was obtained from all the participants involved in the study.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Jun Liu: Writing – original draft, Investigation, Data curation, Conceptualization. **Yiru Pan:** Writing – review & editing, Writing – original draft. **Liuxi Wang:** Investigation. **Ahui Tao:** Data curation. **Yuanyuan Deng:** Data curation. **Yue Qiu:** Data curation. **Yifei Cao:** Methodology. **Shufen Han:** Methodology. **Xiao Yan:** Writing – review & editing. **Xianrong Xu:** Writing – review & editing. **Xuexian Fang:** Writing – review & editing. **Fuzhi Lian:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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