frontiers | Research Topics

Eating disorders and eating disorder awareness

Edited by
Mona Vintilă, Cosmin Goian and Sebastian Gustavo Soneira

Published in
Frontiers in Nutrition
Frontiers in Psychology

ISSN 1664-8714
ISBN 978-2-8325-7450-8
DOI 10.3389/978-2-8325-7450-8

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

About Frontiers

Frontiers is more than just an open access publisher of scholarly articles: it is a pioneering approach to the world of academia, radically improving the way scholarly research is managed. The grand vision of Frontiers is a world where all people have an equal opportunity to seek, share and generate knowledge. Frontiers provides immediate and permanent online open access to all its publications, but this alone is not enough to realize our grand goals.

Frontiers journal series

The Frontiers journal series is a multi-tier and interdisciplinary set of open-access, online journals, promising a paradigm shift from the current review, selection and dissemination processes in academic publishing. All Frontiers journals are driven by researchers for researchers; therefore, they constitute a service to the scholarly community. At the same time, the *Frontiers journal series* operates on a revolutionary invention, the tiered publishing system, initially addressing specific communities of scholars, and gradually climbing up to broader public understanding, thus serving the interests of the lay society, too.

Dedication to quality

Each Frontiers article is a landmark of the highest quality, thanks to genuinely collaborative interactions between authors and review editors, who include some of the world's best academicians. Research must be certified by peers before entering a stream of knowledge that may eventually reach the public - and shape society; therefore, Frontiers only applies the most rigorous and unbiased reviews. Frontiers revolutionizes research publishing by freely delivering the most outstanding research, evaluated with no bias from both the academic and social point of view. By applying the most advanced information technologies, Frontiers is catapulting scholarly publishing into a new generation.

What are Frontiers Research Topics?

Frontiers Research Topics are very popular trademarks of the *Frontiers journals series*: they are collections of at least ten articles, all centered on a particular subject. With their unique mix of varied contributions from Original Research to Review Articles, Frontiers Research Topics unify the most influential researchers, the latest key findings and historical advances in a hot research area.

Find out more on how to host your own Frontiers Research Topic or contribute to one as an author by contacting the Frontiers editorial office: frontiersin.org/about/contact

Eating disorders and eating disorder awareness

Topic editors

Mona Vintilă — West University of Timișoara, Romania

Cosmin Goian — West University of Timișoara, Romania

Sebastian Gustavo Soneira — Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

Citation

Vintilă, M., Goian, C., Soneira, S. G., eds. (2026). *Eating disorders and eating disorder awareness*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-7450-8

Table of contents

frontiers | Frontiers in Nutrition

TYPE Editorial
PUBLISHED 16 January 2026
DOI 10.3389/fnut.2025.1769959

OPEN ACCESS

EDITED AND REVIEWED BY
Andrew Scholey,
Northumbria University, United Kingdom

*CORRESPONDENCE
Mona Vintila
✉ mona.vintila@e-uvt.ro
Cosmin Goian
✉ cosmin.goian@e-uvt.ro
Sebastian G. Soneira
✉ sebastiansoneira@gmail.com

RECEIVED 17 December 2025
REVISED 17 December 2025
ACCEPTED 30 December 2025
PUBLISHED 16 January 2026

CITATION
Vintila M, Goian C and Soneira SG (2026) Editorial: Eating disorders and eating disorder awareness. *Front. Nutr.* 12:1769959. doi: 10.3389/fnut.2025.1769959

Editorial: Eating disorders and eating disorder awareness

Mona Vintila[1]*, Cosmin Goian[2]* and Sebastian G. Soneira[3]*

[1]Department of Psychology, Faculty of Psychology and Education Sciences, West University of Timisoara, Timisoara, Romania, [2]Department of Social Work, Faculty of Sociology and Social Work, West University of Timisoara, Timisoara, Romania, [3]Department of Psychiatry, Fundacion Para la Lucha Contra las Enfermedades Neurologicas de la Infancia (FLENI), Buenos Aires, Argentina

KEYWORDS

Anorexia and Bulimia, Binge Eating Disorder, diet, eating disorders, eating disorders prevention, food guidelines

Editorial on the Research Topic
Eating disorders and eating disorder awareness

Eating disorders, as highlighted by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V), represent a significant and growing concern within the field of mental health. The four most prevalent eating disorders—Anorexia Nervosa, Bulimia Nervosa, Binge Eating Disorder (BED), and Avoidant/Restrictive Food Intake Disorder (ARFID)—are increasing, with some studies suggesting they have reached "epidemic" status.

This Research Topic has attracted a considerable number of interesting papers, covering diverse areas and utilizing a variety of approaches, including systematic reviews, exploratory analysis, psychosocial profiles, validation of psychometric instruments, interventions, and case studies. The research flow is comprehensive, addressing everything from health literacy and dietary knowledge to the role of socio-cultural factors, the relationship with body image, and subsequent implications for weight loss. The papers also examine interventions such as written emotional disclosure, bariatric surgery, or plastic surgery, as well as the evaluation of orthorexia, rounded out by interesting case studies.

Key findings from reviewed studies

Health literacy and sociodemographics

- The study "Eating disorders and health literacy in Germany" found that suspected eating disorders were more likely in female adolescents than male adolescents, but gender was not a determining factor in adults.
- The rate of suspected eating disorders increased with age in adolescents but decreased with age in adults.
- While education levels were not related to suspected eating disorders, low social status was associated with higher rates in adults, but not in adolescents.
- Inadequate or problematic health literacy and a negative body image were linked to higher rates of suspected eating disorders compared to adequate health literacy and a more positive body image.

Dietary knowledge and psychosocial factors

- Research on Chinese college students showed a significant association between dietary knowledge based on the Chinese Dietary Guidelines and adherence to healthy dietary behaviors. This supports previous systematic reviews indicating that greater dietary knowledge tends to lead to healthier eating patterns in American and European populations.
- Among adolescents in Shandong Province, China, a higher psychosocial score was associated with a greater likelihood of maintaining a healthy dietary pattern.
- This association remained consistent across various demographic factors, including age, sex, residence, parental education, and family wealth. However, the ownership of a computer and access to the Internet modified the relationship between the psychosocial profile and the healthy dietary score.

Body image and intentions

- The effect of body image on weight-loss intention among college students can be direct or indirect, mediated by self-efficacy and self-esteem (including a chained intermediary role).
- Body image and self-efficacy both have a significantly negative correlation with weight-loss intention. Conversely, self-esteem has a significantly positive correlation with weight-loss intention.
- A study on Chinese female university students found that body shape and BMI directly influence eating disorder behavioral intentions. The findings suggest that young Chinese women's eating disorder intentions are increasingly influenced by external factors related to body shape and BMI.
- Sociocultural standards promoting idealized appearance and the objectification of women's bodies are consistently linked to negative body image outcomes and an increased desire for cosmetic surgery. Research suggests that body image flexibility may act as a protective factor in reducing the desire for cosmetic surgery.

Interventions and clinical complications

- Bariatric surgery is considered the most potent treatment for obesity and is believed to alleviate the symptoms of food addiction. A study of 78 patients found that bariatric surgery significantly and rapidly reduces food addiction scores, with improvements sustained for up to 2 years.
- While most food addiction symptoms remitted quickly, social/interpersonal problems, hazardous use, and large amount/longer use showed delayed improvement, suggesting distinct mechanisms for behavioral persistence.
- A systematic review showed that written emotional disclosure intervention is effective in alleviating eating disorder symptoms and improving patients' body image problems.
- Scurvy, a rare disease caused by vitamin C deficiency, can occur in individuals with restrictive eating disorders like Anorexia Nervosa (AN), leading to severe health complications. Patients with co-occurring AN and scurvy often present with gastrointestinal, psychiatric, and dermatological symptoms.
- The Chinese version of the Orthorexia Nervosa Inventory (ONI) was found to possess ** strong reliability and validity**, making it a promising tool for assessing orthorexia tendencies and behaviors.

Eating disorders in athletes

- The demanding physical requirements of football, which often involve maintaining a specific physique, can lead to harmful eating behaviors among professional female players due to internal and external pressures.
- Cultural norms influence the prevalence and types of eating disorders, with differences in eating habits, beauty standards, and socio-cultural pressures affecting their development.
- A study on Polish and Turkish professional female football players found no nationality-based differences in eating disorder prevalence, but found the disorder to be widespread, affecting about 40% of players.
- Nutritional status impacts ED risk, with higher risk found among both underweight and overweight players.
- A case study of an orienteering athlete with Anorexia Nervosa highlighted the critical importance of continuous monitoring, timely intervention, and a coordinated multidisciplinary team in addressing eating disorders in athletes.

Conclusion

This Research Topic underscores the significance of effective communication among healthcare professionals and the necessity for comprehensive treatment strategies that include psychological, nutritional, and medical support in eating disorders. The studies collectively highlight the importance of early detection, suitable intervention, and the prevention of long-term health complications for effective eating disorder prevention.

Author contributions

MV: Writing – original draft. CG: Writing – original draft. SS: Writing – original draft.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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

Publisher's note

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 16 August 2024
DOI 10.3389/fpsyg.2024.1458259

OPEN ACCESS

EDITED BY
Sebastian Gustavo Soneira,
Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

REVIEWED BY
Mun Yee Kwan,
Hofstra University, United States
Jing Li,
Sichuan University, China
Matias Iglesias,
Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

*CORRESPONDENCE
Xiong Xue
✉ emilyerxx82@outlook.com

RECEIVED 02 July 2024
ACCEPTED 07 August 2024
PUBLISHED 16 August 2024

CITATION
Yiyi O, Xue X, Jiong L and Yanhui Z (2024) Research on the influence of body image on college students' weight-loss intention: chained intermediary analysis of self-efficacy and self-esteem.
Front. Psychol. 15:1458259.
doi: 10.3389/fpsyg.2024.1458259

Research on the influence of body image on college students' weight-loss intention: chained intermediary analysis of self-efficacy and self-esteem

Ouyang Yiyi[1,2], Xiong Xue[2]*, Luo Jiong[3] and Zhang Yanhui[2]

[1]School of Economics and Management, Chengdu Sport University, Chengdu, China, [2]College of Physical Education, Chongqing University of Posts and Telecommunications, Chongqing, China, [3]College of Physical Education, Southwest University, Chongqing, China

Purpose: This paper aims to explore the relationship between body image, self-efficacy, self-esteem, and weight-loss intention among college students, offering insights to promote healthy and confident lifestyle habits.

Methods: Undergraduate students from western China were selected using a stratified random sampling method. Data were analyzed using SPSS 19.0 and AMOS 21.0 statistical software.

Results: (1) Body image showed a significantly positive correlation with self-efficacy and self-esteem but a negative correlation with weight-loss intention. Self-efficacy exhibited a significantly positive correlation with self-esteem and a negative correlation with weight-loss intention, while self-esteem was significantly negatively correlated with weight-loss intention. (2) Body image directly impacted weight-loss intention [Effect Size (ES) = −0.120]. Self-efficacy (ES = −0.069) and self-esteem (ES = −0.119) played significant mediating roles between body image and weight-loss intention, respectively. (3) The chained intermediary role of self-efficacy and self-esteem also reached significance (ES = −0.038).

Conclusion: Body image conducts effect on the degree of weight-loss intention among college students through direct ways or indirect ways such as the intermediary role of self-efficacy and self-esteem, and also the chained intermediary role of self-efficacy and self-esteem. In addition, self-esteem is another key factors affecting college students' weight-loss intention.

KEYWORDS

body image, self-efficacy, self-esteem, weight-loss intention, intermediary effect

Introduction

Body image refers to an individual's cognitive picture of their physical appearance, comprising both objective perceptions and subjective evaluations of various bodily characteristics. This multifaceted cognitive picture encompasses dimensions such as appearance, body shape, physical abilities, and overall health condition. Importantly, the level of self-awareness regarding body image is known to significantly impact emotional states and

health-related behaviors, such as weight control, social adaptation, stress management, personal development, and interpersonal interactions (Wang et al., 2017). In today's world with highly developed online media, people often focus on their own body shape and appearance, while easily overlooking their health. Excessive exposure to styles like "slender figures" and "perfect bodies" publicized by media can lead to low body satisfaction. It is precisely because of this decline in body satisfaction that various weight-loss concepts emerge. Thus, some people may even resort to unhealthy weight-loss methods to improve negative body image. In this case, the risk of chronic diseases and psychological disorders is increased (Wei et al., 2012; Gillen, 2015; Andrew et al., 2016; Sun et al., 2017).

Weight-loss intention refers to various motivations that individuals derive when dissatisfied with their body shape such as the motivation to lose weight through exercise, dieting, or undergoing liposuction surgery at a cosmetic clinic (Huang et al., 2014; Lin and Lin, 2016). Relevant studies have found a strong correlation between individual body satisfaction and weight-loss intention. The more positive one's body image, the lower their degree of weight-loss intention. Conversely, individuals dissatisfied with their body image or holding negative perceptions are more likely to initiate weight-loss intention and behaviors (Sun et al., 2017; Liu et al., 2019). Weight-loss behaviors come from weight-loss motivations and intention, both of which are then influenced by individuals' cognitive processes, evaluations, and attitudes toward themselves. People with higher weight-loss motivation and intention are more likely to adopt extreme weight-loss methods and are at greater risk of exacerbating eating disorder symptoms (Ouyang et al., 2023). According to problem-behavior theory, an individual's behavior should be studied from a developmental perspective and through the interaction of personality, environment, and behavior systems. An individual may exhibit different behaviors based on their environment, and similarly, the environment may have different effects on behavior depending on the individual (Jessor, 1987). Recent researches (Annesi, 2018; Hopkins and Bennett, 2018; Robertson et al., 2020) have pointed out that self-efficacy influences weight-loss intention, with higher self-efficacy associated with lower weight-loss intention, while lower self-efficacy associated with higher weight-loss intention. Self-efficacy refers to one's subjective prediction of their abilities to accomplish a specific task. It also represents the tendency for individuals to judge and feel whether their actions can achieve a certain goal. It includes three meanings: firstly, it belongs to the category of ability perception but is not equivalent to actual abilities; secondly, it involves expectations about whether a particular goal can be achieved before engaging in an activity; thirdly, it means a subjective judgment of one's ability to reach a goal (Ouyang et al., 2020). Meanwhile, some scholars have proposed that positive body image can effectively enhance self-efficacy, which in turn can mitigate and reduce the degree of weight-loss intention (Annesi and Mareno, 2015; Pan and Peña, 2017; Talleyrand et al., 2017; Soheila et al., 2018; Ouyang et al., 2021). This seems to have proved that body image may exert an influence on weight-loss intention through self-efficacy, potentially indicating an intermediary role of self-efficacy between body image and weight-loss intention.

Additionally, contemporary college students are particularly susceptible to internalizing the ideal "thin" body shape promoted by the media and the associated values. This makes them more likely to develop negative self-evaluations of their appearance, tending to view themselves as objects of others' judgment, and neglecting their self-worth and internal feelings, which in turn leads to decreased self-esteem (Ouyang et al., 2021). Self-esteem refers to one's positive or negative attitudes toward themselves, which can be both comprehensive and specific (Hülya et al., 2006). One may evaluate qualities of its own separately, or integrate these qualities to give an overall assessment. Therefore, self-esteem is an emotional assessment that individuals make about themselves, serving as a crucial indicator of whether health behaviors will be implemented. What's more, it correlates well with the degree of weight-loss intention. Individuals with lower self-esteem often suffer from depression and anxiety, leading to an increase in weight-loss intention (Zhu et al., 2005; Margaret et al., 2017; Peng et al., 2017; Kamody et al., 2018). Based on relevant studies, body image is a significant factor influencing self-esteem among college students, with a positive predictive effect. Compared to college students with higher levels of body image, those with lower levels tend to spend more time on their bodies and comparing themselves with others. This behavior contributes to negative emotions and a decrease in self-esteem, thereby increasing weight-loss intentions among college students (Kamody et al., 2018; Ouyang et al., 2020). Furthermore, self-esteem is influenced by social values, the degree of importance attached to certain matters, and the evaluations individuals receive. Excessive social publicity of ideal body will strengthen college students' focus on body shape, leading to an imbalance in their expectations of their bodies and then resulting in negative emotions and low self-esteem (Klomsten et al., 2004; Borges et al., 2010; Lian, 2012; Koronczai et al., 2013), driving an increase in weight-loss intention (Yigiter, 2014). Consequently, body image can influence weight-loss intention through self-esteem. To potentially reduce weight-loss intention among college students, it is important to both promote a healthy body image and address the improvement of self-esteem levels. This suggests that self-esteem may play an intermediary role between body image and weight-loss intention. At the same time, other studies have shown that self-efficacy has a positive influence on the self-esteem, which means individuals with higher self-efficacy tend to have stronger confidence (Cao and Zhang, 2018; Liao et al., 2019). Although self-efficacy primarily emphasizes an individual's evaluation of their own abilities and self-esteem pertains to the evaluation of self-worth, enhancing self-efficacy can help increase a sense of control, thereby improving self-evaluation. Therefore, an increase in self-efficacy can enhance self-esteem. Further studies (Nock et al., 2016; Ouyang et al., 2023; Pyykkö et al., 2023) have demonstrated that as individuals' self-efficacy improves, their self-esteem is likely to increase, which in turn reduces weight-loss intention.

In conclusion, body image, self-efficacy, and self-esteem are all significant factors influencing weight-loss intention, with each of these factors being important negative predictors of weight-loss intention. Body image can effectively enhance college students' self-efficacy and self-esteem, thereby reducing their weight-loss intention. Moreover, there is a positive correlation between self-efficacy and self-esteem. This may indicate that positive body image of college students can enhance self-efficacy, leading to the development of stable self-esteem. Could this be a key factor in inhibiting weight-loss intention? However, previous research has rarely explored the relationship between "body image + self-efficacy + self-esteem + weight-loss intention," particularly the lack of in-depth investigation into whether a chain mediating mechanism exists between "self-efficacy + self-esteem." Based on this, our research constructs a chain mediation model of body image, self-efficacy, self-esteem, and weight-loss intention, and integrates body image, self-efficacy, and self-esteem as personality systems to examine their effects on weight-loss intention,

to reveal the relevant mechanisms affecting weight-loss intention of college students and better promote the development of healthy and confident habits among college students, thus providing practical references for enhancing their physical and mental health. Therefore, the following hypotheses are proposed: (1) self-efficacy mediates body image and weight-loss intention; (2) self-esteem mediates body image and weight-loss intention; and (3) self-efficacy and self-esteem act as a chain mediator between body image and weight-loss intention.

Subjects and methods

Subjects

The survey was conducted with students enrolled in a comprehensive university in western China. First, the students were classified according to subject categories and grades, and then 1,000 students were randomly selected. With the help of physical education teachers and college counselors and the approval of the Ethics Committee, the selected subjects were investigated anonymously. A total of 1,000 questionnaires were distributed, and 887 valid questionnaires were recovered. The effective recovery rate of the questionnaire was 88.7%. The basic sample information is as follows (shown in Table 1): the participants include 472 male students and 415 female students with an average age of 20.91 ± 1.39 years, height of 172.19 ± 8.08 cm, weight of 65.88 ± 11.36 kg, and Body Mass Index (BMI) of 22.13 ± 2.92. This effective recovery rate was 82%. Among them, there are 234 freshmen, 322 sophomores, 245 juniors, and 197 seniors. The individual BMI values were converted according to BMI formula: BMI = weight (kilograms)/height (square meters). According to college students' physical fitness BMI standard published by the Ministry of Education (Chen et al., 2019), the authors divided them into three groups by BMI: lightweight group (BMI < 20 kg/m^2) with 217 samples, normal-weight group (BMI = 20–25 kg/m^2) with 486 samples, and overweight group (BMI > 25 kg/m^2) with 184 samples.

Research methods

Questionnaire survey

This is a descriptive study with a structured questionnaire as the research tool, and all data are obtained from questionnaires. To ensure the preciseness and effectiveness of the research, a two-stage questionnaire survey approach was employed. Specifically, the procedure involved generating a preliminary draft based on the content of the research and the reference to a large number of research documents. Subsequently, a small-scale survey involving 200 participants was conducted, during which normality distribution, reliability analysis, and exploratory factor analysis were examined. Items with minimal contribution were eliminated, followed by structural model validation. Finally, the questionnaire is divided into five parts.

TABLE 1 Basic information of the sample (N = 887).

		n	%
Gender	Male	472	53.21
	Female	415	46.79
Grade	Freshmen	234	26.38
	Sophomore	211	23.79
	Junior	245	27.62
	Senior	197	20.74
BMI	Lightweight group	217	24.46
	Normal-weight group	486	54.79
	Overweight group	184	20.74

The average age is 20.91 ± 1.39 years, height of 172.19 ± 8.08 cm, weight of 65.88 ± 11.36 kg.

(1) Personal background information: This component covers the basic background information on the subject's gender, grade, height, weight, BMI, etc.
(2) Body image scale: Mainly refers to the Multidimensional Body-Self Relations Questionnaire (MBSRQ) edited by Cash et al. with a total of 37 items (Cash et al., 1990). The scale is compiled by the Likert five-point scale. The options "Totally Agree," "Very Agree," "Not Sure," "Very Disagree," and "Totally Disagree" count as 5, 4, 3, 2, and 1 scores, respectively. The higher the total scores, the more positive is the perceived body image. The verification results of the measurement model of the scale are as follows: the parameter values of $X^2/DF = 1.539$; Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Incremental Fit Index (IFI), Goodness-of-Fit Index (GFI), and Root Mean Square Error of Approximation (RMSEA) are 0.945, 0.981, 0.987, 0.971, 0.976, and 0.049, respectively, which meets the acceptable standards and shows that the model fits well with the data obtained from the survey, and the scale has a good structure validity. The three dimensions are composed of physical fitness evaluation, weight concern, appearance adaptation, appearance evaluation, and health evaluation. Cronbach's α values of the whole-body image scale and all its dimensions are greater than 0.70 (0.79–0.91), which fully confirms the good reliability of the scale. Therefore, the body image scale has good reliability and validity.
(3) Self-efficacy scale: Mainly refers to the General Self Efficacy Scale (GSES) complied by Wang et al. (2001) with a total of 10 questions. The options "Totally Wrong," "Basically Right," "Almost Right," and "Absolutely Right" count as 1, 2, 3, and 4 scores, respectively. The higher the total scores, the better is the general self-efficacy of an individual. The verification results of the measurement model of the scale are as follows: the parameter values of $X^2/DF = 1.609$; AGFI, CFI, TLI, IFI, GFI, and RMSEA are 0.931, 0.928, 0.962, 0.954, 0.946, and 0.036, respectively, which meets the acceptable standards and shows that the scale has a good structure validity. Cronbach's α values of the whole self-efficacy scale are equal to 0.82, which fully confirms the good reliability of the scale. Therefore, the self-efficacy scale has good reliability and validity.
(4) Self-esteem scale: Mainly refers to the Self-esteem Scale complied by Rosenberg (Tian, 2006), and translated and revised to get 10 questions finally. The four options from "Totally Disagree," to "Totally Agree" count as 1 to 4 scores, respectively, in which questions 2, 5, 6, 8, and 9 are reversed questions and will be scored in reverse. The verification results of the measurement model of the scale are as follows: the parameter values of $X^2/DF = 1.639$; AGFI, CFI, TLI, IFI, GFI, and RMSEA are0.943, 0.991, 0.980, 0.991, 0.979, and 0.051, respectively, which meets

the acceptable standards and shows that the scale has a good structure validity. The two dimensions are composed of self-acceptance and self-negation. Cronbach's α values of the whole self-esteem scale and all its dimensions are greater than 0.70 (0.74–0.80), which fully confirms the good reliability of the scale. Therefore, the self-esteem scale has good reliability and validity.

(5) Weight-loss intention scale: The weight-loss motivation subscale in the eating disorder inventory (EDI) adapted from Garner et al. (1983), with an additional statement from the author ("I am willing to lose weight"), totaling 6 questions. The subject expressed his/her weight-loss intention by scoring Likert five-level interval scale (5 = Strongly agree: 1 = Strongly disagree). The higher the score was, the stronger the weight-loss intention would be represented. The verification results of the measurement model of the scale are as follows: the parameter values of $X^2/DF = 1.561$; AGFI, CFI, TLI, IFI, GFI, and RMSEA are 0.997, 0.994, 0.981, 0.992, 0.997, and 0.026, respectively, which meets the acceptable standards and shows that the scale has a good structure validity. Cronbach's α values of the whole weight-loss intention scale are 0.73, which fully confirms the good reliability of the scale. Therefore, the weight-loss intention scale has good reliability and validity.

Statistical analysis

Data obtained in this study was analyzed using SPSS19.0 and AMOS 21.0 software packages. The statistical methods included descriptive statistics, Kolmogorov–Smirnov test, reliability analysis, exploratory factor analysis, Harman single factor test, correlation analysis, structural equation model, Bootstrap analysis, etc. The significance level of all variables was set as $\alpha = 0.05$.

To ensure the rigor of the research, before data analysis began, it was necessary to test the normal distribution of all variables in the pre-test and formal test. By using the Kolmogorov–Smirnov Test, it was determined that all the continuous variables in the pre-test and normal test conformed to a normal distribution (All the p values were significantly higher than 0.05).

This research uses Harman single-factor test to test the possible common method biases. The results show that the characteristic roots of a total of 14 factors are greater than 1, among which the largest factor explained variance is 21.11%, far from the critical standard of 40%. The research is less likely to be affected by common method biases, which is within the acceptable range.

Results

Related analysis on college students' body image, self-efficacy, self-esteem, and weight-loss intention

Pearson correlation was used to analyze the correlation coefficients among body image, self-esteem, self-efficacy, and weight-loss intention (see Table 2). The results show that in the structure of physical fitness evaluation, appearance adaptation, appearance evaluation, weight concern, health evaluation, and self-esteem, self-acceptance and self-negation are positively correlated. Additionally, in this structure both self-acceptance and self-negation are all positively correlated with self-efficacy. However, self-acceptance and self-negation are all negatively correlated with weight-loss intention, while self-efficacy is inversely correlated with weight-loss intention. Furthermore, correlation analyses between demographic variables and research variables reveal that gender, grade, and BMI show no significant correlations with the variables of this research. Therefore, they are not controlled for in the hypothesis testing process. The results of the correlation analyses provide the foundation for testing subsequent hypotheses.

Model validation analysis of college students' body image, self-efficacy, self-esteem, and weight-loss intention

To investigate the relationship between body image and self-esteem, self-efficacy, and weight-loss intention and examine the intermediary role of self-esteem and self-efficacy and according to the intermediary effect testing process proposed by Wen and Ye (2014), this research adopts AMOS to make a structural equation model analysis on the relationship among body image, self-efficacy, self-esteem, and weight-loss intention. Take for example Figure 1 after the model has been modified, and the model fit indexes are: $X^2/DF = 1.304 < 2.000$, $CFI = 0.998$, $GFI = 0.994$, $AGFI = 0.984$, $TLI = 0.995$, and $IFI = 0.998$, all of which are >0.900 and $RMSEA = 0.019 < 0.080$, showing that the model can be built up.

From the findings, it is evident that from the standardized path coefficient β and significance level in the mixed model structure in Figure 1 that body image has a significantly positive predictive effect on self-efficacy and weight-loss intention ($\beta = 0.36^{***}$, $p < 0.001$; $\beta = 0.33^{***}$, $p < 0.001$), while body image has a significantly negative predictive effect on weight-loss intention ($\beta = -0.12^{**}$, $p < 0.01$). Additionally, both self-efficacy and self-esteem demonstrate significant negative predictive effects on weight loss intentions ($\beta = -0.19^{***}$, $p < 0.001$; $\beta = -0.36^{***}$, $p < 0.001$, respectively). Moreover, self-efficacy positively predicts self-esteem significantly ($\beta = -0.30^{***}$, $p < 0.001$). To verify the intermediary effect of self-efficacy and self-esteem on body image and weight-loss intention, the research adopts a non-parametric percentile Bootstrap process to make a significance test on intermediary effect. Five thousand samples were taken repeatedly from the original data to calculate a 95% Confidence Interval (CI). If the standardized path coefficient 95% CI does not include 0, that means the intermediary effect is significant. The 95% CI of the chained intermediary effect of body image from self-efficacy, self-esteem, to weight-loss intention is from −0.049 to −0.020; that of body image from self-efficacy to weight-loss intention is from −0.099 to −0.047; that of body image from self-esteem to weight-loss intention is from −0.152 to −0.076. The three intervals mentioned earlier do not include 0, which shows each intermediary effect is significant. Further decomposing the effects of each variable on weight-loss intention, as shown in Table 3, the direct effect of body image on weight-loss intention is −0.120. The total intermediary effect (−0.226) is the sum of the intermediary effects of the three paths, which represents the total indirect effect. The sum of the direct effect and the total intermediary effect is the total effect, which is −0.346. The effect sizes of the three intermediary paths in this research are

TABLE 2 Related analysis on college students' body image, self-efficacy, self-esteem, and weight-loss intention ($N = 887$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$).

	$M \pm SD$	Gender	Grade	BMI	PFE	AD	AE	WC	HE	SA	SN	SE	WLI
Gender	–	1.00											
Grade	–	0.01	1.00										
BMI	22.13 ± 2.92	0.01	0.02	1.00									
PFE	29.20 ± 9.90	0.03	0.04	0.03	1.00								
AD	10.71 ± 4.08	0.04	0.01	0.01	0.57***	1.00							
AE	13.62 ± 5.27	−0.03	0.02	0.01	0.53***	0.48***	1.00						
WC	10.62 ± 3.95	−0.02	0.03	0.03	0.52***	0.47***	0.54***	1.00					
HE	13.31 ± 4.01	0.01	0.01	0.04	0.43***	0.49***	0.46***	0.54***	1.00				
SA	13.11 ± 2.89	0.01	0.03	0.03	0.23***	0.25***	0.33***	0.19***	0.25***	1.00			
SN	15.63 ± 2.84	0.01	0.02	0.01	0.22***	0.21***	0.24***	0.23***	0.17***	0.55***	1.00		
SE	24.91 ± 5.68	−0.02	0.03	0.01	0.27***	0.24***	0.22***	0.29***	0.28***	0.31***	0.30***	1.00	
WLI	13.90 ± 5.72	0.04	0.03	0.01	−0.28***	−0.20***	−0.35***	−0.24***	−0.26***	−0.33***	−0.39***	0.37***	1.00

PFE, physical fitness evaluation; AD, appearance adaptation; AE, appearance evaluation; WC, weight concern; HE, health evaluation; SA, self-acceptance; SN, self-negation; SE, self-efficacy; WLI, weight-loss intention.

calculated by dividing each intermediary effect value by the total effect. They are 10.98, 19.94, and 34.39%, respectively.

Discussion

Influence of body image on weight-loss intention

This research finds that body image has a significantly negative predictive effect on weight-loss intention. This result indicates that individuals with more positive body image tend to have lower weight-loss intention, which is consistent with the findings of scholars such as Sun et al. (2017) and Liu et al. (2019). Related research suggests that college students are easily exposed to social and cultural pressure and tend to internalize the ideal images promoted by the media, using these media standards as their own. Excessive exposure to ideal body image can lead to lower body image satisfaction. Those who do not meet these standards are likely to develop varying degrees of weight-loss intention and engage in weight-loss behaviors (e.g., dieting, taking weight-loss products, excessive exercise) to conform to these standards (Hou and Lu, 2008; Wei et al., 2012; Kvardova et al., 2020; Marks et al., 2020). In addition, influenced by factors such as family, peers, and media, weight-loss behaviors have become a trend and fashion. Slim and slender figures are highly favored and acknowledged by adolescents, leading them to adopt various weight-loss methods in pursuit of the ideal slim body shape. However, unreasonable weight-loss methods can cause both physical and psychological harm to adolescents. Furthermore, some scholars argue that adolescents tend to have a cognitive bias between actual body weight and ideal body weight. They often perceive their actual body weight to be heavier than their ideal body weight, leading to a heightened focus on appearance and the pursuit of a rational slim body shape and body image. This ultimately results in a decrease in adolescents' body image and an increase in obesity anxiety (Sun et al., 2013; Cao et al., 2014; Huang and Liu, 2019). Liu et al. (2019) also believed that body image can negatively predict the degree of weight-loss intention among college students. The lower college students' satisfaction with their body image, the higher their weight-loss intention. Therefore, body image is an important factor influencing the degree of weight-loss intention among college students, and there is a negative predictive effect between body image and weight-loss intention.

Intermediary effect of self-efficacy

This research finds that body image has a significant positive effect on self-efficacy. This result indicates that people with more positive body image tend to have higher self-efficacy, whereas those with more negative body image tend to have lower self-efficacy. This result is basically consistent with the findings of the research of Stockton et al. (2009) and Ouyang et al. (2020). Meanwhile, studies have also confirmed that college students' body image can positively predict the level of self-efficacy, and the more positive the body image of college students, the higher their self-efficacy (Wu et al., 2006; Annesi, 2019). This study also finds that self-efficacy has a significant negative effect on the weight-loss intention, which indicates that the higher the self-efficacy of college students, the lower the weight-loss intention. Indeed, it proves the research findings of Annesi, Hopkins and Robertson that there is a significant negative correlation between self-efficacy and weight-loss intention, with college students who have higher self-efficacy tending to have lower weight-loss intention, and those with lower self-efficacy tending to have higher weight-loss intention (Annesi, 2018; Hopkins and Bennett, 2018; Robertson et al., 2020). This study also finds that body image can negatively affect weight-loss intention both directly and indirectly through the intermediary effect of self-efficacy, indicating that a positive body image can enhance one's cognitive evaluation of their body, thus promoting self-efficacy among college students (Zhang et al., 2015). As self-efficacy increases, individuals tend to have more positive self-evaluations, effectively improving college students' perceptions and evaluations of their own body image, leading to increased self-acceptance and subsequently reducing weight-loss intention (Annesi and Mareno, 2015; Pan and Peña, 2017; Talleyrand et al., 2017; Soheila et al., 2018; Ouyang et al., 2021). Therefore, body image can influence weight-loss intention through self-efficacy.

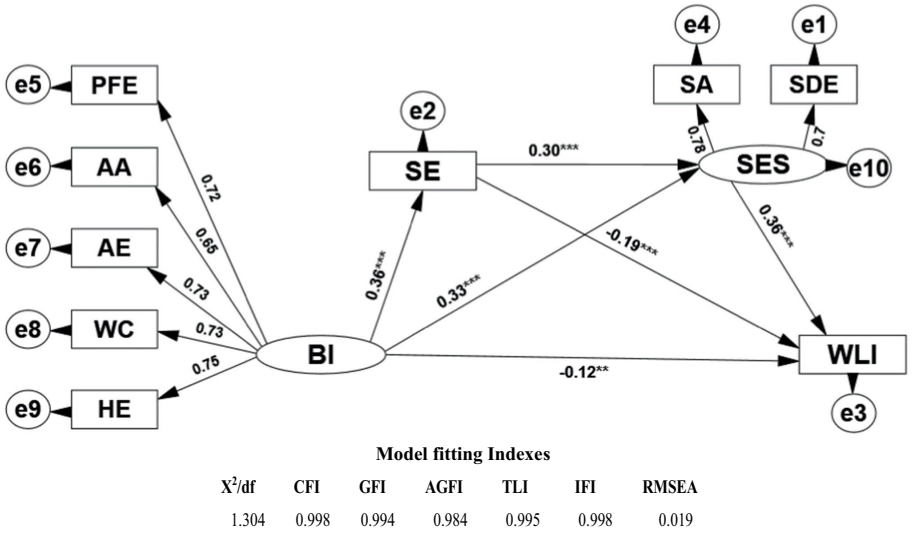


FIGURE 1
Path analysis diagram and model fit test of body image, self-efficacy, self-esteem, and weight-loss intention. PFE, physical fitness evaluation; AD, appearance adaptation; AE, appearance evaluation; WC, weight concern; HE, health evaluation; SA, self-acceptance; SN, self-negation; SE, self-efficacy; WLI, weight-loss intention; BI, Body image; SES, self-esteem; SE, self-efficacy.

TABLE 3 Path and effect decomposition table of body image on weight-loss intention.

Effect	Path relationship	Effect size	Bootstrap SE	Bootstrap 95%CI	Relative intermediary effect (%)
Direct effect	Body image→weight-loss intention	−0.120	0.026	[−0.175, −0.071]	34.68
Indirect effect	Body image→self-efficacy→self-esteem→weight-loss intention	−0.038	0.007	[−0.049, −0.020]	10.98
	Body image→self-efficacy→weight-loss intention	−0.069	0.013	[−0.099, −0.047]	19.94
	Body image→self-esteem→weight-loss intention	−0.119	0.019	[−0.152, −0.076]	34.39
Total intermediary effect		−0.226	0.031	[−0.280, −0.156]	65.32

In conclusion, combined with the Bootstrap test program for intermediary effect, the first hypothesis that self-efficacy plays an intermediary role between body image and weight-loss intention is true. Therefore, in order to promote the correct and positive body image, college students can not only directly improve their weight-loss intention, but also indirectly affect their weight-loss intention through increasing self-efficacy.

Intermediary effect of self-esteem

This research finds that body image has a significant positive effect on self-esteem, indicating that the more positively individuals perceive their body image, the higher their self-esteem tends to be, and vice versa. This is consistent with the findings of Borges, Guo, Peng, and Zheng: body image has a significant positive predictive effect on self-esteem (Borges et al., 2010; Guo et al., 2017; Peng et al., 2017; Zheng et al., 2019). Scholars such as Kamody, Koronczai, Leng and Zhang argue that adolescent body image is a crucial factor influencing self-esteem (Koronczai et al., 2013; Zhang et al., 2015; Kamody et al., 2018; Leng et al., 2020). Moreover, body image serves as a reliable predictor of both physical self and self-esteem. Positive body image tends to be associated with a heightened sense of body value and positive emotions, which can enhance adolescents' self-esteem, confidence, and self-acceptance. Conversely, negative body image is linked to a diminished sense of body value and extreme depressive emotions, leading to lower self-esteem, lack of confidence, and self-negation. Furthermore, college students are more likely to be influenced by societal values, the importance they place on certain issues, and evaluations. Excessive societal promotion of ideal body standards increases their focus on body shape, leading to an imbalance between their body expectations and reality, resulting in negative emotions and low self-esteem (Christine et al., 2020; Ouyang et al., 2023). This study also finds a significant negative impact of self-esteem on weight-loss intention. Individuals with low self-esteem tend to pay more attention to their body shape, leading to stronger weight-loss intentions. Conversely, those with high self-esteem feel more confident and acceptive of their body shape, resulting in reduced weight-loss intention. These research results have just proved those of Bruin, Lai, and Lei, who suggest that self-esteem is an emotional evaluation individuals have of themselves, serving

as a crucial factor in predicting the implementation of health behaviors (Lei et al., 2005; Lai et al., 2006; Bruin et al., 2009). Research also suggests that self-esteem is a crucial factor in mitigating weight-loss intention among college students. Those with high self-esteem are more confident in their body shape, which reduces their weight-loss intention, whereas those with low self-esteem are less confident and thus have a stronger weight-loss intention. Therefore, the level of self-esteem in college students can effectively reflect the degree of their weight-loss intention (Margaret et al., 2017; Cao and Zhang, 2018; Kamody et al., 2018; Christine et al., 2020; Selensky and Carels, 2021). This study also finds that body image can indirectly influence weight-loss intention through the intermediary effect of self-esteem. Klomsten and Lian agree that body image is the most powerful predictor of overall self-esteem that in turn negatively impacts weight-loss intention (Lian, 2012; Koronczai et al., 2013). Meanwhile, research has also confirmed that an increasing number of college students, due to dissatisfaction with their body shape, often experience depression, anxiety, and negative body image, which leads to a decrease in self-esteem. This dissatisfaction drives them to alter their body image to align with current esthetic standards, thereby increasing their weight-loss intention (Yigiter, 2014). Conversely, college students with a more positive body image typically have higher self-esteem and lower weight-loss intention (Margaret et al., 2017; Peng et al., 2017; Christine et al., 2020; Selensky and Carels, 2021). Therefore, body image can influence weight-loss intention through self-esteem.

In conclusion, combined with the Bootstrap test program for intermediary effect, the second hypothesis that self-esteem plays an intermediary role between body image and weight-loss intention is true. Positive body image among college students can enhance self-esteem, and stable self-esteem plays a crucial role in inhibiting weight-loss intention. Therefore, in addition to directly improving weight-loss intention, body image can also indirectly influence them by increasing self-esteem.

Chained intermediary effect of self-efficacy and self-esteem

This research shows through the results of the Bootstrap test program for the intermediary effect that body image can affect college students' weight-loss intention through self-efficacy, which affects through part of the intermediary effect of self-esteem. This verifies Hypothesis 3 that self-efficacy and self-esteem play a chained intermediary role between body image and weight-loss intention, showing that individuals with lower body image are more likely to have lower self-efficacy, leading to lower self-esteem and even self-negation in promoting the college students' weight-loss intention. On the contrary, individuals with higher body image tend to enhance self-efficacy among college students, thereby boosting self-esteem and fostering a stronger self-acceptance, which in turn can effectively suppress weight-loss intention among college students. As previous research has already confirmed, both self-efficacy and self-esteem serve as mediators between body image and weight-loss intention. Furthermore, previous studies have proved the correlation between self-efficacy and self-esteem, indicating that higher levels of self-efficacy positively influence an individual's self-esteem, while lower levels of self-efficacy may hinder it (Wang et al., 2016; Ouyang et al., 2021). Additionally, scholars have found (Nock et al., 2016; Ouyang et al., 2023; Pyykkö et al., 2023) that as college students' self-efficacy increases, it positively promotes their self-esteem, which in turn reduces weight-loss intention. This supports the fact that an improvement in body image among college students can enhance their self-efficacy, leading to stronger self-esteem and a subsequent reduction in weight-loss intention. Conversely, a decline in body image has the opposite effect. Therefore, college students' body image negatively impacts their weight-loss intention through the chain mediation effect of self-efficacy and self-esteem.

In conclusion, body image can directly impact weight-loss intention, as well as indirectly influence them through the intermediary effects of self-efficacy, self-esteem, and the chained intermediary effect of self-efficacy and self-esteem. These findings provide theoretical foundations for establishing a positive body image among college students. Meanwhile, they offer important practical insights for promoting self-efficacy and self-esteem, and reducing unhealthy weight-loss behaviors among college students.

Conclusion and limitation

Conclusion

Body image has a significantly positive correlation on self-efficacy and self-esteem, and has a significantly negative correlation on weight-loss intention; self-efficacy has a significantly positive correlation on self-esteem, and has a significantly negative correlation on weight-loss intention, and self-esteem has a significantly positive correlation on weight-loss intention; meanwhile, self-efficacy and self-esteem can have an intermediary effect on body image and weight-loss intention, and "self-efficacy + self-esteem" also have a chained intermediary effect on body image and weight-loss intention.

Limitation

There are still some limitations in this study. Firstly, this study is cross-sectional, meaning it cannot determine causal relationships between variables or establish temporal order. Compared to longitudinal data, this approach might lead to different estimates and conclusions. Therefore, future research could use longitudinal tracking studies to explore clearer causal relationships between variables and address these issues, aiding in further testing of the chain mediation model proposed in this study. Secondly, this study did not specifically screen college students for obesity (whether they are seeking treatment), depressive symptoms, or eating disorders, but it is hoped that future research can aim to address these limitations to provide a more comprehensive understanding. Finally, numerous factors influence undergraduates' weight-loss intention. The effects of body image, self-efficacy and self-esteem on weight-loss intention are the only ones which are considered in this study. It is hoped that more external or psychological factors are supported to be used to explore the weight loss issue of undergraduates in the future, in purpose to help them develop healthy and confident lifestyles.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Ethics Committee of Southwest University Hospital. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

OY: Writing – original draft, Writing – review & editing. XX: Writing – original draft, Writing – review & editing. LJ: Writing – original draft, Writing – review & editing. ZY: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This study was supported by the Planning Project of Humanities and Social Sciences Granted by Chongqing Education Commission of China (23SKGH110), and the Scientific Research Project Granted by Chongqing Sports Bureau of China (A202323).

Conflict of interest

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

Publisher's note

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

References

Andrew, R., Tiggemann, M., and Clark, L. (2016). Positive body image and young women's health: implications for sun protection, cancer screening, weight loss and alcohol consumption behaviours. *J. Health Psychol.* 21, 28–39. doi: 10.1177/1359105314520814

Annesi, J. (2018). Moderating effects of depression, food cravings, and weight-related quality-of-life on associations of treatment-targeted psychosocial changes and physical activity in adolescent candidates for bariatric surgery [article]. *J. Phys. Act. Health* 15, 946–953. doi: 10.1123/jpah.2018-0099

Annesi, J. J. (2019). Exercise effects on mood, and its associations with self-regulatory skills, self-efficacy, and eating changes during the year following weight-loss treatment. *Women Health* 59, 687–701. doi: 10.1080/03630242.2018.1544968

Annesi, J. J., and Mareno, N. (2015). Improvement in emotional eating associated with an enhanced body image in obese women: mediation by weight-management treatments' effects on self-efficacy to resist emotional cues to eating. *J. Adv. Nurs.* 71, 2923–2935. doi: 10.1111/jan.12766

Borges, G., Benjet, C., Medina-Mora, M. E., and Miller, M. (2010). Body mass index and its relationship to mental disorders in the Mexican adolescent mental health survey. *Salud Publica Mex.* 52, 103–110. doi: 10.1590/S0036-36342010000200001

Bruin, A. P., Woertman, L., Bakker, F. C., and Oudejans, R. R. D. (2009). Weight-related sport motives and girls' body image, weight control behaviors, and self-esteem. *Sex Roles* 60, 628–641. doi: 10.1007/s11199-008-9562-8

Cao, D. S., Lu, Y., Lei, J. P., Mao, C. M., and Yao, Y. P. (2014). Appearance preoccupation, appearance self-evaluation, obesity anxiety, self-classified weight and drive for thinness among adolescents. *Chin. Ment. Health J.* 28, 356–360. doi: 10.3969/j.issn.1000-6729.2014.05.007

Cao, X. T., and Zhang, L. H. (2018). Chain mediating effect of regulatory emotional self-efficacy and self-control between self-esteem and aggressiveness in adolescents. *Chin. Ment. Health J.* 32, 574–579. doi: 10.3969/j.issn.1000-6729.2018.07.007

Cash, T. F., Counts, B., and Huffine, C. E. (1990). Current and vestigial effects of overweight among women: fear of fat, attitudinal body image, and eating behaviors. *J. Psychopathol. Behav. Assess.* 12, 157–167. doi: 10.1007/BF00960765

Chen, H. B., Yu, S. Y., Bai, G. B., and Lv, X. F. (2019). A cross-sectional historical study of the physical health changing trends of the freshmen at Xidian University between 2006 and 2016. *J. Phys. Educ.* 26, 116–122. doi: 10.16237/j.cnki.cn44-1404/g8.20190606.006

Christine, S. B., Andreas, S., Jan, H. R., Gunn, P., Oddgeir, F., Jorunn, S. B., et al. (2020). The norwegian healthy body image intervention promotes positive embodiment through improved self-esteem - sciencedirect. *Body Image* 35, 84–95. doi: 10.1016/J.BODYIM.2020.08.014

Garner, D. M., Olmstead, M. P., and Polivy, J. (1983). Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *Int. J. Eat. Disord.* 2, 15–34. doi: 10.1002/1098-108X(198321)2:2<15::AID-EAT2260020203>3.0.CO;2-6

Gillen, M. M. (2015). Associations between positive body image and indicators of men's and women's mental and physical health. *Body Image* 13, 67–74. doi: 10.1016/j.bodyim.2015.01.002

Guo, Q. G., Luo, J., Sang, M. L., and Xie, H. D. (2017). Influence of self-esteem and body image on sports participation in students. *J. Xi'an Phys. Educ. Univ.* 34, 730–738. doi: 10.16063/j.cnki.issn1001-747x.2017.06.015

Hopkins, C. M., and Bennett, G. G. (2018). Weight-related terms differentially affect self-efficacy and perception of obesity [article]. *Obesity* 26, 1405–1411. doi: 10.1002/oby.22255

Hou, X. Y., and Lu, H. Y. (2008). The determinants of body dissatisfaction and the influence of body dissatisfaction on weight-loss intention: a study on Taiwanese female college students. *J. Health Promot. Health Educ.* 44, 119–138. doi: 10.7022/jhphe.200806.0119

Huang, H. Y., and Liu, J. X. (2019). Factors related to the effectiveness of weight loss among the members of a nutrition counseling center. *J. Health Promot. Health Educ.* 43, 1–21. doi: 10.6345/THE.NTNU.DHPHE.034.2018.F02

Huang, X. Y., Ye, S. R., and Yang, W. H. (2014). Research on relations of body mass index, body image, intention to lose weight and movement behavior of college students. *NCYU Phys. Educ. Health Recreat. J.* 13, 1–12. doi: 10.6169/ncyujpehr.13.1.01

Hülya, A. F., Macide, T., and Koca, C. (2006). An examination of eating attitudes and physical activity levels of Turkish university students with regard to self-presentational concern. *Eat. Behav.* 7, 362–367. doi: 10.1016/j.eatbeh.2005.11.011

Jessor, R. (1987). Problem-behavior theory, psychosocial development, and adolescent problem drinking. *Br. J. Addict.* 82, 331–342. doi: 10.1111/j.1360-0443.1987.tb01490.x

Kamody, R. C., Thurston, I. B., Decker, K. M., Kaufman, C. C., Sonneville, K. R., and Richmond, T. K. (2018). Relating shape/weight based self-esteem, depression, and anxiety with weight and perceived physical health among young adults [article]. *Body Image* 25, 168–176. doi: 10.1016/j.bodyim.2018.04.003

Klomsten, A. T., Skaalvik, E. M., and Espnes, G. A. (2004). Physical self-concept and sports: do gender differences still exist? *Sex Roles* 50, 119–127. doi: 10.1023/B:SERS.0000011077.10040.9a

Koronczai, B., Kökönyei, G., Urbán, R., Kun, B., Pápay, O., Nagygyörgy, K., et al. (2013). The mediating effect of self-esteem, depression and anxiety between satisfaction with body appearance and problematic internet use. *Am. J. Drug Alcohol Abuse* 39, 259–265. doi: 10.3109/00952990.2013.803111

Kvardova, N., Machackova, H., and Smahel, D. (2020). The direct and indirect effects of online social support, neuroticism, and web content internalization on the drive for thinness among women visiting health-oriented websites. *Int. J. Environ. Res. Public Health* 17:2416. doi: 10.3390/ijerph17072416

Lai, X. R., Li, B. X., Wu, D. M., Zhao, G. X., Lv, C. M., Zhuo, J. C., et al. (2006). A study of the relationships among self-esteem, body-image and exercise behavior of junior high school students in Taipei city. *J. Health Educ.* 25, 73–103. doi: 10.7022/jhe.200606.0073

Lei, L., Wang, J. P., Zhang, L., Bi, Y., and Chen, W. (2005). Predictors of drive for thinness in female college students in Beijing. *Chin. Ment. Health J.* 12, 152–155. doi: 10.3321/j.issn:1000-6729.2005.03.002

Leng, X. C., Chen, H., Shi, P., Zhang, Y., Rexiatijiang, K., and Bian, Z. M. (2020). The impact of physical appearance perfectionism on female college students' restrained eating: a chain mediating model. *Chin. J. Clin. Psych.* 28, 799–803. doi: 10.16128/j.cnki.1005-3611.2020.04.031

Lian, S. J. (2012). Television viewing, BMI, self-esteem, internalization and college women's perceptions of baby image. *J. Nat. Taiwan Coll. Arts*. 90, 141–166. doi: 10.6793/jntca.201204.0141

Liao, H. P., Yan, X. B., and Zhang, H. (2019). Impact of political skills and self-efficacy on occupational adaptability: the intermediary roe of self-esteem. *J. Psychol. Sci.* 42, 144–149. doi: 10.16719/j.cnki.1671-6981.20190122

Lin, H. L., and Lin, H. Z. (2016). The correlation between body shape perception, exercise participation and eating attitudes of female college students. *Tamkang J. Phys. Educ.* 19, 51–63. doi: 10.6976/tjpe.201611_(19).0005

Liu, T. O., Wang, J. M., Ouyang, Q., and Qin, Y. M. (2019). Relationship between weight loss intention and body satisfaction conformity behavior among college students in 4 universities in Wuhan. *Chinese J. Health Educ.* 35, 208–211. doi: 10.16168/j.cnki.issn.1002-9982.2019.03.004

Margaret, M., Dordevic, A. L., and Bonham, M. P. (2017). Systematic review and meta-analysis: the impact of multicomponent weight management interventions on self-esteem in overweight and obese adolescents. *J. Pediatr. Psychol.* 42, 379–394. doi: 10.1093/jpepsy/jsw101

Marks, R. J., Foe, A. D., and Collett, J. (2020). The pursuit of wellness: social media, body image and eating disorders. *Child Youth Serv. Rev.* 119:105659. doi: 10.1016/j.childyouth.2020.105659

Nock, N. L., Ievers-Landis, C. E., Dajani, R., Knight, D., Rigda, A., Narasimhan, S., et al. (2016). Physical activity self-efficacy and fitness: family environment relationship correlates and self-esteem as a mediator among adolescents who are overweight or obese. *Child. Obes.* 12, 360–367. doi: 10.1089/chi.2016.0007

Ouyang, Y. Y., Luo, J., Teng, J. S., Zhang, T. R., Wang, K., and Li, J. (2021). Research on the influence of media internalized pressure on college students' sports participation-chained intermediary analysis of social physique anxiety and weight control self-efficacy. *Front. Psychol.* 12:654690. doi: 10.3389/fpsyg.2021.654690

Ouyang, Y. Y., Peng, J., Luo, J., Jinsheng, T., Kun, W., and Jing, L. (2023). Effects of short-video use on undergraduates' weight- loss intention: a regulatory mediation model. *Curr. Psychol.* 42, 25206–25217. doi: 10.1007/s12144-022-03611-z

Ouyang, Y. Y., Wang, K., Zhang, T. R., Peng, L., Song, G., and Luo, J. (2020). The influence of sports participation on body image, self-efficacy, and self-esteem in college students. *Front. Psychol.* 10:3039. doi: 10.3389/fpsyg.2019.03039

Pan, W., and Peña, J. (2017). The exposure effects of online model pictures and weight-related persuasive messages on Women's weight-loss planned behaviors [article]. *J. Health Commun.* 22, 858–865. doi: 10.1080/10810730.2017.1367339

Peng, X. T., Chen, Y. J., and Zhu, X. W. (2017). Effect of social network site appearance comparison on depression:the chain mediating role of body image satisfaction and self-esteem. *Chin. J. Clin. Psych.* 25, 959–962+958. doi: 10.16128/j.cnki.1005-3611.2017.05.036

Pyykkö, J. E., Hinnen, C., Aydin, Ö., Nieuwdorp, M., De Brauw, L. M., Bruin, S. C., et al. (2023). Attachment style and post-bariatric surgery health behaviours: the mediating role of self-esteem and health self-efficacy. *BMC Psychol.* 11:248. doi: 10.1186/s40359-023-01273-5

Robertson, M. C., Green, C. E., Liao, Y., Durand, C. P., and Basen-Engquist, K. M. (2020). Self-efficacy and physical activity in overweight and obese adults participating in a worksite weight loss intervention: multistate modeling of wearable device data [article]. *Cancer Epidemiol. Biomarkers Prev.* 29, 769–776. doi: 10.1158/1055-9965.Epi-19-0907

Selensky, J. C., and Carels, R. A. (2021). Weight stigma and media: an examination of the effect of advertising campaigns on weight bias, internalized weight bias, self-esteem, body image, and affect. *Body Image* 36, 95–106. doi: 10.1016/j.bodyim.2020.10.008

Soheila, R., Shiva, J., Arezou, T., Ramona, R., and Atefeh, Y. (2018). How does obesity, self-efficacy for eating control and body image in women affect each other? *Maedica* 13, 223–228. doi: 10.26574/maedica.2018.13.3.223

Stockton, M. B., Lanctot, J. Q., McClanahan, B. S., Klesges, L. M., Klesges, R. C., Kumanyika, S., et al. (2009). Self-perception and body image associations with body mass index among 8-10-year-old African American girls. *J. Pediatr. Psychol.* 34, 1144–1154. doi: 10.1093/jpepsy/jsp023

Sun, L. P., Sun, X., Ma, L. Y., Zhang, J. H., Chai, J. X., and Mei, S. L. (2017). Study on the relationship of body satisfaction and the intention of weight loss among college students. *Chin. J. School Health* 38, 364–366. doi: 10.16835/j.cnki.1000-9817.2017.03.014

Sun, Q. Q., Zheng, L. J., and Zheng, Y. (2013). Sexual objectification and women's self-objectification. *Adv. Psychol. Sci.* 21, 1794–1802. doi: 10.3724/SP.J.1042.2013.01794

Talleyrand, R. M., Gordon, A. D., Daquin, J. V., and Johnson, A. J. (2017). Expanding our understanding of eating practices, body image, and appearance in African American women: a qualitative study [article]. *J. Black Psychol.* 43, 464–492. doi: 10.1177/0095798416649086

Tian, L. M. (2006). Shortcoming and merits of Chinese version of Rosenberg(1965) self-esteem scale. *Psychol. Explor.* 2, 88–91. doi: 10.3969/j.issn.1003-5184.2006.02.020

Wang, C. K., Hu, Z. F., and Liu, Y. (2001). Evidences for reliability and validity of the Chinese version of general self-efficacy scale. *Chinese J. Appl. Psychol.* 7, 37–40. doi: 10.3969/j.issn.1006-6020.2001.01.007

Wang, Y. H., Lv, Z. Y., Chen, H., Wu, S. S., and Xiao, Z. L. (2016). Body image disturbance among males: the influence and the hypothesized mechanism of mass media. *Adv. Psychol. Sci.* 24, 282–292. doi: 10.3724/SP.J.1042.2016.00282

Wang, Y. H., Xie, X. C., Chen, H., and Lei, L. (2017). Body image disturbance among females: the influence and the mechanism of social network sites. *Chin. J. Clin. Psych.* 25, 1079–1082+1087. doi: 10.16128/j.cnki.1005-3611.2017.06.018

Wei, W., Wang, J. P., Liang, Y., and Liu, D. Y. (2012). Influence of slimming advertisements on attentional bias of female individuals with body-image disturbance. *Chin. J. Clin. Psych.* 20, 457–460+456. doi: 10.16128/j.cnki.1005-3611.2012.04.003

Wen, Z. L., and Ye, B. J. (2014). Analysis of mediating effects: the development of methods and models. *Adv. Psychol. Sci.* 22, 731–745. doi: 10.3724/SP.J.1042.2014.00731

Wu, X. J., Yang, B., Li, S., Chang, S. Z., Wang, F. T., Tang, T. L., et al. (2006). The influence of body image and self-efficacy on exercise behavior of female college students. *J. Tianjin Univ. Sport* 13, 363–365. doi: 10.3969/j.issn.1005-0000.2006.04.025

Yigiter, K. (2014). A comparative study on American and Turkish students? Self esteem in terms of sport participation: a study on psychological health. *Educ. Res. Rev.* 9, 531–534. doi: 10.5897/ERR2014.1721

Zhang, L. M., Zhang, L. W., and Zhang, T. T. (2015). Research progress on the relationship between physical self and mental health. *Chinese J. Sports Med.* 34, 1180–1185. doi: 10.16038/j.1000-6710.2015.12.009

Zheng, X. L., Yu, Z. X., Wang, Z. Y., and Yuan, Q. X. (2019). The relationship between mindfulness and self-esteem of adolescents: the mediating effect of self-efficacy. *Chinese J. Behav. Med. Brain Sci.* 28, 793–796. doi: 10.3760/cma.j.issn.1674-6554.2019.09.006

Zhu, W., Du, Q. J., Yi, Y. L., and Zhang, Q. L. (2005). Correlation between body image and self-esteem in women of positive weight loss. *Chinese J. Tissue Eng. Res.* 9, 233–235. doi: 10.7666/d.y601033

frontiers | Frontiers in Nutrition

TYPE Systematic Review
PUBLISHED 03 September 2024
DOI 10.3389/fnut.2024.1466388

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
Cecilia Castillo,
Nutriologa Infantil, Chile
Dennis Gibson,
Denver Health Medical Center, United States

*CORRESPONDENCE
Sunny Cui
✉ sunny.work.2002@gmail.com

RECEIVED 17 July 2024
ACCEPTED 21 August 2024
PUBLISHED 03 September 2024

CITATION
Cui S (2024) A comprehensive review on the co-occurrence of scurvy and anorexia nervosa.
Front. Nutr. 11:1466388.
doi: 10.3389/fnut.2024.1466388

A comprehensive review on the co-occurrence of scurvy and anorexia nervosa

Sunny Cui*

Department of Biological Sciences, Dartmouth College, Hanover, NH, United States

Scurvy, a rare disease resulting from vitamin C deficiency, can occur in individuals with restrictive eating disorders like anorexia nervosa (AN), leading to severe health complications. This review explores the complex relationship between scurvy and AN, highlighting the overlapping symptoms and challenges in diagnosis and treatment. Vitamin C is essential for collagen synthesis, immune function, and neurotransmitter production, and its deficiency manifests as fatigue, gingival bleeding, joint pain, and perifollicular hemorrhages. AN exacerbates these symptoms through extreme food restriction, causing severe nutritional deficiencies. Analyzing nine case reports, this review reveals that patients with co-occurring AN and scurvy often present with gastrointestinal, psychiatric, and dermatological symptoms. Treatment with vitamin C supplementation typically results in rapid symptom improvement. However, the malnutrition inherent in AN complicates the clinical picture, making timely diagnosis and intervention crucial. This review underscores the importance of a comprehensive, multidisciplinary approach to managing these conditions, emphasizing the need for early recognition and treatment to prevent severe complications. Future research should include a more diverse patient population to enhance understanding of the interplay between AN and scurvy, aiming to improve patient outcomes through tailored treatment strategies.

KEYWORDS

vitamin deficiencies, scurvy, anorexia nervosa, eating disorders, vitamin C deficiency, diagnosis and treatment

1 Introduction

Scurvy is a rare condition resulting from a deficiency of vitamin C, also known as ascorbic acid. It was first identified in the 18th century by British naval surgeon James Lind, who discovered that citrus fruits could prevent and treat the disease among sailors (1, 2). Vitamin C serves as a cofactor in the biosynthesis of collagen, a structural protein essential for the maintenance and repair of connective tissues, including skin, blood vessels, bones, and cartilage (3). It acts as a reducing agent, donating electrons to specific enzymes that hydroxylate proline and lysine residues in procollagen (3). This hydroxylation allows stabilization and initiation of cross-linking in collagen fibers, providing tensile strength and structural integrity to tissues (3, 4). Therefore, the lack or weakened tensile strength of collagen fibers from vitamin C deficiency explains most of the symptoms observed in patients with scurvy. Moreover, vitamin C has a plethora of other auxiliary functions in the human body. It is involved in the synthesis of neurotransmitters, such as norepinephrine and serotonin, serving a cofactor for the enzymes dopamine β-hydroxylase and tryptophan hydroxylase (1, 3). Furthermore, vitamin C is required for the synthesis of carnitine, a transport molecule of fatty

acids into mitochondria for energy production (5). Vitamin C has antioxidant ability, protecting cells from damage by free radicals and regenerating other antioxidants like Vitamin E back to their active forms (2, 4). Finally, Vitamin C plays a role in immune function by stimulating production and function of white blood cells (6).

Early signs of scurvy include fatigue, malaise, and inflammation of the gums, progressing to more severe symptoms if untreated (1). Traditionally, scurvy is characterized by symptoms such as anemia, gingivitis, skin hemorrhages, joint pain, and swelling (1, 2). Other signs include bleeding gums and the loosening of teeth, often accompanied by perifollicular hemorrhages-tiny blood spots around hair follicles (7). These symptoms are among the first indicators that facilitate the diagnosis and subsequent treatment of the disease. Scurvy-induced skin lesions are characterized by the appearance of petechiae, purpura, and bruising, particularly in areas subjected to mechanical pressure such as the legs (7). The skin may become rough and dry, eventually leading to hyperkeratosis and hair follicle abnormalities. If left untreated, the skin will exfoliate, and the condition can become life-threatening. Other symptoms, such as general weakness may also be observed as secondary complications if scurvy persists without intervention. These symptoms result from the impaired function of collagen-dependent tissues and the body's inability to repair itself adequately (1, 2). The histopathological features of scurvy are often non-specific but can include fragmented collagen fibers, capillary fragility, and minimal inflammatory infiltrate (8). These features contribute to the widespread hemorrhages seen in advanced cases of the disease.

Several factors can cause the nutritional deficiencies that lead to scurvy, including a lack of dietary sources of vitamin C, alcoholism, and medical conditions like gastrointestinal disorders that hinder vitamin absorption (8). Psychological conditions, such as disordered eating, also contribute to insufficient vitamin intake. Anorexia nervosa (AN) exemplifies this, characterized by persistent behaviors that interfere with weight gain, such as severely restricted food consumption (9). This reduced food intake makes AN the mental health disorder with the highest mortality rate, often due to starvation or suicide (10, 11). Diagnosing AN requires a medical professional and adherence to the criteria in the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) (12). These criteria includes (1) a significant low body weight in the patient's developmental or biological context due to restricted calorie intake, (2) an intense fear of gaining weight, and (3) having a distorted view of either their body or the medical seriousness associated with low body weight (12). Reduced macronutrient and vitamin intake experienced in patients with AN adversely affects multiple bodily systems. Symptoms in AN patients, including dermatological manifestations, vary based on factors such as purging behavior, illness duration, and overall nutrient intake (13). Common skin-related symptoms include xerosis (dry skin), cheilitis (lip inflammation), acne, effluvium (hair shedding), and nail lesions (13, 14). Other symptoms may include nausea, cachexia (severe weight loss and muscle wasting), constipation, and cardiac issues.

Healthcare providers must understand the overlapping and differential symptoms to differentiate between the two conditions. In scurvy, due to the deficiency of vitamin C, impaired collagen synthesis tends to present as weakened blood vessels, resulting in presentations of petechiae, purpura, and perifollicular hemorrhages, along with characteristic corkscrew hairs and hyperkeratotic papules around hair follicles. Conversely, dermatologic findings in AN are more often related to malnutrition, including xerosis, lanugo hair, and acrocyanosis, with purpura typically only occurring in the context of concomitant thrombocytopenia from severe malnutrition. Gastrointestinal features of AN traditionally include delayed gastric emptying, bloating, and constipation, while symptoms suggestive of defective collagen synthesis such as gum disease or loosening of teeth are more indicative of a scurvy co-diagnosis. Finally, scurvy will tend to present with certain symptoms not traditionally characteristic of AN, such as anemia, musculoskeletal pain from subperiosteal hemorrhages, and "scorbutic rosary" due to costochondral junction enlargement.

Addressing the underlying nutritional deficiencies is crucial for improving patient outcomes and preventing severe complications associated with both disorders. Treatment for scurvy is straightforward and highly effective, typically involving vitamin C supplements or vitamin C-rich foods like citrus fruits, tomatoes, and green leafy vegetables (3). With proper treatment, scurvy symptoms usually resolve rapidly, allowing patients to recover fully. Early diagnosis and intervention are vital to prevent the severe and potentially fatal complications of prolonged vitamin C deficiency.

AN can lead to scurvy due to severe vitamin C deficiencies from restricted food intake, but the relationship is not well understood, with clinical presentations varying widely. While other restrictive eating disorders, such as bulimia nervosa, binge-eating disorder, or avoidant/restrictive food intake, may also raise the risk of scurvy, their pathologies and symptomatic presentations differ significantly from AN due to the different types and amounts of food they consume (15). Therefore, studying these disorders separately is important to understand the specific nutritional deficiencies they cause. This study reviews several case studies from medical literature that document concurrent cases of AN and scurvy, highlighting the symptoms and clinical outcomes of these patients.

2 Methods

This study is the most comprehensive literature review to date on the intersection of scurvy and anorexia nervosa (AN). Three major academic databases-Google Scholar, PubMed, and Web of Science-were systematically searched to ensure thorough coverage. The search strategy used a combination of relevant terms: ("scurvy" OR "vitamin C deficiency" OR "ascorbic acid deficiency") AND "anorexia*," aimed at capturing all studies related to scurvy and AN, as well as related nutritional deficiencies and their health impacts. The search yielded 8,260 results in Google Scholar, 33 in PubMed, and 36 in Web of Science. Articles available in English and published after 1952 were included to maintain consistency in symptom translation and diagnosis criteria. Abstracts were reviewed to ensure alignment with the research goals, resulting in 52 articles from Google Scholar, 13 from PubMed, and 9 from Web of Science passing the preliminary review, totaling 74 articles. Data extraction used a standardized form to collect information on symptoms, treatment plans, outcomes measured, and key findings related to scurvy and AN. These articles were then thoroughly read in the final review. Articles had to meet specific criteria to pass the final review: reporting a case of AN and scurvy simultaneously, providing

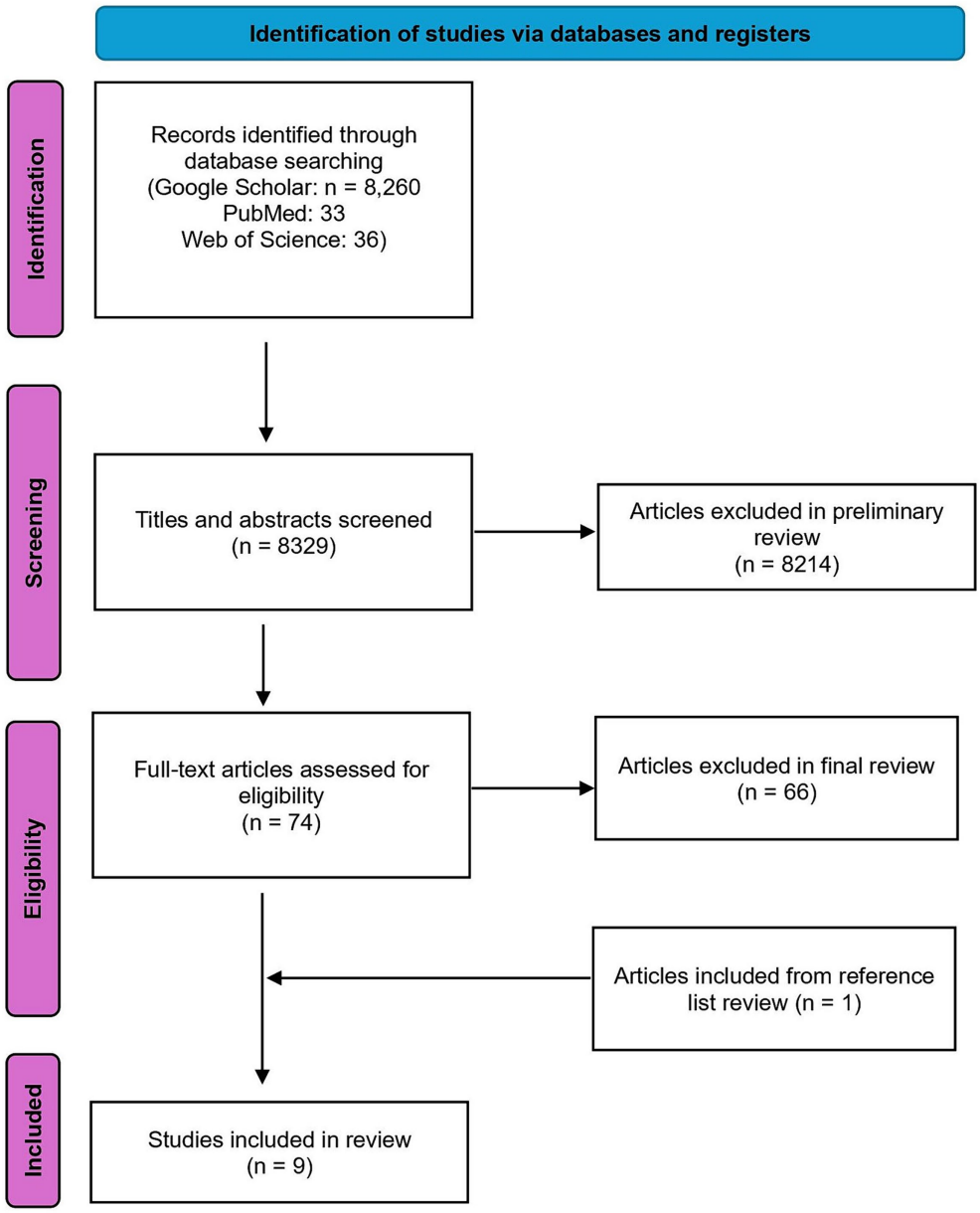


FIGURE 1
PRISMA diagram.

original research data or comprehensive reviews, and excluding patients with other medical conditions affecting scurvy or AN diagnosis. Six articles from the preliminary Google Scholar search were included in the final review, along with two new articles from PubMed. No new articles from Web of Science met the inclusion criteria. References of all final review articles were checked to fill any literature gaps, identifying one additional piece of literature. A total of nine case reports were reviewed, with Figure 1 outlining the protocol for literature identification.

3 Results

Nine total case reports were analyzed based on the criteria set during the literature search. The total age range of participants was 10–59. Eight reported participants were female, one was male, and three were aged 18 or below at the time of AN and scurvy diagnosis.

Gastrointestinal symptoms were prevalent among the patients. Three case reports documented gingival-related issues: two cases reported gingival bleeding and irritation, one case described gingival hypertrophy. Additionally, decreased bowel sounds and early satiety with epigastric pain and reducing constipation were noted in two other cases. Psychiatric symptoms were also commonly observed. General weakness (asthenia), malaise, or fatigue were reported in six of the nine cases. Cognitive dysfunction was noted in three cases, including delayed speech and motor retardation. Dermatological symptoms were significant and varied across reports. Purpura, rashes, or ecchymosis in the lower extremities was prevalent in every case, while five cases reported perifollicular purpura. Two cases reported

TABLE 1 Symptoms of patients with concurrent anorexia nervosa and scurvy.

Author	Year	Age, Sex	Gastrointestinal	Psychiatric	Skin	Cardiovascular	Other
da Silva et al. (18)	2023	10 M	Gingival edema and bleeding during tooth brushing	Asthenia (general weakness), weakness, malaise, sadness.	Pain and purpuric lesions on the lower limbs. Swollen and inflamed gums. Symmetrically distributed purpuric and palpable lesions on the lower limbs without edema.	Unreported	Unreported
Du & Kulkarni (19)	2024	15F	Gingival bleeding, Gingival irritation	Fatigue	Rash on both legs, nonblanching perifollicular papules. Mild swelling on her left cheek. Scant cervical lymphadenopathy. Soft, subcutaneous fluid collection on the left knee. Perifollicular hemorrhages. Faint corkscrew hairs. Perifollicular papules. Gingival irritation along the lower gum line.	Tachycardia	Menorrhagia
Gisondi & Bellinato (16)	2022	59F	Unreported	Unreported	Striped purpura and ecchymoses on the legs.	Unreported	Unreported
Levavasseur et al. (33)	2015	38F	Unreported	Unreported	Purpura and spontaneous hematomas on the lower extremities. Perifollicular hyperkeratosis. Hair dystrophy with corkscrew hair. Spontaneous hematomas on the legs.	Unreported	Unreported
Martin-Benllock et al. (20)	2023	37F	Gingival hypertrophy without bleeding. Arthromyalgia in the lower limbs	Anxiety, mood lability. Asthenia. Cognitive schemas and behavioral responses indicative of a dysfunctional personality. Repeated anxiety crises.	Spontaneous ecchymoses. Folliculitis with perifollicular purpura in the lower limbs.	Unreported	Unreported
Peixoto et al. (17)	2018	21F	Unreported	Fatigue, weakness, and myalgias	Ecchymosis. Scattered petechiae on the torso and legs. Hands' xerosis. Nail fragility. Lanugo-like body hair on arms and back.	Pedal edema	Unreported
Roy-Lavalee et al. (21)	2020	16F	Decreased bowel sounds	Delayed speech and cognitive slowing. Diffuse muscle weakness.	Multiple tiny hyperpigmented perifollicular petechial papules. Corkscrew hairs on the abdomen. Rash on lower leg	Bradycardia. Poor peripheral perfusion. Hypotension. Decreased peripheral pulses.	Cachexia, Unable to ambulate independently
Christopher et al. (22)	2002	46F	Early satiety. Epigastric pain and tenderness. Constipation. Petechiae on hard palate. Poor oral hygiene. Periodontal disease. Temporal wasting. Scant occult blood on rectal examination.	Fatigue, lethargy. Psycho motor retardation.	Nonpruritic rash on lower extremities. Palpable perifollicular papules. Nonpalpable purpuric macules and papules. Hemorrhages and ecchymoses around the knee. Lanugo over the arms.	Easy bruising.	Cachexia
Mehta et al. (23)	1996	40F	Unreported	Weakness, fatigue, myalgia.	Purpuric rash. Hyperpigmented face. Dry fissured skin on hands. Perifollicular purpura. Ecchymosis on the right inner thigh. Focal dermal hemorrhage. Anergy. Perifollicular purpura.	Severe pulmonary hypertension. Dilated pulmonary artery. Ventricular and atrial enlargement on the right side of the heart.	Shortness of breath. Moderate synovial swelling, warmth, and pain on palpation of the ankles. Interstitial edema. Hematuria.

10.3389/fnut.2024.1466388

corkscrew hairs. Other dermatological symptoms included a hyperpigmented face with dry fissured hands (one case) and hands' xerosis with nail fragility (one case). Cardiovascular symptoms were less frequently reported. Symptoms included tachycardia (one case), bradycardia with hypotension and poor peripheral perfusion (one case), pulmonary hypertension (one case), and pedal edema (one case). Other symptoms included menorrhagia (one case) and cachexia (two cases). The symptoms recorded for all patients are reported in Table 1.

The causes of admission of patients comorbid with scurvy and AN are summarized in Figure 2. Four of the eight patients were admitted either solely or partially due to purpura or rashes on the lower limbs. Four of the eight patients were also admitted either solely or partially due to cachexia symptoms. Other reasons patients were admitted include menorrhagia (one case), impaired systemic circulation with poor peripheral perfusion (one case), and dehydration (one case). One patient [59F, recorded by Gisondi and Bellinato (16)] was not included as no description was given on admission reason. One patient [21F, recorded by Peixoto et al. (17)] was admitted due to failing to respond to outpatient care, but no details were provided on the reason for original admittance into outpatient care.

Following diagnosis of scurvy and AN, eight out of eight patients were treated with vitamin C supplementation. One patient (59F, recorded by Gisondi & Bellinato) (16) was not included as treatment regimen and patient outcome was not described. 5 of the 9 cases measured ascorbic acid level prior to treatment, with serum vitamin levels ranging from 0.06 mg/dL - 0.23 mg/dL (RV = 0.4–1.5 mg/dL). BMI ranged between 11.4–17.7 kg/m2. All patients saw either substantial improvements in their symptoms or a complete recovery between 4 and 30 days after initiation of vitamin C supplementation. All patients were given vitamin C orally, at a dosage ranging from 250 mg - 1000 mg daily. Oral vitamin C supplementation was usually sufficient in resolving any dermatological issues and most characteristic symptoms related to scurvy. Dietetic advice, additional vitamin supplementation, or increased caloric intake were used to address other issues. No cases reported the results of subsequent treatment on AN status. The cause for admission, treatment, and outcome results are reported in Table 2.

4 Discussion

The symptoms experienced by patients with co-occurring AN and scurvy highlight the multifaceted impact of these conditions. Common symptoms such as fatigue and weakness were observed in seven cases (17–23) while purpuric lesions or petechiae were noted in all nine cases. These findings emphasize that fatigue and weakness are prevalent in both scurvy and AN patients, with skin manifestations like purpuric lesions and petechiae being particularly common in scurvy but likely exacerbated by malnutrition from AN. The prevalence of psychiatric symptoms, including asthenia and cognitive dysfunction, are also compounded by the psychological stressors inherent in AN. Research indicates that both AN and scurvy can impair cognitive function through mechanisms involving malnutrition and vitamin deficiency-induced neural damage (24–27). To address these complex symptoms, a comprehensive treatment approach is likely beneficial. This should include administering vitamin C and other necessary vitamins that are deficient in these cases to alleviate symptoms of scurvy and related deficiencies, while also gradually increasing dietary intake from the onset to address all nutritional deficiencies associated with AN. Given the significant psychiatric manifestations, ongoing psychiatric evaluation and support should be integrated into the treatment regimen, helping manage immediate symptoms and prevent behavioral relapse. Additionally, patients presented with dermatological manifestations in this study such as a hyperpigmented face, dry fissured hands, and nail fragility suggest that the combination of AN and scurvy may lead to complex skin presentations, as corroborated by previous case

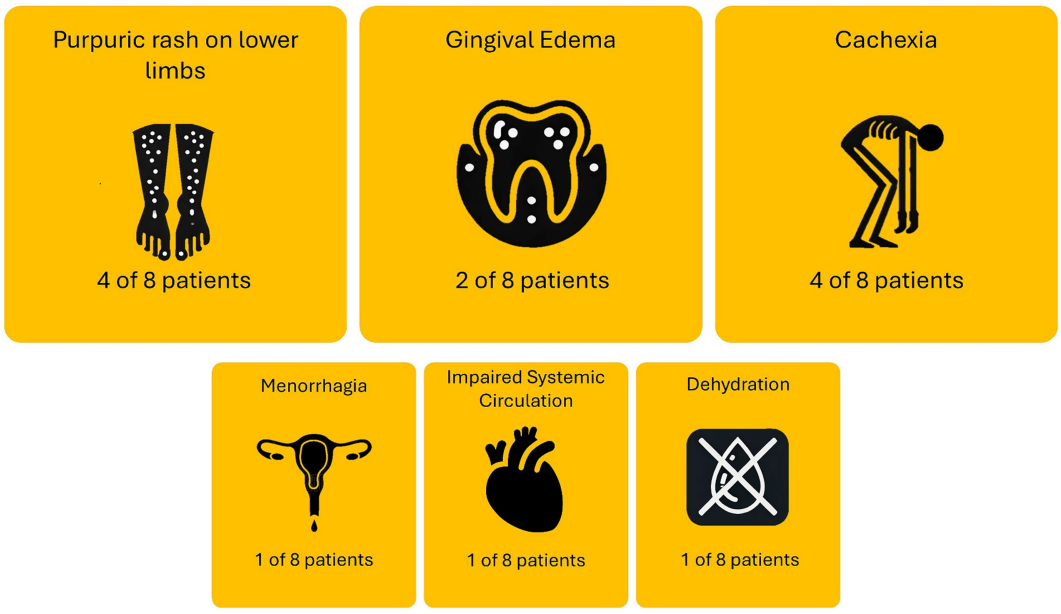


FIGURE 2
Causes of admission for patients comorbid with scurvy and anorexia nervosa.

TABLE 2 BMI, cause of admission, vitamin C level, comorbidities, treatment, and outcome of patients with scurvy and anorexia nervosa.

Author	Weight, Height, BMI	Cause of Admission	Vitamin C Serum (RV: 0.4–2.0 mg/dL)	Comorbidities	Treatment	Outcome
da Silva et al. (18)	27.7 kg, 138 cm, 14.57 kg/m^2	Pain and purpuric lesions on lower limbs, gingival edema	Ascorbic acid was not measured	Healthy, no comorbidities	100 mg of oral vitamin C thrice daily for 1 week, followed by 100 mg of oral vitamin C once daily	7 days after treatment start, substantial recovery with improved diet, mood, and lower limb pain.
Du & Kulkarni (19)	N/A	Progressive and spreading rash on lower limbs, gingival edema, menorrhagia	<0.09 mg/dL (measured 4 days after discharge)	Not reported	Oral vitamin C supplements, dosage not specified	N/A
Gisondi & Bellinato (16)	N/A	N/A	<0.1 mg/dL	Not Reported	Not Reported	N/A
Levavasseur et al. (33)	N/A	Purpura and spontaneous hematomas on lower limbs	Ascorbic acid was not measured	Chronic Hepatitis C, Iron Deficiency, history of drug addiction	1 g of oral vitamin C daily for 1 month	1 month after treatment start for complete recovery.
Martin-Benllock et al. (20)	42.5 kg, 167 cm,15.24 kg/m^2	Cachexia, severe malnutrition	0.06 mg/dL	Anxiety, no DSM diagnosis	1 g of oral vitamin C daily for 1 month. 100 mg of oral iron daily and 5 mg of folate daily.	4 days after treatment start, substantial improvement of joints, skin, and gait.
Peixoto et al. (17)	N/A, N/A, 11.4 kg/m^2	Failure to respond to outpatient treatment	Ascorbic acid was not measured	Not reported	300 mg of oral vitamin C daily for 6 weeks	14 days after treatment start, improved cutaneous signs
Roy-Lavalee et al. (21)	33.1 kg, 170.2 cm, 11.43 kg/m^2	Cachexia, low weight and cardiovascular support for bradycardia, poor peripheral perfusion, hypotension, dehydration	0.23 mg/ dl	Healthy, no comorbidities	250 mg of oral vitamin C daily. Paediatric multivitamin that included 50 mg of sodium ascorbate daily.	4 weeks after treatment start, improved cutaneous signs
Christopher et al. (22)	38.6 kg, 165 cm, 14.18 kg/m^2	Cachexia	Ascorbic acid was not measured	Nephrolithiasis, malnutrition, and normocytic anemia. Surgical history included hysterectonomy, bilateral salpingo-oophorectomy,	Treated with ascorbic therapy via vitamin supplements and enteral supplements. Did not specify duration.	7 days after treatment start, complete recovery.
Mehta et al. (23)	44 kg, 157.5 cm, 17.74 kg/m^2	Cachexia (myalgia, weakness, fatigue) and purpura in lower limbs	0.2 mg/dL	Amenorrheic since birth	supplemental vitamin C and other supportive therapies. Did not specify duration.	12 days after treatment start, substantial recovery.

studies documenting similar symptoms in isolated cases of scurvy and AN (8, 9).

AN can alter the presentation of symptoms traditionally associated with scurvy, given the widespread physiological impacts of AN on various body systems (Figure 3) (13). It is reasonable to believe a patient with AN can eventually develop scurvy due to malnutrition. AN-related conditions like gastrointestinal distress, reduced appetite, and impaired nutrient absorption (such as vomiting and diarrhea) can deplete essential vitamins and worsen or exacerbate the overall nutritional status of a patient. AN can also obscure the presence of scurvy. For instance, fatigue, malaise, and dermatological changes are characteristic of both, and providers may potentially

focus on AN treatment with little avail if vitamin deficiencies are not addressed first.

Despite being an ancient disease, scurvy remains prevalent. This is particularly true among individuals with restrictive eating disorders and other at-risk populations (28). Modern cases often arise from inadequate dietary intake, a situation not uncommon even in developed societies. Scurvy's clinical presentation can also be mistaken for other conditions, such as rheumatoid arthritis, clotting disorders, or anemia, due to symptoms like joint pain, petechiae, and anemia (29). Additionally, other vitamin deficiencies, such as beriberi (vitamin B1 deficiency) and pellagra (vitamin B3 deficiency), can present with neuropsychiatric and dermatological symptoms similar to those of scurvy and also co-present with AN, further complicating the clinical picture (30, 31).

The complexity of treating these overlapping conditions is heightened by the fact that anorexia nervosa, a psychiatric illness characterized by a refusal to consume food, inherently leads to macro and micronutrient deficiencies. This refusal, along with other hallmark features of AN such as distorted body image and an intense fear of gaining weight, directly impacts patients' adherence to treatment regimens. Moreover, the stigma and psychological burden of eating disorders can lead to underreporting of symptoms, further delaying accurate diagnosis.

Given the common symptoms, healthcare providers should likely maintain suspicion for vitamin deficiencies in patients with restrictive eating behaviors. Nonetheless, AN and scurvy can differ in crucial ways, and differential diagnosis is possible. Specifically, petechiae, purpura, and perifollicular hemorrhages may more likely indicate scurvy in patients with AN, as these symptoms are not typically observed in AN alone. Supporting this, all nine case reports in this study documented such symptoms in their patients, all occurring within lower extremities. This is likely due to increased hydrostatic pressure caused by gravity, which exacerbates the fragility of blood vessels weakened by vitamin C deficiency, resulting in subcutaneous internal bleeding. Symptoms of gum disease may also assist in diagnosis, with this study finding three cases (18, 19, 23) reporting gingival bleeding or irritation in their patients. Additionally, corkscrew hairs can serve as a strong indicator to parse out AN and scurvy, as vitamin C deficiency reduces disulfide bonds and keratin cross-linkage in hair (32). As evidence of this, three cases (19, 21, 33) in this study report such symptoms. However, corkscrew hairs are not invariably present in patients with scurvy, as they present in typically older patients and may not be obvious if the period of vitamin deficiency does not coincide with active hair growth phases (32). While delayed wound healing may not be immediately apparent upon a patient's hospital admission and was not reported in any case within this study, it can also serve as a differential indicator (34). Finally, anemia was reported in one patient (22). Vitamin C enhances absorption of non-heme iron and reduces ferrous iron to ferric iron, and thus scurvy patients are often reported to have microcytic anemia (35). In contrast, microcytic anemia is rare in AN, further suggesting the need to evaluate for concomitant vitamin C deficiency when such anemia is observed. However, other forms of anemia from vitamin deficiencies can present similarly, such as megaloblastic anemia due to folate or vitamin B12 deficiency, or hemolytic anemia due to vitamin E deficiency (36, 37). Thus, a combination of indicators and symptoms should be used by clinicians to accurately diagnose patients who may have scurvy co-presenting with AN, allowing for earlier further evaluation of vitamin C deficiency in hospital settings.

One limitation of this review is the limited number and diversity of case reports available on the concurrent presentation of scurvy and AN. Due to the rarity of these comorbid conditions, detailed literature on patient demographics, symptoms, and treatment regimens is scarce. Most existing reports focus on female patients, even though men are estimated to account for approximately 25% of all AN cases (38). This lack of male representation could lead to an incomplete understanding of how scurvy manifests in male patients with AN, given potential biological differences in nutritional needs and metabolic responses. Consequently, the current literature may not fully capture the variability in symptom presentation and treatment outcomes across different genders. Furthermore, the retrospective nature of this study introduces inherent limitations, such as the inability to control for confounding variables and biases present in the original reports. Examples of confounding variables include the severity and duration of AN, variations in patients' overall nutritional status, and the presence of other comorbid conditions such as depression, anxiety, or gastrointestinal disorders that can affect nutrient absorption and overall health. Additionally, differing healthcare access and treatment adherence among patients can further complicate the interpretation of case reports. Publication bias is another significant concern, as more severe or unusual cases are more likely to be reported, potentially skewing the overall understanding of these comorbid conditions' typical presentation and progression. This bias may lead to an overemphasis on atypical cases, making it difficult to generalize findings to the broader population of patients with both scurvy and AN. Future research should aim to include a wider range of case reports and prospective studies to provide a more comprehensive and balanced understanding of these conditions.

In conclusion, the intersection of scurvy and AN presents a complex clinical challenge, highlighting the significant impact of vitamin C deficiencies in AN patients. Recognizing the distinct systemic presentations of AN and scurvy is essential due to overlapping symptoms such as fatigue, malaise, and dermatological changes. Differentiating scurvy from AN involves identifying symptoms that are uncommon in AN alone. Petechiae, purpura, and perifollicular hemorrhages, especially in the lower extremities due to weakened blood vessel walls, are strong indicators of scurvy. Gingival bleeding, corkscrew hairs, and anemia can further aid in distinguishing between the two conditions. These clinical signs, when present, should prompt consideration of scurvy in AN patients and lead to further diagnostic measures such as a plasma ascorbic acid test. A comprehensive treatment approach involving immediate vitamin C supplementation, increased dietary intake, and ongoing psychiatric support is essential. Furthermore, more comprehensive nutritional assessments may improve early detection and subsequence management, potentially mitigating severe complications. This review highlights the limitations in the current literature, as few detailed case reports on concurrent scurvy and AN exist. This is particularly true for male patients, resulting in an incomplete understanding of these comorbid conditions. Future research should include diverse case reports and prospective studies, considering biological differences between genders and addressing psychological factors that hinder treatment adherence.

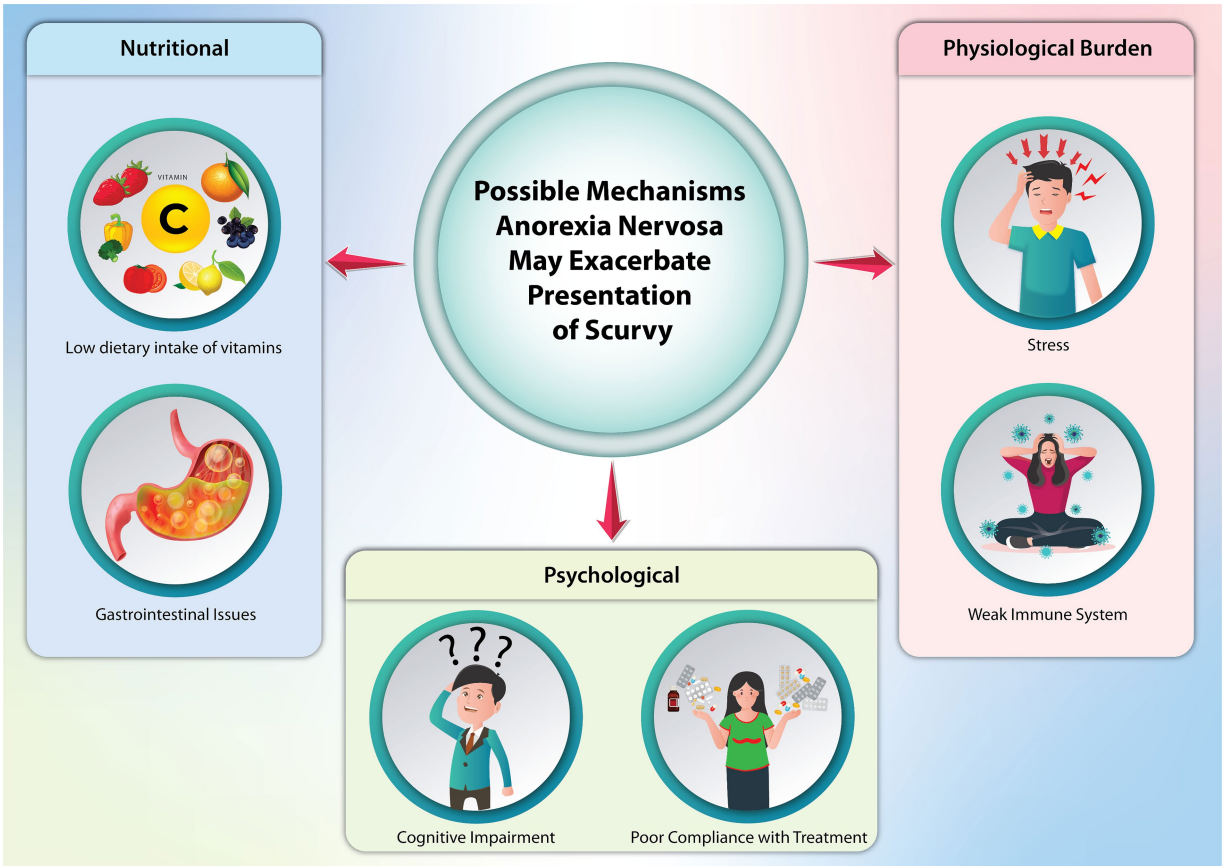


FIGURE 3
Possible mechanisms anorexia nervosa may exacerbate the presentation of scurvy.

Furthermore, given the small sample size in the current review, a larger controlled study in a representative sample is necessary to accurately identify the prevalence of scurvy in the population. It is also essential clinicians remain vigilant about the possibility of specific vitamin C deficiency in patients with AN, allowing for early detection and timely treatment of scurvy.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

SC: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

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

Conflict of interest

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

Publisher's note

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

References

1. Dresen E, Lee ZY, Hill A, Notz Q, Patel JJ, Stoppe C. History of scurvy and use of vitamin C in critical illness: a narrative review. *Nutr Clin Pract*. (2023) 38:46–54. doi: 10.1002/ncp.10914

2. Trapani S, Rubino C, Indolfi G, Lionetti P. A narrative review on pediatric scurvy: the last twenty years. *Nutrients*. (2022) 14:684. doi: 10.3390/nu14030684

3. Sauberlich HE. Pharmacology of vitamin C. *Annu Rev Nutr*. (1994) 14:371–91. doi: 10.1146/annurev.nu.14.070194.002103

4. Cantatore FP, Loperfido MC, Magli DM, Mancini L, Carrozzo M. The importance of vitamin C for hydroxylation of vitamin D3 to 1, 25 (OH) 2D3 in man. *Clin Rheumatol*. (1991) 10:162–7. doi: 10.1007/BF02207657

5. Belsky JB, Wira CR, Jacob V, Sather JE, Lee PJ. A review of micronutrients in sepsis: the role of thiamine, l-carnitine, vitamin C, selenium and vitamin D. *Nutr Res Rev*. (2018) 31:281–90. doi: 10.1017/S0954422418000124

6. Van Gorkom GN, Klein Wolterink RG, Van Elssen CH, Wieten L, Germeraad WT, Bos GM. Influence of vitamin C on lymphocytes: an overview. *Antioxidants*. (2018) 7:41. doi: 10.3390/antiox7030041

7. Hahn T, Adams W, Williams K. Is vitamin C enough? A case report of scurvy in a five-year-old girl and review of the literature. *BMC Pediatr*. (2019) 19:74–6. doi: 10.1186/s12887-019-1437-3

8. Olmedo JM, Yiannias JA, Windgassen EB, Gornet MK. Scurvy: a disease almost forgotten. *Int J Dermatol*. (2006) 45:909–13. doi: 10.1111/j.1365-4632.2006.02844.x

9. Setnick J. Micronutrient deficiencies and supplementation in anorexia and bulimia nervosa: a review of literature. *Nutr Clin Pract*. (2010) 25:137–42. doi: 10.1177/0884533610361478

10. Birmingham CL, Su J, Hlynsky JA, Goldner EM, Gao M. The mortality rate from anorexia nervosa. *Int J Eat Disord*. (2005) 38:143–6. doi: 10.1002/eat.20164

11. Hoek HW. Incidence, prevalence and mortality of anorexia nervosa and other eating disorders. *Curr Opin Psychiatry*. (2006) 19:389–94. doi: 10.1097/01.yco.0000228759.95237.78

12. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. American Psychiatric Publishing. (2013). doi: 10.1176/appi.books.9780890425596

13. Beumont PJ. Clinical presentation of anorexia nervosa and bulimia nervosa. *Eating Disorders Obesity*. (2002) 2:162–70.

14. Zipfel S, Giel KE, Bulik CM, Hay P, Schmidt U. Anorexia nervosa: aetiology, assessment, and treatment. *Lancet Psychiatry*. (2015) 2:1099–111. doi: 10.1016/S2215-0366(15)00356-9

15. Berkman ND, Lohr KN, Bulik CM. Outcomes of eating disorders: a systematic review of the literature. *Int J Eat Disord*. (2007) 40:293–309. doi: 10.1002/eat.20369

16. Gisondi P, Bellinato F. Scurvy as presenting sign of anorexia nervosa. *J Cutan Med Surg*. (2022) 26:645. doi: 10.1177/12034754221100193

17. Peixoto MJ, Nunes P, Melo R, Timóteo S. Scurvy in anorexia nervosa: a case report. *J Clin Neurosci Mental Health*. (2018) 5:9. doi: 10.21035/ijcnmh.2018.5.9

18. da Silva NC, Caselli PF, Marinho CP, Lopez LD, Vasconcelos FM, Nauff MV, et al. Scurvy and food selectivity in childhood: a case report. *Einstein*. (2023) 21:eRC0356. doi: 10.31744/einstein_journal/2023RC0356

19. Du T, Kulkarni A. Scurvy in an adolescent: a case report. *Cureus*. (2024) 16:e58782. doi: 10.7759/cureus.58782

20. Martín-Benlloch S, Brotons-Bañón E, Casanova-Rama A, López-Brotons M, Milla-Olaya B, Seguí-Pérez M, et al. Scurvy, from suspicion to current reality. *Clin Case Rep Int*. (2023) 7:1456

21. Roy-Lavallee J, Bahrani B, Weinstein M, Katzman DK. Scurvy: an unexpected nutritional complication in an adolescent female with anorexia nervosa. *J Adolesc Health*. (2020) 67:618–20. doi: 10.1016/j.jadohealth.2020.02.022

22. Christopher K, Tammaro D, Wing EJ. Early scurvy complicating anorexia nervosa. *South Med J*. (2002) 95:1065–6. doi: 10.1097/00007611-200295090-00024

23. Mehta CL, Cripps D, Bridges AJ. Systemic pseudovasculities from scurvy in anorexia nervosa. *Arthritis Rheumatism*. (1996) 39:532–3. doi: 10.1002/art.1780390322

24. Reville MC, O'Connor L, Frampton I. Literature review of cognitive neuroscience and anorexia nervosa. *Curr Psychiatry Rep*. (2016) 18:1–8. doi: 10.1007/s11920-015-0651-4

25. Tchanturia K, Campbell IC, Morris R, Treasure J. Neuropsychological studies in anorexia nervosa. *Int J Eat Disord*. (2005) 37:S72–6. doi: 10.1002/eat.20119

26. Wright AD, Stevens E, Ali M, Carroll DW, Brown TM. The neuropsychiatry of scurvy. *Psychosomatics*. (2014) 55:179–85. doi: 10.1016/j.psym.2013.10.003

27. Plevin D, Galletly C. The neuropsychiatric effects of vitamin C deficiency: a systematic review. *BMC Psychiatry*. (2020) 20:1–9. doi: 10.1186/s12888-020-02730-w

28. Smith A, Di Primio G, Humphrey-Murto S. Scurvy in the developed world. *CMAJ*. (2011) 183:E752–5. doi: 10.1503/cmaj.091938

29. Rubino C, Mastrangelo G, Bartolini E, Indolfi G, Trapani S. The pitfall in differential diagnosis of musculoskeletal symptoms in children: a case series of pediatric scurvy. JCR. *J Clin Rheumatol*. (2021) 27:S362–7. doi: 10.1097/RHU.0000000000001562

30. Hegyi J, Schwartz RA, Hegyi V. Pellagra: dermatitis, dementia, and diarrhea. *Int J Dermatol*. (2004) 43:1–5. doi: 10.1111/j.1365-4632.2004.01959.x

31. Dhir S, Tarasenko M, Napoli E, Giulivi C. Neurological, psychiatric, and biochemical aspects of thiamine deficiency in children and adults. *Front Psych*. (2019) 10:447129. doi: 10.3389/fpsyt.2019.00207

32. Goldberg LJ, Lenzy Y. Nutrition and hair. *Clin Dermatol*. (2010) 28:412–9. doi: 10.1016/j.clindermatol.2010.03.038

33. Levavasseur M, Becquart C, Pape E, Pigeyre M, Rousseaux J, Staumont-Sallé D, et al. Severe scurvy: an underestimated disease. *Eur J Clin Nutr*. (2015) 69:1076–7. doi: 10.1038/ejcn.2015.99

34. Gandhi M, Elfeky O, Ertugrul H, Chela HK, Daglilar E. Scurvy: rediscovering a forgotten disease. *Diseases*. (2023) 11:78. doi: 10.3390/diseases11020078

35. Ceglie G, Macchiarulo G, Marchili MR, Marchesi A, Aufiero LR, Di Camillo C, et al. Scurvy: still a threat in the well-fed first world? *Arch Dis Child*. (2019) 104:381–3. doi: 10.1136/archdischild-2018-315496

36. Castellanos-Sinco HB, Ramos-Peñafiel CO, Santoyo-Sánchez A, Collazo-Jaloma J, Martínez-Murillo C, Montaño-Figueroa E, et al. Megaloblastic anaemia: folic acid and vitamin B12 metabolism. *Revista Médica Del Hospital General De México*. (2015) 78:135–43. doi: 10.1016/j.hgmx.2015.07.001

37. Oski FA, Barness LA. Vitamin E deficiency: a previously unrecognized cause of hemolytic anemia in the premature infant. *J Pediatr*. (1967) 70:211–20. doi: 10.1016/S0022-3476(67)80416-5

38. Hudson JI, Hiripi E, Pope HG Jr, Kessler RC. The prevalence and correlates of eating disorders in the National Comorbidity Survey Replication. *Biol Psychiatry*. (2007) 61:348–58. doi: 10.1016/j.biopsych.2006.03.040

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 16 September 2024
DOI 10.3389/fpsyg.2024.1464651

OPEN ACCESS

EDITED BY
Sebastian Gustavo Soneira,
Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

REVIEWED BY
Delfina Lahitou Herlyn,
National Scientific and Technical Research Council (CONICET), Argentina
Leticia Fiorentini,
Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

*CORRESPONDENCE
Lars König
lars.koenig@stiftung-gesundheitswissen.de

†These authors have contributed equally to this work and share first authorship

RECEIVED 14 July 2024
ACCEPTED 26 August 2024
PUBLISHED 16 September 2024

CITATION
König L, Schröder R, Hamer T and Suhr R (2024) Eating disorders and health literacy in Germany: results from two representative samples of adolescents and adults.
Front. Psychol. 15:1464651.
doi: 10.3389/fpsyg.2024.1464651

Eating disorders and health literacy in Germany: results from two representative samples of adolescents and adults

Lars König[1,2*†], Rebekka Schröder[1†], Tim Hamer[1] and Ralf Suhr[1,2]

[1]Stiftung Gesundheitswissen, Berlin, Germany, [2]Institut für Medizinische Soziologie und Rehabilitationswissenschaft, Charité – Universitätsmedizin Berlin, Berlin, Germany

Introduction: Eating disorders are associated with substantial burden for the affected individuals including negative health outcomes and increased mortality. So far, prevention programs for eating disorders have yielded mixed results concerning their efficacy. Therefore, more targeted prevention programs need to be developed. Health literacy has been identified as a potential influencing factor of eating disorders. This study aimed at exploring the relationship between likely cases of eating disorders and health literacy, alongside additional sociodemographic factors.

Materials and methods: Two large samples of adults (N = 3,011) and adolescents (N = 1,021) representative of the German-speaking population in Germany were recruited. Likely cases of eating disorders were identified using the SCOFF questionnaire. Health literacy was assessed with the HLS-EU-Q16 questionnaire. Sociodemographic information, including age, gender, social status and level of education, and subjective body image were obtained. χ^2-tests of independence were calculated to determine the association between the investigated constructs.

Results: Suspected eating disorders were more likely in female than male adolescents but were not related to gender in adults. Rates of suspected eating disorders increased with increasing age in adolescents and decreased with increasing age in adults. While levels of education were unrelated to suspected eating disorders, low social status was associated with higher rates of suspected eating disorders in adults but not adolescents. Inadequate or problematic health literacy and negative body image were associated with higher rates of suspected eating disorders compared to adequate health literacy and more positive body image.

Discussion: Likely cases of eating disorders are related to health literacy and body image as well as sociodemographic factors. These constructs should therefore be addressed in future research to improve prevention programs.

KEYWORDS

eating disorder, health literacy, body image, health, representative, Germany, adolescents, adults

1 Introduction

Eating disorders, such as anorexia nervosa, bulimia nervosa and binge-eating disorder, are severe psychiatric disorders associated with significant psychological and physical impairment (Treasure et al., 2020; World Health Organization, 2019). Eating disorders are characterized by abnormal eating or weight-control behaviors often accompanied by disturbed body image (Treasure et al., 2020). Patients with anorexia nervosa show a persistent pattern of restrictive eating or other behaviors that are aimed at establishing or maintaining abnormally low body weight (World Health Organization, 2019). Both bulimia nervosa and binge-eating disorder are characterized by recurrent binge-eating episodes, in which individuals experience loss of control over their eating behavior and consume large portions of food in a discrete period of time (Treasure et al., 2020; Giel et al., 2022; World Health Organization, 2019). For patients with bulimia nervosa, these episodes are accompanied by compensatory behaviors such as self-induced vomiting to prevent weight gain (Treasure et al., 2020), which do not regularly occur in binge-eating disorder (Giel et al., 2022).

On a global level, 12-months prevalences of all eating disorders are estimated at 2.2% for women and 0.7% for men (Galmiche et al., 2019). For a majority of patients with eating disorders, age of eating disorder onset is before 25 years with a peak age of 15 years (Preti et al., 2009; Solmi et al., 2022). Results concerning a potential increase in eating disorder prevalences in recent years are heterogeneous (Keski-Rahkonen and Mustelin, 2016; Steinhausen and Jensen, 2015). However, a rise in hospital admissions in patients with eating disorders, especially in anorexia nervosa, has been observed, which was further accelerated during the COVID-19 pandemic in recent years (Devoe et al., 2023; Holland et al., 2016).

Although eating disorder prevalences are still relatively low compared to other psychiatric conditions, eating disorders have serious implications, both at an individual and societal level (Chan et al., 2023; Chesney et al., 2014; GBD 2019 Mental Disorders Collaborators, 2022; Ágh et al., 2016). Specifically, eating disorders are associated with high rates of psychiatric comorbidities such as mood and anxiety disorders, physical conditions including cardiovascular and metabolic problems due to malnutrition, weight loss and compensatory behaviors as well as decreased quality of life (Keski-Rahkonen and Mustelin, 2016; Preti et al., 2009; Treasure et al., 2020; Westmoreland et al., 2016; Ágh et al., 2016). When compared to other mental disorders, eating disorders—after substance-abuse disorders—have the second highest number of years-of-potential-life-lost (Chan et al., 2023). Furthermore, eating disorders, particularly anorexia nervosa, are among the psychiatric disorders with the highest mortality rates (Harris and Barraclough, 1998; Arcelus et al., 2011), as evidenced by standardized mortality ratios five to six times that of the general population (Arcelus et al., 2011). Also, while many patients with eating disorders eventually recover, chronicity of the disorders occurs in almost a quarter of patients (Solmi et al., 2024).

The etiology of eating disorders is still subject of ongoing debate. In addition to biological risk factors (e.g., genetics, microbiome), environmental and psychological risk factors play a crucial role in developing eating disorders. These include sexual and physical abuse, trauma and childhood obesity, higher educational attainment, body image-related factors and use of appearance-focused social media, among others (Barakat et al., 2023; Solmi et al., 2021).

Although there are effective treatments available for all major eating disorders (Herpertz et al., 2018; Monteleone et al., 2022; Murray et al., 2019) not all individuals with eating disorders seek or receive treatment (Hart et al., 2011). Among the common barriers that prevent individuals from getting treatment are stigma and shame about the disorder, denial or failure to recognize the severity of symptoms, and practical barriers such as the cost and accessibility of treatments (Ali et al., 2017).

In a recent meta-analysis of a widely-used screening inventory that is also employed in the present study, 22.4% of children and adolescents (age 7–18 years) were identified as suspected of having an eating disorder, with rates in girls (30.0%) almost double those in boys (17.0%) (López-Gil et al., 2023). Similar or slightly lower rates of potential eating disorders were also found in three German-speaking samples (Herpertz-Dahlmann et al., 2008; Cohrdes et al., 2019; Zeiler et al., 2016). Critically, positive screens for eating disorders in younger age are not only predictive of potential underlying full-blown eating disorders but also of current quality of life (Zeiler et al., 2016), as well as overweight, obesity and depressive symptoms later in life (Herpertz-Dahlmann et al., 2015).

The numerous risk factors for eating disorders (Barakat et al., 2023; Solmi et al., 2021) and the substantial burden of the diseases (Ágh et al., 2016; Keski-Rahkonen and Mustelin, 2016; GBD 2019 Mental Disorders Collaborators, 2022) underline the need of preventive interventions (Herpertz-Dahlmann et al., 2015). Onset of most eating disorders in adolescence and the fact that recovery rates are higher in adolescents than in adults and in patients at earlier vs. later stages of the disorder suggest that targeted interventions for prevention or early detection and intervention in children and adolescents may prove to be particularly valuable (Steinhausen and Jensen, 2015; Ambwani et al., 2020; Preti et al., 2009; Kalindjian et al., 2022).

So far, a number of prevention programs to battle eating disorders have been developed with mixed results concerning their efficacy (Koreshe et al., 2023; Le et al., 2017). However, some interventions (e.g., media literacy interventions for universal prevention) have been identified as promising in terms of symptom reductions (Le et al., 2017) and certain intervention programs (e.g., dissonance-based prevention programs) were found to even prevent future onset of eating disorders (Stice et al., 2021). Therefore, identifying groups that might particularly benefit from prevention programs, is vital to improve the efficacy of these programs (Le et al., 2017). The present study was designed to address this need and to explore potential associations with health literacy.

Health literacy refers to the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health (Nutbeam, 1998). It has been associated with several health-related topics, including disordered eating (Fleary et al., 2018; Campanino et al., 2023; Boberová and Husárová, 2021; Bullivant et al., 2020). For example, it has been shown that individuals with anorexia nervosa and bulimia nervosa had lower levels of subjective health literacy and higher levels of objective health literacy when compared to healthy controls (Campanino et al., 2023). In addition, a negative relationship between health literacy and symptoms of eating disorders was found, particularly in participants who perceived themselves to be overweight (Boberová and Husárová, 2021). Therefore, targeting health literacy in prevention programs could be particularly promising.

The aim of the present investigation was to explore the association between suspected cases of eating disorders and sociodemographic variables, body image and health literacy in two representative samples of German-speaking adolescents (12–17 years) and adults (≥ 16 years) in Germany.

2 Materials and methods

2.1 Ethical considerations

The study was designed to comply with the ethical principles for medical research involving human subjects as set out in the Declaration of Helsinki. A study protocol was submitted to the ethics committee of the Berlin Medical Association. The ethics committee had no ethical or professional objections to the study protocol (reference Eth-64/23). Before the study started, participants gave their informed consent to take part in the study. For participants aged 15 and younger, informed consent was provided by their parents. Participants could withdraw from the study at any time. Participants were not compensated for their participation by the independent non-profit foundation Stiftung Gesundheitswissen. Furthermore, only anonymized data was provided to the Stiftung Gesundheitswissen.

2.2 Survey methodology and data acquisition

For this study, data from two independent samples were collected by two market research institutes.

Data for the adult sample (≥ 16 years) was collected by forsa (Gesellschaft für Sozialforschung und statistische Analysen mbH) in December 2023 using the forsa.omninet online panel. The panel has around 100,000 participants and is representative of the German-speaking population with internet access in Germany. For the present investigation, a representative sample was drawn from the panelists 16 years and older. Data collection was carried out online with computer-assisted web interviews. A total of 3,011 participants provided complete questionnaires. Survey weights were calculated by forsa using an iterative proportional fitting approach according to the following weight variables and combinations: (a) gender × age (in the groups 16–29 years, 30–45 years, 46–64 years, ≥ 65 years) × region (West Germany and Berlin, East Germany) and (b) federal state. The weighting was based on the population census of the German Federal Statistical Office.

Data for the adolescent sample was collected by GIM (Gesellschaft für innovative Marktforschung mBH). The study population consisted of pupils aged 12 to 17 from Germany. Data collection was carried out with a mixed-mode approach (similar to representative German JIM-Studie 2023) using computer-assisted web interviews (about 2/3 of all interviews) and computer-assisted face-to-face interviews (about 1/3 of all interviews). A total of 1,021 complete questionnaires were obtained. Data collection was carried out in November and December 2023. Survey weights were calculated in an iterative procedure according to the following weight variables and combinations: age × gender, education and federal state. The weighting was based on data from the Federal Statistical Office and the ma Radio survey.

2.3 Measures

2.3.1 Sociodemographic information

Participants provided basic sociodemographic information including gender (male, female, diverse [in adolescents only]), age and federal state of residence (in the adult sample) or federal state of the currently attended schools (in the adolescent sample). For further analyses, individuals were divided into groups, according to age (16–29 years, 30–45 years, 46–64 years, ≥ 65 years, in the adult sample; 12–13 years, 14–15 years, 16–17 years, in the adolescent sample) and gender (male, female, diverse [in adolescents only]).

In addition, information on (subjective) social status and educational levels were obtained.

Adults were asked to indicate their highest level of formal education. Participants were then categorized into three groups, i.e., low (equivalent to no formal education or basic secondary school; ohne Haupt-/Volksschulabschluss, Haupt-/Volksschulabschluss), middle (equivalent to intermediate secondary school; Mittlere Reife, Realschulabschluss, Fachschulreife, Abschluss der Polytechnischen Oberschule, Fachhochschulreife, Abschluss einer Fachoberschule) and high formal level of education (equivalent to most advanced secondary school, e.g., grammar schools to obtain a general or specialized university entrance qualification, or university degree; Abitur, allgemeine oder fachgebundene Hochschulreife, Fach-/Hochschulstudium). To obtain level of education from adolescents, they were first asked to indicate the type of school they currently attend and then divided into two categories: high (equivalent to most advanced secondary school, e.g., grammar schools, where a general university entrance qualification can be obtained; Gymnasium) and low educational levels (all other school types).

Subjective social status of the adult participants was assessed using the German version of the MacArthur scale (Hoebel et al., 2015; Adler et al., 2000). The scale makes use of a ladder metaphor in which the top rung (rung 10) represents the individuals with highest status and the bottom rung (rung 1) represents the individuals with lowest status. The participants are asked to indicate on which of the 10 possible rungs they place themselves. Three categories of subjective social status were determined according to the respondents' answers, i.e., low subjective social status (scores 1–4), middle subjective social status (scores 5–7) and high subjective social status (scores 8–10).

Social status in the adolescent sample was obtained using the German version of the Revised Family Affluence Scale (FAS III) (Torsheim et al., 2016). The scale consists of six items asking the participants about their family's material assets, e.g., if they own a dishwasher or how often they have been on a holiday abroad in the past year. A total score is obtained by adding up answers across items. Cut-offs to determine categories were defined according to quintiles. Three categories were distinguished, e.g., low (bottom 20%, scores 0–5), middle (middle 60%, scores 6–9), and high (top 20%, scores 10–14) social status (Moor et al., 2024; Corell et al., 2021).

2.3.2 SCOFF

The Sick, Control, One Stone, Fat, Food (SCOFF) questionnaire is a questionnaire initially developed to screen for anorexia nervosa and bulimia nervosa (Morgan et al., 1999). Here, the German translation was used (Hölling and Schlack, 2007). The questionnaire consists of five items conveyed as questions, each addressing one the

core features of anorexia nervosa and bulimia nervosa, e.g., concerning recent weight loss and loss of control when eating. Participants are asked to answer each question with "yes" or "no" and a sum score is calculated across all items. If two or more questions are answered with "yes," participants are considered likely to have an eating disorder. Across validation studies, the SCOFF questionnaire has yielded high sensitivity and specificity (Kutz et al., 2020; Botella et al., 2013). In addition, moderate to high test–retest reliability coefficients were obtained (Garcia et al., 2011; Garcia-Campayo et al., 2005; Leung et al., 2009).

2.3.3 Body image

To assess the participants' subjective body image, they were asked to indicate if they considered themselves to be exactly the right weight, a bit too thin, far too thin, a bit too fat or far too fat (Cohrdes et al., 2019). Three groups were determined: (1) individuals who consider themselves to have the right weight, (2) individuals who consider themselves to be a bit too thin or fat and (3) individuals who consider themselves to be far too thin or fat.

TABLE 1 Sample characteristics of the weighted and unweighted sample of adults.

Variable	Unweighted sample, n (%)	Weighted sample, n (%)
Gender		
Male	1,483 (49.3%)	1,475 (49.0%)
Female	1,528 (50.7%)	1,536 (51.0%)
Age groups		
16–29 years	535 (17.8%)	531 (17.6%)
30–45 years	658 (21.9%)	721 (24.0%)
46–64 years	946 (31.4%)	976 (32.4%)
≥ 65 years	872 (29.0%)	783 (26.0%)
Level of education		
Low	768 (25.5%)	691 (23.0%)
Middle	1,110 (36.9%)	1,147 (38.1%)
High	1,130 (37.5%)	1,170 (38.8%)
Missing values	3 (0.1%)	3 (0.1%)
Social status		
Low	418 (13.9%)	426 (14.2%)
Middle	1992 (66.2%)	1988 (66.0%)
High	597 (19.8%)	593 (19.7%)
Missing values	4 (0.1%)	4 (0.1%)
Body image (Do you think you are…)		
… exactly the right weight?	886 (29.4%)	865 (28.7%)
…a bit too thin/fat?	1707 (56.7%)	1719 (57.1%)
…far too thin/fat?	417 (13.8%)	427 (14.2%)
Missing values	1 (0.0%)	1 (0.0%)
Health literacy		
Inadequate/problematic	1,192 (39.6%)	1,201 (39.9%)
Adequate	1790 (59.4%)	1784 (59.2%)
Missing values	29 (1.0%)	26 (0.9%)

2.3.4 HLS-EU-Q16

Health literacy was assessed using the German translation of the short version of the European Health Literacy Survey instrument (HLS-EU-Q16) (Jordan and Hoebel, 2015; Pelikan et al., 2014; Sørensen et al., 2013). The questionnaire consists of 16 items, answered on a 4-point Likert scale ranging from "very easy," over "fairly easy," "fairly difficult" to "very difficult." Questions address subjective difficulty in accessing, understanding, appraising and applying information concerning healthcare, disease prevention and health promotion (Sørensen et al., 2013). To calculate an overall sum score, item responses were first dichotomized (e.g., 1 = "fairly easy" and "very easy," 0 = "fairly difficult" and "very difficult") and then added up across all dichotomized items. Levels of health literacy were determined according to the overall scores, i.e., inadequate or problematic health literacy for scores from 0 to 12 and adequate health literacy for scores from 13 to 16. The HLS-EU-Q16 questionnaire has yielded high internal consistency and test–retest reliability coefficients (Jordan and Hoebel, 2015; Eronen et al., 2019; Bergman et al., 2023).

2.4 Statistical analysis

The statistical analyses were conducted with the statistical software SPSS (version 29.0.2.0, IBM). Individuals with missing data for one construct or questionnaire item were excluded from all analyses concerning these constructs or questionnaires. To analyze whether the proportions of individuals identified as likely having an eating disorder by the SCOFF questionnaire were independent of the categorical sociodemographic and psychological factors studied here (i.e., gender, age, education, social status, body image, health literacy), χ^2-tests of independence were calculated. Effect sizes for these tests are reported as Cramer's *V*. For χ^2-tests of contingency tables larger than 2×2, significant results were followed up with post-hoc Bonferroni-adjusted *z*-tests.

3 Results

3.1 Adults

3.1.1 Sample characteristics adults

The adult sample consisted of $N = 3{,}011$ individuals. The sample characteristics. i.e., gender, age, level of education, social status, body image and health literacy categories, before (unweighted) and after (weighted) the weighting procedure can be found in Table 1.

3.1.2 Associations with likely eating disorders in adults

In the weighted total samples of adults, 19.6% ($N = 590$) screened positive on the SCOFF suggesting an increased likelihood of having an eating disorder. 80.2% of participants ($N = 2{,}414$) screened negative and 0.2% ($N = 7$) had missing values in at least one SCOFF item impeding the calculation of the sum score.

An overview of the proportions of positive SCOFF screens for all sociodemographic and psychological categories in the adult sample can be found in Table 2.

At the descriptive level, women were more likely to screen positive for eating disorders (20.8%) than men (18.4%), but this

association was not significant, χ^2 (1, $N = 3{,}004$) = 2.71, $p = 0.100$, $V = 0.03$. There was a significant association between age and the SCOFF categories, χ^2 (3, $N = 3{,}004$) = 15.66, $p = 0.001$, $V = 0.07$. Descriptively, the proportions of positive SCOFF screenings decreased with increasing age (16–29 years: 22.7%; 30–45 years: 22.2%; 46–64 years: 19.7%; ≥ 65 years: 15.2%). Post-hoc tests revealed that the 16–29 years and 30–45 years groups did not differ significantly from each other and from the 46–64 years group, but from the ≥65 years group. There were no further significant differences between the age groups. The proportion of individuals scoring positive on the SCOFF did not differ by level of education, χ^2 (2, $N = 3{,}001$) = 2.24, $p = 0.327$, $V = 0.03$, with similar rates in low (18.2%), middle (20.9%) and high (19.2%) educational levels. However, there was a significant association between subjective social status and fulfilling the SCOFF screening criterion, χ^2 (2, $N = 3{,}001$) = 30.58, $p < 0.001$, $V = 0.10$. Post-hoc tests revealed that participants with lower subjective social status were more likely to screen positive for eating disorders than participants with middle and high subjective social status (low: 29.2%, middle: 18.6%, high: 16.0%), whereas the middle and high subjective social status groups did not significantly differ from each other.

Body image was significantly associated with fulfilling the SCOFF screening criterion, χ^2 (2, $N = 3{,}004$) = 303.27, $p < 0.001$, $V = 0.32$. Participants who considered themselves to be far too thin or far too fat were more likely to screen positive for eating disorders (48.1%) than those who considered themselves to be a bit too thin or fat (18.9%) and those who believed to have exactly the right weight (7.2%). Post-hoc tests revealed that these differences were significant for all three groups.

There was a significant association between the SCOFF and health literacy categories, χ^2 (1, $N = 2{,}983$) = 69.26, $p < 0.001$, $V = 0.15$, indicating lower proportions of positive SCOFF screenings in individuals with adequate (14.7%) vs. inadequate and problematic health literacy (27.1%).

TABLE 2 Proportions of positive and negative SCOFF screens in the adult sample for the gender, age, level of education, social status, body image and health literacy categories.

	Likely to have an eating disorder (%)	Not likely to have an eating disorder (%)
Gender		
Male	18.4%	81.6%
Female	20.8%	79.2%
Age groups		
16–29 years	22.7%	77.3%
30–45 years	22.2%	77.8%
46–64 years	19.7%	80.3%
≥ 65 years	15.2%	84.8%
Level of education		
Low	18.2%	81.8%
Middle	20.9%	79.1%
High	19.2%	80.8%
Social status		
Low	29.2%	70.8%
Middle	18.6%	81.4%
High	16.0%	84.0%
Body image (Do you think you are…)		
… exactly the right weight?	7.2%	92.8%
…a bit too thin/fat?	18.9%	81.1%
…far too thin/fat?	48.1%	51.9%
Health literacy		
Inadequate/problematic	27.1%	72.9%
Adequate	14.7%	85.3%

A positive SCOFF screen, defined as two or more "yes"-responses on the five SCOFF items, classifies individuals as likely to have an eating disorder. To confirm the presence of an eating disorder, positive screens need to be followed up with a more in-depth clinical assessment.

3.2 Adolescents

3.2.1 Sample characteristics adolescents

The adolescent sample consisted of $N = 1{,}021$ individuals. The sample characteristics. i.e., gender, age, level of education, social status, body image and health literacy categories, before (unweighted) and after (weighted) the weighting procedure can be found in Table 3.

3.2.2 Associations with likely eating disorders in adolescents

In the weighted total samples of adolescents, 18.9% ($N = 193$) screened positive on the SCOFF suggesting an increased likelihood of having an eating disorder. 81.1% of participants ($N = 828$) screened negative. There were no missing values.

An overview of the proportions of positive SCOFF screens for all sociodemographic and psychological categories in the adolescent sample can be found in Table 4.

Girls were significantly more likely to screen positive for eating disorders (23.4%) than boys (14.6%), χ^2 (1, $N = 1{,}018$) = 12.89, $p < 0.001$, $V = 0.11$. There was a significant association between age groups and the SCOFF categories, χ^2 (2, $N = 1{,}022$) = 13.43, $p = 0.001$, $V = 0.12$. Descriptively, the proportions of positive SCOFF screenings increased with increasing age (12–13 years: 13.9%, 14–15 years: 18.0%, 16–17 years: 24.8%). Post-hoc tests revealed significant differences between the youngest and oldest groups, but not differences between the 14–15-year-olds and any other group. The proportion of adolescents scoring positive on the SCOFF did not differ by level of education, χ^2 (1, $N = 1{,}021$) = 0.42, $p = 0.517$, $V = 0.02$, with similar rates in low (18.2%) and high (19.9%) educational levels. There was also no significant association between social status and fulfilling the SCOFF screening criterion, χ^2 (2, $N = 1{,}021$) = 4.96, $p = 0.084$, $V = 0.07$. Descriptively, participants with lower and middle social status were less likely to screen positive for eating disorders than participants with high social status (low: 18.4%, middle: 17.1%, high: 23.7%).

Body image was significantly associated with fulfilling the SCOFF screening criterion, χ^2 (2, $N = 1{,}020$) = 82.75, $p < 0.001$, $V = 0.29$. Participants who considered themselves to be a bit or far too thin or fat were significantly more likely to screen positive for eating disorders (29.5 and 41.8%, respectively) than individuals who believed to have exactly the right weight (9.2%). There was no significant difference between the individuals who considered themselves a bit vs. far too thin or fat.

TABLE 3 Sample characteristics of the weighted and unweighted sample of adolescents.

Variable	Unweighted sample, n (%)	Weighted sample, n (%)
Gender		
Male	514 (50.3%)	527 (51.6%)
Female	504 (49.4%)	492 (48.2%)
Diverse	3 (0.3%)	3 (0.3%)
Age groups		
12–13 years	340 (33.3%)	339 (33.2%)
14–15 years	346 (33.9%)	343 (33.6%)
16–17 years	335 (32.8%)	339 (33.2%)
Level of education		
Low	603 (59.1%)	603 (59.1%)
High	418 (40.9%)	418 (40.9%)
Social status		
Low	115 (11.3%)	114 (11.2%)
Middle	668 (65.4%)	666 (65.2%)
High	238 (23.3%)	241 (23.6%)
Body image (Do you think you are…)		
… exactly the right weight?	562 (55.0%)	565 (55.4%)
…a bit too thin/fat?	403 (39.5%)	400 (39.2%)
…far too thin/fat?	56 (5.5%)	56 (5.4%)
Health literacy		
Inadequate/problematic	548 (53.7%)	544 (53.3%)
Adequate	473 (46.3%)	477 (46.7%)

TABLE 4 Proportions of positive and negative SCOFF screens in the adolescent sample for the gender, age, level of education, social status, body image and health literacy categories.

	Likely to have an eating disorder (%)	Not likely to have an eating disorder (%)
Gender		
Male	14.6%	85.4%
Female	23.4%	76.6%
Age groups		
12–13 years	13.9%	86.1%
14–15 years	18.0%	82.0%
16–17 years	24.8%	75.2%
Level of education		
Low	18.2%	81.8%
High	19.9%	80.1%
Social status		
Low	18.4%	81.6%
Middle	17.1%	82.9%
High	23.7%	76.3%
Body image (Do you think you are…)		
… exactly the right weight?	9.2%	90.8%
…a bit too thin/fat?	29.5%	70.5%
…far too thin/fat?	41.8%	58.2%
Health literacy		
Inadequate/problematic	24.6%	75.4%
Adequate	12.4%	87.6%

A positive SCOFF screen, defined as two or more "yes"-responses on the five SCOFF items, classifies individuals as likely to have an eating disorder. To confirm the presence of an eating disorder, positive screens need to be followed up with a more in-depth clinical assessment.

There was a significant association between SCOFF and health literacy categories, χ^2 (1, $N = 1{,}021$) = 24.93, $p < 0.001$, $V = 0.16$, indicating lower proportions of positive SCOFF screenings in adolescents with adequate (12.4%) vs. inadequate and problematic health literacy (24.6%).

4 Discussion

4.1 Principal findings

The present study investigated the suspected presence of eating disorders in two representative samples of the German-speaking population in Germany and its association with sociodemographic and psychological factors including body image and health literacy.

Overall, 19.6% of adults and 18.9% of adolescents screened positive for eating disorders. For adolescents, these proportions are largely in line with previous investigations in Germany (Herpertz-Dahlmann et al., 2008; Cohrdes et al., 2019). However, for adults, results are substantially higher than in a previous investigation (Richter et al., 2017). This discrepancy might reflect an increase in potential eating disorder prevalences in the last years, previously reported outside Germany (Romano et al., 2022) or it might be due to methodological differences between our own and the previous study (Richter et al., 2017). The same questionnaire might produce different results when used in an online compared to an offline sample, e.g., due to social desirability (Zhang et al., 2017; Richter et al., 2017).

Among adolescents, large and significant gender differences were delineated. Specifically, girls were more likely to screen positive for eating disorders than boys, which is consistent with previous meta-analytic findings from global data (López-Gil et al., 2023). In our sample, rates of positive screenings for eating disorders in boys were slightly lower than in the same meta-analysis (López-Gil et al., 2023) but broadly similar to previous investigations in German-speaking samples (Herpertz-Dahlmann et al., 2008; Cohrdes et al., 2019; Zeiler et al., 2016). In contrast, rates in girls were lower in our sample when compared to the meta-analysis and previous investigations in German-speaking samples (Herpertz-Dahlmann et al., 2008; Cohrdes et al., 2019; Zeiler et al., 2016), which might be cautiously interpreted as an overall negative trend over time, previously only observed in boys (Cohrdes et al., 2019). However, this can only be determined more in depth when screening questionnaires are followed up with detailed diagnostic interviews in positively screened individuals.

Surprisingly, there were no significant gender differences in the adult sample, which contrasts previous findings of increased

prevalences of eating disorders in women vs. men (Solmi et al., 2014), but is consistent with previous reports of decreased gender differences in the SCOFF questionnaire with increasing age (Herpertz-Dahlmann et al., 2015; Richter et al., 2017).

In both samples, the likely presence of eating disorders was associated with age. In adolescents, an increase from the younger to the older age groups was observed, as in a previous meta-analysis (López-Gil et al., 2023) and other investigations in German speaking samples (e.g., Herpertz-Dahlmann et al., 2008). In the adult sample, the proportions of positive SCOFF screens decreased with increasing age, also in line with previous research (Solmi et al., 2014). Together, the results point to a peak of suspected eating disorder presence in late adolescence and early adulthood (Herpertz-Dahlmann, 2015). Prevention programs should therefore specifically target this age group.

Levels of education were not significantly associated with positive SCOFF screens in either sample. This finding is consistent with previous research with mixed or null results concerning the association of educational levels and eating disorders (Mitchison and Hay, 2014; Barakat et al., 2023; Solmi et al., 2014).

Social status was significantly associated with positive SCOFF screens only in adults, where higher proportions of suspected eating disorders were found in individuals with low compared to middle and high subjective social status. Descriptively, this pattern of results was reversed in adolescents (i.e., higher proportions with higher social status), but differences did not reach statistical significance. Importantly, social status was assessed differently in both samples, which is why results are not entirely comparable. In adults, social status was assessed with a subjective ranking, which might more closely mirror the perceived social structure of society. Conversely, the approach in adolescents might more specifically represent socioeconomic status as the items refer to material assets in the family. Overall, no clear associations of social status and eating disorders have been identified (Barakat et al., 2023).

As in previous studies (Cohrdes et al., 2019; Štefanová et al., 2020), subjective body image was significantly associated with suspected eating disorders in both groups. Critically, in both samples, proportions of positive eating disorder screens above 40% were found in those who considered themselves far too thin or far too fat. This is particularly worrying since shape or weight concerns are key features of both anorexia nervosa and bulimia nervosa (Treasure et al., 2020). However, no objective measure of weight or body mass index was obtained in this study, which is why subjective body image cannot be put into context of actual overweight or underweight. Cautiously, the results suggest that body image should be regarded as particularly important factors to address in future prevention programs. First approaches focusing on body image have been developed and evaluated but more high-quality research is needed to assess their effectiveness in reducing eating disorder symptoms or prevent onset of eating disorders (Yager and O'Dea, 2008; Le et al., 2017; Koreshe et al., 2023).

To our knowledge, this was the first study to link potential eating disorders with health literacy in large population-representative samples in Germany. In both our samples, higher proportions of suspected eating disorders were found in individuals with problematic or inadequate health literacy than in those with adequate health literacy. This finding is in line with previous research (Campanino et al., 2023; Boberová and Husárová, 2021). Although the cross-sectional design of our study precludes causal interpretation, our results suggest that health literacy may be an important factor to integrate into prevention strategies for eating disorders. First programs to enhance health literacy have been conceptualized and evaluated (Visscher et al., 2018; Walters et al., 2020). However, there is still a need for more targeted interventions, higher quality evaluations and a broader dissemination of positively-evaluated programs (Visscher et al., 2018; Walters et al., 2020).

4.2 Limitations

The results of this study have to be interpreted in the light of several limitations.

First, the cross-sectional design of the study does not allow causal interpretations of the association of the investigated constructs (Wang and Cheng, 2020). This means, for example, that we cannot unequivocally identify low health literacy as a risk factor for eating disorders as the direction of the association might be reversed.

Second, the adult sample is only representative of the German-speaking population with internet access in Germany. This means, that the results cannot be generalized to individuals without internet access or with limited knowledge of the German language.

Third, a recent meta-analysis points to reduced sensitivity of the SCOFF when applied in community samples compared to more homogeneous samples (such as young females) (Kutz et al., 2020), which has also been found in Germany (Richter et al., 2017).

Fourth, the SCOFF was not designed to address other—arguably even more prevalent—eating disorders such as binge eating disorders (Morgan et al., 1999; Kutz et al., 2020). A revision and extension of the questionnaire covering this topic might be necessary in the future.

Fifth, this study focused on potential eating disorders. However, some of the constructs reported here, such as negative body image, might not only be related to eating disorders but also to other psychiatric conditions such as mood disorders that are not the focus of the present work (Paans et al., 2018). Future studies should address potential associations between body image, different psychiatric conditions and eating behaviors, especially due to their high comorbidity (Preti et al., 2009).

Lastly, a further limitation concerning the SCOFF questionnaire is a potential inaccuracy in the German translation, which has been pointed out before (Zeiler et al., 2016) and might inflate the number of positive SCOFF screenings. The English verb "dominates" in item 5 was translated to "beeinflusst sehr" which can be back-translated to "influences a lot." In our sample, as in other German samples (Zeiler et al., 2016; Herpertz-Dahlmann et al., 2015), the rate of positive responses to this question is higher than in non-German speaking samples (Watson et al., 2015; e.g., Peat et al., 2015). Specifically, in the present study, 40.7% of adults and 26.0% of adolescents gave an affirmative response to this item. However, overall rates of positive SCOFF screenings in our samples are not higher than in a recent meta-analysis (López-Gil et al., 2023). This can be interpreted in two ways: either the inaccurate translation does not negatively impact the diagnostic accuracy of the SCOFF or prevalences of likely eating disorders are in fact lower in Germany but inflated by the disproportionate number of affirmations of item 5. Taken together, we propose a re-evaluation of the German version of the SCOFF to make it more comparable to other language versions.

4.3 Summary and conclusion

This was the first study to comprehensively investigate the associations of the suspected presence of eating disorders, particularly anorexia nervosa and bulimia nervosa, with several sociodemographic variables as well as body image and health literacy in two large and population-representative samples of German-speaking adolescents and adults. Suspected eating disorders were more likely in female than male adolescents but were not related to gender in adults. Highest rates of suspected eating disorders were found in late adolescence and early adulthood. While levels of education were unrelated to suspected eating disorders, low subjective social status was associated with higher rates of suspected eating disorders in adults but not adolescents. Individuals with low levels of health literacy and negative body image had higher levels of suspected eating disorders than individuals with adequate health literacy and more positive body image. The overall high rates of suspected eating disorders in both samples highlight the need for more preventive programs to lower the overall burden of the disorders. These could be targeted particularly at female individuals in late adolescence and early adulthood and should address aspects of body image and health literacy.

Data availability statement

The datasets generated and analyzed during this study are the property of the independent, nonprofit foundation Stiftung Gesundheitswissen and are available on reasonable request. Requests to access the datasets should be directed to lars.koenig@stiftung-gesundheitswissen.de. This study was part of a larger study, and therefore the raw data set contains further variables that have not been described because they exceed the scope of this study.

Ethics statement

A study protocol was submitted to the ethics committee of the Berlin Medical Association. The ethics committee had no ethical or professional objections to the study protocol (reference Eth-64/23). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants and their legal guardians/next of kin if they were younger than 16 years.

Author contributions

LK: Writing – review & editing. RSc: Writing – original draft. TH: Writing – review & editing. RSu: Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This research was funded by the independent, nonprofit foundation Stiftung Gesundheitswissen.

Acknowledgments

The authors want to thank the editor and the reviewers for taking the time and effort necessary to review the manuscript. Their insightful comments helped to improve the quality of the manuscript.

Conflict of interest

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

Publisher's note

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

References

Adler, N. E./Epel, E. S., Castellazzo, G., and Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: preliminary data in healthy white women. *Health Psychol.* 19, 586–592. doi: 10.1037/0278-6133.19.6.586

Ágh, T., Kovács, G., Supina, D., Pawaskar, M., Herman, B. K., Vokó, Z., et al. (2016). A systematic review of the health-related quality of life and economic burdens of anorexia nervosa, bulimia nervosa, and binge eating disorder. *Eat. Weight Disord.* 21, 353–364. doi: 10.1007/s40519-016-0264-x

Ali, K., Farrer, L., Fassnacht, D. B., Gulliver, A., Bauer, S., and Griffiths, K. M. (2017). Perceived barriers and facilitators towards help-seeking for eating disorders: a systematic review. *Int. J. Eat. Disord.* 50, 9–21. doi: 10.1002/eat.22598

Ambwani, S., Cardi, V., Albano, G., Cao, L., Crosby, R. D., Macdonald, P., et al. (2020). A multicenter audit of outpatient care for adult anorexia nervosa: symptom trajectory, service use, and evidence in support of "early stage" versus "severe and enduring" classification. *Int. J. Eat. Disord.* 53, 1337–1348. doi: 10.1002/eat.23246

Arcelus, J., Mitchell, A. J., Wales, J., and Nielsen, S. (2011). Mortality rates in patients with anorexia nervosa and other eating disorders. A meta-analysis of 36 studies. *Arch. Gen. Psychiatry* 68, 724–731. doi: 10.1001/archgenpsychiatry.2011.74

Barakat, S., McLean, S. A., Bryant, E., Le, A., Marks, P., Touyz, S., et al. (2023). Risk factors for eating disorders: findings from a rapid review. *J. Eat. Disord.* 11:8. doi: 10.1186/s40337-022-00717-4

Bergman, L., Nilsson, U., Dahlberg, K., Jaensson, M., and Wångdahl, J. (2023). Validity and reliability of the arabic version of the HLS-EU-Q16 and HLS-EU-Q6 questionnaires. *BMC Public Health* 23:304. doi: 10.1186/s12889-023-15226-5

Boberová, Z., and Husárová, D. (2021). What role does body image in relationship between level of health literacy and symptoms of eating disorders in adolescents? *Int. J. Environ. Res. Public Health* 18:3482. doi: 10.3390/ijerph18073482

Botella, J., Sepúlveda, A. R., Huang, H., and Gambara, H. (2013). A meta-analysis of the diagnostic accuracy of the SCOFF. *Span. J. Psychol.* 16:E92. doi: 10.1017/sjp.2013.92

Bullivant, B., Rhydderch, S., Griffiths, S., Mitchison, D., and Mond, J. M. (2020). Eating disorders "mental health literacy": a scoping review. *J Ment Health* 29, 336–349. doi: 10.1080/09638237.2020.1713996

Campanino, C., Falone, A., Rossi, E., Angeletti, L. L., Cassioli, E., Gemignani, S., et al. (2023). Health literacy in female patients affected by anorexia nervosa and bulimia nervosa: a cross-sectional study with pair-matched controls. *Eat. Weight Disord.* 28:59. doi: 10.1007/s40519-023-01588-7

Chan, J. K., Correll, C., Wong, C., Chu, R., Fung, V., Wong, G., et al. (2023). Life expectancy and years of potential life lost in people with mental disorders: a systematic review and meta-analysis. *EClinicalMedicine* 65:102294. doi: 10.1016/j.eclinm.2023.102294

Chesney, E., Goodwin, G. M., and Fazel, S. (2014). Risks of all-cause and suicide mortality in mental disorders: a meta-review. *World Psychiatry* 13, 153–160. doi: 10.1002/wps.20128

Cohrdes, C., Göbel, K., Schlack, R., and Hölling, H. (2019). Essstörungssymptome bei Kindern und Jugendlichen: Häufigkeiten und Risikofaktoren: Ergebnisse aus KiGGS Welle 2 und Trends. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 62, 1195–1204. doi: 10.1007/s00103-019-03005-w

Corell, M., Chen, Y., Friberg, P., Petzold, M., and Löfstedt, P. (2021). Does the family affluence scale reflect actual parental earned income, level of education and occupational status? A validation study using register data in Sweden. *BMC Public Health* 21:1995. doi: 10.1186/s12889-021-11968-2

Devoe, D. J., Han, A., Anderson, A., Katzman, D. K., Patten, S. B., Soumbasis, A., et al. (2023). The impact of the COVID-19 pandemic on eating disorders: a systematic review. *Int. J. Eat. Disord.* 56, 5–25. doi: 10.1002/eat.23704

Eronen, J., Paakkari, L., Portegijs, E., Saajanaho, M., and Rantanen, T. (2019). Assessment of health literacy among older Finns. *Aging Clin. Exp. Res.* 31, 549–556. doi: 10.1007/s40520-018-1104-9

Fleary, S. A., Joseph, P., and Pappagianopoulos, J. E. (2018). Adolescent health literacy and health behaviors: a systematic review. *J. Adolesc.* 62, 116–127. doi: 10.1016/j.adolescence.2017.11.010

Galmiche, M., Déchelotte, P., Lambert, G., and Tavolacci, M. P. (2019). Prevalence of eating disorders over the 2000-2018 period: a systematic literature review. *Am. J. Clin. Nutr.* 109, 1402–1413. doi: 10.1093/ajcn/nqy342

Garcia, F. D., Grigioni, S., Allais, E., Houy-Durand, E., Thibaut, F., and Déchelotte, P. (2011). Detection of eating disorders in patients: validity and reliability of the French version of the SCOFF questionnaire. *Clin. Nutr.* 30, 178–181. doi: 10.1016/j.clnu.2010.09.007

Garcia-Campayo, J., Sanz-Carrillo, C., Ibañez, J. A., Lou, S., Solano, V., and Alda, M. (2005). Validation of the Spanish version of the SCOFF questionnaire for the screening of eating disorders in primary care. *J. Psychosom. Res.* 59, 51–55. doi: 10.1016/j.jpsychores.2004.06.005

GBD 2019 Mental Disorders Collaborators (2022). Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990-2019: a systematic analysis for the global burden of disease study 2019. *Lancet Psychiatry* 9, 137–150. doi: 10.1016/S2215-0366(21)00395-3

Giel, K. E., Bulik, C. M., Fernandez-Aranda, F., Hay, P., Keski-Rahkonen, A., Schag, K., et al. (2022). Binge eating disorder. *Nat. Rev. Dis. Primers* 8:16. doi: 10.1038/s41572-022-00344-y

Harris, E. C., and Barraclough, B. (1998). Excess mortality of mental disorder. *Br. J. Psychiatry J. Ment. Sci.* 173, 11–53. doi: 10.1192/bjp.173.1.11

Hart, L. M., Granillo, M. T., Jorm, A. F., and Paxton, S. J. (2011). Unmet need for treatment in the eating disorders: a systematic review of eating disorder specific treatment seeking among community cases. *Clin. Psychol. Rev.* 31, 727–735. doi: 10.1016/j.cpr.2011.03.004

Herpertz, S., Fichter, M., Herpertz-Dahlmann, B., Hilbert, A., Tuschen-Caffier, B., Vocks, S., et al. (2018). S3-Leitlinie Diagnostik und Behandlung der Essstörungen. Berlin, Heidelberg.

Herpertz-Dahlmann, B. (2015). Adolescent eating disorders: update on definitions, symptomatology, epidemiology, and comorbidity. *Child Adolesc. Psychiatr. Clin. N. Am.* 24, 177–196. doi: 10.1016/j.chc.2014.08.003

Herpertz-Dahlmann, B., Dempfle, A., Konrad, K., Klasen, F., and Ravens-Sieberer, U. (2015). Eating disorder symptoms do not just disappear: the implications of adolescent eating-disordered behaviour for body weight and mental health in young adulthood. *Eur. Child Adolesc. Psychiatry* 24, 675–684. doi: 10.1007/s00787-014-0610-3

Herpertz-Dahlmann, B., Wille, N., Hölling, H., Vloet, T. D., and Ravens-Sieberer, U. (2008). Disordered eating behaviour and attitudes, associated psychopathology and health-related quality of life: results of the BELLA study. *Eur. Child Adolesc. Psychiatry* 17, 82–91. doi: 10.1007/s00787-008-1009-9

Hoebel, J., Müters, S., Kuntz, B., Lange, C., and Lampert, T. (2015). Messung des subjektiven sozialen Status in der Gesundheitsforschung mit einer deutschen Version der MacArthur Scale. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 58, 749–757. doi: 10.1007/s00103-015-2166-x

Holland, J., Hall, N., Yeates, D. G. R., and Goldacre, M. (2016). Trends in hospital admission rates for anorexia nervosa in Oxford (1968-2011) and England (1990-2011): database studies. *J. R. Soc. Med.* 109, 59–66. doi: 10.1177/0141076815617651

Hölling, H., and Schlack, R. (2007). Essstörungen im Kindes- und Jugendalter. Erste Ergebnisse aus dem Kinder- und Jugendgesundheitssurvey (KiGGS). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 50, 794–799. doi: 10.1007/s00103-007-0242-6

Jordan, S., and Hoebel, J. (2015). Gesundheitskompetenz von Erwachsenen in Deutschland: Ergebnisse der Studie "Gesundheit in Deutschland aktuell" (GEDA). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 58, 942–950. doi: 10.1007/s00103-015-2200-z

Kalindjian, N., Hirot, F., Stona, A.-C., Huas, C., and Godart, N. (2022). Early detection of eating disorders: a scoping review. *Eat. Weight Disord.* 27, 21–68. doi: 10.1007/s40519-021-01164-x

Keski-Rahkonen, A., and Mustelin, L. (2016). Epidemiology of eating disorders in Europe: prevalence, incidence, comorbidity, course, consequences, and risk factors. *Curr. Opin. Psychiatry* 29, 340–345. doi: 10.1097/YCO.0000000000000278

Koreshe, E., Paxton, S., Miskovic-Wheatley, J., Bryant, E., Le, A., Maloney, D., et al. (2023). Prevention and early intervention in eating disorders: findings from a rapid review. *J. Eat. Disord.* 11:38. doi: 10.1186/s40337-023-00758-3

Kutz, A. M., Marsh, A. G., Gunderson, C. G., Maguen, S., and Masheb, R. M. (2020). Eating disorder screening: a systematic review and Meta-analysis of diagnostic test characteristics of the SCOFF. *J. Gen. Intern. Med.* 35, 885–893. doi: 10.1007/s11606-019-05478-6

Le, L. K.-D., Barendregt, J. J., Hay, P., and Mihalopoulos, C. (2017). Prevention of eating disorders: a systematic review and meta-analysis. *Clin. Psychol. Rev.* 53, 46–58. doi: 10.1016/j.cpr.2017.02.001

Leung, S. F., Lee, K. L., Lee, S. M., Leung, S. C., Hung, W. S., Lee, W. L., et al. (2009). Psychometric properties of the SCOFF questionnaire (Chinese version) for screening eating disorders in Hong Kong secondary school students: a cross-sectional study. *Int. J. Nurs. Stud.* 46, 239–247. doi: 10.1016/j.ijnurstu.2008.09.004

López-Gil, J. F., García-Hermoso, A., Smith, L., Firth, J., Trott, M., Mesas, A. E., et al. (2023). Global proportion of disordered eating in children and adolescents: a systematic review and Meta-analysis. *JAMA Pediatr.* 177, 363–372. doi: 10.1001/jamapediatrics.2022.5848

Mitchison, D., and Hay, P. J. (2014). The epidemiology of eating disorders: genetic, environmental, and societal factors. *Clin. Epidemiol.* 6, 89–97. doi: 10.2147/CLEP.S40841

Monteleone, A. M., Pellegrino, F., Croatto, G., Carfagno, M., Hilbert, A., Treasure, J., et al. (2022). Treatment of eating disorders: a systematic meta-review of meta-analyses and network meta-analyses. *Neurosci. Biobehav. Rev.* 142:104857. doi: 10.1016/j.neubiorev.2022.104857

Moor, I., Herke, M., Markert, J., Böhm, M., Reiß, F., Bilz, L., et al. (2024). Trends in health inequalities in childhood and adolescence in Germany: results of the HBSC study 2009, 10 - 2022. *J. Health Monit.* 9, 79–98. doi: 10.25646/11876

Morgan, J. F., Reid, F., and Lacey, J. H. (1999). The SCOFF questionnaire: assessment of a new screening tool for eating disorders. *BMJ* 319, 1467–1468. doi: 10.1136/bmj.319.7223.1467

Murray, S. B., Quintana, D. S., Loeb, K. L., Griffiths, S., and Le Grange, D. (2019). Treatment outcomes for anorexia nervosa: a systematic review and meta-analysis of randomized controlled trials. *Psychol. Med.* 49, 535–544. doi: 10.1017/S0033291718002088

Nutbeam, D. (1998). Health promotion glossary. *Health Promot. Int.* 13, 349–364. doi: 10.1093/heapro/13.4.349

Paans, N. P. G., Bot, M., Brouwer, I. A., Visser, M., and Penninx, B. W. J. H. (2018). Contributions of depression and body mass index to body image. *J. Psychiatr. Res.* 103, 18–25. doi: 10.1016/j.jpsychires.2018.05.003

Peat, C. M., Von Holle, A., Watson, H., Huang, L., Thornton, L. M., Zhang, B., et al. (2015). The association between internet and television access and disordered eating in a Chinese sample. *Int. J. Eat. Disord.* 48, 663–669. doi: 10.1002/eat.22359

Pelikan, J. M., Röthlin, F., and Ganahl, K. (2014). Measuring comprehensive health literacy in general populations: Validation of instrument, indices and scales of the HLS-EU study: Bethesda, MD Available at: https://www.bumc.bu.edu/healthliteracyconference/files/2014/06/pelikan-et-al-harc-2014-fin.pdf.

Preti, A., De Girolamo, G., Vilagut, G., Alonso, J., De Graaf, R., Bruffaerts, R., et al. (2009). The epidemiology of eating disorders in six European countries: results of the ESEMeD-WMH project. *J. Psychiatr. Res.* 43, 1125–1132. doi: 10.1016/j.jpsychires.2009.04.003

Richter, F., Strauss, B., Braehler, E., Adametz, L., and Berger, U. (2017). Screening disordered eating in a representative sample of the German population: usefulness and psychometric properties of the German SCOFF questionnaire. *Eat. Behav.* 25, 81–88. doi: 10.1016/j.eatbeh.2016.06.022

Romano, K. A., Lipson, S. K., Beccia, A. L., Quatromoni, P. A., Gordon, A. R., and Murgueitio, J. (2022). Changes in the prevalence and sociodemographic correlates of eating disorder symptoms from 2013 to 2020 among a large national sample of U.S. young adults: a repeated cross-sectional study. *Int. J. Eat. Disord.* 55, 776–789. doi: 10.1002/eat.23709

Solmi, F., Hatch, S. L., Hotopf, M., Treasure, J., and Micali, N. (2014). Prevalence and correlates of disordered eating in a general population sample: the South East London community health (SELCoH) study. *Soc. Psychiatry Psychiatr. Epidemiol.* 49, 1335–1346. doi: 10.1007/s00127-014-0822-3

Solmi, M., Monaco, F., Højlund, M., Monteleone, A. M., Trott, M., Firth, J., et al. (2024). Outcomes in people with eating disorders: a transdiagnostic and disorder-specific systematic review, meta-analysis and multivariable meta-regression analysis. *World Psychiatry* 23, 124–138. doi: 10.1002/wps.21182

Solmi, M., Radua, J., Olivola, M., Croce, E., Soardo, L., de Pablo, S., et al. (2022). Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Mol. Psychiatry* 27, 281–295. doi: 10.1038/s41380-021-01161-7

Solmi, M., Radua, J., Stubbs, B., Ricca, V., Moretti, D., Busatta, D., et al. (2021). Risk factors for eating disorders: an umbrella review of published meta-analyses. *Braz. J. Psychiatry* 43, 314–323. doi: 10.1590/1516-4446-2020-1099

Sørensen, K., van den Broucke, S., Pelikan, J. M., Fullam, J., Doyle, G., Slonska, Z., et al. (2013). Measuring health literacy in populations: illuminating the design and development process of the European health literacy survey questionnaire (HLS-EU-Q). *BMC Public Health* 13:948. doi: 10.1186/1471-2458-13-948

Štefanová, E., Bakalár, P., and Baška, T. (2020). Eating-disordered behavior in adolescents: associations with body image, body composition and physical activity. *Int. J. Environ. Res. Public Health* 17:6665. doi: 10.3390/ijerph17186665

Steinhausen, H.-C., and Jensen, C. M. (2015). Time trends in lifetime incidence rates of first-time diagnosed anorexia nervosa and bulimia nervosa across 16 years in a Danish nationwide psychiatric registry study. *Int. J. Eat. Disord.* 48, 845–850. doi: 10.1002/eat.22402

Stice, E., Onipede, Z. A., and Marti, C. N. (2021). A meta-analytic review of trials that tested whether eating disorder prevention programs prevent eating disorder onset. *Clin. Psychol. Rev.* 87:102046. doi: 10.1016/j.cpr.2021.102046

Torsheim, T., Cavallo, F., Levin, K. A., Schnohr, C., Mazur, J., Niclasen, B., et al. (2016). Psychometric validation of the revised family affluence scale: a latent variable approach. *Child Indic. Res.* 9, 771–784. doi: 10.1007/s12187-015-9339-x

Treasure, J., Duarte, T. A., and Schmidt, U. (2020). Eating disorders. *Lancet* 395, 899–911. doi: 10.1016/S0140-6736(20)30059-3

Visscher, B. B., Steunenberg, B., Heijmans, M., Hofstede, J. M., Devillé, W., van der Heide, I., et al. (2018). Evidence on the effectiveness of health literacy interventions in the EU: a systematic review. *BMC Public Health* 18:1414. doi: 10.1186/s12889-018-6331-7

Walters, R., Leslie, S. J., Polson, R., Cusack, T., and Gorely, T. (2020). Establishing the efficacy of interventions to improve health literacy and health behaviours: a systematic review. *BMC Public Health* 20:1040. doi: 10.1186/s12889-020-08991-0

Wang, X., and Cheng, Z. (2020). Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest* 158, S65–S71. doi: 10.1016/j.chest.2020.03.012

Watson, H. J., Hamer, R. M., Thornton, L. M., Peat, C. M., Kleiman, S. C., Du, S., et al. (2015). Prevalence of screening-detected eating disorders in chinese females and exploratory associations with dietary practices. *Eur. Eat. Disord. Rev.* 23, 68–76. doi: 10.1002/erv.2334

Westmoreland, P., Krantz, M. J., and Mehler, P. S. (2016). Medical complications of anorexia nervosa and bulimia. *Am. J. Med.* 129, 30–37. doi: 10.1016/j.amjmed.2015.06.031

World Health Organization (2019). International classification of diseases, eleventh revision (ICD-11). The global standard for diagnostic health information. Available at: https://icd.who.int/browse11.

Yager, Z., and O'Dea, J. A. (2008). Prevention programs for body image and eating disorders on university campuses: a review of large, controlled interventions. *Health Promot. Int.* 23, 173–189. doi: 10.1093/heapro/dan004

Zeiler, M., Waldherr, K., Philipp, J., Nitsch, M., Dür, W., Karwautz, A., et al. (2016). Prevalence of eating disorder risk and associations with health-related quality of life: results from a large school-based population screening. *Eur. Eat. Disord. Rev.* 24, 9–18. doi: 10.1002/erv.2368

Zhang, X. C., Kuchinke, L., Woud, M. L., Velten, J., and Margraf, J. (2017). Survey method matters: online/offline questionnaires and face-to-face or telephone interviews differ. *Comput. Hum. Behav.* 71, 172–180. doi: 10.1016/j.chb.2017.02.006

frontiers | Frontiers in Nutrition

TYPE Original Research
PUBLISHED 18 September 2024
DOI 10.3389/fnut.2024.1456782

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
Mateusz Rozmiarek,
Poznan University of Physical Education, Poland
Randhall Carteri,
Centro Universitário Metodista IPA, Brazil

*CORRESPONDENCE
Wiktoria Staśkiewicz-Bartecka
✉ wstaskiewicz@sum.edu.pl

RECEIVED 29 June 2024
ACCEPTED 06 September 2024
PUBLISHED 18 September 2024

CITATION
Staśkiewicz-Bartecka W, Aktaş S, Zydek G, Kardas M, Kałuża M and Michalczyk MM (2024) Eating disorder risk assessment and sociocultural attitudes toward body image among Polish and Turkish professional female football players.
Front. Nutr. 11:1456782.
doi: 10.3389/fnut.2024.1456782

Eating disorder risk assessment and sociocultural attitudes toward body image among Polish and Turkish professional female football players

Wiktoria Staśkiewicz-Bartecka[1,2]*, Samet Aktaş[3], Grzegorz Zydek[4], Marek Kardas[1], Martyna Kałuża[5] and Małgorzata Magdalena Michalczyk[2]

[1]Department of Food Technology and Quality Evaluation, Department of Dietetics, Faculty of Public Health in Bytom, Medical University of Silesia in Katowice, Zabrze, Poland, [2]Institute of Sport Sciences, Jerzy Kukuczka Academy of Physical Education in Katowice, Katowice, Poland, [3]High School of Physical Education and Sports, Batman University, Batman, Türkiye, [4]Department of Sport Nutrition, Jerzy Kukuczka Academy of Physical Education in Katowice, Katowice, Poland, [5]Nutrition and Sports Performance Research Group, The Jerzy Kukuczka Academy of Physical Education in Katowice, Katowice, Poland

Introduction: Football requires high physical fitness and often involves maintaining a specific physique, leading to harmful eating behaviors due to internal and external pressures. Cultural norms influence the prevalence and types of eating disorders (ED), with differences in eating habits, beauty standards, and socio-cultural pressures affecting ED development. This study assesses ED risk and analyzes socio-cultural attitudes toward body image among Polish and Turkish female football players.

Methods: The study was conducted from April to June 2024 and included 103 professional female football players aged 18–35 from Polish (n = 49) and Turkish (n = 54) clubs. Data were collected using the CAWI method via Google Forms. Participants completed EAT-26 and SATAQ-3 questionnaires, assessing ED risk and socio-cultural attitudes toward body image.

Results: 40.8% of participants were at risk for ED. No differences in ED prevalence were found between groups of different nationalities. Polish footballers at risk of ED scored higher on the Internalization-Pressure and Information subscales and the overall SATAQ-3 score. A weak but significant positive correlation was found between SATAQ-3 and EAT-26 scores.

Discussion: The study finds no nationality-based differences in ED prevalence among professional female football players, but ED is widespread, affecting about 40% of players. Nutritional status impacts ED risk, with higher risk among underweight and overweight players. Polish players are more influenced by socio-cultural standards of body image promoted by mass media. The study underscores the need for regular screening and psychological support.

KEYWORDS

eating disorders, female football player, body image, professional sport, sport nutrition

1 Introduction

Football requires a high level of physical fitness, often necessitating the maintenance of a specific physique (1). Athletes face both internal and external pressures, including from teammates, coaches, and sports systems, to achieve and maintain a particular body shape for optimal performance and to meet esthetic ideals (2–5). These pressures can lead to overtraining and harmful eating behaviors, such as dietary restrictions and self-induced vomiting, particularly among women who face additional appearance-related pressures (2, 3, 6, 7). Social media further exacerbates these issues by promoting unrealistic beauty standards (8). Although there is evidence linking social media use to eating disorder (ED) prevalence among football players, there is a lack of research specifically on female players (9).

Eating disorders are behavioral disorders characterized by excessive weight control and obsessive thinking about food (8). According to American Psychiatric Association's classification (DSM-V), these disorders are categorized into specific (e.g., anorexia nervosa, bulimia nervosa) and non-specific types, which include behaviors like emotional eating or food fanaticism (10). The International Statistical Classification of Diseases and Health Problems (ICD-11) classifies eating disorders as mental disorders linked to physiological and psychological factors, often accompanied by anxiety, depression, obsessive-compulsive disorder, and reduced quality of life (11). These disorders lead to harmful eating behaviors, such as starvation, frequent meal skipping, overeating followed by purging, and excessive exercise (12). Abnormal eating behaviors and overtraining in female athletes can lead to Relative Energy Deficiency in Sport (RED-S), a syndrome marked by low energy availability due to an imbalance between energy expenditure and intake (13, 14). RED-S, which evolved from the "female athlete triad," is associated with injuries, reduced athletic performance, and serious health issues (13, 14).

Although there is extensive literature on ED in athletes, results are inconclusive. Some studies report higher levels of ED psychopathology in athletes compared to non-athletes, while others find no difference or the opposite effect (15). Differences in aspects such as body dissatisfaction, striving for thinness, and food restriction complicate the prioritization of research and prevention efforts without identifying specific at-risk sports and sociocultural factors (16–18).

ED are well-documented among athletes in esthetic sports, where they are judged on aspects like harmony of movement, physical attractiveness, and thinness (19, 20). However, recent studies show that ED also occur in non-esthetic sports, including individual sports like running, triathlon, cycling, and sports with weight categories (21–25). Therefore, it may be more appropriate to categorize sports as lean and non-lean (25).

Ball sports, where athletes' weight and size do not directly affect performance, are classified as non-lean sports (25, 26). Despite this, studies show the presence of eating disorders (ED) among female footballers and volleyball players (9, 27). For example, Staśkiewicz et al. (9) found that many football players are at risk of developing ED, and Torres-McGehee et al. (28) reported that 25% of female football players experienced overeating. ED can occur in both lean esthetic and non-esthetic sports, including ball sports.

In the literature on the risk of ED among athletes, there are increasing inquiries about whether the risk of developing these disorders varies depending on the position of players on the field and their injury history. For instance, research by Torres-McGehee et al. has shown that athletes who have undergone periods of rehabilitation after injuries often exhibit higher levels of anxiety about their body and weight (28). Prolonged inactivity may lead to concerns about losing physical fitness, which in turn increases the risk of developing unhealthy eating patterns, such as excessive caloric restriction or intensive exercise to quickly regain fitness. On the other hand, research by Escobar-Molina et al. found that athletes participating in sports with a higher risk of injury are more susceptible to eating disorders due to the pressure to return to training and competition as quickly as possible (24). The rehabilitation process can lead to an obsession with weight and physical performance, particularly among athletes who fear losing their place on the team roster.

Additionally, the position of an athlete on the field can significantly influence the perceived risk of eating disorders. Studies on athletes playing different positions in football have shown that forward are often more exposed to pressure related to appearance and weight compared to defenders or goalkeepers (21). This group of players often strives to maintain a low body fat percentage, which is associated with the pressure to maintain a specific physique and physical fitness, especially in sports where speed and agility play a key role. Further research, such as that conducted by Sundgot-Borgen and Torstveit, indicated that female athletes in certain field positions, particularly those in more physically demanding roles, may be more susceptible to eating disorders (29). These positions require maintaining low body weight and high endurance, which can lead to unhealthy dietary practices to meet these demands.

Nationality and culture significantly impact the assessment of ED, influencing beauty norms, social expectations, access to resources, and psychological aspects (30). Cultural differences in beauty standards and ethnic diversity in diets and rituals can affect ED types and prevalence (31). Studies highlight differences in ED psychopathology between Western and non-Western societies, emphasizing the need for culturally sensitive assessment tools (32). The rise of ED in non-Western countries challenges the view that they are solely a Western issue, revealing complex cultural interactions (33). Western societies show higher levels of body dissatisfaction and general psychopathology than non-Western countries (34). Cultural pressures and media portrayals of ideal bodies further complicate the relationship between culture and ED development (35). Effective ED assessment requires considering cultural context to provide appropriate diagnosis and treatment.

Sociocultural theory provides a framework for exploring how environmental influences affect body image concerns. The Sociocultural Attitudes Toward Appearance Questionnaire (SATAQ-3) measures awareness and internalization of societal influences on appearance (36). Research consistently supports a strong relationship between sociocultural influences and body dissatisfaction (37).

The purpose of the study is to assess the risk of ED and analyze sociocultural attitudes toward body image among Polish and Turkish female football players. The study aims to identify differences in ED risk levels and attitudes toward beauty standards and social pressures between the two groups, taking into account the influence of nationality on these phenomena.

The study hypothesized that (1) female football players are at significant risk of eating disorders, furthermore (2) female football players from Poland and Turkey differ in their risk of eating disorders

(3) there are differences in socio-cultural attitudes toward body image between the groups.

2 Materials and methods

2.1 The procedure of the survey

The survey was conducted from April to June 2024. Utilizing the CAWI (Computer-Assisted Web Interview) method, data was collected via a web form, an accepted approach in psychological research. Google Forms was chosen for its user-friendliness, accessibility, and customizability. Athletes were given a QR code before the start of the training session that directed them to the survey. Researchers explained the process beforehand to ensure proper understanding and minimize errors. The female football players completed the survey as soon as they received the QR code, and no time limit was set for completing the questionnaire.

The study used purposive sampling. With this method, the sample was selected to represent characteristics and specific experiences related to the topic of the study. Determining precise selection criteria, such as gender, sports discipline, and nationality, was crucial to achieving the study's objectives.

Participants in the study were informed about the purpose of the study and its anonymity and were asked to accept the rules of data sharing. Information about informed and voluntary participation in the study was at the beginning of the questionnaire. The World Medical Association's Declaration of Helsinki guided the conduct of this study. The study was approved by the Bioethics Committee of the Silesian Medical University in Katowice (BNW/NWN/0043–3/641/35/23, date of approval: 22/09/2023) in light of the Law of December 5, 1996 on the Profession of Physician and Dentist (Journal of Laws 2016, item 727).

2.2 Study participants

The study involved 103 female football players aged 18–35 from 4 sports clubs, 2 clubs were located in Poland ($n = 49$) and 2 in Turkey ($n = 54$). Based on the location of the clubs, the players were divided into two groups: Polish female football players (PL) and Turkish female football players (TR). The Polish players competed in the Ekstraliga (1st level of play) and I Liga (2nd level of play), while the Turkish players participated in the Women's 2nd league (3rd level of play) and Women's 3rd league (4th level of play). All clubs participating in the study, according to the statutes of the Polish Football Association (PZPN) and the Turkish Football Federation (TFF), participate in professional football competitions (38, 39). The response rate for the PL group was 90.74%, and for the TR group, it was 96.42%.

The study was conducted in the final phase of the starting spring round of the 2023/2024 league season, all players were tested during the same period of the training macrocycle to obtain comparable results.

The inclusion criteria for the study were as follows: (1) female gender (2) club consent for study participation, (3) voluntary participation, (4) age 18 years or older, (5) active player status at the time of the study, (6) no injuries leading to a training break of at least 7 days within the last 2 months, (7) proficiency in Polish or Turkish. The exclusion criterion was any incorrectly or incompletely completed questionnaire.

2.3 Research tools

A survey questionnaire was used to conduct the study, which consisted of a metric section (respondent's data: age, height, weight, chronic diseases including mental disorders such as depression, eating disorders, neurosis, etc., medications taken, education, position held, sports experience, number of workouts per week, sources of nutritional knowledge, food exclusions, information on social media use) and questionnaires- Socio-Cultural Attitudes Questionnaire (SATAQ 3) Eating Attitudes Test (EAT-26).

2.3.1 Body mass index

The nutritional status of the subjects was evaluated through the calculation of the body mass index (BMI). BMI was derived using the standard formula:

$$BMI = \frac{body\ weight\ (kg)}{height\ (m)^2}$$

The results were interpreted according to the World Health Organization (WHO) (40).

2.3.2 EAT-26

The study used a screening tool to assess ED risk, the American Dietary Attitudes Test developed by Garner et al. 448. This questionnaire is a widely recognized standardized instrument used to identify symptoms indicative of ED risk. It is designed to screen individuals both with a clinical diagnosis and those at risk for AN, BN, or obesity. EAT-26 is one of the most extensively used diagnostic tools in global studies on the prevalence of eating disorders. The author of the Polish standardization of the tool is K. Wlodarczyk-Bisaga (41), while the Turkish standardization was developed by F. Elif Ergüney-Okumuş and H. Özlem Sertel-Berk (42). The test is not a diagnostic tool, but some authors have suggested that the EAT-26 can identify cases at risk for ED on the clinical spectrum (43).

The interpretation of the EAT-26 questionnaire consists of three "referral criteria" that determine whether the respondent should report for further evaluation of ED risk:

1. The final score on the EAT-26 questionnaire is calculated by summing the scores from 26 questions that evaluate attitudes toward nutrition. Questions 1 through 25 are scored as follows: Always = 3 points; Usually = 2 points; Often = 1 point; Other answers = 0 points. Question 26 is scored inversely: "Never" = 3 points, and so forth. The total score ranges from 0 to 78. A score of 20 or higher indicates a potential risk for an eating disorder, warranting consultation with a specialist for further evaluation.
2. Questions regarding behavioral patterns may indicate the presence of symptoms associated with ED or recent significant weight loss. These questions target compensatory behaviors such as the use of laxatives, self-induced vomiting, binge eating, excessive physical activity, and rapid and significant weight loss over a short period. An affirmative response to any of these questions might suggest abnormalities and necessitate further diagnostic evaluation for ED.

3. The survey contains specific questions about respondents' height, body mass, and gender, which are essential for calculating the BMI. BMI can indicate potential risks of ED, particularly if the body mass is significantly low relative to age standards. By evaluating BMI alongside height, body mass, and gender data, it becomes possible to identify individuals at risk and highlight the need for further analysis. Interpretation of women's BMI compared to norms for age (44).

The overall EAT-26 scale in the Polish version showed very good omega McDonald's internal consistency at 0.811. For individual subscales, it was 0.790 for part A, 0.777 for part B. In contrast, the Turkish version of the EAT-26 scale showed satisfactory omega McDonald's internal consistency of 0.727. For individual subscales, it was 0.742 for part A, 0.704 for part B.

2.3.3 SATAQ-3

The Socio-Cultural Attitudes Toward Appearance Scale 3 (SATAQ 3) is a widely used method of measuring the influence of socio-cultural norms promoted by mass media on attitudes and behaviors regarding the body and physical appearance. The scale was developed by Heinberg and Thompson (45). The SATAQ 3 questionnaire and its earlier versions are useful methods for assessing the strength of pressure and internalization of socio-cultural standards of body image and physical appearance. Correlational studies have shown significant associations between the SATAQ 3 and measures of body image and ED indicators, such as body dissatisfaction and striving to be excessively thin (46). The questionnaire consists of 30 items to which the respondent should respond using a five-point Likert scale, where 1 means strongly disagree and 5 means strongly agree. The scale has four homogeneous factors: Internalization-General, Internalization- Athlete, Pressures and Information. Cronbach's α coefficient calculated for the entire tool was 0.96 (45). The original internal structure of the SATAQ-3 has not been replicated in the different versions and adaptations (47).

The study used the Polish version of the questionnaire developed by Izydorczyk B. Lizińczyk S. (48) and the Turkish version developed by Swami V. et al. (49).

2.3.3.1 Polish version

The results of factor analysis and unsatisfactorily low values of factor loadings for the identified factors in items #3 and #9 resulted in the exclusion of these items from the Polish version of the SATAQ-3 questionnaire, which contains 28 questions (46). Four factors obtained in the Polish version of the SATAQ-3 questionnaire were named differently than in the English version of the tool. Internalization-Pressure scale (12 items), Internalization-Information Seeking scale (6 items), Internalization-Athlete scale (4 items), Information scale (6 items). Cronbach's α coefficients were satisfactory for the individual subscales of the tool in the surveyed population of Polish men and women. They ranged from 0.76 to 0.92. The Polish adaptation and normalization of the SATAQ-3 have similar reliability and statistical properties to the original version of the tool developed by Thompson et al. (42, 46).

The overall SATAQ scale in the Polish version showed very good internal consistency of McDonald's omega at 0.927. For the "Internalization-Pression" scale it was 0.956 for the "Internalization-Athlete" scale it was 0.849 for the "Internalization-Information Seeking" scale it was 0.817 for the "Information scale" it was 0.831.

2.3.3.2 Turkish version

The results of the analysis showed that item #20 appeared to cross-load two factors, this resulted in the exclusion of this item from the Turkish version of the SATAQ-3 questionnaire, which contains 29 questions (47). The Turkish version of the SATAQ-3 questionnaire has four factors: Information (9 items), Pressure (7 items), Internalization-General (9 items), and Internalization-Athlete (4 items) and internal consistency of the scale in was 0.93, while it ranged between 0.70 and 0.91 for the subscales. The Turkish adaptation and normalization of the SATAQ-3 have similar reliability and statistical properties to the original version of the tool developed by Thompson et al. (45, 48, 49).

The overall SATAQ scale in the Turkish version showed very good internal consistency of McDonald's omega at 0.923. For the "Internalization- General" scale it was 0.828 for the "Pressure" scale it was 0.888 for the "Internalization-Athlete" scale it was 0.734 for the "Information" scale it was 0.846.

2.4 Statistical analysis

Statistical analyses were performed using Statistica v.13.3 (Stat Soft Poland) and the R package v. 4.0.0 (2020) under the GNU GPL (The R Foundation for Statistical Computing). To present quantitative data, mean values and standard deviations ($X \pm S$) were calculated; for qualitative data, percentage notation was used.

The statistical analysis used the Chi^2 and Fisher's exact test to compare groups. The Chi^2 test was used to evaluate differences between groups for categorical variables such as education level, sources of nutrition knowledge, and frequency of additional training outside the sports club. Fisher's exact test was used in situations where the sample sizes in each category were too small for the Chi-square test to be meaningful. The significance of differences between female football players of different origins was assessed using Student's t-test for two parametric groups, analysis of variance (ANOVA) for three or more parametric groups, Mann–Whitney U test for two non-parametric groups, and Kruskal-Wallis test for three or more non-parametric groups. Pairwise comparisons of body weight measurements were made using the Durbin-Conover test.

To examine the relationship between EAT-26 and SATAQ-3 scores, the Spearman Correlation Coefficient was used. This coefficient measures the strength and direction of the relationship between two ordinal variables.

A linear regression analysis was conducted to assess the relationship between various dimensions of sociocultural internalization and the EAT-26 score, which measures the risk of ED. The results of the analysis are presented in the form of regression coefficients (Estimates), along with standard deviations, t-statistics, and statistical significance levels.

A value of $p < 0.05$ was used as a criterion for statistical significance.

3 Results

3.1 Characteristic study group

One hundred and three female football players participated in the study after considering the inclusion and exclusion criteria. Based on their club origin, the players were divided into two groups: the first group ($n = 49$) consisted of female players from Polish clubs (PL),

while the second group ($n = 54$) consisted of female players from clubs located in Turkey (TR). One female football player had a chronic illness (allergy) and was taking medication (Flixonase). The educational background of the participants varied between the two groups. Female athletes from Poland had primary ($N = 11$), secondary ($n = 29$), and higher education ($n = 9$), while Turkish women had only secondary ($n = 9$) and higher education ($n = 45$; $p < 0.001$). There were differences in the sources of nutritional knowledge among the female athletes. The Polish women drew their knowledge mainly from the internet ($n = 25$) and from a nutritionist ($n = 11$), while the Turkish women obtained theirs from a coach ($n = 22$) and the internet ($n = 17$; $p < 0.001$). No significant differences were observed in performing additional training units outside the sports club ($p = 0.559$), with the majority of female athletes declaring that they train 1–2 times per week ($n = 44$) or 3–4 times per week ($n = 35$). According to the interpretation of the BMI index, one female athlete from Poland was overweight, while five female athletes from Turkey were underweight ($p = 0.056$).

The players were also asked about their lowest and highest body weight in adulthood, as well as what they thought was the ideal body There was a statistically significant difference between PL and TR female football players in the question about the highest body weight ($p = 0.017$). In addition, there was a statistically significant difference between the highest ($p < 0.001$), lowest ($p < 0.001$), and ideal ($p = 0.002$) body weight and current body weight for the entire study group (Table 1).

3.2 Risk of ED

Based on the results of the EAT-26, Part A questionnaire, it was estimated that 11.7% of the respondents (both Polish and Turkish women) were at risk for ED and should seek further diagnosis from a specialist. There were no significant differences between the groups in the total EAT-26, Part A test score, which may indicate the risk of developing eating disorders ($p = 0.242$). Additionally, there were no statistically significant differences between the groups in terms of nutritional status as interpreted by BMI value according to WHO recommendations ($p = 0.787$), education level ($p = 0.208$), and the amount of additional training outside the sports club ($p = 0.123$), about the total score of the EAT-26, Part A test.

According to the accepted results in the behavioral questions from the EAT-26 test, Part B, it was estimated that 28.6% of Polish and 33.3% of Turkish female football players met the criterion that may indicate a risk of developing ED. There was no significant effect of nationality on EAT-26 test scores for behavioral questions ($p = 0.602$). Additionally, no statistically significant differences were found between groups in terms of nutritional status as interpreted through BMI values according to WHO recommendations ($p = 0.291$), education level ($p = 0.637$), and the amount of additional training outside the sports club ($p = 0.192$) concerning the total EAT-26 Part B test score.

According to the accepted norms in Part C of the EAT-26 test (low body weight compared to age norms), it was estimated that 2% of Polish and 16.7% of Turkish female football players met a criterion that may indicate a risk of developing an ED. There was a significant effect of nationality on the results of Part C of the EAT-26 test ($p = 0.012$). Additionally, no statistically significant differences were found between the groups in terms of education level ($p = 0.162$) and the amount of additional training outside the sports club ($p = 0.345$) to the EAT-26 Part C test score.

Based on the overall results and interpretation of the EAT-26 questionnaire, it was found that 40.8% of the female respondents (both Polish and Turkish) met at least one of the three criteria that may indicate the likely existence or susceptibility to ED. These individuals should see a specialist for further diagnosis. There was no significant effect of the level of origin on the overall EAT-26 score ($p = 0.231$). Statistically significant differences were found between nutritional status interpreted through BMI values according to WHO recommendations and the total EAT-26 score ($p = 0.004$). Overweight and underweight athletes were more likely to have an increased risk of ED. There was no relationship between education level and the total EAT-26 test score ($p = 0.416$). However, there was a correlation between the frequency of extra training outside of the football club and the total EAT-26 test score ($p = 0.025$). The conducted study did not show a statistically significant relationship between the players' position on the field and the risk of ED, as assessed by the EAT-26 scale. The result of the statistical analysis ($p = 0.328$) suggests that the

TABLE 1 Characteristics of the study group, including the current, lowest, highest, and considered ideal body mass of female football players ($n = 103$).

	Total ($n = 103$)	PL ($n = 59$)	TR ($n = 54$)	p-value
Age [years]	21.80 ± 3.47	22.20 ± 4.15	21.40 ± 2.70	0.295
Height [cm]	166.00 ± 6.16	168.00 ± 5.81	155.00 ± 6.09	0.006*
Body mass [kg]	58.10 ± 6.31	60.50 ± 5.76	55.90 ± 6.03	<0.001*
BMI [kg/m^2]	21.00 ± 1.61	21.40 ± 1.28	20.60 ± 1.79	0.010*
Body mass; CURRENT	58.10 ± 6.31	60.50 ± 5.76	55.90 ± 6.03	0.257
Body mass; LOWEST	53.80 ± 7.29	56.80 ± 6.26	51.20 ± 7.17	0.393
Body mass; HIGHEST	61.70 ± 7.48	64.1 ± 7.38	59.6 ± 6.96	0.017*
Body mass; IDEAL	57.70 ± 5.45	59.30 ± 5.46	56.20 ± 5.05	0.006*
CURRENT – HIGHEST $p < 0.001$* CURRENT – LOWEST $p < 0.001$* CURRENT – IDEAL $p = 0.002$*				

All data are presented in the table as mean and standard deviation (X ± SD); BMI, Body Mass Index; PL, Polish female football player; TR, Turkish female football player; *$p < 0.05$.

position played by the athlete does not significantly influence the risk of developing eating disorders (Table 2).

3.3 Influence of sociocultural attitudes toward appearance on ED risks

Analyzing the results obtained using the SATAQ-3, significant statistical relationships were found in the group of Polish athletes. Football players at risk of developing ED scored higher in the sections Internalization-Pressure (26.5 ± 12.2 vs. 18.3 ± 7.04, $p = 0.010$), Information (13.6 ± 5.05 vs. 10.5 ± 3.54, $p = 0.041$), and the total scale (69.8 ± 17.8 vs. 56.8 ± 15.3, $p = 0.011$). In the group of Turkish athletes, no statistically significant relationships were found between the scores in individual sections and the risk of developing ED. Additionally, significant statistical differences were found between the groups of Polish and Turkish athletes in the overall number of points obtained (61.3 ± 17.2 for the PL group vs. 73.1 ± 19.6 for the TR group, $p = 0.002$). Detailed information is presented in Table 3.

3.4 Relationship between SATAQ-3 score and EAT-26

The analysis revealed a statistically significant positive correlation between the scores of SATAQ-3 and EAT-26 ($p = 0.036$, $\rho = 0.207$). This indicates a weak but significant association, suggesting that higher scores on one test are related to higher scores on the other (Figure 1).

3.4.1 Linear regression analysis of EAT-25 AND SATAQ-3 in PL group

The Table 4 presents the results of a linear regression analysis aimed at examining the relationship between various dimensions of sociocultural internalization (Internalization-Pressure, Internalization-Information Seeking, Internalization-Athlete, Information) and the EAT-26 score, which measures the risk of eating disorders. A significant effect on the EAT-26 score was observed for two variables: Internalization-Pressure ($p < 0.001$) and Information ($p = 0.029$). Internalization-Pressure had a positive impact on the score, indicating that greater internalization of societal pressure is associated with an increased risk of eating disorders. On the other hand, the Information variable had a negative effect, suggesting that access to information may reduce the risk of ED. The other variables, such as Internalization-Information Seeking and Internalization-Athlete, did not have a significant impact on the EAT-26 score ($p > 0.05$). The model's fit measure ($R^2 = 0.33$) indicates that approximately 33% of the variability in EAT-26 scores can be explained by these predictors.

3.4.2 Linear regression analysis of EAT-25 AND SATAQ-3 in TR group

The Table 5 presents the results of a linear regression analysis aimed at investigating the relationship between several

TABLE 2 Summary of ED risk estimation (EAT-26; $n = 103$).

EAT-26	Total (103)		PL ($n = 49$)		TR ($n = 54$)		p-value
Elevated risk	No risk	Elevated risk	No risk	Elevated risk	No risk	Elevated risk	
Part A n (%)	91 (88.3)	12 (11.7)	43 (87.8)	6 (12.2)	48 (88.9)	6 (11.1)	*0.858*
Part B n (%)	71 (68.9)	32 (31.1)	35 (71.4)	14 (28.6)	36 (66.7)	18 (33.3)	0.602
Part C n (%)	93 (90.3)	10 (9.7)	48 (98.0)	1 (2.0)	45 (83.3)	9 (16.7)	0.012*
Entire n (%)	61 (59.2)	42 (40.8)	32 (65.3)	17 (34.7)	29 (53.7)	25 (46.3)	0.231

PL, Polish female football player; TR, Turkish female football player; *$p < 0.05$.

TABLE 3 Comparison of SATAQ-3 scores between Polish and Turkish female football players based on risk of developing ED (EAT-26).

	PL					TR			
Scale	Total ($n = 49$)	ER ($n = 17$)	NR ($n = 32$)	p-value	Scale	Total ($n = 54$)	ER ($n = 25$)	NR ($n = 29$)	p-value
I-P 12–60 point	21.2 ± 9.86	26.5 ± 12.2	18.3 ± 7.04	0.010*	P 7–35 points	15.7 ± 6.16	15.7 ± 5.59	15.8 ± 6.87	0.773
I-I S 6–30 points	17.7 ± 5.94	17.7 ± 4.01	17.7 ± 6.81	0.674	I-G 9–45 points	22.5 ± 5.61	22.6 ± 5.55	22.6 ± 5.76	0.986
I-A 4–20 points	10.9 ± 4.25	11.9 ± 3.94	10.3 ± 4.35	0.184	I-A 4–20 points	11.8 ± 3.80	11.6 ± 3.88	12.0 ± 3.77	0.564
I 6–30 points	11.6 ± 4.35	13.6 ± 5.05	10.5 ± 3.54	0.041*	I 9–45 points	23.1 ± 7.12	23.0 ± 7.67	23.2 ± 6.74	0.715
Total 28–140 points	61.3 ± 17.2	69.8 ± 17.8	56.8 ± 15.3	0.011*	Total 29–145 points	73.1 ± 19.6	72,8 ± 21.1	73.4 ± 18.5	0.609
p-value	0.002*								

All data are presented in the table as mean and standard deviation (X ± SD); PL, Polish female football player; TR, Turkish female football player; *$p < 0.05$; ER, Elevated Risk; NR, No Risk; *$p < 0.05$; I-P, Internalization-Pressure; I-I S, Internalization-Information Seeking; I-A, Internalization-Athlete; I, Information; P, Pressure; I-G, Internalization-General.

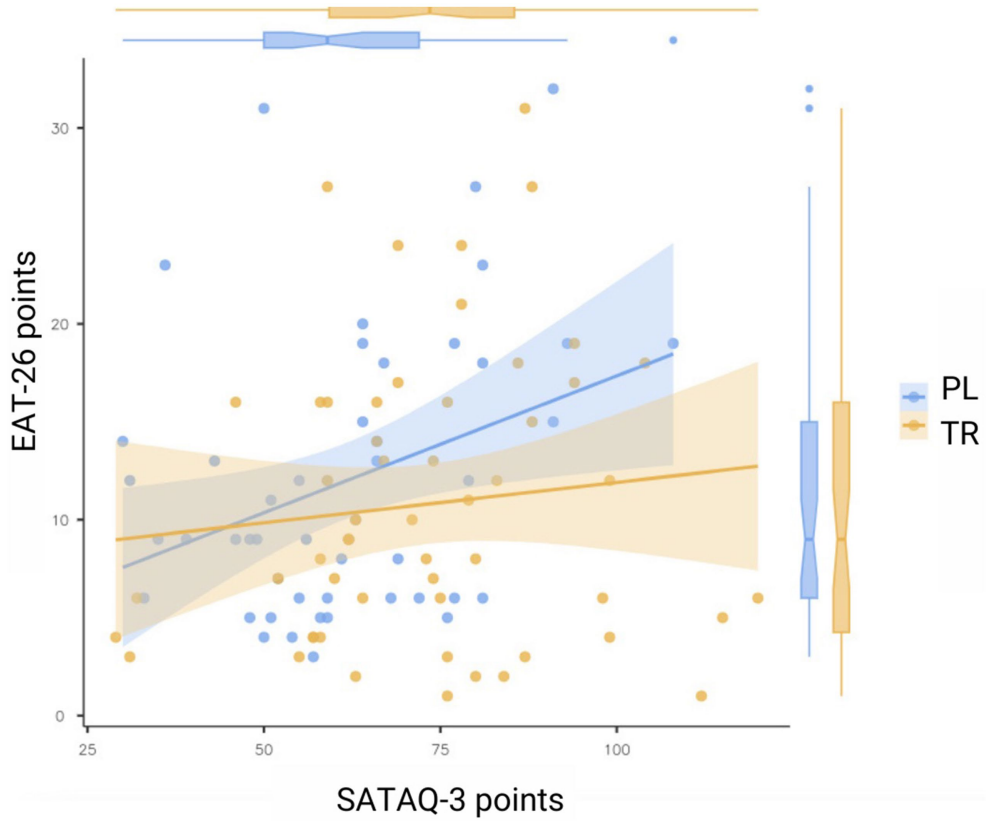


FIGURE 1
Statistical analysis of the relationship of scores in the SATAQ-3 and EAT-26 tests ($n = 103$).

TABLE 4 Linear regression analysis of sociocultural predictors and EAT-26 score in PL group ($n = 49$).

Model coefficients – EAT-26 score; $R = 0.574$; $R^2 = 0.330$				
Predictor	Estimate	SE	t	*p*-value
Intercept	8.3347	3.673	2.269	0.028
Internalization-Pressure	0.5131	0.134	3.823	< 0.001
Internalization-Information Seeking	−0.0324	0.153	−0.212	0.833
Internalization-Athlete	0.0274	0.256	0.107	0.915
Information	−0.6030	0.267	−2.257	0.029

TABLE 5 Linear regression analysis of sociocultural predictors and EAT-26 score in TR group ($n = 54$).

Model coefficients – EAT-26 score; $R = 0.306$; $R^2 = 0.0938$				
Predictor	Estimate	SE	t	*p*-value
Intercept	2.8540	4.461	0.640	0.525
Pressure	−0.5210	0.285	−1.828	0.074
Internalization-General	0.6846	0.339	2.022	0.049
Internalization-Athlete	−0.0876	0.364	−0.240	0.811
Information	0.0554	0.212	0.262	0.795

sociocultural dimensions (Pressure, Internalization-General, Internalization-Athlete, Information) and the EAT-26 score, which measures the risk of eating disorders. The model shows that Internalization-General has a significant positive impact on the EAT-26 score ($p = 0.049$), indicating that higher internalization of general sociocultural standards is associated with an increased risk of eating disorders. The remaining variables were not statistically significant, indicating they do not have a notable impact on the EAT-26 score.

The model's fit ($R^2 = 0.0938$) suggests that approximately 9.38% of the variance in the EAT-26 score can be explained by the predictors included in the model, which indicates a relatively weak fit.

4 Discussion

Following Papathomas and Lavallee's (50) call for greater methodological pluralism and focus on athletes from sports with traditionally low ED incidence, this study found that female football players are at significant risk for ED, challenging traditional classifications of high- and low-risk sports. The study aimed to assess ED risk and analyze socio-cultural attitudes toward body image among Polish and Turkish professional female football players, identifying differences in ED risk levels and attitudes toward beauty standards and social pressure, with a focus on the influence of nationality.

The high risk of ED among this group of athletes, as indicated by the EAT-26 results, is alarming, with an estimated 40.8% at risk.

Although football is not typically associated with a high risk of ED, our findings suggest that Polish and Turkish female football players may be vulnerable. Assessing ED in this group is crucial due to the serious risks to both physical and mental health. ED can lead to severe nutritional deficiencies, negatively affecting physical performance and increasing injury risk. Long-term ED can shorten athletes' careers and are often accompanied by psychological issues, potentially leading to depression, anxiety, and even suicidal thoughts.

The prevalence of ED among women can vary significantly by country, influenced by cultural, social, and economic factors, as well as the specific sports environments (51). Cultural beliefs and attitudes are key contributors to ED development, with prevalence differing across racial, ethnic, and national groups and evolving (52). Although ED are more widespread in various cultural groups than previously recognized, our study found no differences between the Polish and Turkish groups.

In the study by Abbot et al. (53), the prevalence of ED among football players was assessed using EAT-26, and it was shown that approximately 11% of the athletes, according to the test interpretation, are at risk for developing ED. In the study conducted by Izquierdo et al. (54), similar ED risk rates were reported, indicating that about 11% of men and women playing football were at risk or suffering from ED. However, in the only other study that assessed the prevalence of ED risk among elite female football players, the results were less alarming. In that study, none of the 36 professional athletes scored higher than the clinical cut-off point of 20 in EAT-26 (29). Our results indicate that the problem is significantly more widespread. Similar conclusions regarding the greater prevalence of these disorders were demonstrated in the study by Staśkiewicz-Bartecka and Kardas (9), where it was shown that 16.7% of male football players are at risk for ED.

In the present study, approximately 40.8% of female football players were identified as being at risk of developing ED, a figure significantly higher than those reported in previous studies such as Abbott et al., where the prevalence was approximately 11% (53). Several factors could explain this discrepancy. Firstly, the training status and season moment at which the study was conducted might have influenced the findings. Our study was carried out in the final phase of the spring round, a period that likely involves peak physical demands and psychological stress as players prepare for or compete in crucial matches. The pressures related to performance, maintaining fitness levels, and adhering to body image ideals during this phase could heighten the risk of disordered eating behaviors (29).

Furthermore, the higher percentages found in our study could also be attributed to cultural and environmental factors that differ between studies. For instance, the sociocultural influences on body image, particularly in Polish athletes, who scored higher on the SATAQ-3 subscales related to media pressure, may contribute to a greater internalization of appearance ideals, thereby increasing ED risk. The differences in training intensity, nutritional guidance, and psychological support available in the clubs studied compared to other research settings could also play a role. Future research should consider controlling for these variables to better understand their impact on ED prevalence among athletes.

Overall, the data suggest that the prevalence of ED is related to socio-cultural attitudes toward appearance. In our study, it was shown that individuals at risk for ED exhibited higher levels of socio-cultural attitudes toward appearance. The analysis showed that in the group of Polish athletes, significant statistical relationships were found between scores in the Internalization-Pressure ($p = 0.010$), Information ($p = 0.041$) sections, and the overall SATAQ-3 scale ($p = 0.011$). In the group of Turkish athletes, no such relationships were found. Furthermore, significant statistical differences between the two groups of athletes in the total number of points obtained in the SATAQ-3 scale ($p = 0.002$) indicate the diversity of cultural influences. The analysis revealed a statistically significant positive correlation between the EAT-26 and SATAQ-3 test scores ($p = 0.036$, $\rho = 0.207$). This means that there is a weak but significant relationship between the scores of these two tests, suggesting that higher scores in one test are associated with higher scores in the other. Although the correlation is significant, it is important to note that the correlation coefficient ($\rho = 0.207$) indicates a weak strength of this relationship.

These results support and extend the existing literature on the relationship between socio-cultural attitudes toward appearance and ED. In the study by Calogero et al. (55), higher SATAQ-3 scores were shown for patients with BN. Patients with BN scored higher than all other groups in the Internalization-Athlete section and higher in the General Internalization section than the AN groups. The means for the ED sample were higher than the means reported for non-ED individuals, except for the Information subscale. Correlations between the SATAQ-3 subscales and the ED assessment scale (EDI) indicated a positive association between the measures. The utility of the SATAQ-3 measure should be considered in any future research aimed at determining predictive factors for the occurrence of ED problems. The SATAQ-3 is reliable and valid in samples of individuals with ED and is an appropriate measure for use in this population (52). The study by Yessenia Lazo Montoya et al. (56) confirms our results. An association was observed between SATAQ-3 scores, both overall and subscale scores, and the risk of developing ED (EAT-26).

Over the past two decades, studies have documented an increase in the public's desire for slim female figures. Greater media exposure is linked to more pronounced ED symptoms. The internalization of the thin ideal has been identified as a causal risk factor for ED and a significant predictor of success in prevention efforts (57).

The study posed three key hypotheses: (1) female football players are significantly at risk of eating disorders (ED), furthermore (2) female football players from Poland and Turkey differ in their risk of ED, and (3) there are differences in socio-cultural attitudes toward body image between the groups.

The results partially confirmed these hypotheses. About 40% of participants were at risk of ED, confirming the first hypothesis. However, no significant differences in ED risk were found between Polish and Turkish players, contradicting the second hypothesis. The third hypothesis was confirmed, as Polish players were more influenced by socio-cultural factors promoted by the media, while Turkish players showed no significant differences in this regard. This highlights the need for culturally tailored interventions and the importance of regular screening and psychological support for all female football players.

4.1 Strengths and limitations

The strengths of this study include a high participant response rate (90.74% for the Polish group and 96.42% for the Turkish group), which enhances the representativeness of the findings and reduces the risk of selection bias. Additionally, the study was conducted in the final phase of the spring round of the 2023/2024 league season, allowing for comparable results in the context of the athletes' training phase. The study provides new information on cultural differences and their impact on the development of ED among professional female football players from different countries, which constitutes a valuable contribution to the existing scientific literature. This comparison is crucial for understanding how varying cultural contexts impact the mental and physical health of athletes, which is significant for global prevention and treatment strategies.

However, the study also has some limitations. Firstly, the use of a cross-sectional design prevents establishing causal relationships between variables. Future research should include a longitudinal component that would allow for tracking changes over time and more reliably determining the direction of influence. Additionally, the study sample consisted exclusively of professional female football players, which may limit the generalizability of the results to other groups of athletes or the general population. Another limitation is the possibility of self-report errors, which may affect the accuracy of the collected data, especially in the context of assessing body weight and height. Although well-validated research tools were used, cultural differences may affect the way questions in the questionnaires are interpreted and answered. One of the significant limitations of our study is the lack of detailed data on the participants' body composition, such as body fat percentage, muscle mass, or water distribution, which could provide more precise information on health status and potential risks related to eating disorders. The BMI, although commonly used, does not account for differences in body composition, which may lead to an inaccurate assessment of nutritional status in individuals with higher muscle mass, typical of athletes. Moreover, our study lacks detailed information on nutritional parameters, such as dietary habits, intake of macro- and micronutrients, and access to appropriate dietary support. These data could provide valuable insights into the relationships between nutritional status and the risk of ED. Including this information in future studies could contribute to a more comprehensive understanding of the factors influencing the risk of developing ED in athletes.

5 Conclusion

The results of this study showed that professional female football players, regardless of nationality, are significantly at risk of ED, with approximately 40% of the players being at risk. It was demonstrated that nutritional status, interpreted through the BMI index, affects the risk of ED. Female football players with underweight and overweight had a higher risk of ED. Furthermore, differences were found in the influence of socio-cultural attitudes toward body image among players of different nationalities. Polish female football players are characterized by the higher influence of socio-cultural standards of body image and appearance promoted in the mass media. Polish players at risk of developing eating disorders scored higher in the subscales of Internalization-Pressure and Information, as well as in the overall SATAQ-3 test score. This relationship was not observed among Turkish players. The study found a weak but significant positive correlation between SATAQ-3 and EAT-26 scores, indicating that higher socio-cultural pressure and internalization are associated with a higher risk of developing ED. These results suggest the significant role of regular screenings and mental health support for professional female football players.

Data availability statement

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

Ethics statement

The studies involving humans were approved by the Bioethics Committee of the Silesian Medical University in Katowice (BNW/NWN/0043-3/641/35/23, date of approval: 22/09/2023). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

WS-B: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Writing – original draft, Writing – review & editing. SA: Data curation, Writing – review & editing. GZ: Data curation, Writing – review & editing. MKr: Writing – review & editing. MKł: Writing – review & editing. MM: Supervision, Writing – review & editing.

Funding

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

Conflict of interest

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

Publisher's note

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

References

1. Romann M, Rüeger E, Hintermann M, Kern R, Faude O. Origins of relative age effects in youth football—a nationwide analysis. *Front Sports Act Living*. (2020) 2:591072. doi: 10.3389/fspor.2020.591072

2. Galli N, Petrie T, Chatterton J. Team weigh-ins and self-weighing: relations to body-related perceptions and disordered eating in collegiate male athletes. *Psychol Sport Exerc*. (2017) 29:51–5. doi: 10.1016/j.psychsport.2016.12.004

3. Scott CL, Haycraft E, Plateau CR. Teammate influences and relationship quality are associated with eating and exercise psychopathology in athletes. *Appetite*. (2019) 143:104404. doi: 10.1016/j.appet.2019.104404

4. de Bruin AK, Oudejans RR. Athletes' body talk: the role of contextual body image in eating disorders as seen through the eyes of elite women athletes. *J Clin Sport Psychol*. (2018) 12:675–98. doi: 10.1123/jcsp.2018-0047

5. Thiemann P, Legenbauer T, Vocks S, Platen P, Auyeung B, Herpertz S. Eating disorders and their putative risk factors among female German professional athletes. *Eur Eat Disord Rev*. (2015) 23:269–76. doi: 10.1002/erv.2360

6. de Oliveira Coelho GM, da Silva Gomes AI, Ribeiro BG, de Abreu Soares E. Prevention of eating disorders in female athletes. *Open Access J Sports Med*. (2014) 5:105–13. doi: 10.2147/OAJSM.S36528

7. Matusik A, Grajek M, Szlacheta P, Korzonek-Szlacheta I. Comparison of the prevalence of eating disorders among dietetics students and students of other fields of study at selected universities (Silesia, Poland). *Nutrients*. (2022) 14:3210. doi: 10.3390/nu14153210

8. Grajek M, Krupa-Kotara K, Sas-Nowosielski K, Misterska E, Kobza J. Prevalence of orthorexia in groups of students with varied diets and physical activity (Silesia, Poland). *Nutrients*. (2022) 14:2816. doi: 10.3390/nu14142816

9. Staśkiewicz-Bartecka W, Kardas M. Eating disorders risk assessment and body esteem among amateur and professional football players. *Nutrients*. (2024) 16:945. doi: 10.3390/nu16070945

10. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5). Philadelphia, PA: American Psychiatric Publishing (2013).

11. WHO. ICD-11 international classification of diseases 11 the revision; the global standard for diagnostic health information. Geneva, Switzerland: WHO (2019).

12. Sharps FRJ, Wilson LJ, Graham CAM, Curtis C. Prevalence of disordered eating, eating disorders and risk of low energy availability in professional, competitive and recreational female athletes based in the United Kingdom. *Eur J Sport Sci*. (2022) 22:1445–51. doi: 10.1080/17461391.2021.1943712

13. Tayne S, Hrubes M, Hutchinson MR, Mountjoy M. Female athlete triad and RED-S In: S Rocha Piedade, A Imhoff, M Clatworthy, M Cohen and J Espregueira-Mendes, editors. The sports medicine physician. Cham, Switzerland: springer (2019). 395–411.

14. Mountjoy M, Sundgot-Borgen JK, Burke LM, Ackerman KE, Blauwet C, Constantini N, et al. IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. *Br J Sports Med*. (2018) 52:687–97. doi: 10.1136/bjsports-2018-099193

15. Chapa DA, Johnson SN, Richson BN, Bjorlie K, Won YQ, Nelson SV, et al. Eating-disorder psychopathology in female athletes and non-athletes: a meta-analysis. *Int J Eat Disord*. (2022) 55:861–85. doi: 10.1002/eat.23748

16. Holm-Denoma JM, Scaringi V, Gordon KH, Van Orden KA, Joiner TE Jr. Eating disorder symptoms among undergraduate varsity athletes, club athletes, independent exercisers, and nonexercisers. *Int J Eat Disord*. (2009) 42:47–53. doi: 10.1002/eat.20560

17. Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. *Clin J Sport Med*. (2004) 14:25–32. doi: 10.1097/00042752-200401000-00005

18. Martinsen M, Bratland-Sanda S, Eriksson AK, Sundgot-Borgen J. Dieting to win or to be thin? A study of dieting and disordered eating among adolescent elite athletes and non-athlete controls. *Br J Sports Med*. (2010) 44:70–6. doi: 10.1136/bjsm.2009.068668

19. De Bruin AP, Oudejans RRD, Bakker FC. Dieting and body image in aesthetic sports: a comparison of Dutch female gymnasts and non-aesthetic sport participants. *Psychol Sport Exerc*. (2007) 8:507–20. doi: 10.1016/j.psychsport.2006.10.002

20. Torstveit MK, Rosenvinge JH, Sundgot-Borgen J. Prevalence of eating disorders and the predictive power of risk factor models in female elite athletes: a controlled study. *Scand J Med Sci Sports*. (2008) 18:108–18. doi: 10.1111/j.1600-0838.2007.00657.x

21. Gorrell S, Nagata JM, Hill KB, Carlson JL, Shain AF, Wilson J, et al. Eating behavior and reasons for exercise among competitive collegiate male athletes. *Eat Weight Disord*. (2021) 26:75–83. doi: 10.1007/s40519-019-00819-0

22. Godoy-Izquierdo D, Ramírez MJ, Díaz I, López-Mora C. A systematic review on exercise addiction and the disordered eating-eating disorders continuum in the competitive sport context. *Int J Ment Heal Addict*. (2021) 21:529–61. doi: 10.1007/s11469-021-00610-2

23. Barrack MT, Van Loan MD, Rauh M, Nichols JF. Disordered eating, development of menstrual irregularity, and reduced bone mass change after a 3-year follow-up in female adolescent endurance runners. *Int J Sport Nutr Exerc Metabol*. (2021) 31:337–44. doi: 10.1123/ijsnem.2021-0011

24. Escobar-Molina R, Rodríguez-Ruiz S, Gutiérrez-García C, Franchini E. Weight loss and psychological-related states in high-level judo athletes. *Int J Sport Nutr Exerc Metabol*. (2015) 25:110–8. doi: 10.1123/ijsnem.2013-0163

25. Mancine RP, Gusfa DW, Moshrefi A, Kennedy SF. Prevalence of disordered eating in athletes categorized by emphasis on leanness and activity type–a systematic review. *J Eat Disord*. (2020) 8:47–9. doi: 10.1186/s40337-020-00323-2

26. Stojmenović D, Stojmenović T. Physiological parameters of professional football players in teams of various levels. *Pedagogy Phys Cult Sports*. (2023) 27:361–7. doi: 10.15561/26649837.2023.0502

27. Sundgot-Borgen J. Prevalence of eating disorders in elite female athletes. *Int J Sport Nutr*. (1993) 3:29–40. doi: 10.1123/ijsn.3.1.29

28. Torres-McGehee TM, Emerson DM, Pritchett K, Moore EM, Smith AB, Uriegas NA. Energy availability with or without eating disorder risk in collegiate female athletes and performing artists. *J Athl Train*. (2021) 56:993–1002. doi: 10.4085/JAT0502-20

29. Sundgot-Borgen J, Torstveit MK. The female football player, disordered eating, menstrual function and bone health. *Br J Sports Med*. (2007) 41:i68–72. doi: 10.1136/bjsm.2007.038018

30. Kumari R, Rosali B, Anubhav V, Pawanindra L. Hindi translation, cultural adaptation and validation of eating disorder diagnostic scale: a study from bariatric clinics, Maulana Azad Medical College & Lok Nayak Hospital, New Delhi, in North India. *Indian J Psychiatry*. (2022) 64:S573. doi: 10.4103/0019-5545.341517

31. Liya MA, Cortney SA, Warren KM, Culbert KM. Disordered eating in Asian American women: sociocultural and culture-specific predictors. *Front Psychol*. (2019) 10:1950. doi: 10.3389/FPSYG.2019.01950

32. Zaida A, Nicola B, Jue C, Roser G, Qing K, Fernando F-A, et al. Eating symptomatology and general psychopathology in patients with anorexia nervosa from China, UK, and Spain: a cross-cultural study examining the role of social attitudes. *PLoS One*. (2017) 12:e0173781. doi: 10.1371/JOURNAL.PONE.0173781

33. Smith ML, Dunne PE, Pike KM. Cross-cultural differences in eating disorders. *Encycl Feed Eat Disord*. (2017) 178–81. doi: 10.1007/978-981-287-104-6_54

34. Gaspar MCDMP, de Morais Sato P, Scagliusi FB. Under the "weight" of norms: social representations of overweight and obesity among Brazilian, French and Spanish dietitians and laywomen. *Soc Sci Med*. (2022) 298:114861. doi: 10.1016/j.socscimed.2022.114861

35. Melisse B, de Beurs E, van Furth EF. Eating disorders in the Arab world: a literature review. *J Eat Disord*. (2020) 8:59–19. doi: 10.1186/s40337-020-00336-x

36. Knauss C, Paxton SJ, Alsaker FD. Relationships amongst body dissatisfaction, internalisation of the media body ideal and perceived pressure from media in adolescent girls and boys. *Body Image*. (2007) 4:353–60. doi: 10.1016/j.bodyim.2007.06.007

37. Lovering ME, Rodgers RF, George JE, Franko DL. Exploring the tripartite influence model of body dissatisfaction in postpartum women. *Body Image*. (2018) 24:44–54. doi: 10.1016/j.bodyim.2017.12.001

38. PZPN. (2024). Statutes of PZPN. Available at: https://pzpn.pl/federacja/dokumenty (accessed on 9 June 2024).

39. TTF. (2024). Statutes of the Turkish football federation. Available at: http://www.tff.org/Resources/TFF/Documents/02010DK/TFF/ENG/Tal/TFF-Statutes.pdf (Accessed on 9 June 2024).

40. World Health Organization. Mean body mass index (BMI). Geneva, Switzerland. Available online: WHO (2019).

41. Włodarczyk-Bisaga K, Dolan B. A two-stage epidemiological study of abnormal eating attitudes and their prospective risk factors in polish schoolgirls. *Psychol Med*. (1996) 26:1021–32. doi: 10.1017/S0033291700035340

42. Erguney-Okumus F, Sertel-Berk H. The psychometric properties of the eating attitudes test short form (EAT-26) in a college sample. *Studies Psychol-Psikol Calismalari Derg*. (2020) 40:57–78. doi: 10.26650/SP2019-0039

43. Garner DM, Garfinkel PE. The eating attitudes test: an index of the symptoms of anorexia nervosa. *Psychol Med*. (1979) 9:273–9. doi: 10.1017/s0033291700030762

44. Garner D. (2024). The eating attitudes test (EAT-26). Available at: https://www.eat-26.com/interpretation/ (Accessed on 3 March 2024).

45. Heinberg LJ, Thompson JK, Stromer S. Development and validation of sociocultural attitudes towards appearance questionnaire (SATAQ). *Int J Eat Disord*. (1995) 17:81–9. doi: 10.1002/1098-108X(199501)17:1<81::AID-EAT2260170111>3.0.CO;2-Y

46. Sánchez-Carracedo D, Barrada JR, López-Guimerà G, Fauquet J, Almenara CA, Trepat E. Analysis of the factor structure of the sociocultural attitudes towards appearance questionnaire (SATAQ-3) in Spanish secondary-school students through exploratory structural equation modeling. *Body Image*. (2012) 9:163–71. doi: 10.1016/j.bodyim.2011.10.002

47. Izydorczyk B. Postawy i zachowania wobec własnego ciała w zaburzeniach odżywiania [attitudes and behaviors towards one's own body in eating disorders]. Warszawa: Wydawnictwo Naukowe PWN (2014).

48. Izydorczyk B, Lizińczyk S. The polish adaptation of the sociocultural attitudes towards appearance SATAQ 3 questionnaire. *Health Psychol Rep*. (2020) 8:68–82. doi: 10.5114/hpr.2020.91443

49. Swami V, Özgen L, Gökçen E, Petrides KV. Body image among female university students in Turkey: concurrent translation and validation of three body image measures. *Int J Cult Ment Health*. (2015) 8:176–91. doi: 10.1080/17542863.2014.917117

50. Papathomas A, Lavallee D. Eating disorders in sport: a call for methodological diversity. *Rev Psicol Deporte*. (2012) 21:387–92.

51. Wu J, Liu J, Li S, Ma H, Wang Y. Trends in the prevalence and disability-adjusted life years of eating disorders from 1990 to 2017: results from the global burden of disease study 2017. *Epidemiol Psychiatr Sci*. (2020) 29:e191. doi: 10.1017/S2045796020001055

52. Miller MN, Pumariega AJ. Culture and eating disorders: a historical and cross-cultural review. *Psychiatry Interpers Biolog Processes*. (2001) 64:93–110. doi: 10.1521/psyc.64.2.93.18621

53. Abbott W, Brett A, Brownlee TE, Hammond KM, Harper LD, Naughton RJ, et al. The prevalence of disordered eating in elite male and female soccer players. Eat. Weight Disord.-stud. *Anorex Bulim Obes*. (2021) 26:491–8. doi: 10.1007/s40519-020-00872-0

54. Izquierdo EN, Ceballos I, Ramírez MJ. Risk for eating disorders in "high" and "low" risk sports and football (soccer): a profile analysis with clustering techniques. *J Sport Psych*. (2019) 28:117–26.

55. Calogero RM, Davis WN, Thompson JK. The sociocultural attitudes toward appearance questionnaire (SATAQ-3): reliability and normative comparisons of eating disordered patients. *Body Image*. (2004) 1:193–8. doi: 10.1016/j.bodyim.2004.01.004

56. Montoya YL, Quenaya A, Mayta-Tristán P. Mass media influence and risk of developing eating disorders in female students from Lima. *Peru Arch Argent Pediatr*. (2015) 113:519–25. doi: 10.5546/aap.2015.eng.519

57. Batista M, Antić LŽ, Žaja O, Jakovina T, Begovac I. Predictors of eating disorder risk in anorexia nervosa adolescents. *Acta Clin Croat*. (2018) 57:399–410. doi: 10.20471/acc.2018.57.03.01

frontiers | Frontiers in Nutrition

TYPE Original Research
PUBLISHED 19 September 2024
DOI 10.3389/fnut.2024.1418950

OPEN ACCESS

EDITED BY
Sebastian Gustavo Soneira,
Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

REVIEWED BY
Valeria Teresa Pedrón,
Universidad del Salvador, Argentina
Carolina Abulafia,
National Scientific and Technical Research Council (CONICET), Argentina

*CORRESPONDENCE
Yong Zhao
✉ zhaoyong@cqmu.edu.cn

†These authors have contributed equally to this work

RECEIVED 17 April 2024
ACCEPTED 30 August 2024
PUBLISHED 19 September 2024

CITATION
Shi Y, Fu L, Li S, Jiang K, Shi Z, Sharma M and Zhao Y (2024) Psychosocial profiles influencing healthy dietary behaviors among adolescents in Shandong Province, China: a cross-sectional study.
Front. Nutr. 11:1418950.
doi: 10.3389/fnut.2024.1418950

Psychosocial profiles influencing healthy dietary behaviors among adolescents in Shandong Province, China: a cross-sectional study

Ya Shi[1,2,3,4†], Lin Fu[1,2,3,4†], Shengping Li[5], Ke Jiang[1,2,3,4], Zumin Shi[6], Manoj Sharma[7,8] and Yong Zhao[1,2,3,4,9*]

[1]School of Public Health, Chongqing Medical University, Chongqing, China, [2]Research Center for Medicine and Social Development, Chongqing Medical University, Chongqing, China, [3]Research Center for Public Health Security, Chongqing Medical University, Chongqing, China, [4]Nutrition Innovation Platform-Sichuan and Chongqing, School of Public Health, Chongqing Medical University, Chongqing, China, [5]Chongqing Health Center for Women and Children, Women and Children's Hospital of Chongqing Medical University, Chongqing, China, [6]Human Nutrition Department, College of Health Sciences, QU Health, Qatar University, Doha, Qatar, [7]Department of Social and Behavioral Health, School of Public Health, University of Nevada, Las Vegas, NV, United States, [8]Department of Internal Medicine, Kirk Kerkorian School of Medicine, University of Nevada, Las Vegas, NV, United States, [9]Chongqing Key Laboratory of Child Nutrition and Health, Children's Hospital of Chongqing Medical University, Chongqing, China

Objectives: We aimed to assess the influence of psychosocial profiles on dietary behaviors among school-aged adolescents in China.

Methods: A cross-sectional study was conducted involving 7,862 adolescents from 100 schools in Shandong, China. Psychosocial profiles and dietary behaviors were assessed using the Junior High School Students' Psychosocial Profiles Questionnaire (JPPQ) and the Chinese Diet Quality Questionnaire (DQQ), respectively. Linear regression models were used to investigate the association between adolescents' psychosocial profiles and dietary behaviors.

Results: The mean age of the participants was 13.18 ± 1.15years; 48.5% of them were boys. The majority of participants (97.90%) were Han Chinese, and approximately half of the participants (50.90%) resided in rural areas. After adjusting for sociodemographic characteristics and family computer and Internet ownership and usage, healthy dietary behavior was positively correlated with higher psychosocial profile scores ($p < 0.05$). The stratified analysis results revealed that the group with the highest psychosocial profile score was associated with an increased overall global dietary reference (GDR) score in "households without a family computer and Internet" (β: 5.357, 95% CI: 4.931–5.784, $p < 0.05$).

Conclusion: Good psychosocial profiles exhibit a positive influence on healthy dietary behaviors. Therefore, policymakers should focus on Internet usage to maximize the positive effects on global youth health behaviors.

KEYWORDS

psychosocial profiles, dietary behavior, adolescent, Shandong, cross-sectional study

Introduction

Adolescence is a critical transitional stage in life, during which individuals are particularly susceptible to psychological issues stemming from various factors, such as the school

environment and social influences (1, 2). Emotional stressors such as academic pressure, exposure to bullying at school, and familial conflicts can contribute to the development of psychological disturbances in adolescents. Additionally, the complexities of interpersonal relationships during this period further exacerbate these problems (3). The widespread use of online media devices also increases the risk of sleep deprivation among adolescents, which can have detrimental effects on both their physical health and mental well-being (4). According to the World Health Organization, approximately one in seven individuals aged 10–19 years worldwide experiences mental disorders, accounting for 13% of the disease burden in this age group (5).

Psychosocial profiles of adolescents encompass a multifaceted construct that integrates societal and psychological elements. These profiles can be assessed through the adolescent's self-reported internalizing indicators, such as self-perception, emotional self-awareness, and externalizing behaviors, including school bullying and aggressive tendencies. These indicators also reflect adolescents' psychological status (6, 7). Research has shown that negative self-perceptions, lack of supportive peer relationships, and exposure to school bullying may contribute to the onset or exacerbation of depression (8–13). As adolescents progress through this stage of life, their physical and psychosocial development can significantly influence their food choices and eating behaviors (14, 15).

As adolescents seek independence and social connections, they may consume more calorie-dense foods, which can lead to obesity (16). Furthermore, social media exposure among children and adolescents promotes increased eating behaviors during viewing sessions, which also leads to obesity (17).

Consequently, these changes in psychological profiles and sedentary behaviors increase the risk of obesity among adolescents, which is becoming a significant public concern globally (18).

Given the abovementioned trend, the 2020–2025 Dietary Guidelines for Americans (DGA) emphasize the importance of establishing and maintaining healthy dietary behaviors early in life in order to reduce the risk of diet-related chronic diseases (19, 20). Evaluating dietary behaviors involves the use of dietary quality assessment tools to measure dietary quality scores, which help in determining adherence to a healthy dietary pattern (21, 22).

Healthy dietary patterns, generally characterized by the consumption of fruits, vegetables, fish, and whole grains, are widely recognized as essential components of a healthy diet. These patterns may reduce the incidence of mental illness and improve psychological well-being (23–26). Unfortunately, research by Chinese scholars indicates that the current eating habits of Chinese teenagers are suboptimal. A study involving 12,860 adolescents aged 11–18 years in Shanghai revealed that a significant portion of their diet consisted of high-sugar and high-calorie foods, with the prevalence of consuming vegetables and fruits less than once a day being 25.9 and 47.2%, respectively (27).

Additionally, a school-based investigation in Zhengzhou reported that up to 80.5% of vocational high school students consumed sugar-sweetened beverages at least once a week (28). There is a bidirectional relationship between psychological states and healthy dietary behaviors. Specifically, a positive psychological state often leads to better attention to dietary variety and balanced nutrition, thereby enhancing dietary quality. Similarly, a high-quality diet can help reduce psychological disorders. This reciprocal relationship underscores how improvements in one area can positively influence the other, creating a mutually reinforcing effect. Nutritional interventions may be enhanced by comprehending the psychological status of adult food consumers (29). As children grow older and face greater stress, the development of healthy eating behaviors becomes more constrained (30). These findings suggest that psychological status is intricately linked to healthy eating behaviors.

The majority of research on the correlation between healthy eating and psychosocial profiles has primarily concentrated on adults and the elderly, with limited investigation on younger adults. Furthermore, Rajaram et al. (31) and Parrott et al. (32) have highlighted the significant focus on memory cognition and memory disorders in various studies related to dietary patterns, with limited exploration of their connection to psychological status. Additionally, studies on the relationship between eating behaviors and different psychological status among adolescent populations are lacking.

Relevant reviews have emphasized the importance of addressing the long-term health outcomes of adolescents (33). With the rising prevalence of mental illness and psychosocial problems among secondary school students and the significant role of healthy dietary behaviors in maintaining well-being, it is imperative to investigate the impact of psychosocial profiles on the dietary behaviors of adolescents. To fully consider the psychosocial profiles of adolescents, we analyzed three main layers: self-perception, which is an internalization indicator, bullying perception, and peer relations, which serve as externalization indicators.

Materials and methods

Study design and sample

In this study, we utilized the data retrieved from the Population Health Data Archive (PHDA), which is a data-sharing platform. This cross-sectional study was conducted to investigate the impact of psychological status on health and health-related behaviors of junior school students in Shandong, China. The probability proportional to size (PPS) sampling method was adopted, and 100 schools from 10 administrative districts were randomly selected based on the specific geography, population, and socio-economic level of the province in the 2020 academic year. Schools with fewer than 100 students in each grade or fewer than 300 students in total were not included in this study. Information regarding socioeconomic status, social interaction, nutrition and diet, psychological status, mental health, school adaptation, quality of life, spare-time physical activity, risk behaviors, and physical fitness was obtained for this study.

Further details of the PHDA design and sampling methods have been published in previous research (34, 35). The survey sample consisted of 11,393 junior adolescents from Shandong Province. After excluding unreasonable samples and those with missing information on crucial sociological characteristics or psychological status, a total of 7,862 participants were included in the data analysis. Our study encompasses cities from approximately half of the prefecture-level cities in Shandong, covering the three principal regions: Lunan, Luzhong, and Lubei. The sample distribution across these regions demonstrates variability, with each region contributing between 0.07 and 0.23% of the total sample. This distribution aligns with the observed trend of higher population density in the more developed areas and lower density in the less developed regions of Shandong. The sample was randomly selected from various cities across the Shandong Province, ensuring a comprehensive and representative view (Figures 1, 2).

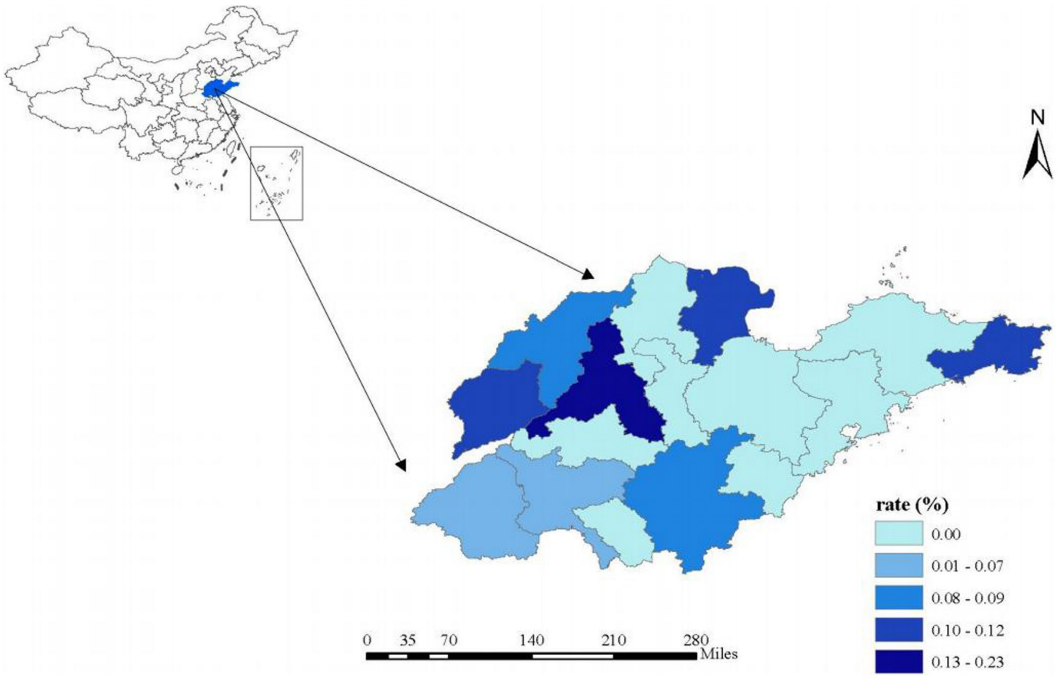


FIGURE 1
Distribution of survey respondents by city. The proportion of adolescents distributed in each city = the number of respondents in each city/the total number of respondents* 100%.

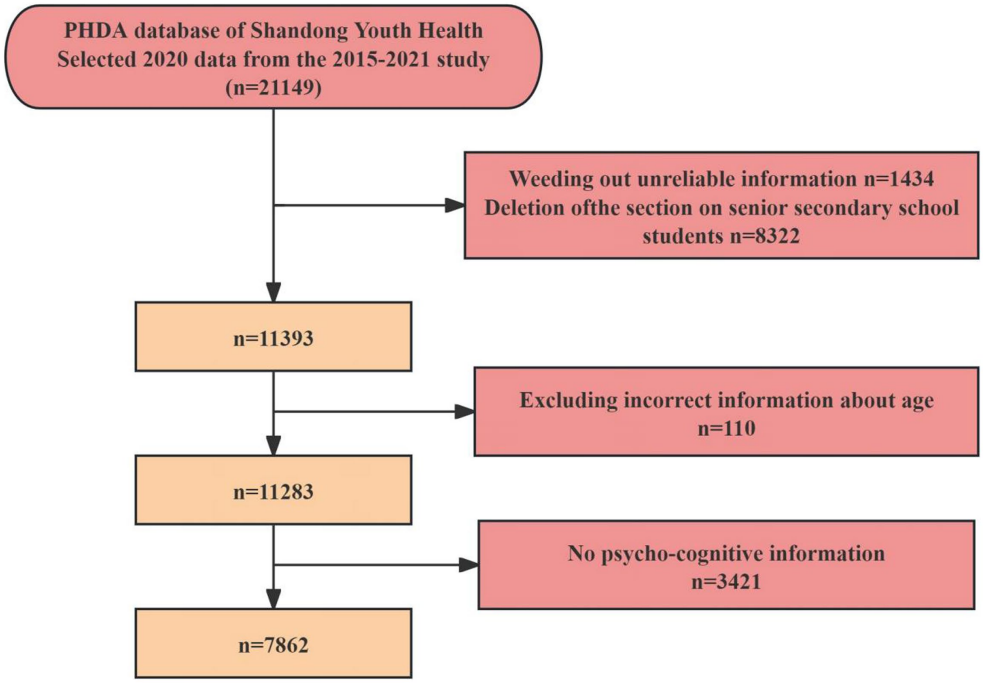


FIGURE 2
Flowchart of participant.

Outcome variables: junior high school students health and dietary patterns score

The 17-item questionnaire was developed based on the Global Dietary Reference (GDR) list. Participants' dietary status was evaluated using the modified Chinese Diet Quality Questionnaire (DQQ), which is a 5-point scale (1–5) for rapid qualitative and quantitative analyses of participants' diet quality (36). An additional inventory file shows this in more detail (Supplementary material S1).

The DQQ includes three dietary scores: the GDR healthy score, the GDR-limit score, and the overall GDR score. The GDR-healthy score reflects global recommendations for health-promoting foods in healthy diets. The GDR-limit score reflects global recommendations for limiting certain dietary components. A low overall GDR score, a low GDR-healthy score, and a high GDR-limit score indicate poor diet quality (34, 37). Frequencies of weekly consumption in the questionnaire were scored as follows: more than once a day (5), about once a day (4), about once every other day (3), one or two times a week (2), and never (1).

The total dietary pattern score was calculated based on the two components using the formula below: overall GDR score= GDR-Healthy score-GDR-Limit score. A high overall GDR score represents high quality. In this study, Cronbach's α was 0.87, and the questionnaire demonstrated good construct validity (KMO 0.91, Bartlett's test $p < 0.001$).

Exposure variables: junior high school students' psychosocial profiles

The Junior High School Students' Psychosocial Profiles Questionnaire (JPPQ) has 17 items (Supplementary material S2). It has three main sections, such as self-perceptions, peer relationships, and perceptions of school bullying. The tool was developed based on the relevant psychological studies (35, 38). Using a 5-point scale, the JPPQ assessed participants' psychological status, with acceptable internal consistency for self-perceptions, peer relationships, and school bullying perceptions (Cronbach's $\alpha = 0.86$) in this research. Each participant was asked to answer the self-perception questions such as "In general, I have a lot to be proud of," with responses ranging from low to high across five levels, namely (1) never, (2) seldom, (3) sometimes, (4) usually, and (5) always. Additionally, they were asked to respond to the questions about peer relationships and bullying perceptions of the tool, which is a validated method for assessing psychosocial status. The students completed the questionnaire by responding to a series of inquiries. For example, "I enjoy studying with my friends," with responses similarly divided into five levels, namely (1) completely inconsistent, (2) not quite consistent, (3) sometimes fit, (4) more in line with, and (5) very consistent. For negatively phrased items, the score assignments were reversed. For example, the item "I cannot talk with other people" had its scores reversed: (5) completely inconsistent, (4) not quite consistent, (3) sometimes fit, (2) more in line with, and (1) very consistent. Thus, the overall score of the psychosocial profiles was calculated by summing the scores of the self-perceptions, peer relationship perceptions, and campus bullying perceptions. A high overall score indicates a positive psychosocial status, reflecting a favorable trend in social skills and self-confidence.

Covariates

Adolescents' demographic information includes age, sex (boys/girls), residence, nationality (the Han nationality/minority), educational level of adolescents' parents (primary school or below/secondary school/secondary vocational school, high school/college or higher), family wealth level (poor/middle/good), accommodation (no/yes), single son or daughter (no/yes), and residence (urban/rural). These variables, along with the family computer and network situation (none/ one of the above/both), were considered covariates in this study. The family computer and Internet situation was ascertained through self-reporting. Specifically, participants responded to the question, "Do you have a computer and internet access at home?" by selecting from the options of "none," "one of the above," and "both." The classifications of these variables were predefined based on previous research (39, 40).

Statistical analysis

All data were analyzed using SPSS (version 26.0, IBM Corporation, Armonk, NY, United States) and Stata software (version 18.0, Stata Corp., LLC). Categorical variables were described using frequencies and percentages, whereas the mean (standard deviation) was used to describe adolescents' age and the different GDR scores (GDR-healthy, GDR-limit, and overall GDR). The scores were converted to percentages and then divided into quartiles to analyze the psychosocial profiles of adolescents. Categorical variables were compared using the chi-squared test, while continuous variables were analyzed using ANOVA to assess differences between groups. Linear regression analysis was employed to investigate the relationship between adolescents' dietary patterns and their psychosocial profiles. In subgroup analyses, the multiplicative interaction between psychosocial profiles and covariates (sex, nationality, accommodation, residence, only child, family economic status, family computer and network situation, and parental education level) was examined by including the product of these variables in the regression model. All tests were two-sided, and a p-value of <0.05 was considered statistically significant.

Results

Basic demographic characteristics

The sample characteristics are presented in Table 1. A total of 7,862 participants were included (48.50% were boys and 51.50% were girls). The majority of participants (97.90%) were Han Chinese, and approximately half of the participants (50.90%) lived in rural areas. The average age of participants was 13.18 ± 1.15 years. A small proportion of junior high school students (25.50%) were only children; similarly, only 29.40% of them chose to board at school from Monday through Thursday. Computer network penetration in the families of people in the high psychosocial profile subgroup was significantly higher than that in the low subgroup.

Additionally, 80.50% of adolescents were in the middle family wealth level. The vast majority of fathers (73.80%) and mothers (69.00%) had education levels of junior high or senior high school. Participants in the highest psychosocial profiles subgroup (the quartile 4 group) had a GDR-healthy score of 39.69 ± 6.91, a GDR-limit score of 11.81 ± 3.57 and an overall GDR score of 27.88 ± 7.04. Figure 3 shows the relationship between participants' performance on different GDR scores (GDR-healthy, GDR-limit, and overall GDR) and their psychosocial status.

TABLE 1 Sample characteristics by quartile of adolescents' JPPQ score: PHDA ($N = 7,862$).

Characteristics	Total		Adolescents' JPPQ score[a]								*p*-value
			Quartile 1		Quartile 2		Quartile 3		Quartile 4		
Sample (*n*)	*N* = 7,862		*N* = 2,106		*N* = 1,897		*N* = 1,891		*N* = 1,968		
Sex (*n*, %)											0.206
Boys	3,810	(48.50)	1,048	(49.20)	889	(46.90)	896	(47.60)	977	(50.00)	
Girls	4,052	(51.50)	1,084	(50.80)	1,005	(53.10)	986	(52.40)	977	(50.00)	
Age, mean (SD)	13.18	(1.15)	13.36	(1.12)	13.19	(1.11)	13.09	(1.15)	13.05	(1.20)	<0.001**
Nationality (*n*, %)											0.479
Han	7,693	(97.90)	2,091	(98.10)	1,850	(97.70)	1,835	(97.50)	1,917	(98.10)	
Other	169	(2.10)	41	(1.90)	44	(2.30)	47	(2.50)	37	(1.90)	
Residence (*n*, %)											<0.001**
Urban	3,862	(49.10)	881	(41.30)	906	(47.80)	977	(51.90)	1,098	(56.20)	
Rural	4,000	(50.90)	1,251	(58.70)	988	(52.20)	905	(48.10)	856	(43.80)	
Only child (*n*, %)											<0.001**
Yes	2,002	(25.50)	481	(22.60)	411	(21.70)	503	(26.70)	607	(31.10)	
No	5,860	(74.50)	1,651	(77.40)	1,483	(78.30)	1,379	(73.30)	1,347	(68.90)	
Family wealth level (*n*, %)											0.03*
Poor	937	(11.90)	265	(12.40)	233	(12.30)	231	(12.30)	208	(10.60)	
Medium	6,325	(80.50)	1,674	(78.50)	1,536	(81.10)	1,516	(80.60)	1,599	(81.80)	
Good	600	(7.60)	193	(9.10)	125	(6.60)	135	(7.20)	147	(7.50)	
Father's education level (*n*, %)											<0.001**
College or higher	1,381	(17.60)	246	(11.50)	268	(14.10)	403	(21.40)	464	(23.70)	
High school	2,484	(31.60)	546	(25.60)	627	(33.10)	622	(33.00)	689	(35.30)	
Junior high school	3,314	(42.20)	1,046	(49.10)	843	(44.50)	730	(38.80)	695	(35.60)	
Primary school and below	683	(8.70)	294	(13.80)	156	(8.20)	127	(6.70)	106	(5.40)	
Mother's education level (*n*, %)											<0.001**
College or higher	1,262	(16.10)	208	(9.80)	250	(13.20)	351	(18.70)	453	(23.20)	
High school	2,180	(27.70)	478	(22.40)	537	(28.40)	540	(28.70)	625	(32.00)	
Junior high school	3,244	(41.30)	967	(45.40)	830	(43.80)	750	(39.90)	697	(35.70)	
Primary school and below	1,176	(15.00)	479	(22.50)	277	(14.60)	241	(12.80)	179	(9.20)	

(Continued)

10.3389/fnut.2024.1418950

10.3389/fnut.2024.1418950

TABLE 1 (Continued)

Characteristics	Total		Adolescents' JPPQ score[a]								*p*-value
			Quartile 1		Quartile 2		Quartile 3		Quartile 4		
Sample (*n*)	*N* = 7,862		*N* = 2,106		*N* = 1,897		*N* = 1,891		*N* = 1,968		
Family Computer and Internet situation (*n*, %)											<0.001**
Both	7,042	(89.60)	1,788	(83.90)	1,697	(89.60)	1,731	(92.00)	1,826	(93.40)	
One of the above	281	(3.60)	104	(4.90)	71	(3.70)	52	(2.80)	54	(2.80)	
Neither	539	(6.90)	240	(11.30)	126	(6.70)	99	(5.30)	74	(3.80)	
Accommodation (*n*, %)											<0.001**
No	5,553	(70.60)	1,342	(62.90)	1,330	(70.20)	1,389	(73.80)	1,492	(76.40)	
Yes	2,309	(29.40)	790	(37.10)	564	(29.80)	493	(26.20)	462	(23.60)	
Diet pattern score, mean (SD)											<0.001**
GDR-healthy score	37.46	(7.21)	36.19	(7.67)	36.39	(6.99)	37.66	(6.63)	39.69	(6.91)	
GDR-limit score	12.47	(4.07)	13.67	(4.87)	12.31	(3.74)	11.96	(3.57)	11.81	(3.57)	
Overall GDR score	24.99	(7.22)	22.52	(7.26)	24.08	(6.84)	25.70	(6.56)	27.88	(7.04)	

[a]Data are presented as mean (SD) for continuous measures, and *n* (%) for categorical measures, *$p < 0.05$, **$p < 0.001$.

Association between adolescents' psychosocial profiles and healthy dietary scores

There was a positive association between psychosocial profile scores and healthy dietary pattern scores. In the fully adjusted model, across the quartiles of psychosocial profiles score, the regression coefficient (95%CI) for the healthy dietary score was 0.00, 1.33 (0.90–1.77), 2.84 (2.41–3.28), and 4.89 (4.44–5.34), respectively (p for trend < 0.001) (Table 2). The psychosocial score was positively associated with the GDR-heathy score but inversely associated with the GDR-limit score (Supplementary material S3). Good self-perception, harmonious peer relationships, and no or little experience with school bullying were positively associated with healthy dietary behaviors (Supplementary Figure S1).

Stratified analysis according to demographic characteristics and family computer and Internet situation

In subgroup analyses, the association between the psychosocial profile scores and overall GDR was stronger in families without computers and the Internet than in those with these resources (p-value for interaction). No associations between psychological scores and other sociodemographic factors were found (Table 3).

Discussion

In our study focusing on adolescents in Shandong, China, it was observed that good psychosocial profiles were linked to higher overall GDR scores, indicating a greater likelihood of adopting healthy dietary behaviors, especially among those with families without computers and the Internet. This healthy dietary pattern was characterized by a high intake of fruits, vegetables, fish, and dairy products [35].

Comparison with evidence in the literature

Consistent with our findings, recent systematic reviews and meta-analyses have shown that poor psychological status is linked to unhealthy eating patterns (41). The use of psychological medications may affect dietary quality (42). Rodgers et al. (43) reported that adolescent boys and girls frequently exhibit eating disorder behaviors due to psychological issues, low mood, and other psychological factors associated with social media, as highlighted in a biopsychosocial model. Another study in Jordan found that adolescents who experienced negative peer pressure and self-esteem issues had a high prevalence of eating disorders. These disorders are frequently associated with unhealthy behaviors, such as smoking and alcohol consumption (44). This result aligns with our findings. During adolescence, harmonious peer relationships facilitate the development of healthy dietary habits; conversely, they can also lead to unhealthy behaviors. People with celiac disease who have good self-perception tend to eat healthily, and this positive self-perception is linked to a better quality of life among Chilean schoolchildren (45). Roy et al. (46)

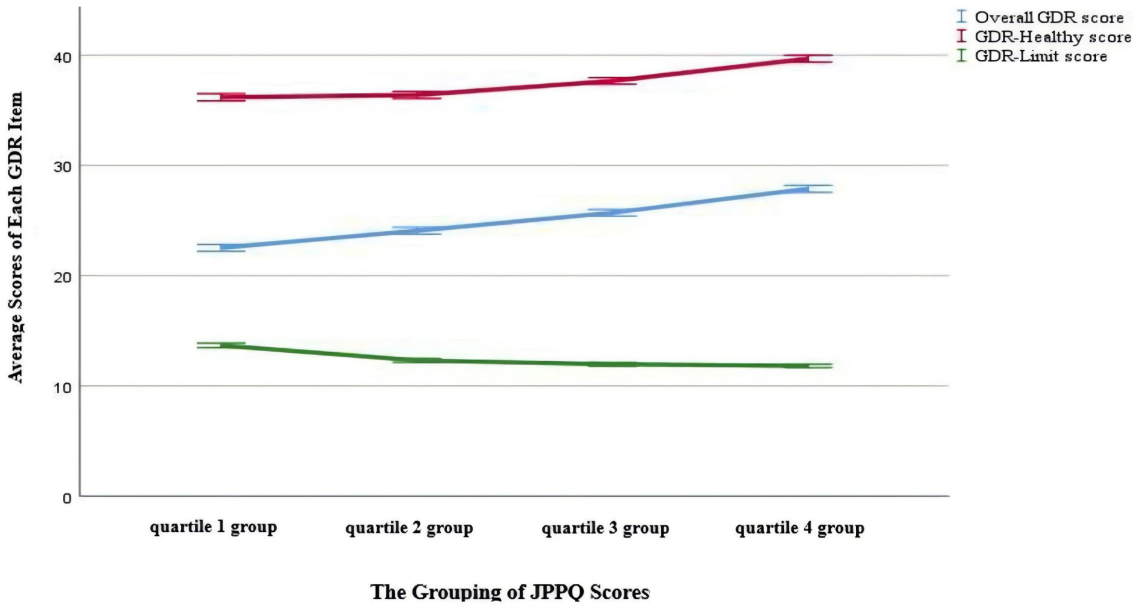


FIGURE 3
Relationship between participants' performance on different GDR scores (GDR-Healthy, GDR-Limit, and Overall GDR) and their psychosocial profiles.

TABLE 2 The relationship between quartiles of adolescents' JPPQ score and healthy dietary pattern score.

	Model 1[a]				Model 2[b]				Model 3[c]			
	β	95% CI		*p*-value	β	95% CI		*p*-value	β	95% CI		*p*-value
Quartile 2 vs. Quartile 1	1.56	1.13	1.99	<0.001**	1.37	0.93	1.80	<0.001**	1.33	0.89	1.76	<0.001**
Quartile 3 vs. Quartile 1	3.18	2.75	3.61	<0.001**	2.89	2.46	3.33	<0.001**	2.84	2.40	3.27	<0.001**
Quartile 4 vs. Quartile 1	5.35	4.93	5.78	<0.001**	4.95	4.50	5.40	<0.001**	4.89	4.44	5.34	<0.001**

[a]Model 1 was the univariate model without adjustment for covariates.
[b]Model 2 was adjusted for demographic covariates.
[c]Model 3 was additionally adjusted for the family computer network situation.
All models refer to the first quartile range *$p < 0.05$, **$p < 0.001$.

found that young adults who often buy and consume food on campus have worse diet quality scores compared to their counterparts, and approaches to improve the campus food environment may improve young adults' diet quality.

Several mechanisms may explain the observed negative association between adherence to healthy dietary patterns and low psychosocial profile scores. Reward and hedonic mechanisms within the body play a significant role in food choices. The sight of tasty fruits and vegetables can reduce stress levels and trigger the release of hormones such as growth hormone-releasing peptides, insulin, and leptin, which promote healthy eating habits (47). Previous research found that adhering to a healthy dietary pattern can reduce the risk of psychosocial issues by increasing serum folate and vitamin B12 levels (48). Additionally, the potential reduction in psychosocial issues through the activation of the body's reward mechanisms could serve as a strong incentive for adopting healthy dietary behaviors, mechanistically validating the relationship between psychological states and healthy dietary behaviors.

In subgroup analyses, the association between the psychosocial profile score and the overall GDR score was stronger among families without computers and the Internet than those with computers and the Internet. Consistent with our results, Marques et al. (49) defined a healthy lifestyle as including daily physical activity, limited screen time to less than 2 h, and a balanced consumption of vegetables and fruits. However, the widespread use of screens in contemporary society often promotes a sedentary lifestyle, causing individuals to spend prolonged periods in inactivity. Extended exposure to screens—whether televisions, computers, tablets, or smartphones—disrupts the natural rhythm of daily physical activity and fosters dependence on online activities, which can quickly escalate into addiction. This digital addiction, marked by an uncontrollable urge to check notifications, scroll through social media, or engage in gaming, significantly reduces both the time and motivation available for physical exercise. The results of the analysis of the 2010 Health Behavior in School-Aged Children International Survey Database (HBSC) revealed a linear decline in the prevalence of healthy behaviors from early adolescence to age 15 across 37 countries and territories. Specifically, the adolescents who used the Internet for hours in the study showed a notably reduced likelihood of adopting a healthy lifestyle compared with those with low screen contact. The Internet offers dual benefits: it facilitates social communication and fosters positive peer relationships among young individuals. However, it also introduces

TABLE 3 Subgroup analyses of the relationship between quartiles of the JPPQ score and the healthy dietary pattern score.

	Quartiles of JPPQ score[a]							
	Quartile 1	Quartile 2		Quartile 3		Quartile 4		*p* value for interaction
Sex								0.346
Boys	0.00	1.73	(1.08–2.38)	2.89	(2.24–3.54)	5.02	(4.37–5.66)	
Girls	0.00	1.00	(0.43–1.57)	2.81	(2.23–3.39)	4.76	(4.17–5.35)	
Nationality								0.327
Han	0.00	1.30	(0.86–1.73)	2.85	(2.41–3.29)	4.91	(4.48–5.35)	
Other	0.00	2.70	(−0.90–6.31)	2.63	(−1.03–6.29)	4.34	(0.44–8.23)	
Accommodation								0.677
No	0.00	1.14	(0.62–1.65)	2.63	(2.12–3.15)	4.76	(4.24–5.27)	
Yes	0.00	1.59	(0.80–2.39)	3.14	(2.32–3.97)	4.93	(4.09–5.77)	
Residence								0.528
Urban	0.00	1.01	(0.37–1.65)	2.44	(1.80–3.07)	4.43	(3.80–5.05)	
Rural	0.00	1.54	(0.95–2.12)	3.12	(2.52–3.73)	5.22	(4.59–5.85)	
Only child								0.187
Yes	0.00	1.93	(1.01–2.86)	3.34	(2.45–4.23)	4.83	(3.96–5.70)	
No	0.00	1.16	(0.68–1.65)	2.66	(2.16–3.16)	4.93	(4.42–5.44)	
Father's education level								0.835
Primary school and below	0.00	0.54	(−0.88–1.95)	2.86	(1.35–4.37)	4.38	(2.79–5.98)	
Junior high school	0.00	1.19	(0.55–1.83)	2.90	(2.23–3.57)	4.93	(4.25–5.62)	
High school	0.00	1.29	(0.51–2.07)	2.52	(1.74–3.31)	4.99	(4.22–5.75)	
College or higher	0.00	2.09	(0.92–3.26)	3.24	(2.16–4.31)	4.78	(3.72–5.85)	
Mother's education level								0.287
Primary school and below	0.00	1.35	(0.28–2.43)	2.76	(1.64–3.89)	4.19	(2.94–5.44)	
Junior high school	0.00	1.20	(0.56–1.85)	2.91	(2.25–3.58)	5.24	(4.56–5.92)	
High school	0.00	0.99	(0.15–1.83)	2.04	(1.20–2.88)	4.43	(3.62–5.25)	
College or higher	0.00	1.86	(0.61–3.11)	3.74	(2.56–4.91)	4.91	(3.78–6.05)	
Family economic status								0.983
Poor	0.00	1.34	(0.10–2.58)	3.12	(1.83–4.40)	4.70	(3.37–6.03)	
Medium	0.00	1.35	(0.88–1.82)	2.83	(2.35–3.30)	4.97	(4.49–5.45)	
Good	0.00	0.91	(−1.29–3.12)	2.42	(0.54–4.30)	3.96	(2.23–5.69)	
Family computer and Internet situation								0.011*
None	0.00	3.19	(1.48–4.90)	5.16	(3.29–7.03)	6.65	(4.61–8.69)	
One of the above	0.00	0.83	(−1.26–2.93)	4.59	(2.24–6.94)	3.78	(1.46–6.09)	
Both	0.00	1.15	(0.69–1.60)	2.56	(2.11–3.02)	4.73	(4.27–5.18)	

[a]Models adjusted for demographic characteristics and family computer and Internet situations.
*$p < 0.05$, **$p < 0.001$.

"cyberbullying," a new form of school bullying that poses additional risks to the well-being of young people (50).

With the rapid development of Internet technology, the role of correct and healthy Internet use in the healthy development of young people cannot be ignored (50, 51). Nevertheless, in the case of universal use of social media, the personality traits of only children are diluted, peer relationship conflicts are weakened, and the psychological status develops in a favorable trend. In addition, a review suggested that AI-derived chat technology will facilitate the process of healthy behaviors among users (51). This result was contrary to the study's findings that the existence of computer networks can encourage healthy eating habits. We deduce that in China, where education policies often involve confiscating media devices such as cell phones, adolescents may exhibit excessive usage once they return home. This behavior, commonly referred to as "revenge behavior," arises as they feel the need to compensate for the restricted use during school hours. Consequently, this overuse of media devices at home can disrupt healthy eating behaviors and potentially reverse the positive dietary habits encouraged during school (52).

In summary, adolescents' psychosocial profiles are closely linked to dietary behaviors. Numerous studies have demonstrated a bidirectional relationship between eating behaviors and psychological status (41, 53). The strengths of the study include a relatively large sample of adolescents from 100 schools in both urban and rural areas and the use of validated tools. Furthermore, we were able to adjust for potential confounders, such as personal characteristics (age, sex, residence, nationality, whether the individual is an only child, and whether they attend a boarding school) and family circumstances (family wealth, home computer network situation, and parental education level).

Limitations

We also acknowledge the following limitations in our study: (a) dietary pattern scores are based on self-reported 1-week diets, which may be subject to recall bias and other bias; (b) the inability to measure family wealth accurately; and (c) the cross-sectional study design, which does not allow for establishing causality.

Conclusion

A higher psychosocial score was associated with a higher likelihood of maintaining a healthy dietary pattern among adolescents in Shandong. However, no interaction was found between participants' basic characteristics and their psychosocial profiles. The association between psychosocial characteristics and healthy dietary behaviors remained consistent across various demographic factors, including age, sex, residence, nationality, parental education level, family wealth, living conditions, and only-child status. The ownership of a computer and access to the Internet modified the association between the psychosocial profile and the healthy dietary score. Further research through in-depth mechanistic and cohort studies is required to explore the role of psychological factors in shaping eating patterns and behaviors.

Data availability statement

The data presented in the study are deposited in the the Population Health Data Archive (PHDA) repository, accession link https://doi.org/10.12213/11.A0031.202107.209.V1.0.

Ethics statement

The studies involving humans were approved by Ethics Committee of Shandong University, China. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

YS: Conceptualization, Methodology, Writing – original draft, Data curation. LF: Data curation, Methodology, Writing – original draft. SL: Data curation, Writing – review & editing. KJ: Writing – review & editing. ZS: Writing – review & editing. MS: Writing – review & editing. YZ: Supervision, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. The authors declare that this study received funding from Chongqing Health Education Institute (grant number 2024WSJK034). The funder was not involved in the study design, collection, analysis, interpretation of data, the writing of this article or the decision to submit it for publication.

Acknowledgments

The authors sincerely thank Shandong University and the National Population Health Data Center for providing the data and the Chongqing Health Education Institute for funding the original study.

Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2024.1418950/full#supplementary-material

References

1. Wassenaar TM, Wheatley CM, Beale N, Nichols T, Salvan P, Meaney A, et al. The effect of a one-year vigorous physical activity intervention on fitness, cognitive performance and mental health in young adolescents: the fit to study cluster randomised controlled trial. *Int J Behav Nutr Phys Act*. (2021) 18:47. doi: 10.1186/s12966-021-01113-y

2. Björkenstam C, Weitoft GR, Hjern A, Nordström P, Hallqvist J, Ljung R. School grades, parental education and suicide--a national register-based cohort study. *J Epidemiol Community Health*. (2011) 65:993–8. doi: 10.1136/jech.2010.117226

3. Carballo JJ, Llorente C, Kehrmann L, Flamarique I, Zuddas A, Purper-Ouakil D, et al. Psychosocial risk factors for suicidality in children and adolescents. *Eur Child Adolesc Psychiatry*. (2020) 29:759–76. doi: 10.1007/s00787-018-01270-9

4. Carter B, Rees P, Hale L, Bhattacharjee D, Paradkar MS. Association between portable screen-based media device access or use and sleep outcomes: a systematic review and Meta-analysis. *JAMA Pediatr*. (2016) 170:1202–8. doi: 10.1001/jamapediatrics.2016.2341

5. WHO Adolescent and Youth Health. (2023) Available at: https://www.who.int/zh/news-room/fact-sheets/detail/adolescents-health-risks-and-solutions (Accessed March 11, 2024).

6. Prosser NS, Green MJ, Ferguson E, Tildesley MJ, Hill EM, Keeling MJ, et al. Cattle farmer psychosocial profiles and their association with control strategies for bovine viral diarrhea. *J Dairy Sci*. (2022) 105:3559–73. doi: 10.3168/jds.2021-21386

7. Olivier E, Jolin A, Dubé C, Maïano C, Tracey D, Craven RG, et al. Psychosocial difficulties profiles among youth with intellectual disabilities. *J Autism Dev Disord*. (2024). doi: 10.1007/s10803-024-06359-6

8. Liu L, Wang X, Chen B, Chui W-H, Wang X. Association between child abuse, depression, and school bullying among Chinese secondary school students. *Int J Environ Res Public Health*. (2022) 20:697. doi: 10.3390/ijerph20010697

9. Bottino SMB, Bottino CMC, Regina CG, Correia AVL, Ribeiro WS. Cyberbullying and adolescent mental health: systematic review. *Cad Saude Publica*. (2015) 31:463–75. doi: 10.1590/0102-311x00036114

10. King CA, Naylor MW, Segal HG, Evans T, Shain BN. Global self-worth, specific self-perceptions of competence, and depression in adolescents. *J Am Acad Child Adolesc Psychiatry*. (1993) 32:745–52. doi: 10.1097/00004583-199307000-00007

11. Vandersmissen M, Barnetche T, Charlotte A, Bernard J, Jerome D, Landrin J, et al. POS0970 psycho-COGNITIVE factors and adherence in axial SPONDYLOARTHRITIS: a multicenter CROSS-sectional study. *Ann Rheum Dis*. (2023) 82:799.1–799. doi: 10.1136/annrheumdis-2023-eular.4131

12. SciELO–Brazil. Palmar strength and sociodemographic, clinical-functional, and psycho-cognitive factors in elderly with Diabetes Mellitus Palmar strength and sociodemographic, clinical-functional, and psycho-cognitive factors in elderly with Diabetes Mellitus. (2019) Available at: https://www.scielo.br/j/fm/a/tCrrvL7ddWvkS6tWSnVNsWP/ (Accessed March 21, 2024).

13. Masiero M, Cutica I, Russo S, Mazzocco K, Pravettoni G. Psycho-cognitive predictors of burnout in healthcare professionals working in emergency departments. *J Clin Nurs*. (2018) 27:2691–8. doi: 10.1111/jocn.14376

14. Chaudhri OB, Salem V, Murphy KG, Bloom SR. Gastrointestinal satiety signals. *Annu Rev Physiol*. (2008) 70:239–55. doi: 10.1146/annurev.physiol.70.113006.100506

15. Ashton LM, Sharkey T, Whatnall MC, Williams RL, Bezzina A, Aguiar EJ, et al. Effectiveness of interventions and behaviour change techniques for improving dietary intake in young adults: a systematic review and Meta-analysis of RCTs. *Nutrients*. (2019) 11:825. doi: 10.3390/nu11040825

16. Kansra AR, Lakkunarajah S, Jay MS. Childhood and adolescent obesity: a review. *Front Pediatr*. (2020) 8:581461. doi: 10.3389/fped.2020.581461

17. Robinson TN, Banda JA, Hale L, Lu AS, Fleming-Milici F, Calvert SL, et al. Screen media exposure and obesity in children and adolescents. *Pediatrics*. (2017) 140:S97–S101. doi: 10.1542/peds.2016-1758K

18. Kumar S, Kelly AS. Review of childhood obesity: from epidemiology, etiology, and comorbidities to clinical assessment and treatment. *Mayo Clin Proc*. (2017) 92:251–65. doi: 10.1016/j.mayocp.2016.09.017

19. Dominguez LJ, Veronese N, Barbagallo M. Dietary patterns and healthy or unhealthy aging. *Gerontology*. (2024) 70:15–36. doi: 10.1159/000534679

20. Dietary Guidelines for Americans, 2020–2025 and Online Materials | Dietary Guidelines for Americans. (2020) Available at: https://www.dietaryguidelines.gov/resources/2020-2025-dietary-guidelines-online-materials (Accessed August 11, 2024).

21. Moraeus L, Lindroos AK, Lemming EW, Mattisson I. Diet diversity score and healthy eating index in relation to diet quality and sociodemographic factors: results from a cross-sectional national dietary survey of Swedish adolescents. *Public Health Nutr*. (2020) 23:1754–65. doi: 10.1017/S1368980019004671

22. Kanerva N, Kaartinen NE, Schwab U, Lahti-Koski M, Männistö S. The Baltic Sea diet score: a tool for assessing healthy eating in Nordic countries. *Public Health Nutr*. (2014) 17:1697–705. doi: 10.1017/S1368980013002395

23. Iguacel I, Huybrechts I, Moreno LA, Michels N. Vegetarianism and veganism compared with mental health and cognitive outcomes: a systematic review and meta-analysis. *Nutr Rev*. (2021) 79:361–81. doi: 10.1093/nutrit/nuaa030

24. Owen L, Corfe B. The role of diet and nutrition on mental health and wellbeing. *Proc Nutr Soc*. (2017) 76:425–6. doi: 10.1017/S0029665117001057

25. Ocean N, Howley P, Ensor J. Lettuce be happy: a longitudinal UK study on the relationship between fruit and vegetable consumption and well-being. *Soc Sci Med*. (2019) 222:335–45. doi: 10.1016/j.socscimed.2018.12.017

26. Głąbska D, Guzek D, Groele B, Gutkowska K. Fruit and vegetable intake and mental health in adults: a systematic review. *Nutrients*. (2020) 12:115. doi: 10.3390/nu12010115

27. Zhu J, Tan Y, Lu W, He Y, Yu Z. Current assessment of weight, dietary and physical activity behaviors among middle and high school students in Shanghai, China-a 2019 Cross-sectional study. *Nutrients*. (2021) 13:4331. doi: 10.3390/nu13124331

28. Song Y, Liu J, Zhao Y, Gong L, Chen Q, Jiang X, et al. Unhealthy lifestyles and clusters status among 3637 adolescents aged 11–23 years: a school-based cross-sectional study in China. *BMC Public Health*. (2023) 23:1279. doi: 10.1186/s12889-023-16197-3

29. Stevenson RJ. Psychological correlates of habitual diet in healthy adults. *Psychol Bull*. (2017) 143:53–90. doi: 10.1037/bul0000065

30. Hill DC, Moss RH, Sykes-Muskett B, Conner M, O'Connor DB. Stress and eating behaviors in children and adolescents: systematic review and meta-analysis. *Appetite*. (2018) 123:14–22. doi: 10.1016/j.appet.2017.11.109

31. Rajaram S, Jones J, Lee GJ. Plant-based dietary patterns, plant foods, and age-related Cognitive decline. *Adv Nutr Bethesda Md*. (2019) 10:S422–36. doi: 10.1093/advances/nmz081

32. Parrott MD, Carmichael P-H, Laurin D, Greenwood CE, Anderson ND, Ferland G, et al. The association between dietary pattern adherence, Cognitive stimulating lifestyle, and Cognitive function among older adults from the Quebec longitudinal study on nutrition and successful aging. *J Gerontol B Psychol Sci Soc Sci*. (2021) 76:444–50. doi: 10.1093/geronb/gbaa178

33. Dahl RE, Allen NB, Wilbrecht L, Suleiman AB. Importance of investing in adolescence from a developmental science perspective. *Nature*. (2018) 554:441–50. doi: 10.1038/nature25770

34. Wu S, Xiu X, Qian Q. Associations between dietary patterns and physical activity with physical fitness among adolescents in Shandong Province, China: a Cross-sectional study. *Nutrients*. (2023) 15:1425. doi: 10.3390/nu15061425

35. Zhang S-F, Luo W, Dong X-S, Chen W-X, Yi X-R, Zhou W, et al. A dataset on the status quo of health and health-related behaviors of Chinese youth: a longitudinal large-scale survey in the secondary school students of Shandong Province. *Chin Med Sci J Chung-Kuo Hsueh Ko Hsueh Tsa Chih*. (2022) 37:60–6. doi: 10.24920/004051

36. Wang H, Herforth AW, Xi B, Zou Z. Validation of the diet quality questionnaire in Chinese children and adolescents and relationship with pediatric overweight and obesity. *Nutrients*. (2022) 14:3551. doi: 10.3390/nu14173551

37. Herforth AW, Wiesmann D, Martínez-Steele E, Andrade G, Monteiro CA. Introducing a suite of low-burden diet quality indicators that reflect healthy diet patterns at population level. *Curr Dev Nutr*. (2020) 4:nzaa168. doi: 10.1093/cdn/nzaa168

38. Liang R, Wang R-J. Influence of family relationship on college Students' Psychologica cognition and intervention measures. *Heilongjiang Sci*. (2023):80–82+85. doi: 10.3969/j.issn.1674-8646.2023.17.021

39. Khayyatzadeh SS, Shafiee M, Far PE, Ziaee SS, Bagherniya M, Ebrahimi S, et al. Adherence to a healthy dietary pattern is associated with less severe depressive symptoms among adolescent girls. *Psychiatry Res*. (2019) 272:467–73. doi: 10.1016/j.psychres.2018.12.164

40. Fu L, Shi Y, Li S, Jiang K, Zhang L, Wen Y, et al. Healthy diet-related knowledge, attitude, and practice (KAP) and related socio-demographic characteristics among middle-aged and older adults: a Cross-sectional survey in Southwest China. *Nutrients*. (2024) 16:869. doi: 10.3390/nu16060869

41. Teasdale SB, Ward PB, Samaras K, Firth J, Stubbs B, Tripodi E, et al. Dietary intake of people with severe mental illness: systematic review and meta-analysis. *Br J Psychiatry*. (2019) 214:251–9. doi: 10.1192/bjp.2019.20

42. Jakobsen AS, Speyer H, Nørgaard HCB, Karlsen M, Hjorthøj C, Krogh J, et al. Dietary patterns and physical activity in people with schizophrenia and increased waist circumference. *Schizophr Res*. (2018) 199:109–15. doi: 10.1016/j.schres.2018.03.016

43. Rodgers RF, Slater A, Gordon CS, McLean SA, Jarman HK, Paxton SJ. A biopsychosocial model of social media use and body image concerns, disordered eating, and muscle-building behaviors among adolescent girls and boys. *J Youth Adolesc*. (2020) 49:399–409. doi: 10.1007/s10964-019-01190-0

44. Al-sheyab NA, Gharaibeh T, Kheirallah K. Relationship between peer pressure and risk of eating disorders among adolescents in Jordan. *J Obes*. (2018) 2018:7309878–8. doi: 10.1155/2018/7309878

45. Caamaño-Navarrete F, Ángel Latorre-Román P, Guzmán-Guzmán IP, Párraga Montilla J, Jerez-Mayorga D, Delgado-Floody P. Lifestyle mediates the relationship between self-esteem and health-related quality of life in Chilean schoolchildren. *Psychol Health Med*. (2022) 27:638–48. doi: 10.1080/13548506.2021.1934496

46. Roy R, Rangan A, Hebden L, Yu Louie JC, Tang LM, Kay J, et al. Dietary contribution of foods and beverages sold within a university campus and its effect on diet quality of young adults. *Nutrition*. (2017) 34:118–23. doi: 10.1016/j.nut.2016.09.013

47. Leng G, Adan RAH, Belot M, Brunstrom JM, de Graaf K, Dickson SL, et al. The determinants of food choice. *Proc Nutr Soc*. (2017) 76:316–27. doi: 10.1017/S002966511600286X

48. Khosravi M, Sotoudeh G, Amini M, Raisi F, Mansoori A, Hosseinzadeh M. The relationship between dietary patterns and depression mediated by serum levels of folate and vitamin B12. *BMC Psychiatry*. (2020) 20:63. doi: 10.1186/s12888-020-2455-2

49. Marques A, Loureiro N, Avelar-Rosa B, Naia A, De MMG. Adolescents' healthy lifestyle. *J Pediatr*. (2020) 96:217–24. doi: 10.1016/j.jped.2018.09.002

50. O'Keeffe GS, Clarke-Pearson KCouncil on Communications and Media. The impact of social media on children, adolescents, and families. *Pediatrics*. (2011) 127:800–4. doi: 10.1542/peds.2011-0054

51. Aggarwal A, Tam CC, Wu D, Li X, Qiao S. Artificial intelligence-based Chatbots for promoting health behavioral changes: systematic review. *J Med Internet Res*. (2023) 25:e40789. doi: 10.2196/40789

52. Central People's Government of the People's Republic of China. Arsenic Hao Order No. 50 of the Ministry of Education of the People's Republic of China Provisions on the Protection of Minors in Schools_State Council Departmental Documents_China.gov.cn. (2021) Available at: https://www.gov.cn/zhengce/zhengceku/202106/02/content_5614946.htm (Accessed March 20, 2024).

53. Begdache L, Chaar M, Sabounchi N, Kianmehr H. Assessment of dietary factors, dietary practices and exercise on mental distress in young adults versus matured adults: a cross-sectional study. *Nutr Neurosci*. (2019) 22:488–98. doi: 10.1080/1028415X.2017.1411875

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 18 October 2024
DOI 10.3389/fpsyg.2024.1453815

OPEN ACCESS

EDITED BY
Sebastian Gustavo Soneira,
Fundación Para la Lucha Contra las Enfermedades Neurológicas de la Infancia (FLENI), Argentina

REVIEWED BY
Cristina Segura-Garcia,
University of Magna Graecia, Italy
Daniela Gomez,
Pontificia Universidad Católica de Chile, Chile

*CORRESPONDENCE
Zhongyu Ren
renzhongyu@swu.edu.cn
Jianhua Cao
caojianhua2019@hotmail.com

†These authors have contributed equally to this work and share first authorship

RECEIVED 24 June 2024
ACCEPTED 16 August 2024
PUBLISHED 18 October 2024

CITATION
Ren Z, Hao Z and Cao J (2024) The association between dietary knowledge based on the *Chinese Dietary Guidelines* and adherence to healthy dietary habits: a large-scale cross-sectional study. *Front. Psychol.* 15:1453815. doi: 10.3389/fpsyg.2024.1453815

The association between dietary knowledge based on the *Chinese Dietary Guidelines* and adherence to healthy dietary habits: a large-scale cross-sectional study

Zhongyu Ren[1*†], Zixuan Hao[1†] and Jianhua Cao[2*]

[1]School of Physical Education, Southwest University, Chongqing, China, [2]Department of Physical Education, Chongqing Institute of Foreign Studies, Chongqing, China

Introduction: Previous systematic review has shown that individuals with more comprehensive dietary knowledge tend to engage in healthier eating patterns among American or European population. However, research on the association between dietary knowledge based on the *Chinese Dietary Guidelines* and healthy dietary behaviors, particularly among adolescents and college students in China, is lacking. This study aimed to examine the association between dietary knowledge based on the *Chinese Dietary Guidelines* and adherence to healthy dietary behaviors among adolescents and college students in China.

Methods: A cross-sectional study was conducted in China in August and October 2023. The study involved 527 adolescents and 11,856 college students. A convenience and cluster sampling methodology was employed to select one or two grades from 33 different university majors. The dietary behaviors of college students were evaluated by assessing their consumption of nine food groups: water, eggs, milk and milk products, vegetables, fruit, red meat, soy and soy products, seafood, and sugar-sweetened beverages. The dietary behaviors of adolescents were evaluated by assessing their consumption of five food groups: fast food, salty snack foods, fruits, vegetables, and soft drinks and sugared fruit beverages. The participants' dietary knowledge was assessed using the *Chinese Dietary Guidelines*. The relationship between dietary knowledge and behaviors was examined using a multivariate logistic regression analysis.

Results: The questionnaire response rate was 100.0%. Multivariate logistic regression analysis revealed a significant positive association between dietary knowledge and the likelihood of exhibiting diverse dietary behaviors among college students. After adjusting for gender, age, family income, place of residence, and parents' education levels, the results demonstrated a positive association between dietary knowledge and adherence to 4–8 eating habits among college students. In contrast, similar association was not observed among adolescent.

Conclusion: This study revealed a significant association between dietary knowledge based on the Guidelines and adherence to healthy dietary behaviors among college students in China. That is to say, the higher the level of dietary knowledge based on the Guidelines among college students, the healthier the dietary behaviors they tend to adopt in their daily lives. These findings indicate the necessity of developing educational interventions based on the Guidelines to enhance dietary knowledge among individuals with limited dietary knowledge. Such interventions could facilitate the acquisition of essential health-related

knowledge and strengthen motivation to engage in healthy dietary behaviors. Future studies should employ longitudinal prospective designs or randomized controlled trials in order to establish a causal association between dietary knowledge based on the Guidelines and healthy dietary behaviors.

KEYWORDS

dietary knowledge, *Chinese Dietary Guidelines*, dietary habits, cross-sectional, Chinese

1 Introduction

With the sustained development of the economy and steady improvement of living standards, significant changes have occurred in the dietary habits of Chinese residents. High-calorie and high-fat diets have become increasingly popular. This shift has raised public health concerns. Studies have shown that nearly one-fifth of the global population is at risk of chronic non-communicable diseases, such as hypertension and diabetes, due to poor dietary habits (Afshin et al., 2019). Conversely, a balanced diet is associated with lower mortality (Shan et al., 2023) and increased lifespan (Fadnes et al., 2023), highlighting the urgent need to promote healthy dietary patterns in medicine and nutrition science.

College is the starting point for independent daily life(Vila-Martí et al., 2021; Ma, 2011) and defining moment for acquiring dietary autonomy and shaping dietary behaviors that could be sustained into adulthood(Winpenny et al., 2018). A longitudinal study found that the intake of vegetables and fruits decreased between the ages of 14 and 23 years and peaked around the age of 30 years, whereas the intake of sugary drinks and candy peaked around the age of 18 years and then began to decline (Winpenny et al., 2018). Another longitudinal survey of individuals aged 30–59 years revealed that healthy dietary patterns increased with age (Talegawkar et al., 2020). Unhealthy eating habits in early life had adverse effects on long-term health outcomes, including Type 2 diabetes (Malik et al., 2012), hypertension (Qiufen et al., 2022), colorectal cancer (Thordardottir et al., 2022), and arterial stiffness (Van de Laar et al., 2013). This suggests that exploring the dietary behaviors of college students and identifying the influencing factors is significant for understanding and improving their nutritional health.

The *Chinese Dietary Guidelines* (hereafter, the *Guidelines*) present a scientific consensus on healthy dietary behaviors and have informed nutrition promotion and health initiatives of health education workers, policymakers, and other stakeholders. The *Guidelines* are intended to help individuals make informed food choices and promote physical activity to maintain health and prevent nutrition-related diseases (Wang, 2021). Since the last century, nutrition education programs have been disseminated globally through schools (Al-Jawaldeh et al., 2023), government agencies (Ukam and Otareh, 2019), and health promotion organizations (Robles et al., 2019), aiming to improve residents' understanding of nutrition and encourage balanced diets. However, research has not explored the general population's nutritional knowledge, particularly regarding government-developed dietary guidelines and core food group recommendations, and its impact on dietary behavior. Thus, an understanding of how nutritional education translates into healthy dietary behaviors in daily life is lacking.

Previous systematic review has shown a positive association between nutritional knowledge and dietary behaviors among American or European population (Spronk et al., 2014). However, not all studies observed this relationship. Moreover, although studies have shown a positive association between knowledge of dietary guidelines and healthy dietary habits, these studies focused on single dietary behaviors among primary and middle school students (Feng Peng et al., 2019) and the general adult population(Huang FeiFei et al., 2015). The Chinese government and health experts have long worked to develop effective measures to improve dietary behavior. For example, the Government of China advocates the implementation of nutritional health science and education campaigns, including National Nutrition Week, National Food Safety Awareness Week, National Student Nutrition Day and National Iodine Deficiency Disease Prevention and Control Day (GOOTS Council, 2017). However, due to the imbalance between theoretical research and practical implementation, new interventions to promote healthy dietary behavior have been continuously called for. The National Nutrition Plan (2017–2030) requires disseminating dietary guidelines and nutritional health knowledge to various groups (Yan, 2017).

Therefore, this study examined the relationship between knowledge of dietary guidelines and dietary behaviors considering multiple food groups among secondary school and college students in China. A comprehensive understanding of this relationship is essential for developing nutrition education strategies and public health policies.

2 Methods

2.1 Research design and population

This study adopted a cross-sectional research design. A questionnaire survey was conducted at the physical fitness testing centers of four college (two in Sichuan Province and two in Chongqing Municipality) and 11 college (six in Liaoning Province, one in Jilin Municipality, and four in Chongqing Municipality) in China in August 2023 and October 2023, respectively (Ma et al., 2024). The present investigation was carried out using a stratified random sampling method, which accounted for sampling error and the stratification factor (stratified by grade). A random sample of 1–2 grades was selected from 33 majors drawn from 11 universities in accordance with the grade stratification and random number table method. A total of 11,856 university students, with a median age of 19.0 years, were sampled, and the response rate was 100.00%. Written informed consent was obtained from all participants. For participants aged below 16, parental consent was obtained following a

comprehensive evaluation. This study was approved by the Ethics Committee of the School of Physical Education of Southwest University.

The China Health and Nutrition Survey (CHNS), which was established in 1989, is an ongoing prospective cohort study. A previous study has published a detailed study design (Du et al., 2013). In brief, the multi-stage random cluster sampling method was used to select 4,400 households and 19,000 participants, covering nine provinces (Guizhou, Guangxi, Heilongjiang, Henan, Hubei, Hunan, Liaoning, Jiangsu, and Shandong). This study utilized the 2015 CHNS data and included individuals aged 18 years and younger as study subjects (n = 2,742). After removing individuals with missing sociodemographic characteristics, and diet-related variables, a total of 527 subjects were involved in the final analysis. Publicly available datasets were analyzed in this study. This data can be found here: https://www.cpc.unc.edu/projects/china (CCFDCA Prevention, 2015). Prior to the commencement of the study, ethical approval was obtained from the Institutional Review Board of the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health, Chinese Center for Disease Control and Prevention.

2.2 Assessment of eating behaviors

Food preferences are an indicator of one's attitude and consumption patterns with regard to specific food types (Ma et al., 2021), and an individual's food preferences have the potential to significantly influence their long-term health outcomes (Wang et al., 2024). Food preferences were assessed by five questions in the CHNS questionnaires (Wang et al., 2024). Adolescents were asked to rate their preference for five types of food items: fast food (e.g., pizza, burgers), salty snacks (e.g., potato chips), fruits, vegetables, and soft drinks and sugared fruit beverages. Responses were rated on a five-point Likert scale (1 = strongly dislike, 5 = strongly like). These scores were converted into binary variables: scores of 4 and 5 were classified as liking the food, whereas scores of 1–3 were classified as reflecting dislike or neutrality (Ma et al., 2021).

The dietary behaviors of college students were assessed using the adult version of the Chinese Dietary Pagoda (CN Society, 2022). Participants were asked to report their dietary habits regarding the intake of water, eggs, milk and milk products, vegetables, fruits, red meat, soy and soy products, and seafood. An additional item on sugar-sweetened beverages was derived from a prospective cohort study that showed a 21% higher risk of premature death among individuals who consumed ≥2 cups of sugar-sweetened beverages per day compared to those who consumed <1 cup per month (Gitanjali, 2015). Water consumption was assessed using one question: "How much water do you consume on average per day?" Responses were rated on a six-point scale (< 250 mL, 250–500 mL, 500–1,000 mL, 1,000–1,500 mL, 1,500–2000 mL, and > 2000 mL) and categorized as regular (≥ 1,500 mL) or irregular (< 1,500 mL) water intake. Sugar-sweetened beverage intake was assessed using one question: "On average, how many sugar-sweetened beverages do you drink per day?" Responses were rated on a five-point scale (none/never consume, < 500 mL, 500–1,000 mL, 1,000–1,500 mL, and > 1,500 mL) and categorized as ingesting or not ingesting. Egg intake was assessed using one question: "How many eggs do you eat on average per day?" Responses were rated on a five-point scale (0/never consume, 1, 2, 3, 4, and > 4) and categorized as regular (≥ 1) or irregular (0) consumption. Milk and dairy product intake was assessed using one question: "How much milk and dairy products do you consume on average per day?" Responses were rated on a five-point scale (none/never consume, < 250 mL, 250–500 mL, 500–750 mL, and > 750 mL) and categorized as regular (≥ 250 mL) or irregular (< 250 mL) consumption. Vegetable and fruit intake was assessed using one question: "On average, how many times a day do you eat vegetables or fruit?" Responses were rated on a five-point scale (never, once, twice, three times, four times, and more than four times) and categorized as regular (once or more) or irregular (never) consumption. Red meat, soy, and fish intake was assessed using one question: "On average, how many times a week do you eat red meat (including pork, beef, lamb, and processed products such as bacon and sausages), soy products, or fish products?" Responses were rated on an eight-point scale (less than once/never consume, once, twice, three times, four times, five times, six times, and daily) and categorized as regular (twice or more) or irregular (less than twice) consumption.

For each food type, responses categorized as regular consumption were assigned a score of 1, whereas those categorized as irregular were assigned a score of 0. Total scores were obtained by summing scores for all food types and ranged from 0 to 9, with higher scores indicating healthier eating habits. The reliability of the participants' reported dietary behaviors over time was quantified using the intra-group correlation coefficient (ICC). The ICC values were statistically significant and ranged from 0.947 to 0.987, indicating high retest reliability of the assessed dietary behaviors.

2.3 Assessment of dietary knowledge based on *Guidelines*

The participants' dietary knowledge was assessed using the Dietary Knowledge of Chinese Residents scale (Yang et al., 2020). Responses were rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). These scores were converted into binary variables: scores of 4 and 5 were classified as good dietary knowledge and coded as 1, whereas scores of 1–3 were classified as poor dietary knowledge and coded as 0. Total scores were obtained by summing the individual item scores, with higher total scores indicating greater dietary knowledge. The study population were divided into quartiles based on dietary knowledge scores to compare different levels of knowledge. The Cronbach's alpha coefficients were 0.749 and 0.842 for adolescents and college students, respectively, indicating robust internal consistency reliability.

2.4 Statistical methods

All data were imported into an Excel database for organization and generalization. SPSS 23.0 was used for statistical analysis. All categorical data were expressed as percentage (%) and continuous variables were presented as medians [interquartile range (IQR)] due to the non-normal distribution of the data. The chi-square test for categorical variables and the Kruskal-Wallis test for continuous variables were employed to assess the differences in participant characteristics between individuals with categories of dietary knowledge.

We used multivariate logistic regression to examine the association between dietary knowledge and healthy eating behaviors. Dietary knowledge, categorized into quartiles (Q1–Q4), was the independent variable, whereas healthy eating behaviors were the dependent variable. To compare the differences in the likelihood of healthy eating behaviors between groups with different levels of dietary knowledge, odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for Q2, Q3, and Q4, using the Q1 level as the reference group. To examine the effects of potential confounders, two statistical models were constructed for the adolescent: Model 1 was a crude model, and Model 2 was adjusted for gender, age, annual family income, residence, education level. Similarly, two statistical models were constructed for the college student population: Model 1 was a crude model, and Model 2 was adjusted for gender, age, annual household income, place of residence, father's education level, and mother's education level. Moreover, we separately analyzed the association between dietary knowledge and the likelihood of consuming each food type in both Models 1 and 2. All statistical analyses were performed using two-sided tests, with $p < 0.05$ indicating statistical significance.

3 Results

3.1 Participants' characteristics

Table 1 presents the characteristics of the college students. This study included 11,856 college students (33.2% men, 66.8% women, median age = 19.0 years). Among them, 58.9% resided in rural areas, with over one-third (34.6%) reporting an annual household income of over 35,000 yuan. Approximately one-third of the students had parents with a bachelor's degree or higher. Moreover, individuals with higher levels of dietary knowledge tended to be men ($p < 0.001$), be older ($p < 0.001$), and have parents with higher educational levels ($p \leq 0.007$).

Table 2 presents the characteristics of the adolescents. This study included 527 adolescents (51.6% men, 48.4% women, median age = 14.0 years). Among them, 57.3% resided in rural areas, and 63.9% reported an annual household income of over 35,000 yuan. Approximately 1.5% had parents with a bachelor's degree or higher. Moreover, individuals with higher levels of dietary knowledge tended to have higher income levels ($p = 0.043$).

Table 3 demonstrated the results of frequency of numbers of eating behaviors according to the quartile of dietary knowledge score among college students. The fourth quartile with the highest dietary knowledge score showed a significantly highest frequency of adherence to 6 or more eating behaviors ($p < 0.001$). On the other hand, no significant relationship was found between knowledge of dietary habits and adherence to dietary diversity in the adolescent population (Table 4).

3.2 Multifactorial logistic regression analysis of dietary knowledge and likelihood of healthy eating behaviors among college students

In a sample of college students, this study examined the association between dietary knowledge and adherence to the number of different eating habits, with dietary knowledge as the independent variable and adherence to the number of different eating habits as the dependent

TABLE 1 Participants' characteristics according to categories of dietary knowledge based on the Guidelines score (college students).

N = 11,856	Q1	Q2	Q3	Q4	*p* value
Gender, male	29.1	27.4	34.6	42.7	<0.001
Age, year	19.0 (18.0, 19.0)	18.0 (18.0, 19.0)	19.0 (18.0, 19.0)	19.0 (18.0, 19.0)	<0.001
Annual family income, %					
<20,000 yuan	36.6	35.7	34.8	34.9	0.137
20,000–35,000 yuan	27.9	30.8	30.6	30.5	
>35,000 yuan	35.5	33.5	34.7	34.6	
Residence, %					
Town	41.8	40.2	41.7	40.8	0.516
Rural	58.2	59.8	58.3	59.2	
Father's education level, %					
Primary and below	22.8	24.4	23.0	25.5	0.007
Junior high	38.4	40.4	42.0	37.5	
High school	22.6	20.7	20.6	21.6	
Bachelor degree and above	16.1	14.5	14.4	15.3	
Mother's education level, %					
Primary and below	29.7	32.8	32.2	33.2	0.002
Junior high	36.8	35.8	38.5	34.4	
High school	19.5	19.1	17.1	18.5	
Bachelor degree and above	14.0	12.3	12.1	13.8	

TABLE 2 Participants' characteristics according to categories of dietary knowledge based on the Guidelines score (adolescent).

N = 527	Q1 (*n* = 143)	Q2 (*n* = 136)	Q3 (*n* = 176)	Q4 (*n* = 72)	*p*- value
Gender, male	53.1	58.1	46.0	50.0	0.196
Age, year	14.0 (13.0, 15.0)	14.0 (12.0, 16.0)	14.0 (13.0, 16.0)	14.0 (12.0, 16.0)	0.056
Annual family income, %					
<20,000 yuan	22.4	19.1	15.9	27.8	0.043
20,000–35,000 yuan	16.1	22.8	13.1	9.7	
>35,000 yuan	61.5	58.1	71.0	62.5	
Residence, %					
Town	45.5	44.1	41.5	37.5	0.692
Rural	54.5	55.9	58.5	62.5	
Education level, %					
Primary and below	46.2	38.2	37.5	36.1	0.318
Junior high	35.7	37.5	39.8	44.4	
High school	9.1	10.3	14.2	11.1	
Bachelor degree and above	0.0	3.7	1.7	0.0	
Unknown	9.1	10.3	6.8	8.3	

TABLE 3 Frequency of numbers of eating behaviors according to the quartile of dietary knowledge score.

College students	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile 4 (highest)	χ^2	*p*- value
Numbers of eating behaviors						
0	0.3	0.3	0.2	0.3	56.983	<0.001
1	2.0	1.7	1.5	1.7		
2	5.4	5.1	4.9	4.5		
3	14.3	11.9	10.6	11.0		
4	19.2	18.3	18.8	18.5		
5	22.9	24.6	22.8	21.9		
6	19.4	20.5	21.4	21.8		
7	11.8	12.8	15.0	13.8		
8	4.0	3.9	4.0	5.5		
9	0.7	0.8	0.8	1.0		

In this table demonstrated the results of frequency of numbers of eating behaviors according to the quartile of dietary knowledge score. The fourth quartile with the highest dietary knowledge score showed a significantly highest frequency of adherence to 6 or more eating behaviors ($p < 0.001$).

variable. The results showed that there was positive association between dietary knowledge and adherence to 4–8 different eating habits.

The findings showed no significant association between dietary knowledge and adherence to two or more eating habits. In the crude model, the odds ratios (95% CI) for adherence to two or more eating habits were 1.14 (0.83, 1.57) for Q2, 1.35 (0.89, 2.04) for Q3, and 1.11 (0.77, 1.60) for Q4, compared to the reference group (Q1) ($p = 0.426$). After adjusting for confounders, the adjusted odds ratios (95% CI) were 1.09 (0.79, 1.50) for Q2, 1.24 (0.81, 1.88) for Q3, and 1.02 (0.70, 1.47) for Q4 ($p = 0.783$; Table 5).

Similarly, no significant association was found between dietary knowledge and adherence to three or more eating habits. Crude odds ratios (95% CI) were 1.09 (0.91, 1.30), 1.18 (0.94, 1.47), and 1.20 (0.97, 1.47) for Q2, Q3, and Q4, respectively, compared to the reference group (Q1) ($p = 0.066$). After adjusting for confounding factors, the adjusted odds ratios (95% CI) were 1.05 (0.88, 1.26) for Q2, 1.09 (0.87, 1.36) for Q3, and 1.10 (0.89, 1.35) for Q4 ($p = 0.345$; Table 6).

However, a significant association emerged for adherence to four or more eating habits. The crude odds ratios (95% CI), compared to the reference group (Q1), were 1.20 (1.07, 1.35) for Q2, 1.35 (1.17, 1.56) for Q3, and 1.33 (1.16, 1.52) for Q4 ($p < 0.001$). After controlling for confounders, the adjusted odds ratios (95% CI) were 1.18 (1.05, 1.33), 1.28 (1.10, 1.48), and 1.24 (1.08, 1.42) for Q2, Q3, and Q4, respectively ($p = 0.001$; Table 7).

TABLE 4 Frequency of numbers of eating behaviors according to the quartile of dietary knowledge score.

Adolescent	Quartile 1 (lowest)	Quartile 2	Quartile 3	Quartile 4 (highest)	χ^2	*p*- value
Numbers of eating behaviors						
0	2.1	4.4	2.8	5.6	12.872	0.612
1	14.0	14.7	10.2	9.7		
2	32.2	33.8	30.1	27.8		
3	26.6	17.6	18.8	22.2		
4	11.2	14.0	17.6	16.7		
5	14.0	15.4	20.5	18.1		

TABLE 5 The associations between dietary knowledge and eating habits (≥2score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	2,971	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	4,175	1.14 (0.83, 1.57)	1.09 (0.79, 1.50)
Quartile 3	2011	1977	1.35 (0.89, 2.04)	1.24 (0.81, 1.88)
Quartile 4 (highest)	2,545	2,493	1.11 (0.77, 1.60)	1.02 (0.70, 1.47)
p- for trend[d]	–	–	0.426	0.783

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 6 The associations between dietary knowledge and eating habits (≥3 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	2,806	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	3,957	1.09 (0.91, 1.30)	1.05 (0.88, 1.26)
Quartile 3	2011	1878	1.18 (0.94, 1.47)	1.09 (0.87, 1.36)
Quartile 4 (highest)	2,545	2,379	1.20 (0.97, 1.47)	1.10 (0.89, 1.35)
p- for trend[d]	–	–	0.066	0.345

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

For adherence to five or more eating habits, a positive association was also observed with dietary knowledge. The crude odds ratios (95% CI) for Q2, Q3, and Q4 were 1.18 (1.07, 1.30), 1.24 (1.11, 1.40), and 1.24 (1.12, 1.39), respectively, compared to the reference group (Q1) ($p < 0.001$). After adjusting for confounding factors, the adjusted odds ratios (95% CI) were 1.16 (1.06, 1.28) for Q2, 1.19 (1.06, 1.34) for Q3, and 1.18 (1.05, 1.31) for Q4 ($p = 0.005$; Table 8).

The pattern held for adherence to six or more eating habits, where a significant positive association was noted. In comparison to the reference group (Q1), the crude odds ratios (95% CI) were 1.10 (1.00, 1.21) for Q2, 1.25 (1.11, 1.40) for Q3, and 1.29 (1.16, 1.44) for Q4 ($p < 0.001$). After controlling for confounders, the adjusted odds ratios (95% CI) were 1.09 (0.99, 1.20) for Q2, 1.19 (1.06, 1.34) for Q3, and 1.22 (1.09, 1.36) for Q4 ($p < 0.001$; Table 9).

A similar significant association was observed for adherence to seven or more eating habits. The crude odds ratios (95% CI) for Q2, Q3, and Q4 were 1.07 (0.95, 1.21), 1.24 (1.07, 1.44), and 1.28 (1.12, 1.47), respectively, compared to Q1 ($p < 0.001$). After adjusting for confounding factors, the adjusted odds ratios (95% CI) were 1.06 (0.94, 1.21) for Q2, 1.18 (1.02, 1.38) for Q3, and 1.21 (1.05, 1.39) for Q4 ($p = 0.003$; Table 10).

A positive association between dietary knowledge and adherence to eight or more eating habits was also found. The crude odds ratios (95% CI), when compared to the reference group (Q1), were 1.00 (0.80, 1.25) for Q2, 1.01 (0.77, 1.31) for Q3, and 1.39 (1.11, 1.76) for Q4 ($p = 0.004$). After controlling for confounders, the adjusted odds ratios (95% CI) were 1.03 (0.82, 1.28) for Q2, 0.98 (0.75, 1.28) for Q3, and 1.32 (1.04, 1.66) for Q4 ($p = 0.028$; Table 11).

TABLE 7 The associations between dietary knowledge and eating habits (≥4 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	2,372	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	3,452	1.20 (1.07, 1.35)	1.18 (1.05, 1.33)
Quartile 3	2011	1,664	1.35 (1.17, 1.56)	1.28 (1.10, 1.48)
Quartile 4 (highest)	2,545	2099	1.33 (1.16, 1.52)	1.24 (1.08, 1.42)
p- for trend[d]	–	–	<0.001	0.001

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 8 The associations between dietary knowledge and eating habits (≥5 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile1 (lowest)	3,040	1787	1.000 (reference)	1.000 (reference)
Quartile2	4,260	2,671	1.18 (1.07, 1.30)	1.16 (1.06, 1.28)
Quartile3	2011	1,286	1.24 (1.11, 1.40)	1.19 (1.06, 1.34)
Quartile4 (highest)	2,545	1,627	1.24 (1.12, 1.39)	1.18 (1.05, 1.31)
p- for trend[d]	–	–	<0.001	0.005

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 9 The associations between dietary knowledge and eating habits (≥6 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	1,092	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	1,621	1.10 (1.00, 1.21)	1.09 (0.99, 1.20)
Quartile 3	2011	828	1.25 (1.11, 1.40)	1.19 (1.06, 1.34)
Quartile 4 (highest)	2,545	1,069	1.29 (1.16, 1.44)	1.22 (1.09, 1.36)
p- for trend[d]	–	–	<0.001	<0.001

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

In contrast, adherence to nine or more eating habits showed no significant association with dietary knowledge. The crude odds ratios (95% CI) were 1.17 (0.69, 1.99) for Q2, 1.10 (0.58, 2.10) for Q3, and 1.42 (0.80, 2.50) for Q4, compared to the reference group (Q1) ($p = 0.276$). After adjusting for confounders, the odds ratios (95% CI) were 1.18 (0.69, 2.02) for Q2, 1.01 (0.53, 1.95) for Q3, and 1.26 (0.71, 2.25) for Q4 ($p = 0.560$; Table 12).

3.3 Multifactorial logistic regression analysis of dietary knowledge and likelihood of healthy eating behaviors among adolescents

In a sample of adolescent, this study examined the association between dietary knowledge and adherence to the number of different eating habits, with dietary knowledge as the independent variable and adherence to the number of different eating habits as the dependent variable.

Similarly, for two or more eating habits, no significant association with dietary knowledge was found. The crude odds ratios (95% CI) were 0.81 (0.44, 1.50), 1.28 (0.68, 2.38), and 1.06 (0.49, 2.32) for Q2, Q3, and Q4, respectively, compared to the reference group (Q1) ($p = 0.491$). After adjusting for confounders, the adjusted odds ratios (95% CI) were 0.85 (0.46, 1.60) for Q2, 1.16 (0.61, 2.20) for Q3, and 1.02 (0.46, 2.26) for Q4 ($p = 0.705$; Table 13).

For adherence to three or more eating habits, the results showed no significant association between dietary knowledge and adherence. The crude odds ratios (95% CI), compared to the reference group (Q1) were 0.83 (0.52, 1.33) for Q2, 1.23 (0.79, 1.91) for Q3, and 1.23 (0.70, 2.18) for Q4 ($p = 0.221$). Adjusted odds ratios (95% CI) were 0.83 (0.52, 1.34) for Q2, 1.13 (0.72, 1.77) for Q3, and 1.19 (0.67, 2.11) for Q4 ($p = 0.373$; Table 14).

TABLE 10 The associations between dietary knowledge and eating habits (≥7 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	503	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	746	1.07 (0.95, 1.21)	1.06 (0.94, 1.21)
Quartile 3	2011	397	1.24 (1.07, 1.44)	1.18 (1.02, 1.38)
Quartile 4 (highest)	2,545	515	1.28 (1.12, 1.47)	1.21 (1.05, 1.39)
p- for trend[d]	–	–	<0.001	0.003

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 11 The associations between dietary knowledge and eating habits (≥8 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	144	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	202	1.00 (0.80, 1.25)	1.03 (0.82, 1.28)
Quartile 3	2011	96	1.01 (0.77, 1.31)	0.98 (0.75, 1.28)
Quartile 4 (highest)	2,545	165	1.39 (1.11, 1.76)	1.32 (1.04, 1.66)
p- for trend[d]	–	–	0.004	0.028

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 12 The associations between dietary knowledge and eating habits (≥9 score).

College students	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	3,040	22	1.000 (reference)	1.000 (reference)
Quartile 2	4,260	36	1.17 (0.69, 1.99)	1.18 (0.69, 2.02)
Quartile 3	2011	16	1.10 (0.58, 2.10)	1.01 (0.53, 1.95)
Quartile 4 (highest)	2,545	26	1.42 (0.80, 2.50)	1.26 (0.71, 2.25)
p- for trend[d]	–	–	0.276	0.560

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

Adherence to four or more eating habits did not show a significant association with dietary knowledge. The crude odds ratios (95% CI) were 1.24 (0.73, 2.10) for Q2, 1.83 (1.13, 2.97) for Q3, and 1.58 (0.86, 2.92) for Q4, compared with the reference group (Q1) ($p = 0.025$). Adjusted odds ratios (95% CI) after controlling for confounding factors were 1.27 (0.74, 2.18) for Q2, 1.68 (1.02, 2.77) for Q3, and 1.53 (0.82, 2.86) for Q4 ($p = 0.059$; Table 15).

Finally, adherence to five or more eating habits revealed no significant association with dietary knowledge. The crude odds ratios (95% CI) for Q2, Q3, and Q4 were 1.12 (0.58, 2.18), 1.58 (0.87, 2.88), and 1.36 (0.63, 2.91), respectively, compared to Q1 ($p = 0.182$). After adjusting for confounders, the odds ratios (95% CI) were 1.19 (0.60, 2.33) for Q2, 1.53 (0.83, 2.83) for Q3, and 1.35 (0.62, 2.92) for Q4 ($p = 0.238$; Table 16).

3.4 Multifactorial logistic regression analysis of dietary knowledge and likelihood of individual dietary habits among college students

This study explored the association between dietary knowledge and individual dietary habits among college students. The odds ratios (95% CI) for water consumption, comparing Q2, Q3, and Q4 to the reference group (Q1), were 0.98 (0.86, 1.12), 1.04 (0.89, 1.22), and 1.14 (0.98, 1.32), respectively ($p = 0.055$). After adjusting for confounding factors, the adjusted odds ratios (95% CI) for Q2, Q3, and Q4 versus Q1 were 1.02 (0.89, 1.17), 1.05 (0.90, 1.24), and 1.14 (0.98, 1.32), respectively ($p = 0.084$; Supplementary Table S1).

10.3389/fpsyg.2024.1453815

TABLE 13 The associations between dietary knowledge and eating habits (≥2 score).

Adolescent	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	143	120	1.000 (reference)	1.000 (reference)
Quartile 2	110	110	0.81 (0.44, 1.50)	0.85 (0.46, 1.60)
Quartile 3	153	153	1.28 (0.68, 2.38)	1.16 (0.61, 2.20)
Quartile 4 (highest)	61	61	1.06 (0.49, 2.32)	1.02 (0.46, 2.26)
p- for trend[d]	–	–	0.491	0.705

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 14 The associations between dietary knowledge and eating habits (≥3 score).

Adolescent	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	143	74	1.000 (reference)	1.000 (reference)
Quartile 2	110	64	0.83 (0.52, 1.33)	0.83 (0.52, 1.34)
Quartile 3	153	100	1.23 (0.79, 1.91)	1.13 (0.72, 1.77)
Quartile 4 (highest)	61	41	1.23 (0.70, 2.18)	1.19 (0.67, 2.11)
p- for trend[d]	–	–	0.221	0.373

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 15 The associations between dietary knowledge and eating habits (≥4 score).

Adolescent	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	143	36	1.000 (reference)	1.000 (reference)
Quartile 2	110	40	1.24 (0.73, 2.10)	1.27 (0.74, 2.18)
Quartile 3	153	67	1.83 (1.13, 2.97)	1.68 (1.02, 2.77)
Quartile 4 (highest)	61	25	1.58 (0.86, 2.92)	1.53 (0.82, 2.86)
p- for trend[d]	–	–	0.025	0.059

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

TABLE 16 The associations between dietary knowledge and eating habits (≥5 score).

Adolescent	Number of participants	Number of healthy eating behaviors	Model 1[a]	Model 2[b]
Categories of dietary knowledge				
Quartile 1 (lowest)	143	20	1.000 (reference)	1.000 (reference)
Quartile 2	110	21	1.12 (0.58, 2.18)	1.19 (0.60, 2.33)
Quartile 3	153	36	1.58 (0.87, 2.88)	1.53 (0.83, 2.83)
Quartile 4 (highest)	61	13	1.36 (0.63, 2.91)	1.35 (0.62, 2.92)
p- for trend[d]	–	–	0.182	0.238

[a]Model 1: crude. [b]Model 2: Adjusted for sex, age, annual family income, father and mother's education (primary and below, junior high, high school, or junior college and above). [c]Adjusted data are expressed as odds ratio (95% confidence intervals). [d]*P* for trend were obtained using multivariate logistic regression analyses.

For egg consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 compared to the reference group (Q1) were 1.01 (0.92, 1.11), 1.11 (0.99, 1.24), and 1.16 (1.04, 1.29), respectively ($p = 0.002$). After accounting for the confounders, the adjusted odds ratios (95% CI) were 1.00 (0.91, 1.10), 1.08 (0.96, 1.21), and 1.12 (1.01, 1.25), respectively ($p = 0.016$; Supplementary Table S2).

Regarding milk consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 in comparison to Q1 were 1.04 (0.94, 1.16), 1.09 (0.96, 1.24), and 1.13 (1.01, 1.28), respectively ($p = 0.031$). After adjusting for confounding factors, the adjusted odds ratios (95% CI) were 1.04 (0.93, 1.15) for Q2, 1.06 (0.93, 1.21) for Q3, and 1.10 (0.98, 1.25) for Q4 ($p = 0.110$; Supplementary Table S3).

In terms of vegetable consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 relative to Q1 were 1.32 (1.08, 1.61), 1.50 (1.16, 1.93), and 1.29 (1.03, 1.62), respectively ($p = 0.015$). Adjusted odds ratios (95% CI) for Q2, Q3, and Q4 were 1.33 (1.09, 1.62), 1.48 (1.15, 1.92), and 1.27 (1.01, 1.60), respectively ($p = 0.028$; Supplementary Table S4).

When examining fruit consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 compared to Q1 were 1.20 (1.07, 1.35), 1.24 (1.08, 1.43), and 1.24 (1.09, 1.42), respectively ($p = 0.001$). After adjusting for confounders, the adjusted odds ratios (95% CI) were 1.16 (1.03, 1.31) for Q2, 1.18 (1.02, 1.37) for Q3, and 1.19 (1.04, 1.36) for Q4 ($p = 0.012$; Supplementary Table S5).

For red meat consumption, the odds ratios (95% CI) comparing Q2, Q3, and Q4 to Q1 were 1.19 (1.05, 1.34), 1.17 (1.01, 1.35), and 1.13 (0.99, 1.29), respectively ($p = 0.113$). After adjusting for confounders, the adjusted odds ratios (95% CI) were 1.16 (1.03, 1.31) for Q2, 1.10 (0.95, 1.28) for Q3, and 1.05 (0.92, 1.21) for Q4 ($p = 0.639$; Supplementary Table S6).

For soy and soy products, the odds ratios (95% CI) for Q2, Q3, and Q4 compared to the reference group (Q1) were 1.17 (1.05, 1.30), 1.25 (1.10, 1.42), and 1.16 (1.03, 1.30), respectively ($p = 0.011$). After adjusting for the confounding factors, the adjusted odds ratios (95% CI) were 1.15 (1.04, 1.28) for Q2, 1.20 (1.05, 1.37) for Q3, and 1.10 (0.97, 1.24) for Q4 ($p = 0.112$; Supplementary Table S7).

The analysis of seafood consumption revealed odds ratios (95% CI) of 0.97 (0.88, 1.06) for Q2, 1.04 (0.93, 1.17) for Q3, and 1.10 (0.99, 1.22) for Q4, compared to the reference group Q1 ($p = 0.036$). After controlling for confounders, the adjusted odds ratios (95% CI) were 0.96 (0.87, 1.06) for Q2, 1.00 (0.89, 1.12) for Q3, and 1.03 (0.92, 1.15) for Q4 ($p = 0.459$; Supplementary Table S8).

Lastly, for sugar-sweetened beverage consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 compared to the reference group (Q1) were 1.05 (0.95, 1.16), 1.13 (1.00, 1.28), and 1.17 (1.04, 1.31), respectively ($p = 0.004$). After adjusting for confounding factors, the adjusted odds ratios (95% CI) were 1.05 (0.94, 1.16) for Q2, 1.12 (0.99, 1.27) for Q3, and 1.16 (1.03, 1.30) for Q4 ($p = 0.007$; Supplementary Table S9).

3.5 Multifactorial logistic regression analysis of dietary knowledge and likelihood of individual dietary habits among adolescent

This study investigated the association between dietary knowledge and individual dietary habits among adolescents. The odds ratios (95% CI) for vegetable consumption in Q2, Q3, and Q4, compared to the reference group (Q1), were 1.57 (0.98, 2.52), 2.78 (1.75, 4.42), and 2.01 (1.12, 3.59), respectively ($p < 0.001$). After adjusting for variables such as sex, age, annual family income, and parents' education, the adjusted odds ratios (95% CI) for Q2, Q3, and Q4 compared to Q1 were 1.64 (1.01, 2.64), 2.62 (1.63, 4.20), and 1.97 (1.09, 3.55), respectively ($p < 0.001$; Supplementary Table S10).

For fruit consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 relative to Q1 were 1.43 (0.83, 2.48), 1.82 (1.07, 3.09), and 2.41 (1.13, 5.16), respectively ($p = 0.007$). After adjusting for sex, age, annual family income, and parents' education, the adjusted ratios (95% CI) were 1.51 (0.86, 2.63) for Q2, 1.89 (1.09, 3.27) for Q3, and 2.51 (1.16, 5.42) for Q4 ($p = 0.006$; Supplementary Table S11).

In terms of fast-food consumption, the odds ratios (95% CI) comparing Q2, Q3, and Q4 to the reference group (Q1) were 1.05 (0.65, 1.67), 1.24 (0.80, 1.93), and 1.38 (0.78, 2.45), respectively ($p = 0.191$). After adjusting for confounding factors such as sex, age, family income, and parents' education, the adjusted odds ratios (95% CI) were 1.08 (0.67, 1.75) for Q2, 1.22 (0.77, 1.92) for Q3, and 1.38 (0.77, 2.47) for Q4 ($p = 0.227$; Supplementary Table S12).

For salty snack consumption, the odds ratios (95% CI) for Q2, Q3, and Q4 compared to Q1 were 0.74 (0.46, 1.18), 1.06 (0.68, 1.65), and 0.79 (0.45, 1.39), respectively ($p = 0.863$). After adjusting for sex, age, annual family income, and parents' education, the adjusted odds ratios (95% CI) for were 0.73 (0.46, 1.17) for Q2, 0.99 (0.63, 1.55) for Q3, and 0.76 (0.43, 1.35) for Q4 ($p = 0.659$; Supplementary Table S13).

The analysis of soft drink and sugared fruit drink consumption revealed odds ratios (95% CI) of 0.52 (0.32, 0.84) for Q2, 0.55 (0.35, 0.86) for Q3, and 0.49 (0.27, 0.89) for Q4 compared to the reference group ($p = 0.008$). After adjusting for sex, age, annual family income, and parents' education, the adjusted odds ratios (95% CI) were 0.51 (0.31, 0.84) for Q2, 0.48 (0.30, 0.77) for Q3, and 0.46 (0.25, 0.83) for Q4 ($p = 0.002$; Supplementary Table S14).

4 Discussion

This was the first study to examine the relationship between nutritional knowledge and dietary behavior based on the *Guidelines*. The results demonstrated that individuals with higher levels of nutritional knowledge tended to exhibit healthy eating patterns for individual food types and a greater propensity for diverse healthy dietary behaviors among college students. In contrast, similar association was not observed among adolescent. Thus, nutritional knowledge was associated with specific dietary behaviors and overall dietary diversity among college students.

The present findings were consistent with those of previous studies indicating that adults with good knowledge of the *Guidelines* exhibited significantly higher daily intake of grains, roots, vegetables, beans, tofu products, fruits, meats, poultry, eggs, and dairy products than those with poor knowledge (Feng Peng et al., 2019), and that primary and middle school students with good knowledge of the *Guidelines* exhibited better hydration habits and higher intake of dark green vegetables and eggs than those with poor knowledge (Huang FeiFei et al., 2015).

This relationship could be explained by the social cognitive theory, which suggests that individuals recognize patterns in their thinking, emotional responses, and behaviors and the conditions in which these occur. A previous study based on the social cognitive theory and

health belief model found that individuals who understand how to change their behaviors and the modifiable aspects of their environment may implement corrective changes (Tougas et al., 2015). According to the social cognitive theory, individuals require a basic understanding of food and healthy eating conditions to effectively change dietary behavior. Individuals who obtain accurate dietary information and recognize the relationship between food intake and health adjust their dietary habits.

Previous study has found a positive correlation between health awareness and healthy dietary habits (Beydoun and Wang, 2008). Many studies have explored the association between dietary knowledge and quality and found that people recognized the usefulness of dietary guidelines, food composition, and expert advice for obtaining healthy dietary patterns (Bonaccio et al., 2013). These findings prompted strong endorsements of health education programs to inform dietary choices. Therefore, a lack of knowledge could lead to unhealthy eating habits, which is supported by sociological theories, such as the social cognitive theory. A longitudinal follow-up survey in China revealed that awareness of the Guidelines among adults increased from 7.8% in 2004 to 24.4% in 2011, indicating that more than 70% of Chinese adults were unaware of the Guidelines (Huang FeiFei et al., 2015). This lack of awareness may be related to unhealthy eating habits. Surprisingly, similar association was not observed among adolescent. It can be reasonably assumed that guardians or school cafeteria staff exert a significant influence on adolescents' dietary habits, given the typical provision of food to this age group by their respective guardians or the school. As a consequence, adolescents are unable to select a range of food items in accordance with their personal preferences.

In China, dietary guidelines significantly enhanced public understanding of food and strengthened self-awareness of the necessity of a balanced diet. The significance of nutritional knowledge was particularly evident when the results were stratified by education level (Supplementary Table S13). It is reasonable to believe that individuals with a higher degree of education may be more inclined to be aware of the nutritional quality of food and thus to choose healthy diets.

4.1 Limitations

This study had several limitations. First, the limited food preference questionnaire hindered our ability to assess the multidimensional nature of dietary preferences. Future studies should explore dietary knowledge based on the *Guidelines* and multidimensional food preferences. Second, due to the cross-sectional design of this study, we could not determine the causal association between dietary knowledge and behaviors. Future cohort studies should examine the association between dietary knowledge and eating behaviors. Third, this study employed a questionnaire on dietary knowledge and eating behaviors that has been extensively used in previous research (Ma et al., 2024; Liu et al., 2023). However, the use of self-report data on congenital deficiencies in the questionnaire limits the accuracy of the investigation into the dietary knowledge and eating behaviors of the participants. Fourth, the adoption of healthy eating behaviors or the acquisition of knowledge about healthy diets over time can result in an excessive preoccupation with healthy eating (Douma et al., 2021), which in turn may give rise to the development of specific healthy eating habits. Such habits may contribute to the occurrence of eating disorders when they become a dominant focus (McCartney, 2016). It would be beneficial for future longitudinal follow-up studies to focus on whether long-term adherence to healthy eating habits, or an unhealthy obsession with healthy eating habits, leads to the development of eating disorders.

5 Conclusion

This study revealed a significant association between dietary knowledge based on the *Guidelines* and adherence to healthy dietary behaviors among college students in China. That is to say, the higher the level of dietary knowledge based on the Guidelines among college students, the healthier the dietary behaviors they tend to adopt in their daily lives. These findings indicate the necessity of developing educational interventions based on the Guidelines to enhance dietary knowledge among individuals with limited dietary knowledge. Such interventions could facilitate the acquisition of essential health-related knowledge and strengthen motivation to engage in healthy dietary behaviors. Future studies should employ longitudinal prospective designs or randomized controlled trials in order to establish a causal association between dietary knowledge based on the Guidelines and healthy dietary behaviors.

Data availability statement

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

Ethics statement

The studies involving humans were approved by the Ethics Committee of the School of Physical Education of Southwest University, and the Institutional Review Board of the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health, Chinese Center for Disease Control and Prevention. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

ZR: Conceptualization, Writing – original draft, Writing – review & editing. ZH: Data curation, Formal analysis, Writing – original draft, Writing – review & editing. JC: Conceptualization, Data curation, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This study was supported by the Ministry of Education of Humanities and Social Science project, China (Grant no. 21YJCZH125) and Chongqing Municipal Social Science Planning Project - Youth Project (Grant no. 2021NDQN66) and the Science and Technology Research Program of

Chongqing Municipal Education Commission (Grant no. KJQN202100216).

Acknowledgments

We would like to thank all the university students who took part in this study for agreeing to participate and giving informed consent for their data to be analyzed. We would also like to thank all the staff for their hard work.

Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1453815/full#supplementary-material

References

Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., et al. (2019). And Maysaa, health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the global burden of disease study 2017. *Lancet* 393, 1958–1972. doi: 10.1016/S0140-6736(19)30041-8

Al-Jawaldeh, A., Matbouli, D., Diab, S., Taktouk, M., Hojeij, L., Naalbandian, S., et al. (2023). School-based nutrition programs in the eastern Mediterranean region: a systematic review. *Int. J. Environ. Res. Public Health* 20:47. doi: 10.3390/ijerph20227047

Beydoun, M. A., and Wang, Y. (2008). Do nutrition knowledge and beliefs modify the association of socio-economic factors and diet quality among US adults? *Prev. Med.* 46, 145–153. doi: 10.1016/j.ypmed.2007.06.016

Bonaccio, M., Castelnuovo, A. D., Costanzo, S., Lucia, F. D., Olivieri, M., Donati, M. B., et al. (2013). Nutrition knowledge is associated with higher adherence to Mediterranean diet and lower prevalence of obesity. Results from the Moli-sani study. *Appetite* 68, 139–146. doi: 10.1016/j.appet.2013.04.026

CN Society. (2022). *The Chinese Dietary Guidelines*.·Available at: http://dg.cnsoc.org/.

CCFDCA Prevention. (2015).·*China Health and Nutrition Survey*. Available at: https://www.cpc.unc.edu/projects/china.

Douma, E. R., Valente, M., and Syurina, E. V. (2021). Developmental pathway of orthorexia nervosa: factors contributing to progression from healthy eating to excessive preoccupation with healthy eating. Experiences of Dutch health professionals. *Appetite* 158:105008. doi: 10.1016/j.appet.2020.105008

Du, S., Zhai, F., Popkin, B. M., and Zhang, B. (2013). Cohort profile: The China health and nutrition survey--monitoring and understanding socio-economic and health change in China, 1989–2011. *Int J Epidemiol* 39, 1435–1440. doi: 10.1093/ije/dyp322

Fadnes, L. T., Celis-Morales, C., Økland, J. M., Parra-Soto, S., Livingstone, K. M., Ho, F. K., et al. (2023). Life expectancy can increase by up to 10 years following sustained shifts towards healthier diets in the United Kingdom. *Nat. food* 4, 961–965. doi: 10.1038/s43016-023-00868-w

Feng Peng, M. W., Feng, Z., and Zhao, Y. (2019). Survey on the awareness of dietary guidelines for Chinese residents (2016) and dietarybehaviors among primary and secondary school students in Chongqing. *Health Med. Res. Pract.* 16, 18–24. doi: 10.11986/j.issn.1673-873x.2019.01.004

Gitanjali, M. (2015). Singh, Renata, Micha, Shahab, Khatibzadeh, Stephen, Lim, Majid, and Ezzati, estimated global, regional, and National Disease Burdens Related to sugar-sweetened beverage consumption in 2010. *Circulation* 132, 639–666. doi: 10.1161/CIRCULATIONAHA.114.010636

GOOTS Council. (2017). *Notice of the General Office of the State Council on Issuing the National Nutrition Plan (2017–2030)*. Available at:·https://www.gov.cn/zhengce/content/2017-07/13/content_5210134.htm.

Huang FeiFei, H. F., Wang HuiJun, W. H., Zhang JiGuo, Z. J., Zhai FengYing, Z. F., and Zhang Bing, Z. B. (2015). The TRENDSIN awareness rate of the dietary guidelines for CHINESERESIDENTS and the EFFECT on dietary pattern. *Nutr. J.* 37, 325–329.

Liu, Q., Wang, L., Ma, Y., and Geng, Y. (2023). Association between dietary knowledge and muscle mass in Chinese older adults: a cross-sectional and longitudinal study. *BMJ Open* 13:e075964. doi: 10.1136/bmjopen-2023-075964

Ma, J. (2011). Reconsideration of the psychological maladjustment phenomenon in freshmen at university. *J. Southwest Minzu Univ.* 1, 230–232.

Ma, Z., He, J., Sun, S., and Lu, T. (2021). Patterns and stability of food preferences among a national representative sample of young, middle-aged, and elderly adults in China: a latent transition analysis. *Food Qual. Prefer.* 94:104322. doi: 10.1016/j.foodqual.2021.104322

Ma, C., Ren, Z., Chen, Z., and Li, C. (2024). The association between interactive health literacy and dietary behaviors among Chinese college students: a large-scale cross-sectional study. *Front. Psychol.* 15:885. doi: 10.3389/fpsyg.2024.1363885

Malik, V. S., Fung, T. T., Van Dam, R. M., Rimm, E. B., Rosner, B., and Hu, F. B. (2012). Dietary patterns during adolescence and risk of type 2 diabetes in middle-aged women. *Diabetes Care* 35, 12–18. doi: 10.2337/dc11-0386

McCartney, M. (2016). Margaret McCartney: clean eating and the cult of healthism. *BMJ* 354. doi: 10.1136/bmj.i4095

Qiufen, S., Dongmei, Y., Junning, F., Canqing, Y., Yu, G., Pei, P., et al. (2022). Healthy lifestyle and life expectancy at age 30 years in the Chinese population: an observational study. *Lancet Public Health* 7, e994–e1004. doi: 10.1016/S2468-2667(22)00110-4

Robles, B., Wright, T. G., Caldwell, J., and Kuo, T. (2019). Promoting congregant health in faith-based organizations across Los Angeles County, 2013–2016. *Prev. Med. Rep.* 16:100963. doi: 10.1016/j.pmedr.2019.100963

Shan, Z., Wang, F., Li, Y., Baden, M. Y., Bhupathiraju, S. N., Wang, D. D., et al. (2023). Healthy eating patterns and risk of Total and cause-specific mortality. *JAMA Intern. Med.* 183, 142–153. doi: 10.1001/jamainternmed.2022.6117

Spronk, I., Kullen, C., Burdon, C., and O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *Br. J. Nutr.* 111, 1713–1726. doi: 10.1017/S0007114514000087

Talegawkar, S. A., Jin, Y., Xue, Q. L., Tanaka, T., Simonsick, E. M., and Tucker, K. L. (2020). Dietary pattern trajectories in middle age and physical function in older age. *J. Gerontol. A Biol. Sci. Med. Sci.* 76, 513–519. doi: 10.1093/gerona/glaa287

Thordardottir, G. S., Einarsdottir, K., Thordardottir, M., Tryggvadottir, L., Valdimarsdottir, U. A., Gudnason, V., et al. (2022). Dietary patterns in adolescence and risk of colorectal cancer: a population-based study. *Cancer Causes Control* 33, 205–211. doi: 10.1007/s10552-021-01524-z

Tougas, M. E., Hayden, J. A., PJ, M. G., Huguet, A., and Rozario, S. (2015). A systematic review exploring the social cognitive theory of self-regulation as a framework for chronic health condition interventions. *PLoS One* 10:e0134977. doi: 10.1371/journal.pone.0134977

Ukam, N. U., and Otareh, A. O. (2019). Effect of nutrition education on the consumption pattern of students of secondary schools in Ikot Okpora of Biase local government area of Cross River state, Nigeria. Global. *J. Educ. Res.* 18:15. doi: 10.4314/gjedr.v18i1.3

Van de Laar, R. J. J., Stehouwer, C. D., van Bussel, B. C. T., Prins, M. H., Twisk, J. W. R., and Ferreira, I. (2013). Adherence to a Mediterranean dietary pattern in early life is associated with lower arterial stiffness in adulthood: the Amsterdam growth and health longitudinal study. *J. Intern. Med.* 273, 79–93. doi: 10.1111/j.1365-2796.2012.02577.x

Vila-Martí, A., Elío, I., and Sumalla-Cano, S. (2021). Eating behavior during first-year college students, including eating disorders—RUVIC-RUNEAT-TCA project. Protocol of an observational multicentric study. *Int. J. Environ. Res. Public Health* 18:9457. doi: 10.3390/ijerph18189457

Wang, C. (2021). *Was officially released*. Healthy China Observation The Scientific Research Report on Dietary Guidelines for Chinese Residents, No. 15.

Wang, S., Shang, Y., Guo, X., and Cui, L. (2024). Relationship between dietary knowledge, food preference, and long-short term health status among Chinese adults. *Asia Pac. J. Clin. Nutr.* 33:213. doi: 10.6133/apjcn.202406_33(2).0008

Winpenny, E. M., van Sluijs, E. M., White, M., Klepp, K.-I., Wold, B., and Lien, N. (2018). Changes in diet through adolescence and early adulthood: longitudinal

trajectories and association with key life transitions. *Int. J. Behav. Nutr. Phys. Act.* 15:86. doi: 10.1186/s12966-018-0719-8

Yan, Y. (2017). *China issues national nutrition plan (2017–2030).*·Available at:·https://english.www.gov.cn/policies/latest_releases/2017/07/13/content_281475725038850.htm.

Yang, Y., He, D., Wei, L., Wang, S., Chen, L., and Luo, M. (2020). Association between diet-related knowledge, attitudes, behaviors, and self-rated health in Chinese adult residents: a population-based study. *BMC Public Health* 20:720. doi: 10.1186/s12889-020-08896-y

frontiers | Frontiers in Nutrition

TYPE Systematic Review
PUBLISHED 10 December 2024
DOI 10.3389/fnut.2024.1476956

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
Khadijeh Irandoust,
Imam Khomeini International University, Iran
Vassilis Martiadis,
Asl Napoli 1 Centro, Italy

*CORRESPONDENCE
Yuexian Tao
✉ Yuextao@outlook.com

†These authors share first authorship

RECEIVED 06 August 2024
ACCEPTED 14 November 2024
PUBLISHED 10 December 2024

CITATION
Wang Y, Xu T, Tao Y and Cai X (2024) Effectiveness of written emotional disclosure interventions for eating disorders: a systematic review and meta-analysis. *Front. Nutr.* 11:1476956. doi: 10.3389/fnut.2024.1476956

Effectiveness of written emotional disclosure interventions for eating disorders: a systematic review and meta-analysis

Yufei Wang†, Tao Xu†, Yuexian Tao* and Xintong Cai

School of Nursing, Hangzhou Normal University, Hangzhou, China

Background: Eating disorders are illnesses that can seriously impair the health and wellbeing of patients. Written emotional disclosure has been recognized as a therapeutic technique that may be helpful in aiding patients' emotional and psychological adjustment. However, it is unclear what favorable effects eating disorder patients can derive from written emotional disclosure therapy. This study aimed to review the effectiveness of written emotional disclosure in treating eating disorders using a systematic review and meta-analysis.

Objective: This study was to examine the validity of written emotional disclosure intervention for eating disorders as well as to provide guidelines for the management of eating disorders in patients.

Methods: Researchers independently developed inclusion and exclusion criteria according to the PICOS principle and systematically searched English literature databases such as PubMed, Medline, Web of Science, Cochrane Library, CINAHL, EBSCO, Embase, and so on, from the time of library construction to December 2023. Cochrane Risk of Bias version 2 (RoB 2) was used to evaluate studies included in this review. All the studies included in this study were randomized controlled trials. Accurate information was extracted and then subjected to meta-analysis with Review Manager 5.4 software. The credibility of the evidence of the studies was assessed using GRADEprofiler 3.6 software.

Results: The final analysis included 13 randomized controlled trials involving 1,444 participants. The written emotional disclosure intervention can decrease eating disorder symptoms scores (SMD = −0.20, 95% CI [−0.34, −0.05], $Z = 2.59$, $p = 0.01$), body dissatisfaction scores (SMD = 0.37, 95% CI [0.21, 0.52], $Z = 4.59$, $p < 0.001$), and thin ideal internalization score (SMD = 0.42, 95% CI [0.22, 0.62], $Z = 4.12$, $p < 0.001$). Anxiety scores (MD = 0.43, 95% CI [−0.77, 1.63], $Z = 0.70$, $p = 0.48$), depression scores (MD = −0.66, 95% CI [−1.78, 0.47], $Z = 1.14$, $p = 0.25$) and negative affect scores (SMD = 0.51, 95% CI [−0.24, 1.27], $Z = 1.33$, $p = 0.18$), with no statistically significant differences.

Conclusion: In conclusion, this systematic review analyzed the existing literature and showed that written emotional disclosure intervention is effective in alleviating eating disorder symptoms and patients' body image problems, but there is insufficient evidence in alleviating depression, anxiety, and negative affect. However, the evidence is limited. Therefore, more research is needed in the future to further enrich the evidence for written emotional disclosure intervention in the field of eating disorders.

Systematic review registration: https://www.crd.york.ac.uk/prospero/, CRD42023445577.

KEYWORDS

written emotional disclosure, expressive writing, eating disorders, body image, meta-analysis

1 Introduction

Eating disorders (EDs) are highly complex illnesses characterized by severe physical and psychological damage to the patient (1, 2). Due to the complexity of diagnosing eating disorders, their diagnostic definitions have been changing over the past decade (3, 4). The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) categorizes types of eating disorders as anorexia nervosa (AN), bulimia nervosa (BN), and eating disorders not otherwise specified (EDNOS) (5). Currently, the DSM-5 (6) incorporates binge-eating disorder (BED) into its overall classification of eating disorders, creating several new diagnosable eating disorders and expanding their definitions. Research indicates that unhealthy eating behaviors can lead to weight issues and disruptions in the endocrine system (7, 8). Additionally, individuals with eating disorders often experience feelings of loneliness or isolation, which can contribute to the development of more severe psychological problems (9). Furthermore, distorted body image perceptions can result in low self-esteem and diminished self-worth for those affected by eating disorders (10).

Also, eating disorders pose a significant threat to global health, and their prevalence is expected to increase. Statistics indicate that 3.3 million people worldwide lose their lives to ED every year (11). Studies have shown that ED can bring out a severe disability burden on society (12, 13). Moreover, according to Jared's report (14), the estimated overall tangible economic burden of eating disorders in the United States amounts to $64.7 billion. The prevalence of eating disorders is high. A survey reported that the prevalence of eating disorders among adolescents in Ukraine, Hungary, and Poland was 37%, 22% and 20%, respectively (3). Some researchers in several reported Asian developing countries, such as Malaysia and Singapore, identified as high-risk populations at 50% and 43%, respectively, showed positive results on early screening for eating disorders (15, 16). And, the prevalence of ED is expected to increase. Several studies have shown that during the COVID-19 pandemic, eating disorders increased (17–20). In addition, based on a study by Taquet et al. (21), eating disorder diagnoses in the United States increased by 15.3% overall in 2020 compared with before COVID-19, and the relative risk has steadily increased since 2020. Therefore, disease management and prevention for people with eating disorders is particularly important.

The symptoms of eating disorders are serious and complex (22), and the types of medications applied in pharmacotherapy are also varied (23). Multifaceted early intervention may become indispensable to reduce the risk of long-term pathology and disability (24). Today, most interventions are focused on psychological, lifestyle, and physical activity (25). Regular high-intensity physical activity has been concluded to improve eating habits and overall health (26). A study by Irandoust et al. (27) proved that lifestyle interventions can be used as a long-term effective treatment modality for individuals with eating disorders. Additionally, Monaco et al. (28) have developed an advanced artificial intelligence platform to provide personalized treatment for patients with eating disorders. Although the current diversity of interventions all have favorable outcomes, psychotherapy is now recognized as a core intervention for the effective treatment of eating disorders (29). Currently, cognitive behavioral therapy (CBT-ED) (30) and low-intensity psychological interventions (31) have come a long way.

In recent years, expressive writing interventions have received increasing attention in the therapy of eating disorders. Expressive writing (EW), also known as written emotional disclosure (WED), is a succinct psychosocial intervention with the potential to improve psychological regulation (32). The characteristic of WED lies in its private nature, allowing individuals to explore their inner emotions without external interference. It is a structured approach to writing that facilitates cognitive and emotional processing of negative experiences and personal challenges, and aims to enhance the process of making meaning by creating narratives about their experiences, thereby prompting individuals to process their emotions and thoughts about traumatic experiences (33).

Regarding the potential effects of WED, it was not until the mid-1990s that a consistent literature began to emerge in the health, clinical, and psychosocial fields confirming the effectiveness of expressive writing in improving health (34). Researchers and medical professionals believe that using this strategy can help people improve their mental health, reduce eating disorder symptoms, and gain emotional control (35). In addition, there is evidence (36) that it can alleviate negative body image issues and develop self-compassion. Currently, in addition to traditional face-to-face writing therapy, remote web-based writing interventions have been developed (37). This improvement has expanded the target population for the intervention by increasing the convenience and effectiveness of the treatment.

Researches have shown that WED can reduce specific symptoms associated with eating disorders such as restricted eating and body dissatisfaction (38–40). However, some studies have shown that there was no significant effect of WED on body mass index or image concerns (41, 42). Lafont et al. (81) showed that WED only improved body image in patients with severe symptoms of eating disorders. Also, a study by Gamber et al. (43) concluded that WED did not reduce eating disorder behaviors or cognitions. It is unclear what favorable effects eating disorder patients can derive from written emotional disclosure therapy. Additionally, there is a lack of sufficient meta-analyses to evaluate the effectiveness of this treatment. Consequently, this study aimed to evaluate the efficacy of written emotional disclosure therapy for eating disorders by conducting a systematic review and meta-analysis.

2 Methods

This study was a systematic review and meta-analysis. The study follows the the guidelines for reporting systematic reviews and meta-analysis (44), specific PRISMA-2020 checklist is in Supplementary Table 3.

2.1 Inclusion and exclusion criteria

Criteria for inclusion included: (1) Individuals diagnosed with an eating disorder, such as anorexia nervosa, bulimia nervosa, or binge eating disorder according to the DSM-IV or DSM-5 classification systems, or individuals with high-risk factors for the development of eating disorders (e.g., internalization of body ideals, body image concerns, stress, cognitive flexibility deficits and so on) and participating in a written emotional disclosure intervention; (2) Participants of any age, gender or ethnicity; (3) Participants involved in the intervention engaged in expressive writing that focused on emotions and thoughts associated with eating disorder experiences; (4) Studies comparing written emotional disclosure interventions with no intervention/waiting list controls, conventional treatment controls, alternative psychological interventions (e.g., CBT, IPT), placebo, or attentional control interventions; (5) Randomized controlled trials (RCTs) comparing written emotional disclosure intervention to a control group. Clinical trials that are not randomized, including quasi-experimental and controlled trials.

Criteria for exclusion included: (1) Participants with comorbid psychiatric conditions unless data is reported separately for those with eating disorders only; (2) Studies evaluating interventions other than written emotional disclosure (e.g., CBT, IPT, medication); (3) Reviews, case studies, opinion pieces and non-empirical studies. (4) The study population included individuals with unspecified psychiatric or eating disorders, individuals with unspecified risk factors for eating disorders (people with ED-NOS will be excluded), or participants involved in treatment other than written emotional disclosure; (5) Studies that have deviation of intervention mode (e.g., studies that de-emphasized writing about affective experiences of eating disorders, focused on verbal disclosure rather than written disclosure, or did not use writing as a primary intervention component).

2.2 Search strategy

A systematic search was conducted across the following databases: PubMed, Medline, Cochrane Library, Web of Science, CINAHL, EBSCO, and Embase. The search included records from the inception of these major databases up to December 31, 2023.

We entered the following search terms in the above database: writing or "expressive writing" or "written disclosure" or "emotional expression" or "emotional disclosure" or "written emotional disclosure" or dairy or self-compassion* and "eating disorder" or "binge eating" or eating disorder* or eating disorders *. Supplementary Table 1 contains specific search formulas for each database.

2.3 Study selection

Titles and abstracts were reviewed independently by two authors (YW and TX). In cases of disagreement, a third author (YT) was consulted. The PRISMA flowchart (Figure 1) summarizes the screening process for identifying, including, and excluding studies at each stage and provides the number of screenings and reasons for exclusion.

2.4 Data collection process

Author (YW) extracted the data and the other author (TX) verified the accuracy and completeness of the extracted data. In the face of uncertainty, the two authors discussed with each other and finally reached an agreement. Among the information obtained were: Study characteristics (authors, year of publication, country, and study design). Participant characteristics included sample size, age, gender, eating disorder diagnoses, or risk factors for eating disorders. Intervention details (form of writing intervention, number and duration of writing sessions, control group details, outcome measures and assessment time points). Supplementary Table 2 contains details about the writing contents of the experimental and control groups, time points for assessment, and follow-up rates.

2.5 Types of outcome measures

2.5.1 Primary outcome

The primary outcome measure was eating disorder symptoms. The severity of eating disorder symptoms was gauged through a standardized self-report questionnaire or clinical rating scale. These scales primarily encompassed the Eating Disorders Examination Questionnaire (EDE-Q) (45), Eating Disorders Examination (EDE) (46) interview, Eating Disorders Scale (EDI) (47), and Eating Disorders Diagnostic Scale (EDDS) (48).

2.5.2 Secondary outcomes

The secondary outcomes of this paper pertain to mental health, body image issues and the negative affect. Mental health levels were determined using standard questionnaires that evaluated depression, anxiety, and others. Typical measures comprise the Hospital Anxiety and Depression Scale (HADS) (49). Body image was assessed by self-report questionnaires such as the Body Shape Questionnaire (BSQ) (50), the Satisfaction and Dissatisfaction with Body Parts Scale (SBPDS) (51), and the Ideal Body Stereotype Scale (IBSS) (52). Negative affect was measured by the Positive Affect and Negative Affect Scale (PANAS) (53).

2.6 Quality assessment

Two authors (YW and XC) independently used the Cochrane Risk of Bias version 2 (RoB 2) tool to evaluate the quality of bias in randomized trials by evaluating the quality of the 13 articles screened. The risk of bias was assessed through five domains: bias in the randomization process, deviations from the intended interventions, missing outcome data, and bias in the measurement of the outcome, with the corresponding entries rated as "Yes, Y," "Probably Yes, PY," "Probably No, PN," "No, N," or "No Information, NI." Overall bias would be judged as "Low," "High" or "Some concerns."

2.7 Data analysis

This paper will provide a narrative summary of the features, interventions, and outcomes of this study. Depending on the heterogeneity of the studies, either fixed or random effects models will be utilized for meta-analysis. Estimate the effect measures of

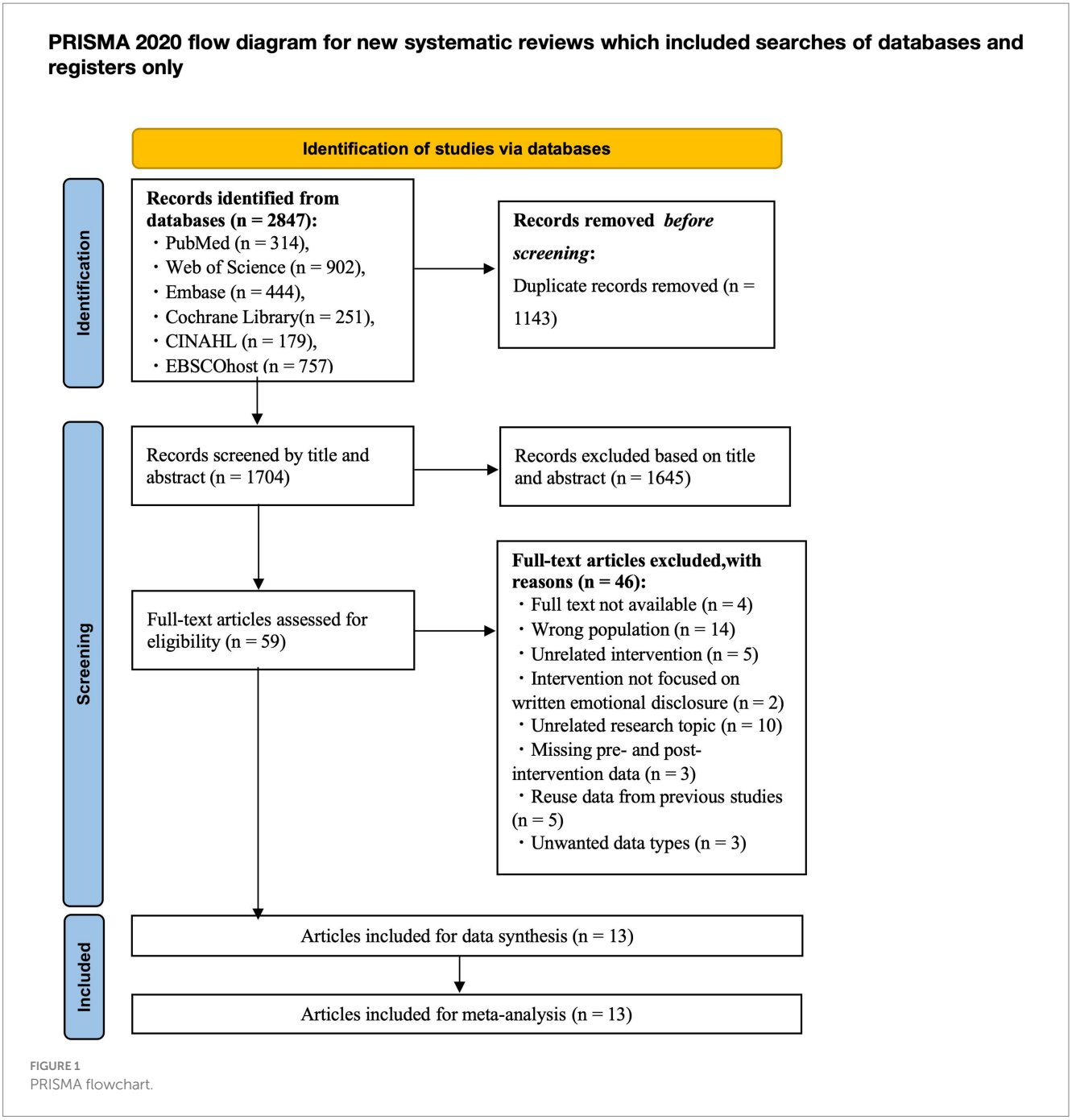


FIGURE 1
PRISMA flowchart.

the primary outcome. Studies presenting a high risk of bias will be excluded from the sensitivity analysis. I^2 will be employed to quantify heterogeneity. In case of significant heterogeneity, subgroup analyses will be conducted to identify potential sources (such as the age of the study population or the follow-up time, etc.). If an adequate amount of research is available, separate meta-analyses will be carried out for subgroups based on the category of eating disorders, the age of the participants, gender, and the form of intervention. Additionally, studies with missing outcome data are evaluated to determine whether appropriate approaches, such as intention-to-treat analyses using inferential methods, are employed to address the missing data. Studies that fail to account for missing data adequately will be regarded as having a greater risk of bias and will be excluded from meta-analysis.

2.7.1 Heterogeneity

Review Manager Software version 5.4 was used for statistical analysis of data. To estimate intervention effects for continuous variables measured by various scales, standardized mean differences (SMDs) along with 95% confidence intervals (CIs) were utilized. The heterogeneity among all included studies was evaluated using the I-squared statistic (I^2). It assesses the extent of heterogeneity, with a value of 0% indicating no observed heterogeneity, 25% representing low heterogeneity, 50% signifying moderate heterogeneity, and 75% indicating high heterogeneity (54). When the $p > 0.1$ and the I^2 statistic

was 50% or lower, homogeneity among studies was assumed, and a fixed-effects model was applied. Conversely, when the $p < 0.1$ and the I^2 statistic exceeded 50%, significant heterogeneity among outcomes was identified, prompting an analysis of the sources of heterogeneity and the adoption of a random-effects model. If the origin of the heterogeneity could not be ascertained, a descriptive analysis of the relevant outcome indicators was conducted. To assess the reliability and robustness of the pooled results, we excluded one study at a time for sensitivity analyses. When heterogeneity was substantial, subgroup analyses were conducted. If the source of heterogeneity remained unidentified, a descriptive analysis was performed to provide a qualitative overview of the outcome indicators of interest. Egger regression tests indicated statistically significant publication bias when $p < 0.05$. The meta-analysis findings were illustrated using forest plots.

2.7.2 Subgroup analysis

The main outcome indicators we addressed were eating disorder symptoms, body dissatisfaction, thin ideal internalization, anxiety, depression, and negative affect. All outcome indicators could be extracted from the studies and included in the software analysis. In the meta-analysis of the outcome indicator body image dissatisfaction, we conducted subgroup analyses for the follow-up time node (1 month) due to high heterogeneity; for the thin ideal internalization indicator, subgroup analyses based on its year of publication, sample size, and occupational characteristics of the population failed to definitively find the source of heterogeneity.

2.7.3 Sensitivity analysis

This study conducted sensitivity analyses on certain outcome measures to evaluate the influence of the included studies on pooled outcomes characterized by significant heterogeneity and to determine whether the synthesized results were robust. When the heterogeneity of the outcomes was high, we performed sensitivity analyses using the exclusion-by-exclusion method. Each study was excluded in turn, and then the remaining study was combined in a meta-analysis, and the changes in the combined results were observed to assess whether the results of the original meta-analysis were significantly changed by certain studies.

2.7.4 Publication bias

This study measured publication bias using funnel plots and Egger regression tests for meta-analysis involving at least 10 studies (54). The presence of publication bias was assessed using Egger's regression intercepts (55). This method involves examining the correlation between the effect size and the standard error of the effect size to determine if there is a significant correlation between the study effect size and the study precision. If there is no publication bias, the regression intercept is zero and significant results indicate the study presents publication bias. Because this study did not include more than 10 studies in any of the several outcome indicators for which analyses were conducted, a method for detecting publication bias would show limited validity; therefore, publication bias was not assessed in this study.

2.8 Certainty assessment

We used the GRADEprofiler 3.6 software (56) to assess the certainty of the body of evidence for outcomes. The tool considers the initial quality of evidence from randomized controlled trials and downgrades or upgrades the quality of evidence based on the rigor of the study design, consistency of the results, precision of the effect sizes, and the potential for publication bias, etc. The quality of evidence output from GRADEprofiler 3.6 is classified into four tiers, namely, high, moderate, low, and very low, and the strength of recommendations is classified into "strong recommendation" and "weak recommendation" to guide clinical decision makers to formulate more precise treatment recommendations based on the understanding of the certainty of the evidence.

3 Results

3.1 Study selection

The process of study selection involved mainly two authors (YW and TX) independently, and during the process of the evaluation, the two authors discussed and strategized to resolve any uncertainties regarding the eligibility of the studies. Any study on which they disagreed was referred to a third author (YT) to review for inclusion. The first search of the literature base generated 2,847 studies. The remaining 1704 studies were screened for title and abstract after removing 1143 duplicate studies. After title and abstract screening, 1,645 studies were excluded. This meant that 59 studies needed to be assessed by reading the full-text. Following reading the full text, 46 studies were excluded due to non-compliance. 13 studies were ultimately included in the meta-analysis. Figure 1 summarizes our process of study selection.

3.2 Characteristics of the study

Among the 13 studies (36–38, 41, 57–65) included in the meta-analysis (Table 1), the majority were from Western European countries ($n = 7$; 53.8%), with four from the United Kingdom (38, 41, 58, 63), two from Sweden (37, 59), and one from the Netherlands (64); some were from the Americas ($n = 4$; 30.8%), with three from the United States (36, 57, 62) and one from Canada (61); and two were from Asia (China) (65) and Oceania (New Zealand) (60), respectively. The gender of the majority of the participant population included in the studies was female ($n = 1,074$; 74.4%), with the majority of the studies targeting women with body image-related concerns ($n = 8$; 61.5%), and the inclusion criteria for only one study (64) was a confirmed diagnosis of eating disorders. One study (64) did not mention the occupations of the participating population, while the rest of the studies focused on university students, and in the studies that did mention the participating population, the majority of the participants belonged to the white ethnic group and were from the European region.

3.3 Characteristics of intervention

3.3.1 Form, session frequency, and duration of WED

Of the 13 studies included, almost all of the forms of written emotional disclosure were conducted in a researcher-led process, where participants were guided by the researcher according to the

TABLE 1 The characteristics of studies.

Author, year and country	Sample	Age (Mean)	Gender	Occupation	Ethnicity	Diagnosis/ risks of eating disorders	Form of EW	Number and duration of writing sessions	Comparison group specifics
Jennifer Brenton-Peters, et al. (2023) New Zealand	53	25.77 (7.99)	Male: 18 Female: 33 Transgender: 2	All students	NZ European 32.08%, Chinese 18.87%, other 24.53%, the rest are those who did not report.	Stress	Under the guidance of researchers /write by hands	10 min	Neutral writing
Danielle Arigo and Joshua M. Smyth (2012) USA	111	18.89 (1.02)	Male: 0 Female: 111	All students	Caucasian 70%, African American 7%, Hispanic/ Latina 6%	Appearance concerns	Under the guidance of researchers/write by hands	Three sessions, each lasts 15 min	Neutral writing
Kheana Barbeau, et al. (2022) Canada	114	25.8(6.9)	Male: 0 Female: 126	All students	White 85.67%	Body image concerns	Under the guidance of researchers/write by e-mails	NR	Neutral writing
Anna C. Ciao, et al. (2021) USA	76	19.90 (3.17)	Male: 13 Female: 60 Transgender: 1 gender neutral: 3	All students	White 78%, Asian 6%, Multiracial 15%, Another Identity 1%	Body image concerns	Under the guidance of peer leaders/Video Intervention	Two 2-h sessions held 1 week apart, each session includes 10 min writing time	No intervention
Philippa East, et al. (2010) UK	48	33.93 (6.32)	Male: 10 Female: 38	All students	NR	Cognitive flexibility deficits	Under the guidance of researchers/write by hands	3 days, Write for 20 min each day	Neutral writing
Ata Ghaderi, et al. (2020) Sweden	148	17.4 (1.5)	NR	Students 93.2%, other 6.8%	NR	Body image concerns	Under the guidance of researchers/write by hands	The writing lasts for a month, with each writing session lasting 40 min	No intervention
Ata Ghaderi, et al. (2022) Sweden	72	33.83 (8.40)	NR	All students	NR	Body dissatisfaction	Under the guidance of researchers/write by hands	30 min	No intervention
Olwyn Johnston, et al. (2009) UK	94	28.9 (9.8)	Male: 9 Female: 71	Students 61.3%, other 38.7%	White 76.3%, other 23.7%	Negative emotions and bulimia symptoms	Under the guidance of researchers/write by e-mails	3 days, write for 20 min each day	Neutral writing
N. Kupeli, et al. (2018) UK	71	20.54 (5.18)	Male: 0 Female: 71	All students	British 32.4%, Other European 2.8%, Indian 1.4%, Bangladeshi 1.4%, Caribbean 1.4%, African 1.4%, Mixed ethnicity 1.4%, Chinese 2.8%, other 4.2%	Stress	Under the guidance of researchers/write by hands	3 days, Write for 15 min each day	Neutral writing

(Continued)

10.3389/fnut.2024.1476956

10.3389/fnut.2024.1476956

TABLE 1 (Continued)

Author, year and country	Sample	Age (Mean)	Gender	Occupation	Ethnicity	Diagnosis/ risks of eating disorders	Form of EW	Number and duration of writing sessions	Comparison group specifics
Eric Stice, et al. (2006) USA	249	17.0 (1.4)	Male: 0 Female: 249	All students	Asian/Pacific Islander 10%, African American 6%, Hispanic 19%, Caucasian 58%, and 7% who specified other or mixed racial heritage.	Body dissatisfaction	Under the guidance of researchers/write by hands	Three individual weekly 45-min sessions	No intervention
Dennis Relojo (2016) UK	141	19.23 (1.21)	Male: 0 Female: 140	All students	NR	Thin-ideal images	Under the guidance of researchers/write by hands	15 min	Neutral writing
Wang and Ding (2023) China	175	20.90 (1.65)	Male: 0 Female: 175	All students	Chinese 100%	Appearance-related cyberbullying	Under the guidance of researchers/write by e-mails	10 min	No intervention
Jorg Tanis et al. (2023) Netherlands	92	35.0 (11.90)	NR	NR	NR	BED, BN UFED with BED-dynamics	Under the guidance of researchers/write by e-mails	Weekly three 45-min sessions	Neutral writing

EW, expressive writing; BED, binge eating disorder; BN, bulimia nervosa; UFED, unspecified feeding or eating disorder; NR, not reported.

writing manual developed by Pennebaker (66). Only one study mentioned a peer-led form of writing (36). The majority of the studies (37, 38, 41, 57, 59, 60, 62, 63) encouraged participants to engage in handwriting at the time of the intervention ($n = 8$; 61.5%). The remaining five studies delivering the intervention via a media format (36, 58, 61, 64, 65). The duration of all writing interventions was mainly concentrated between 10 and 45 min, and the majority of the studies had three writing sessions during the study period, with some of them not mentioning the specific number and duration of the interventions.

3.3.2 Content of WED

In all of the studies, the written emotional disclosure intervention was specified as "encouraging participants to write about their emotional state while experiencing symptoms related to the eating disorder." The content of the writing interventions in 13 studies was categorized into the following three types: (1) Participants wrote in detail about their own emotional experiences when dealing with conditions related to their physical problems; (2) Participants wrote a letter of gratitude or encouragement from another person's point of view (e.g., imagining themselves writing a letter of gratitude or encouragement from a friend's point of view or from the perspective of the macrocosm, or by watching a movie and engaging in reflective writing, wrote about the emotional experiences after the movie, etc.); (3) Encouraging participants to describe moments of strong, positive emotional experiences for themselves and to write what it would be like to fantasize about themselves in that moment. Among the 13 studies, the control group essentially took a neutral writing approach, with writing that consisted of merely describing a superficial topic or describing a milestone dietary goal and did not include describing one's emotional experience. Five of the studies had blank control groups (i.e., there was no intervention for control participants) (36, 37, 57, 59, 65). However, one of the studies added to the blank control group that those who met the criteria for anorexia nervosa, bulimia nervosa, or binge eating disorder at any follow-up assessment in the control group were referred to treatment (57).

3.4 Risk of bias in studies

Two authors (YW and XC) performed a risk assessment of the 13 included studies, the agreement was 80%, and the differences in the assessments were subsequently discussed and revised. The results are shown in the Figures 2, 3. Since few of the included study mentioned information related to allocation concealment, these studies were assessed as "some concerns" when performing the risk of bias assessment of the randomization process. As for the risk of bias, five studies ultimately assessed as "low" (38.5%), five as "some concerns" (38.5%), and three as "high" (23.1%).

3.5 Meta-analysis results

Regarding the eating disorder symptoms, eight studies employed diverse eating disorder screening questionnaires (38, 41, 57, 58, 61, 62, 64, 65); Five studies gauged body dissatisfaction

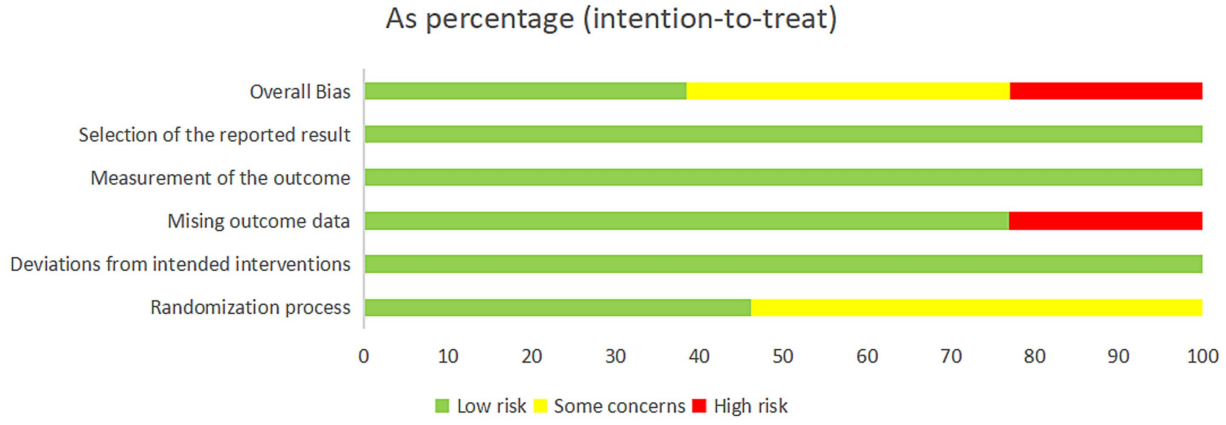


FIGURE 2
Risk of bias summary chart.

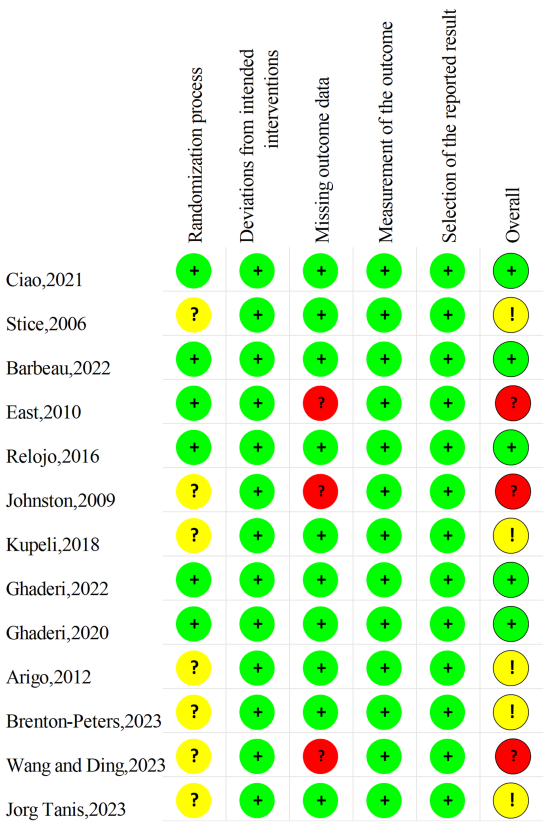


FIGURE 3
Risk of bias table.

by different scales (36, 37, 57, 59, 65); Four studies utilized different versions of the Ideal Body Stereotype Scale to assess the internalization of the ideal body (36, 37, 57, 63). Concerning the measurement of mental health outcomes, two studies utilized the identical anxiety and depression scales (38, 58), and four studies employed distinct negative affect scales (36, 37, 57, 65). Baseline analyses were comparable and data could be merged for meta-analysis.

3.5.1 Eating disorder symptoms

Eight studies analyzed the effect of WED therapy in participants with eating disorders (38, 41, 57, 58, 61, 62, 64, 65). A total of 720 study participants were included. The eight studies were scored using different scales to measure eating disorder symptoms, and SMD were utilized in the subsequent analyses. The results showed low heterogeneity ($p = 0.17$, $I^2 = 33\%$), and a fixed-effect model was used to meta-analysis. The robustness of the results was tested by sensitivity analysis, and one study was excluded (61). After the group heterogeneity disappeared ($p = 0.87$, $I^2 = 0\%$), meta-analysis showed that the difference in the scores of eating disorder symptoms was statistically significant (SMD = −0.20, 95% CI [−0.34, −0.05], $Z = 2.59$, $p = 0.01$) (see Figure 4).

3.5.2 Body dissatisfaction

Five studies analyzed the effect of WED therapy on body dissatisfaction in the study population (36, 37, 57, 59, 65). The five studies examined a total of 394 study participants, who were scored with diverse scales to measure the level of body dissatisfaction before and after the intervention. The outcome was analyzed by utilizing SMD, which showed a high degree of heterogeneity ($p = 0.04$, $I^2 = 60\%$). Use randomized effects model for meta-analysis, subgroup analysis by length of follow-up (with 1 month as the cut-off) showed that heterogeneity still existed within the group with ≤1 month of follow-up ($p = 0.008$, $I^2 = 74\%$). We performed sensitivity analysis and eventually discovered that removing the study of Ghaderi et al. (59) showed no statistically significant results although within-group heterogeneity was reduced ($p = 0.07$, $I^2 = 60\%$), which may indicate that the follow-up time node is one of the factors contributing to the occurrence of heterogeneity. There may be multiple sources of heterogeneity in this result, and further search for sources of heterogeneity is needed. Statistically significant differences were found between scores of body dissatisfaction before and after the intervention (SMD = 0.37, 95% CI [0.21, 0.52], $Z = 4.59$, $p < 0.001$) (Figure 5).

3.5.3 Thin ideal internalization

Four studies analyzed the effect of WED on the thin ideal internalization in the study population (36, 37, 57, 63). A total of 442 study participants were available, and the four studies were analyzed

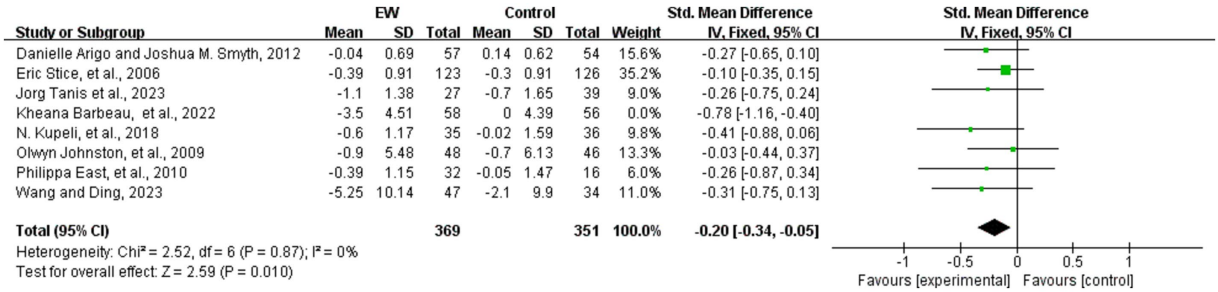


FIGURE 4
Meta-analysis about the effect of WED on alleviating eating disorder symptoms.

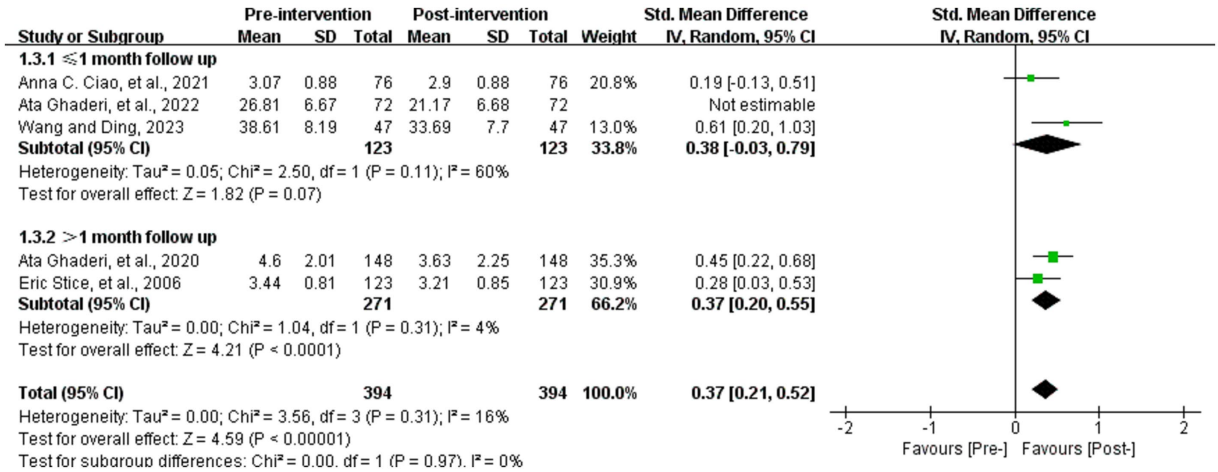


FIGURE 5
Meta-analysis about the effect of WED on alleviating body dissatisfaction.

by utilizing SMD using different scales to gauge the thin ideal internalization. The results showed a high degree of heterogeneity ($p < 0.001$, $I^2 = 93\%$). The meta-analysis used a random-effects model. After the sensitivity analysis, we removed two studies and the heterogeneity disappeared (37, 63) ($p = 0.74$, $I^2 = 0\%$), and the results showed that the difference between the scores of the thin ideal internalization in study population before and after the intervention was statistically significant (SMD = 0.42, 95% CI [0.22, 0.62], $Z = 4.12$, $p < 0.001$), as shown in Figure 6.

3.5.4 Anxiety

Two studies analyzed the effect of WED on anxiety scores in the study populations (38, 58). A total of 142 study participants were included. The two studies used the Hospital Anxiety and Depression Scale (HADS) and were analyzed using MD, which showed no heterogeneity ($p = 0.54$, $I^2 = 0\%$). Meta-analysis was applied using a fixed-effects model, which showed the following results: The difference between anxiety scores was not statistically significant (MD = 0.43, 95% CI [−0.77, 1.63], $Z = 0.70$, $p = 0.48$) (see Figure 7).

3.5.5 Depression

Two studies analyzed the effect of WED on depression scores in the study populations (38, 58). A total of 142 study participants were included. These two studies used the Hospital Anxiety and Depression Scale (HADS), which was analyzed using MD, and the results showed that there was no heterogeneity ($p = 0.38$, $I^2 = 0\%$). Meta-analysis was performed by using a fixed-effects model. The difference in depression scores was not statistically significant (MD = −0.66, 95% CI [−1.78, 0.47], $Z = 1.14$, $p = 0.25$) (see Figure 8).

3.5.6 Negative affect

Four studies analyzed whether the WED intervention had an effect on negative affect in the study population (36, 37, 57, 65). A total of 394 study participants were included the four studies used different scales for negative affect, and were analyzed using SMD, with a large degree of heterogeneity ($p < 0.001$, $I^2 = 96\%$). The random-effects model was used for meta-analysis, which showed that the difference between the negative affect scores in study population before and after the intervention was not statistically significant (SMD = 0.51, 95% CI [−0.24, 1.27], $Z = 1.33$, $p = 0.18$) (see Figure 9).

3.6 Publication bias

Publication bias was not assessed because there were fewer than 10 studies in each of the outcome metrics included in this

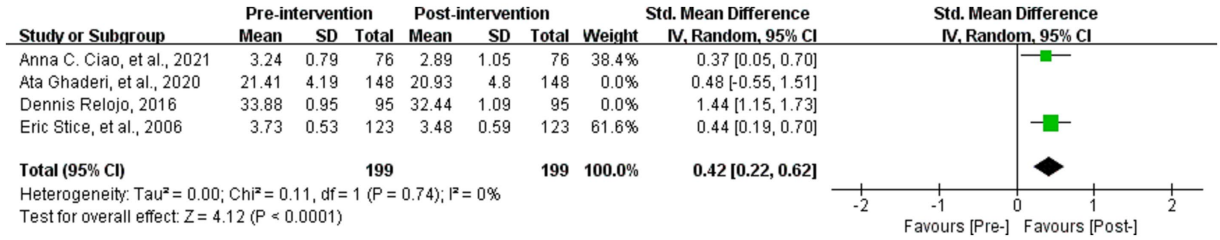


FIGURE 6
Meta-analysis about the effect of WED to mitigate the thin ideal internalization.

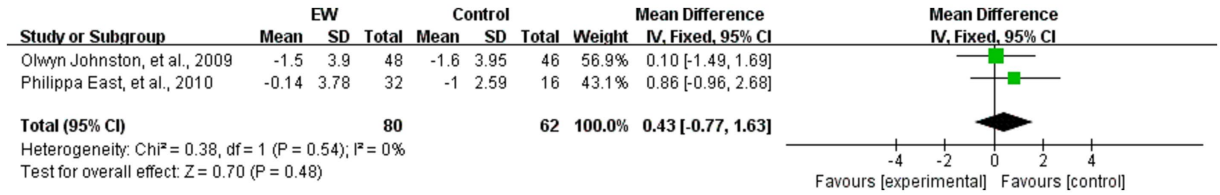


FIGURE 7
Meta-analysis of the effect of a WED intervention to alleviate anxiety.

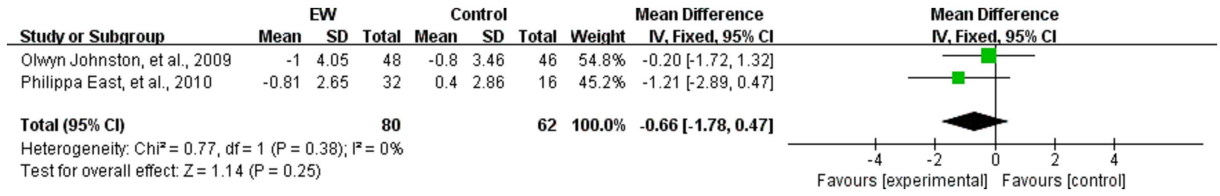


FIGURE 8
Meta-analysis about the effect of a WED intervention to alleviate depression.

study and the validity of detecting publication bias was limited, which limited our ability to assess the impact of potential publication bias. Therefore, we believe that caution should be maintained in interpreting the results of the study, and future studies need to incorporate a wider range of literature, including unpublished studies, to further enhance the robustness and credibility of the findings.

3.7 Certainty of evidence

We evaluated the body of evidence for the outcome indicators involved in the study on the level of evidence, and the results are shown below (Figure 10). This chart shows the credibility of the evidence for eating disorder symptoms, body dissatisfaction, thin ideal internalization, anxiety, depression and negative affect, with eight randomized controlled trials (RCTs) for eating disorder symptoms, four RCTs each for body dissatisfaction and thin ideal internalization, two RCTs each for anxiety and depression, and four RCTs for negative affect. With the exception of negative affect, all of the other studies show a moderate level of evidence credibility.

4 Discussion

4.1 Potential mechanisms of WED to improve eating disorder symptoms

The results of the meta-analysis showed that WED for people with eating disorders or for those with high risk factors for developing such disorders significantly improved their eating disorder symptoms, which is consistent with the results of the Frayne et al. (40). The potential mechanisms by which written emotional disclosure interventions improve eating disorder symptoms may involve inhibitory and cognitive processes. Individuals' failure to actively talk about important psychological phenomena can be viewed as a form of active inhibitory behavior acting on the autonomic and central nervous system activity, which is chronic low-level stress (67). Pennebaker et al. (32) showed that WED can help participants to voluntarily disclose emotional or traumatic experiences, reduces inhibitory behaviors, thereby alleviating stress. After the release of stress, individuals experience relief from negative emotions, which enables them to reassess and understand the negative experiences and emotions associated with eating disorders (58). This capacity helps to

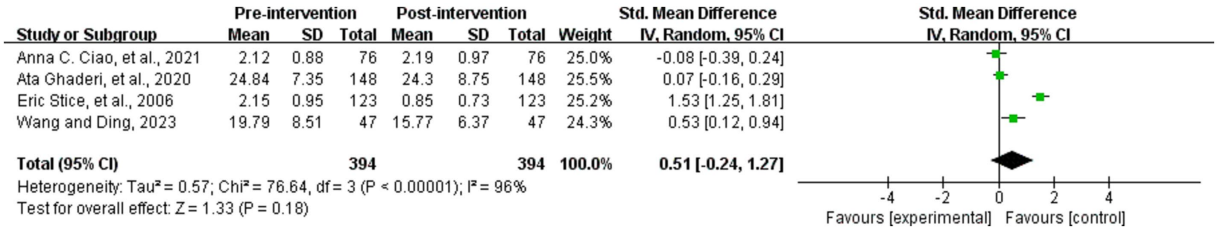


FIGURE 9
Meta-analysis about the effect of WED to reduce negative affect.

Author(s):
Date: 2024-06-17
Question: Should Expressive writing(EW) vs Neutral writing or blank control be used for Eating disorders or have high risks?
Settings: Laboratory or home
Bibliography: . [The effectiveness of written emotional disclosure intervention in eating disorders: a systematic review and meta-analysis]. Cochrane Database of Systematic Reviews [Year], Issue [Issue].

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Expressive writing(EW)	Neutral writing or blank control	Relative (95% CI)	Absolute	Quality	Importance
EDE symptom (Better indicated by lower values)												
8	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	427	407	-	SMD 0.27 lower (0.41 to 0.13 lower)	⊖⊖⊖O MODERATE	CRITICAL
Body dissatisfaction (Better indicated by lower values)												
4	randomised trials	serious[2]	no serious inconsistency	no serious indirectness	no serious imprecision	none	394	394	-	SMD 0.37 higher (0.21 to 0.52 higher)	⊖⊖⊖O MODERATE	CRITICAL
Thin ideal internalization (Better indicated by lower values)												
4	randomised trials	no serious risk of bias	serious[2]	no serious indirectness	no serious imprecision	none	442	442	-	SMD 0.58 higher (0.05 to 1.1 higher)	⊖⊖⊖O MODERATE	CRITICAL
Anxiety (Better indicated by lower values)												
2	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	80	62	-	MD 0.43 higher (0.77 lower to 1.63 higher)	⊖⊖⊖O MODERATE	IMPORTANT
Depression (Better indicated by lower values)												
2	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	none	80	62	-	MD 0.66 lower (1.78 lower to 0.47 higher)	⊖⊖⊖O MODERATE	IMPORTANT
Negative affect (Better indicated by lower values)												
4	randomised trials	no serious risk of bias	very serious[2]	no serious indirectness	no serious imprecision	none	394	394	-	SMD 0.51 higher (0.24 lower to 1.27 higher)	⊖⊖OO LOW	IMPORTANT

[1] The sample size is small, with a wide confidence interval.
[2] High heterogeneity

FIGURE 10
The certainty of evidence.

reduce the excessive focus on and sense of control over food, thereby alleviating the symptoms of eating disorders. Thus, WED interventions can be used as an effective psychotherapeutic modality in the eating disorder community and across a wide range of populations.

4.2 Impact of WED on body image issues

Meta-analysis results from this study showed that the WED intervention was able to relieve body dissatisfaction and thin ideal internalization among eating disorder patients and those with high-risk factors developing eating disorders, which is similar to the findings of Stice as well as Rodriguez et al. (68, 69). Melnyk et al. (70) concluded that eating disorders are associated with body image issues. And, improving body image issues can play a role in eating regulation (71). This process may involve emotion and cognition. Research has concluded that WED provides individuals with access to emotional release and helps them deal with negative emotions associated with body image (72). Reassessing and understanding one's body image by writing about one's feelings and experiences (73). Self-compassionate expressive writing with a body focus helps people with eating disorders to self-accept and diminish body dissatisfaction by reducing the pursuit of an ideal body image (61).

Meta-analysis showed the high level of heterogeneity, we conducted a heterogeneity analysis. We looked for multiple subgroups, but with unsatisfactory results. After sensitivity analysis, the heterogeneity disappeared after excluding the two studies that had a large impact on the results, and therefore these two studies were considered as possible major sources of heterogeneity. Further analysis revealed that the two excluded studies were of low quality and lacked some specific information (e.g., gender and ethnicity) to be used in the analysis of heterogeneity and could be the source of heterogeneity.

4.3 Role of WED on anxiety, depression, and the negative affect

The results of the meta-analysis in this study revealed that the WED intervention had no effect on the levels of anxiety and

depression, as well as on the negative affect of the study population. However, research has shown that WED intervention was effective in reducing levels of anxiety and depression in the eating disorder population long after the intervention (38). Another result showed that WED applied to cancer caregivers may improve their adverse conditions of burden, anxiety, and depression (74). It is evident that WED is valid in improving conditions such as anxiety and depression, but the effectiveness may be different due to the different study populations. This may also be attributed to the condition of eating disorder disease, which complicates the negative psychological emotions in this population. Therefore, the role of WED interventions on anxiety, depression, and negative affect in eating-disordered populations cannot be concluded with certainty, more careful consideration is needed.

4.4 Comparative effectiveness of emotional expression interventions

This meta-analysis has focused on examining the effectiveness of WED interventions for eating disorders (EDs), with results indicating that WED has certain effects in alleviating ED symptoms. However, the realm of emotional expression extends beyond writing, and other forms of emotional expression interventions, such as verbal therapy and art therapy, are also worthy of attention. Verbal disclosure, by providing immediate feedback and interpersonal interaction, may be more conducive for some individuals to deeply understand and process their emotions. Empirical studies have provided evidence to corroborate that verbal disclosure can facilitate emotional expression and cognitive restructuring, which are crucial for the recovery process in eating disorders. Several studies (75, 76) have investigated the role of recovered eating disorder patients as therapists, using verbal self-disclosure in treatment. Results showed that sharing their insights helps patients better understand recovery, reduces shame, and alleviates eating disorder symptoms. This approach effectively encourages patients to self-disclosure, yielding positive therapeutic effects.

Art therapy can enhance an individual's emotional regulation capabilities and reduce stress and anxiety, both of which are closely related to emotional states associated with ED symptoms. A systematic review conducted by Griffin et al. (77) demonstrated that art therapy enhances self-esteem and alleviates anxiety in individuals with eating disorders by fostering self-expression, increasing self-awareness, and cultivating new perspectives and a sense of pride. Also, the study by Trably et al. (78) showed that art therapy has the potential to enhance specific dimensions of individuals with eating disorders: in particular, music therapy has been shown to significantly alleviate post-meal anxiety, while dance movement therapy can markedly reduce body dissatisfaction.

Nevertheless this meta-analysis did not encompass direct comparisons between these interventions, mainly due to the scarcity of eligible studies and the heterogeneity in methodologies and outcome measurements. Consequently, we advocate for future research to investigate the comparative efficacy of WED against other emotional expression therapies. This exploration is crucial for discerning their respective benefits and suitability in ED treatment. Such analyses would deepen our comprehension of intervention efficacy and uncover individual propensities and reactions to various therapeutic approaches, laying the groundwork for tailored treatment strategies.

4.5 Future perspectives on WED

The majority of the current research has focused on examining the effects of WED on females and adolescents in Western Europe, so future research could focus more on populations of different ages, genders, geographic areas, and cultural backgrounds. In addition, changes in the environment in which WED is implemented could be considered in the future. Currently, most implementation sites are mainly in laboratories and medical facilities. According to the meta-analysis by Frattaroli, compared to a controlled laboratory setting, WED is more effective at home (79). Also, Gripsrud et al. (80) found in interviews with breast cancer patients that it was easier for them to complete their writing at home.

The frequency, duration, and setting of WED implementation, as well as the instructor who delivered the intervention, were not standardized in the current study. The duration of WED implementation was 15–30 min in most studies, but a few studies fell outside this time range. Most studies chose to conduct WED interventions in the laboratory. The pre-intervention instructors were mostly researchers, with a few adopting peer instruction. Therefore, in the future, consideration needs to be given to the development of a harmonized guideline for clinicians as well as practitioners on the application of WED in the ED population. This guide could focus on describing the frequency and duration of writing, detailing the topics and types of writing, noting the context in which the writing is implemented, considering the interaction of ED population characteristics with writing (e.g., gender, age, geographic region, etc.), and designating the instructor who will implement the intervention.

4.6 Limitations and prospects

Several limitations of this meta-analysis need to be mentioned. First, the quality of the included 13 studies was low. Most of the studies only mentioned randomization without elaborating on the specific methods, and very few of them had reference to allocation concealment and specific blinding information. This lack of detail may have some impact on the results of risk of bias assessment. Second, the majority of the study populations were college students and women, the baseline level of eating disorder symptoms in these participants may not be consistent, increasing the risk of selection bias. Third, this study may exist the risk of publication bias. This may be related to the fact that the included studies focused on observing groups of women in Western countries. This limitation is primarily attributed to the existing focus on female patients within the field of eating disorders and the geographical scope of the research. Further attention needs to be paid to individuals from different cultural backgrounds and of different genders in relevant studies in the future, thereby expanding the sample size and validating the consistency of WED's therapeutic efficacy across various populations. Furthermore, some studies may have obtained more significant results as they used specific scales. Several of the outcome indicators were not scored using a uniform scale, which may have limited our ability to synthesize the results of the studies. And it may be at potential risk of publication bias.

Additionally, some of the outcome indicators were highly heterogeneous and may be associated with sample size, baseline level of the study population, age, gender, cultural background, and duration of follow-up. However, the limited information provided by the included studies resulted in this study not being able to analyze the sources of heterogeneity in depth. In future studies, we will pre-define possible subgroups at the study design stage and include these subgroups (e.g., gender, age, and region) in meta-analyses, even if some information is missing, and try to obtain data from other sources or use alternative indicators. We will also improve the data extraction process, handle missing data more transparently, and select appropriate statistical methods to better understand and account for heterogeneity.

Moreover, the absence of direct comparisons between WED and other emotional expression interventions in our systematic review and meta-analysis. This is primarily due to the diversity of included studies and limitations in data availability. Specifically, the heterogeneity in methodologies, participant characteristics, and outcome measures across different studies complicate direct comparisons. Furthermore, the limited number of studies in the existing literature that directly compare WED with other emotional expression interventions restricts our ability to conduct a comprehensive comparison. Therefore, we recommend that future research should address these limitations to more accurately assess the impact of various intervention measures on eating disorder symptoms.

5 Conclusion

The available evidence from this study suggests that WED is effective in alleviating eating disorder symptoms and body image problems, but there is inadequate evidence in relieving depression, anxiety, and negative affect. Hence, future researches on the impact of WED on depression, anxiety, and negative affect in eating disordered populations should be appropriately emphasized to explore its role.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

YW: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Software, Supervision, Writing – original draft, Writing – review & editing. YT: Project administration, Supervision, Writing – review & editing. TX: Conceptualization, Methodology, Resources, Supervision, Writing – review & editing. XC: Data curation, Methodology, Software, Writing – original draft.

Funding

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

Acknowledgments

We would like to extend our acknowledgement to each of the authors who contributed to the manuscript.

Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2024.1476956/full#supplementary-material

References

1. Bulik CM, Coleman JRI, Hardaway JA, Breithaupt L, Watson HJ, Bryant CD, et al. Genetics and neurobiology of eating disorders. *Nat Neurosci*. (2022) 25:543–54. doi: 10.1038/s41593-022-01071-z

2. Treasure J, Duarte TA, Schmidt U. Eating disorders. *Lancet*. (2020) 395:899–911. doi: 10.1016/S0140-6736(20)30059-3

3. Silén Y, Keski-Rahkonen A. Worldwide prevalence of DSM-5 eating disorders among young people. *Curr Opin Psychiatry*. (2022) 35:362–71. doi: 10.1097/YCO.0000000000000818

4. Rangel Paniz G, Lebow J, Sim L, Lacy BE, Farraye FA, Werlang ME. Eating disorders: diagnosis and management considerations for the IBD practice. *Inflamm Bowel Dis*. (2022) 28:936–46. doi: 10.1093/ibd/izab138

5. Falkum E, Pedersen G, Karterud S. Diagnostic and statistical manual of mental disorders, fourth edition, paranoid personality disorder diagnosis: a unitary or a two-dimensional construct? *Compr Psychiatr*. (2009) 50:533–41. doi: 10.1016/j.comppsych.2009.01.003

6. First MB. Diagnostic and statistical manual of mental disorders, 5th edition, and clinical utility. *J Nerv Ment Dis*. (2013) 201:727–9. doi: 10.1097/NMD.0b013e3182a2168a

7. Guo W, Xiong W. From gut microbiota to brain: implications on binge eating disorders. *Gut Microbes*. (2024) 16:2357177. doi: 10.1080/19490976.2024.2357177

8. Presseller EK, Patarinski AGG, Zhang F, Page KA, Srivastava P, Manasse SM, et al. Glucose variability: a physiological correlate of eating disorder behaviors among individuals with binge-spectrum eating disorders. *Int J Eat Disord*. (2022) 55:1788–98. doi: 10.1002/eat.23838

9. Meneguzzo P, Meregalli V, Collantoni E, Cardi V, Tenconi E, Favaro A. Virtual rejection and overinclusion in eating disorders: an experimental investigation of the impact on emotions, stress perception, and food attitudes. *Nutrients*. (2023) 15:1021. doi: 10.3390/nu15041021

10. Gao Z, Zhao J, Peng S, Yuan H. The relationship and effects of self-esteem and body shape on eating disorder behavior: a cross-sectional survey of Chinese university students. *Healthcare*. (2024) 12:1034. doi: 10.3390/healthcare12101034

11. van Hoeken D, Hoek HW. Review of the burden of eating disorders: mortality, disability, costs, quality of life, and family burden. *Curr Opin Psychiatry*. (2020) 33:521–7. doi: 10.1097/YCO.0000000000000641

12. Wu J, Liu J, Li S, Ma H, Wang Y. Trends in the prevalence and disability-adjusted life years of eating disorders from 1990 to 2017: results from the global burden of disease study 2017. *Epidemiol Psychiatr Sci*. (2020) 29:e191. doi: 10.1017/S2045796020001055

13. Thomas JJ, Becker KR. Some of the burden of eating disorders is still hidden. *Lancet Psychiatry*. (2021) 8:263–4. doi: 10.1016/S2215-0366(21)00080-8

14. Streatfeild J, Hickson J, Austin SB, Hutcheson R, Kandel JS, Lampert JG, et al. Social and economic cost of eating disorders in the United States: evidence to inform policy action. *Int J Eat Disord*. (2021) 54:851–68. doi: 10.1002/eat.23486

15. Chua SN, Fitzsimmons-Craft EE, Austin SB, Wilfley DE, Taylor CB. Estimated prevalence of eating disorders in Singapore. *Int J Eat Disord*. (2021) 54:7–18. doi: 10.1002/eat.23440

16. Chua SN, Fitzsimmons-Craft EE, Austin SB, Wilfley DE, Taylor CB. Estimated prevalence of eating disorders in Malaysia based on a diagnostic screen. *Int J Eat Disord*. (2022) 55:763–75. doi: 10.1002/eat.23711

17. Touyz S, Lacey H, Hay P. Eating disorders in the time of COVID-19. *J Eat Disord*. (2020) 8:19. doi: 10.1186/s40337-020-00295-3

18. Rodgers RF, Lombardo C, Cerolini S, Franko DL, Omori M, Fuller-Tyszkiewicz M, et al. The impact of the COVID -19 pandemic on eating disorder risk and symptoms. *Int J Eat Disord*. (2020) 53:1166–70. doi: 10.1002/eat.23318

19. Haripersad YV, Kannegiesser-Bailey M, Morton K, Skeldon S, Shipton N, Edwards K, et al. Outbreak of anorexia nervosa admissions during the COVID-19 pandemic. *Arch Dis Child*. (2021) 106:e15. doi: 10.1136/archdischild-2020-319868

20. Solmi F, Downs JL, Nicholls DE. COVID-19 and eating disorders in young people. *Lancet Child Adoles Health*. (2021) 5:316–8. doi: 10.1016/S2352-4642(21)00094-8

21. Taquet M, Geddes JR, Luciano S, Harrison PJ. Incidence and outcomes of eating disorders during the COVID-19 pandemic. *Br J Psychiatry*. (2022) 220:262–4. doi: 10.1192/bjp.2021.105

22. Solmi M, Radua J, Stubbs B, Ricca V, Moretti D, Busatta D, et al. Risk factors for eating disorders: an umbrella review of published meta-analyses. *Braz J Psychiatr*. (2021) 43:314–23. doi: 10.1590/1516-4446-2020-1099

23. Martiadis V, Castaldo E, Monteleone P, Maj M. The role of psychopharmacotherapy in the treatment of eating disorders. *APA PsycNET*. (2007) 4:51–60. Available at: https://psycnet.apa.org/record/2007-18607-001

24. Klein DA, Sylvester JE, Schvey NA. Eating disorders in primary care: diagnosis and management. *Am Fam Physician*. (2021) 103:22–32. Available at: https://www.aafp.org/pubs/afp/issues/2021/0101/p22.html

25. Aznar Laín S, Román-viñas B. Physical exercise and sports in eating disorders. *Nutr Hosp*. (2022) 39:33–40. doi: 10.20960/nh.04176

26. Taheri M, Esmaeili A, Irandoust K, Mirmoezzi M, Souissi A, Laher I, et al. Mental health, eating habits and physical activity levels of elite Iranian athletes during the COVID-19 pandemic. *Sci Sports*. (2023) 38:527–33. doi: 10.1016/j.scispo.2023.01.002

27. Irandoust K, Parsakia K, Estifa A, Zoormand G, Knechtle B, Rosemann T, et al. Predicting and comparing the long-term impact of lifestyle interventions on individuals with eating disorders in active population: a machine learning evaluation. *Front Nutr*. (2024) 11:1390751. doi: 10.3389/fnut.2024.1390751

28. Monaco F, Vignapiano A, Piacente M, Pagano C, Mancuso C, Steardo L, et al. An advanced artificial intelligence platform for a personalised treatment of eating disorders. *Front Psych*. (2024) 15:1414439. doi: 10.3389/fpsyt.2024.1414439

29. Russell H, Aouad P, Le A, Marks P, Maloney D, Consortium NEDR, et al. Psychotherapies for eating disorders: findings from a rapid review. *J Eat Disord*. (2023) 11:175. doi: 10.1186/s40337-023-00886-w

30. Mulkens S, Waller G. New developments in cognitive-behavioural therapy for eating disorders (CBT-ED). *Curr Opin Psychiatry*. (2021) 34:576–83. doi: 10.1097/YCO.0000000000000745

31. Davey E, Bennett SD, Bryant-Waugh R, Micali N, Takeda A, Alexandrou A, et al. Low intensity psychological interventions for the treatment of feeding and eating disorders: a systematic review and meta-analysis. *J Eat Disord*. (2023) 11:56. doi: 10.1186/s40337-023-00775-2

32. Pennebaker JW, Beall SK. Confronting a traumatic event: toward an understanding of inhibition and disease. *J Abnorm Psychol*. (1986) 95:274–81. doi: 10.1037/0021-843X.95.3.274

33. Pennebaker JW. Opening up: The healing power of expressing emotions. London: Guilford Press (2012).

34. Pennebaker JW. Expressive writing in psychological science. *Perspect Psychol Sci*. (2018) 13:226–9. doi: 10.1177/1745691617707315

35. Qian J, Zhou X, Sun X, Wu M, Sun S, Yu X. Effects of expressive writing intervention for women's PTSD, depression, anxiety and stress related to pregnancy: a meta-analysis of randomized controlled trials. *Psychiatry Res*. (2020) 288:112933. doi: 10.1016/j.psychres.2020.112933

36. Ciao AC, Munson BR, Pringle KD, Roberts SR, Lalgee IA, Lawley KA, et al. Inclusive dissonance-based body image interventions for college students: two randomized-controlled trials of the EVERYbody project. *J Consult Clin Psychol*. (2021) 89:301–15. doi: 10.1037/ccp0000636

37. Ghaderi A, Stice E, Andersson G, Enö Persson J, Allzén E. A randomized controlled trial of the effectiveness of virtually delivered body project (vBP) groups to prevent eating disorders. *J Consult Clin Psychol*. (2020) 88:643–56. doi: 10.1037/ccp0000506

38. East P, Startup H, Roberts C, Schmidt U. Expressive writing and eating disorder features: a preliminary trial in a student sample of the impact of three writing tasks on eating disorder symptoms and associated cognitive, affective and interpersonal factors. *Eur Eat Disord Rev*. (2010) 18:180–96. doi: 10.1002/erv.978

39. Earnhardt JL, Martz DM, Ballard ME, Curtin L. A writing intervention for negative body image: Pennebaker fails to surpass the placebo. *J Coll Stud Psychother*. (2002) 17:19–35. doi: 10.1300/J035v17n01_04

40. Frayne A, Wade TD. A comparison of written emotional expression and planning with respect to bulimic symptoms and associated psychopathology. *Eur Eat Disord Rev*. (2006) 14:329–40. doi: 10.1002/erv.731

41. Kupeli N, Schmidt UH, Campbell IC, Chilcot J, Roberts CJ, Troop NA. The impact of an emotionally expressive writing intervention on eating pathology in female students. *Health Psychol Behav Med*. (2018) 6:162–79. doi: 10.1080/21642850.2018.1491797

42. Ziemer KS, Lamphere BR, Raque-Bogdan TL, Schmidt CK. A randomized controlled study of writing interventions on college Women's positive body image. *Mindfulness*. (2019) 10:66–77. doi: 10.1007/s12671-018-0947-7

43. Gamber AM, Lane-Loney S, Levine MP. Effects and linguistic analysis of written traumatic emotional disclosure in an eating-disordered population. *Perm J*. (2013) 17:16–20. doi: 10.7812/TPP/12-056

44. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. (2021) 22:n71. doi: 10.1136/bmj.n71

45. Mond JM, Hay PJ, Rodgers B, Owen C, Beumont PJV. Validity of the eating disorder examination questionnaire (EDE-Q) in screening for eating disorders in community samples. *Behav Res Ther*. (2004) 42:551–67. doi: 10.1016/S0005-7967(03)00161-X

46. Cooper Z, Cooper PJ, Fairburn CG. The validity of the eating disorder examination and its subscales. *Br J Psychiatry*. (1989) 154:807–12. doi: 10.1192/bjp.154.6.807

47. Garner DMOM. Scoring the eating disorder inventory. *Am J Psychiatry*. (1986) 143:680–1. doi: 10.1176/ajp.143.5.680-a

48. Stice E, Telch CF, Rizvi SL. Development and validation of the eating disorder diagnostic scale: a brief self-report measure of anorexia, bulimia, and binge-eating disorder. *Psychol Assessment*. (2000) 12:123–31. doi: 10.1037/1040-3590.12.2.123

49. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. (1983) 67:361–70. doi: 10.1111/j.1600-0447.1983.tb09716.x

50. Evans C, Dolan B. Body shape questionnaire: derivation of shortened "alternate forms". *Int J Eat Disord*. (1993) 13:315–21. doi: 10.1002/1098-108X(199304)13:3<315::AID-EAT2260130310>3.0.CO;2-3

51. Berscheid E, Walster E, Bohrnstedt G. The happy American body: a survey report. *Psychol Today*. (1973) 7:119–31.

52. Stice E, Fisher M, Martinez E. Eating disorder diagnostic scale: additional evidence of reliability and validity. *Psychol. Assess*. (2004) 16:60. doi: 10.1037/1040-3590.16.1.60

53. Watson D, Clark LA. Affects separable and inseparable: on the hierarchical arrangement of the negative affects. *J Pers Soc Psychol*. (1992) 62:489–505. doi: 10.1037/0022-3514.62.3.489

54. Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. (2002) 21:1539–58. doi: 10.1002/sim.1186

55. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. (1997) 315:629–34. doi: 10.1136/bmj.315.7109.629

56. GRADEprofiler 3.6 Cochrane IMS. (2024). Available at: https://gradeprofiler.software.informer.com/ (Accessed November 8, 2024).

57. Stice E, Shaw H, Burton E, Wade E. Dissonance and healthy weight eating disorder prevention programs: a randomized efficacy trial. *J Consult Clin Psychol*. (2006) 74:263–75. doi: 10.1037/0022-006X.74.2.263

58. Johnston O, Startup H, Lavender A, Godfrey E, Schmidt U. Therapeutic writing as an intervention for symptoms of bulimia nervosa: effects and mechanism of change. *Int J Eat Disord*. (2009) 43:405–19. doi: 10.1002/eat.20714

59. Ghaderi A, Welch E, Zha C, Holmes EA. Imagery rescripting for reducing body image dissatisfaction: a randomized controlled trial. *Cogn Ther Res*. (2022) 46:721–34. doi: 10.1007/s10608-022-10295-z

60. Brenton-Peters J, Consedine NS, Roy R, Cavadino A, Serlachius A. Self-compassion, stress, and eating behaviour: exploring the effects of self-compassion on dietary choice and food craving after laboratory-induced stress. *Int J Behav Med*. (2023) 30:438–47. doi: 10.1007/s12529-022-10110-9

61. Barbeau K, Guertin C, Boileau K, Pelletier L. The effects of self-compassion and self-esteem writing interventions on Women's valuation of weight management goals, body appreciation, and eating behaviors. *Psychol Women Q*. (2022) 46:82–98. doi: 10.1177/03616843211013465

62. Arigo D, Smyth JM. The benefits of expressive writing on sleep difficulty and appearance concerns for college women. *Psychol Health*. (2012) 27:210–26. doi: 10.1080/08870446.2011.558196

63. Relojo D. Moderating effects of dietary restraint and self-compassion in an expressive writing intervention in southeast Asian population. *J Behav Sci*. (2016) 26:1–6. Available at: https://pu.edu.pk/images/journal/doap/PDF-FILES/Article%20No.%2001_v26_2_16.pdf

64. Tanis J, Martijn C, Vroling MS, Maas J, Keijsers GPJ. Reducing binge eating through behavioral-focused versus emotion-focused implementation intentions in patients with binge eating disorder or bulimia nervosa: an experimental approach. *Behav Res Ther*. (2023) 169:104399. doi: 10.1016/j.brat.2023.104399

65. Wang W, Ding X. A pilot randomized trial of self-compassion writing for young adult women engaged in emotional eating in the context of appearance-related cyberbullying. *Int J Eat Disord*. (2023) 56:1520–33. doi: 10.1002/eat.23967

66. Pennebaker JW. Writing about emotional experiences as a therapeutic process. *Psychol Sci*. (1997) 8:162–6. doi: 10.1111/j.1467-9280.1997.tb00403.x

67. Selye H. The stress of life. New York, NY: McGraw-Hill (1976).

68. Stice E, Rohde P, Gau J, Shaw H. Effect of a dissonance-based prevention program on risk for eating disorder onset in the context of eating disorder risk factors. *Prev Sci*. (2012) 13:129–39. doi: 10.1007/s11121-011-0251-4

69. Rodriguez R, Marchand E, Ng J, Stice E. Effects of a cognitive dissonance-based eating disorder prevention program are similar for Asian American, Hispanic, and white participants. *Int J Eat Disord*. (2008) 41:618–25. doi: 10.1002/eat.20532

70. Melnyk SE, Cash TF, Janda LH. Body image ups and downs: prediction of intra-individual level and variability of women's daily body image experiences. *Body Image*. (2004) 1:225–35. doi: 10.1016/j.bodyim.2004.03.003

71. Carraça EV, Silva MN, Markland D, Vieira PN, Minderico CS, Sardinha LB, et al. Body image change and improved eating self-regulation in a weight management intervention in women. *Int J Behav Nutr Phys Act*. (2011) 8:75. doi: 10.1186/1479-5868-8-75

72. Dalton JJ, Glenwick DS. Effects of expressive writing on standardized graduate entrance exam performance and physical health functioning. *J Psychol*. (2009) 143:279–92. doi: 10.3200/JRLP.143.3.279-292

73. Hussain D. Healing through writing: insights from research. *Int J Ment Health Promot*. (2010) 12:19–23. doi: 10.1080/14623730.2010.9721810

74. Harvey J, Sanders E, Ko L, Manusov V, Yi J. The impact of written emotional disclosure on Cancer caregivers' perceptions of burden, stress, and depression: a randomized controlled trial. *Health Commun*. (2018) 33:824–32. doi: 10.1080/10410236.2017.1315677

75. De Vos JA, Netten C, Noordenbos G. Recovered eating disorder therapists using their experiential knowledge in therapy: a qualitative examination of the therapists' and the patients' view. *Eat Disord*. (2016) 24:207–23. doi: 10.1080/10640266.2015.1090869

76. Simonds LM, Spokes N. Therapist self-disclosure and the therapeutic alliance in the treatment of eating problems. *Eat Disord*. (2017) 25:151–64. doi: 10.1080/10640266.2016.1269557

77. Griffin C, Fenner P, Landorf KB, Cotchett M. Effectiveness of art therapy for people with eating disorders: a mixed methods systematic review. *Arts Psychother*. (2021) 76:101859. doi: 10.1016/j.aip.2021.101859

78. Trably F, Gorwood P, Lodovico LD. Art therapy in eating disorders. A systematic review of literature. *Eur Psychiatry*. (2022) 65:S151. doi: 10.1192/j.eurpsy.2022.405

79. Frattaroli J. Experimental disclosure and its moderators: a meta-analysis. *Psychol Bull*. (2006) 132:823–65. doi: 10.1037/0033-2909.132.6.823

80. Gripsrud BH, Brassil KJ, Summers B, Søiland H, Kronowitz S, Lode K. Capturing the experience: reflections of women with breast Cancer engaged in an expressive writing intervention. *Cancer Nurs*. (2016) 39:E51–60. doi: 10.1097/NCC.0000000000000300

81. Lafont J, Oberle CD. Expressive writing effects on body image: symptomatic versus asymptomatic women. *Psychology*. (2014) 5:431–40. doi: 10.4236/psych.2014.55053

frontiers | Frontiers in Nutrition

TYPE Original Research
PUBLISHED 24 December 2024
DOI 10.3389/fnut.2024.1501536

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
José Aparecido Da Silva,
University of Brasilia, Brazil
Jose Carlos Tavares Da Silva,
Estácio de Sá University, Brazil

*CORRESPONDENCE
Zeng Gao
✉ wwzgaozeng@163.com

RECEIVED 25 September 2024
ACCEPTED 12 December 2024
PUBLISHED 24 December 2024

CITATION
Zhao J, Zhao J, Yuan H and Gao Z (2024) Body shape concerns and behavioral intentions on eating disorders: a cross-sectional study of Chinese female university students using an extended theory of reasoned action model.
Front. Nutr. 11:1501536.
doi: 10.3389/fnut.2024.1501536

Body shape concerns and behavioral intentions on eating disorders: a cross-sectional study of Chinese female university students using an extended theory of reasoned action model

Jingyi Zhao[1], Jing Zhao[2], Han Yuan[3] and Zeng Gao[4,5]*

[1]Physical Education Department, Nanjing Institute of Technology, Nanjing, China, [2]College of Educational Science, Guangdong Preschool Normal College in Maoming, Maoming, China, [3]Department of Physical Education, Kyungpook National University, Daegu, Republic of Korea, [4]Department of Physical Education, Xiangtan University, Xiangtan, China, [5]School of Educational Studies, Universiti Sains Malaysia, George Town, Pinang, Malaysia

Background: Weight and body shape concerns have become increasingly common among adolescents. Chinese university students show a high risk of eating disorder behaviors. This study aims to analyze the moderating effect of BMI on the relationships between body shape, attitudes, subjective norms, and eating disorder behavioral intentions among Chinese female university students using the Theory of Reasoned Action (TRA) model.

Methods: A stratified random sample of 679 female Chinese university students (age, mean ± SD = 19.792 ± 1.007) participated in the study. The surveys comprised the Theory of Reasoned Action Questionnaire (TRA-Q) and the Body Shape Questionnaire (BS-Q) to assess their body shape concerns and behavioral intentions regarding eating disorders. Structural equation modeling was used to test the extended TRA model, with body shape as an additional predictor and BMI as a moderator.

Results: Body shape positively affected attitudes ($\beta = 0.444$, $p < 0.001$), subjective norms ($\beta = 0.506$, $p < 0.001$), and intentions ($\beta = 0.374$, $p < 0.001$). BMI significantly moderated the relationships between attitudes ($t = -3.012$, $p < 0.01$), subjective norms ($t = -2.678$, $p < 0.01$), and body shapes ($t = -4.485$, $p < 0.001$) toward eating disorder intentions.

Conclusion: Body shape and BMI directly influence eating disorder behavioral intentions among Chinese female university students. The findings suggest that young Chinese women's eating disorder intentions are increasingly influenced by external factors related to body shape and BMI.

KEYWORDS

body shape concern, behavioral intention, eating disorders, female university students, theory of reasoned action

1 Introduction

Weight and body shape concerns (BSC) are increasingly prevalent among adolescents, contributing to significant physical and mental health challenges. These concerns often lead to psychological disorders such as depression, anxiety, paranoia, and eating disorders such as anorexia nervosa (AN), while also potentially contributing to obesity as a separate health condition (1–4). Body shape dissatisfaction can further result in obesity or malnutrition, negatively impacting self-esteem and leading to distressing conditions like social anxiety, phobias, and severe emotional disturbances (5, 6). Recent studies underscore the alarming prevalence of these issues among Chinese female university students. A survey of 2,023 participants found that 73.36% had attempted to lose weight, 30.55% were already underweight, and 57.39% desired to be thinner-indicating a rising trend of malnourished individuals in this demographic (7, 47). The high prevalence of eating disorders within this group is particularly concerning (8).

Media representation, family dynamics, and peer influences play critical roles in shaping female body image dissatisfaction, often leading to fears of negative judgment based on weight and BSC (9, 10). In severe cases, these pressures can lead to eating disorders such as bulimia (11). Across several Asian countries, including China, Japan, Korea, Taiwan, and Pakistan, high levels of body dissatisfaction and unhealthy eating attitudes have been documented, with gender being a significant factor (12). Moreover, Subjective norm (SN) and behavioral intention (BI) profoundly influence perceptions of BSC, especially among females, who are more likely to develop unhealthy eating behaviors in response to these pressures (13, 14). Previous research has shown that BSC can influence how individuals perceive and respond to social norms regarding eating behaviors (15). This relationship is particularly relevant in Chinese culture, where social pressure regarding body image can be intensified by personal BSC (16). The TRA suggests that an individual's BIs are shaped by their Attitudes (AT) toward the behavior and the perceived social pressures, or SN, to perform or avoid that behavior. The TRA model has been extensively used to predict human BIs in various contexts (17, 18). For instance, studies have shown that AT and social influences strongly drive environmental practices (3), job-related attitudes and intentions (19), and mobile banking adoption (20).

Young female university students, particularly those who are obese, are highly susceptible to external influences, including media portrayals and societal standards, which contribute to body dissatisfaction and the development of eating disorders (6, 21). In China, the situation is increasingly concerning. Obesity rates among university students are rising, and many young women are placing greater importance on their image, often striving for an unhealthy thin ideal. This preoccupation with BSC, coupled with external influences such as media portrayals and peer pressure, significantly increases the risk of developing eating disorders (22, 48). Body mass index (BMI) plays a critical role in this context, influencing both the perception of body image and the health risks associated with obesity, including cardiovascular disease (47, 23). Previous research, including our cross-sectional survey, has demonstrated a significant positive correlation between BSC and eating disorder behaviors among Chinese university students, with gender acting as a moderating factor. Female students, in particular, are more vulnerable to external pressures that can lead to the development of eating disorders (7).

Building on this foundation, the study extends the traditional TRA model by incorporating BSC as an additional predictor variable and BMI as a moderating variable, to understand better BSC influences AT, SN, and BI related to eating disorders among Chinese female university students. This extension allows us to examine how BSC directly influence AT, SN, and BI related to eating disorders.

The research objectives are summarized as follows:

(1) To identify the relationships between body shape concerns and attitudes, subjective norms, and behavioral intentions on eating disorders.
(2) To analyze the moderating effect of BMI on these relationships among Chinese female university students.

2 Conceptual framework and hypotheses

2.1 Conceptual framework

The TRA model, developed by Feishbein and Ajzen (17), suggests that an individual's BIs are influenced by their ATs and SNs. This model posits that certain beliefs and information shape BIs through the mediating effects of personal ATs and perceived social pressure (24, 25). The TRA model has been extensively applied across diverse studies, such as exploring the impact of self-esteem and body dissatisfaction on clothing behaviors among Generation men (26), assessing healthy eating habits (27), examining eating decisions among female university dieters and non-dieters (28), analyzing muscle endurance and BMI among university students (29), and understanding online purchasing intentions for exercise apparel among overweight and obese adults (30).

Despite its widespread application, there has been limited research on the applicability of the TRA model to BSC and their influence on eating disorder BIs. This study addresses this gap by extending the TRA model to analyze the moderating effects of BMI on the relationships between BSC, AT, SN, and BI among Chinese female university students. The proposed research design integrates BSC into the extended TRA model to better understand how variations in BSC impact these relationships (see Figure 1).

2.2 Hypotheses

The research hypotheses are as follows:

> *H1*: Body shape concerns positively affects attitudes.
>
> *H2*: Body shape concerns positively affects subjective norms.
>
> *H3*: Attitudes positively affect behavioral intentions.
>
> *H4*: Subjective norms positively affect behavioral intentions.
>
> *H5*: Body shape concerns positively affects behavioral intentions.

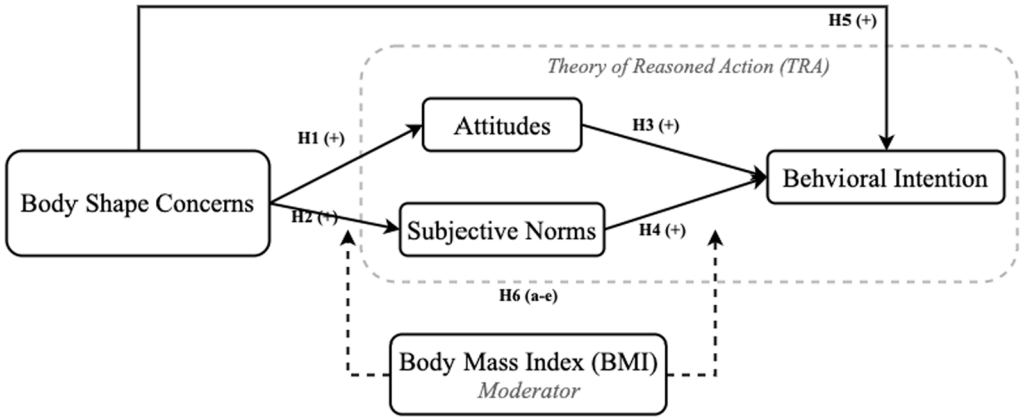


FIGURE 1
Conceptual framework.

H6 (*a–e*): BMI had a significant effect as a moderator variable on the relationship between body shape concerns, attitude, subjective norms, and behavioral intentions.

3 Methods

3.1 Participants

A random sample of 687 female university students was collected from April 20th to May 20th, 2024, at the Nanjing Institute of Technology. The participants' ages as a continuous variable from 18 to 24 years ($M = 19.792$, SD = 1.007). After excluding 8 incomplete responses (1.16%), a final sample of 679 participants was analyzed. Data collection was conducted online from January 1st to April 1st, 2024. The participants' ages were determined from questionnaire responses. Using G*Power 3.1 software, the required sample size was calculated to be 541, with an effect size (f^2) of 0.05, an alpha error probability (α) of 0.05, and a power (1-β) of 0.99. This aligns with similar studies, such as Yang et al. (31) and Dubey and Sahu (32), which used comparable sample sizes. The study was approved by the university ethics committee. All participants were fully informed of the purpose, process, and potential risks of the study before participation and signed an informed consent form. Data collection was conducted after obtaining written consent from the participants.

3.2 Measures

3.2.1 The TRA-Q

The TRA-Q has been used to prove a validated tool and used for evaluating BI on eating disorders (33). It consists of 23 items subdivided into 3 subscales attitudes (5 items), subjective norms (8 items), and behavioral intention (10 items) (33, 34). Participants used a 7-point Likert scale from 1 to 7, which were 1 (Strongly Disagree), 2 (Disagree), 3 (Somewhat Disagree), 4 (Neutral), 5 (Somewhat Agree), 6 (Agree), and 7 (Strongly Agree). The study adopted the Chinese version of the Theory of Reasoned Action Questionnaire (TRA-Q) parts of the theory of planned behavior model (33, 34). This tool has high criterion-related validity and internal consistency ($\alpha = 0.93$) validated for the Chinese population (33, 34).

3.2.2 The BS-Q

The BS-Q has been used to prove a validated tool and used for evaluating BSC (35). It consists of 8 items, and the questionnaire adopted a 6-point Likert scale from 1 to 6 (Rarely, Sometimes, Often, Usually, and Always) (8, 35). Its scores range from 8 to 48, and a score less than 19 indicates no concern with shape, 19 to 25 indicates mild concern with shape, 26 to 33 indicates moderate concern with shape, and over 33 indicates marked concern with shape (35). The study adopted a Chinese version of the Body Shape Questionnaire (BS-Q) (8, 35). The questionnaire demonstrated high reliability, with a coefficient of 0.94, and it has been validated for the Chinese population (7, 8, 35, 36).

3.3 Statistical analysis

The data were analyzed using SPSS version 24.0 statistical software, incorporating descriptive statistics, Pearson correlation analysis, path analysis, and moderation analysis. Structural equation modeling was conducted using SPSS PROCESS, employing maximum likelihood estimation. Model fit was assessed using multiple indices including CFI, TLI, RMSEA, and SRMR. The measurement model was evaluated before testing the structural model, following standard two-step structural equation modeling procedures. Descriptive statistics were used to calculate frequencies, percentages, and chi-squared tests for categorical variables, as well as t-tests for continuous variables. Pearson correlation analysis examined the relationships between all variables. Path analysis was employed to test hypotheses 1 through 5, while moderation analysis assessed the moderating role of BMI in the relationships between body shape concerns, attitudes, subjective norms, and behavioral intentions (hypothesis 6). All questionnaires used were validated Chinese versions from previous studies, ensuring consistency and cultural relevance in data collection.

4 Results

4.1 Demographic characteristics

This study involved 679 female university students from the Nanjing Institute of Technology in Nanjing, China. The average age of the participants was 19.792 years (SD = 1.007), with ages ranging from 18 to 24 years. Most students had a normal BMI (n = 493, 72.61%), while 82 students (12.08%) were classified as overweight. Three students (0.44%) were identified as obese, and 101 students (14.87%) were considered underweight. Additional demographic details are provided in Table 1.

4.2 Descriptive statistics

Table 2 shows demographic characteristics and descriptive statistics. The chi-squared test will be used to analyze four groups of BSC categorical variables, purposing further to confirm whether has a statistically significant difference in the demographic characteristics. Its result reported that BMI ($\chi 2 = 72.548$, $p = 0.001 < 0.01$) and parents' educational status ($\chi^2 = 35.917$, $p = 0.001 < 0.01$) with BSC showed significant differences ($p < 0.05$). Other's ages, family incomes, and parent's marital status did not significantly difference ($p > 0.05$). All participants of average age with no concern with shape (NO-CS), mild concern with shape (MI-CS), moderate concern with shape (MO-CS), and marked concern with shape (MA-CS) respectively are 19.838 yrs. (1.054), 19.866 yrs. (1.012), 19.838 yrs. (1.015), and 19.882 yrs. (0.907). Due to differences in BMI and parents' educational status, we divided the BMI into different level groups, namely underweight (< 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obesity (>29.9 kg/m^2), and the parents' educational status into different level groups, namely elementary school, secondary school, high school, and bachelor and above. According to the significant difference analyses, we further determine if age, BMI, parents' educational status, family income, and parent's marital status had significant differences from all variables. We used the different groups of BMI as continuous variables for analysis.

4.3 Reliability and validity

Table 3 demonstrates that all data underwent reliability and validity checks using factor loading, CR values, AVE values, Cronbach's alpha, and KMO values. All items showed factor loadings above 0.6, CR values exceeding 0.80, AVE values above 0.45, Cronbach's alpha values over 0.80, and KMO values surpassing 0.70. The AVE values being greater than 0.45 indicate suitable convergent validity, meaning that each construct's measurement items can explain more than 45% of the total variance. Although AVE values ideally should be above 0.50 (37), AVE values above 0.45 are

TABLE 1 Demographic characteristics.

Items	Categories	All Participants (n)	%
Age	18 yrs.	55	8.10
	19 yrs.	186	27.39
	20 yrs.	298	43.89
	21 yrs.	107	15.76
	22 yrs.	23	3.39
	23 yrs.	7	1.03
	24 yrs.	3	0.44
Average age		19.792 ± 1.007	
BMI	Underweight	101	14.87
	Normal	493	72.61
	Overweight	82	12.08
	Obesity	3	0.44
Parents' educational status	Elementary School	129	19.00
	Secondary School	242	35.64
	High School	156	22.97
	Bachelor and above	152	22.39
Family income	Low	307	45.21
	Average	316	46.54
	Good	56	8.25
Parents' marital status	Married	626	92.19
	Divorced/Widowed	53	7.81

BMI is body mass index; Underweight is < 18.5 kg/m^2; Normal is 18.5–24.9 kg/m^2; Overweight is 25.0–29.9 kg/m^2; Obesity is > 29.9 kg/m^2; Low is below 16,443 RMB/year; Average is between 16,443 and 41,172 RMB/year; Good is above 41,172 RMB/year; ** $p < 0.01$.

TABLE 2 Descriptive statistics of the BS-Q scores.

Categories	Body shape questionnaire				χ^2	p
	NO-CS *n* (%)	MI-CS *n* (%)	MO-CS *n* (%)	MA-CS *n* (%)		
Age						
18 yrs.	14 (7.87)	21 (8.50)	17 (9.14)	3 (4.41)	19.725	0.348
19 yrs.	53 (29.78)	66 (26.72)	47 (25.27)	20 (29.41)		
20 yrs.	80 (44.94)	113 (45.75)	75 (40.32)	30 (44.12)		
21 yrs.	22 (12.36)	33 (13.36)	40 (21.51)	12 (17.65)		
22 yrs.	5 (2.81)	10 (4.05)	5 (2.69)	3 (4.41)		
23 yrs.	4 (2.25)	1 (0.40)	2 (1.08)	0		
24 yrs.	0	3 (1.21)	0	0		
Average Age	19.838 ± 1.054	19.866 ± 1.012	19.838 ± 1.015	19.882 ± 0.907	–	–
BMI						
Underweight	51 (28.65)	32 (12.96)	10 (5.38)	8 (11.76)	72.548	0.001**
Normal	113 (63.48)	195 (78.95)	145 (77.96)	40 (58.82)		
Overweight	14 (7.87)	20 (8.10)	30(16.13)	18 (26.47)		
Obesity	0	0	1(0.54)	2 (2.94)		
Parents' educational status						
Elementary School	36 (20.22)	55 (22.27)	30 (16.13)	8 (11.76)	35.917	0.001**
Secondary School	51 (28.65)	114 (46.15)	59 (31.72)	18 (26.47)		
High School	44 (24.72)	38 (15.38)	54 (29.03)	20 (29.41)		
Bachelor and above	47 (26.40)	40 (16.19)	43 (23.12)	22 (32.35)		
Family income						
Low	82 (46.07)	97 (39.27)	94 (50.54)	34 (50.00)	8.760	0.188
Average	86 (48.31)	124 (50.20)	78 (41.94)	28 (41.18)		
Good	10 (5.62)	26 (10.53)	14 (7.53)	6 (8.82)		
Parents' marital status						
Married	169 (94.94)	228 (92.31)	164 (88.17)	65 (95.59)	7.144	0.067
Divorced/Widowed	9 (5.06)	19 (7.69)	22 (11.83)	3 (4.41)		

BMI is body mass index; NO-CS is no concern with shape; MI-CS is mild concern with shape; MO-CS is moderate concern with shape; MA-CS is marked concern with shape; Underweight is < 18.5 kg/m^2; Normal is 18.5–24.9 kg/m^2; Overweight is 25.0–29.9 kg/m^2; Obesity is > 29.9 kg/m^2; Low is below 16,443 RMB/year; Average is between 16,443 and 41,172 RMB/year; Good is above 41,172 RMB/year; **$p < 0.01$.

acceptable when the CR value exceeds 0.80 (38, 39). This suggests high consistency and shared variance among the construct's measurement items. Consequently, the results indicate that all questionnaire items and structures are reliable and valid for Chinese female university students.

Table 4 shows the discriminant validity and correlations. The AVE square root value of BSC is greater than the maximum absolute value of the inter-factor correlation coefficient (0.802 > 0.590), indicating that BSC has good discriminant validity. The AVE square root value of AT is greater than the maximum absolute value of the inter-factor correlation coefficient (0.703 > 0.475), indicating that AT has good discriminant validity. The AVE square root value of SN is greater than the maximum absolute value of the inter-factor correlation coefficient (0.679 > 0.591), indicating that SN has good discriminant validity. The AVE square root value of BI is greater than the maximum absolute value of the inter-factor correlation coefficient (0.683 > 0.591), indicating that BI also has good discriminant validity.

4.4 Correlation of all variables

Table 5 reports the Pearson correlation coefficients. The results that BI with AT ($r = 0.410$, $p = 0.001 < 0.05$), SN ($r = 0.591$, $p = 0.001 < 0.05$), BMI ($r = 0.129$, $p = 0.001 < 0.05$), and parents' educational status ($r = 0.129$, $p = 0.003 < 0.05$) were all significant, indicating that BI with AT, SN, BMI, and parents' educational status were positively correlated. BI with age ($r = 0.039$, $p = 0.308 > 0.05$), family Income ($r = -0.006$, $p = 0.872 > 0.05$), and parents' marital status ($r = 0.058$, $p = 0.129 > 0.05$) were not significant, indicating that they were not correlated. BSC with AT ($r = 0.444$, $p = 0.001 < 0.05$), SN ($r = 0.506$, $p = 0.001 < 0.05$), IN ($r = 0.590$, $p = 0.001 < 0.05$), and BMI ($r = 0.247$, $p = 0.001 < 0.05$) were all significant, indicating that BSC was positively correlated with AT, SN, BI, and BMI. In addition, BSC with age ($r = 0.031$, $p = 0.417 > 0.05$), parents' educational status ($r = 0.060$, $p = 0.119 > 0.05$), family Income ($r = -0.005$, $p = 0.900 > 0.05$), and parents' marital status ($r = 0.039$, $p = 0.311 > 0.05$) did not show significance, indicating that they were not correlated.

TABLE 3 Reliability and validity.

Variables	Items	Factor loading	CR	AVE	Cronbach α	KMO
BSC	BS1	0.711	0.935	0.643	0.934	0.922
	BS2	0.804				
	BS3	0.854				
	BS4	0.833				
	BS5	0.871				
	BS6	0.851				
	BS7	0.853				
	BS8	0.844				
AT	AT1	0.796	0.830	0.494	0.829	0.788
	AT2	0.777				
	AT3	0.765				
	AT4	0.800				
	AT5	0.715				
SN	SN1	0.618	0.871	0.461	0.868	0.879
	SN2	0.795				
	SN3	0.687				
	SN4	0.734				
	SN5	0.778				
	SN6	0.655				
	SN7	0.825				
	SN8	0.676				
BI	BI1	0.744	0.897	0.466	0.894	0.849
	BI2	0.749				
	BI3	0.781				
	BI4	0.695				
	BI5	0.776				
	BI6	0.637				
	BI7	0.673				
	BI8	0.770				
	BI9	0.656				
	BI10	0.702				

χ^2 = 3647.704; df = 428; PGFI = 0.605; CR is construct reliability; AVE is average variance extracted; KMO is Kaiser-Meyer-Olkin.

TABLE 4 Discriminant validity and correlations.

Variables	1	2	3	4
1.BS	**0.802**			
2. AT	0.444	**0.703**		
3.SN	0.506	0.475	**0.679**	
4. BI	0.590	0.410	0.591	**0.683**

Diagonal bold is the average variance extracted (AVE); the diagonal bottom is the square value of the correlation coefficient.

4.5 Hypotheses result from H1 to H5

Table 6 presents the hypotheses of the results through the Path analysis, revealing that BSC positively affect ATs ($\beta = 0.444$, CR = 12.914, $p = 0.001 < 0.01$) and SNs ($\beta = 0.506$, CR = 15.273, $p = 0.001 < 0.01$) among Chinese female university students, thus the Hypotheses 1 and Hypotheses 2 results were supported. Moreover, ATs ($\beta = 0.070$, CR = 2.225, $p = 0.026 < 0.05$), SNs ($\beta = 0.372$, CR = 11.378, $p = 0.001 < 0.01$), and BSC ($\beta = 0.374$, CR = 10.526, $p = 0.001 < 0.01$) all positively affect BI among Chinese female university students, so the Hypotheses 3, Hypotheses 4, and Hypotheses 5 results also were supported.

4.6 Hypothesis result of H6

Table 7 shows different BMI groups as a moderation analysis between BSC, AT, SN, and BI. Different BMI groups had no significant effect as a moderator variable on the relationship between BSC toward

TABLE 5 Pearson correlation analysis.

Variables		1	2	3	4	5	6	7	8	9
1. BSC	*r*	1								
	p	–								
2. AT	*r*	**0.444****	1							
	p	0.001	–							
3. SN	*r*	**0.506****	**0.475****	1						
	p	0.001	0.001	–						
4. BI	*r*	**0.590****	**0.410****	**0.591****	1					
	p	0.001	0.001	0.001	–					
5. Age	*r*	0.031	**−0.112****	−0.056	0.039	1				
	p	0.417	0.004	0.144	0.308	–				
6. BMI	*r*	**0.247****	**0.089***	**0.121****	**0.129****	**−0.084***	1			
	p	0.001	0.020	0.002	0.001	0.028	–			
7. Parents' educational status	*r*	0.060	**0.085***	0.061	**0.129****	**−0.184****	0.043	1		
	p	0.119	0.026	0.109	0.003	0.001	0.260	–		
8. Family income	*r*	−0.005	0.001	**−0.102****	−0.006	−0.045	0.075	−0.028	1	
	p	0.900	0.976	0.008	0.872	0.239	0.051	0.460	–	
9. Parents' marital status	*r*	0.039	0.044	0.101	0.058	**−0.148****	0.031	0.043	**−0.169****	1
	p	0.311	0.256	**0.009****	0.129	0.001	0.421	0.261	0.001	–

** $p < 0.01$.

TABLE 6 Path analysis.

Hypothesis	Relationship			*Path Coeff.*	S.E.	*CR*	*p*	Results
	X	→	*Y*					
H1	BSC	→	AT	0.444	0.040	12.914	0.001**	Supported
H2	BSC	→	SN	0.506	0.031	15.273	0.001**	Supported
H3	AT	→	BI	0.070	0.027	2.225	0.026*	Supported
H4	SN	→	BI	0.372	0.034	11.378	0.001**	Supported
H5	BSC	→	BI	0.374	0.034	10.526	0.001**	Supported

*$p < 0.05$; **$p < 0.01$.

TABLE 7 Moderation analysis.

Hypothesis	Relationship			BMI					Results
	X	→	*Y*	*B*	S.E.	*t-values*	*p*	*β*	
H6a	BSC	→	AT	−0.085	0.065	−1.318	0.188	−0.045	Not Supported
H6b	BSC	→	SN	−0.092	0.050	−1.838	0.066	−0.061	Not Supported
H6c	AT	→	IN	−1.143	0.047	−3.012	0.003**	−0.106	Supported
H6d	SN	→	IN	−0.142	0.053	−2.678	0.008**	−0.083	Supported
H6e	BSC	→	IN	−0.219	0.049	−4.485	0.001**	−0.138	Supported

*$p < 0.05$; **$p < 0.01$.

AT ($t = -1.318$, $p = 0.188 > 0.05$), and SN ($t = -1.838$, $p = 0.066 > 0.05$), indirect that different BMI groups no effect. However, different BMI groups had a significant effect as a moderator variable on the relationship between AT ($t = -3.012$, $p = 0.003 < 0.01$), SN ($t = -2.678$, $p = 0.008 < 0.01$), and BSC ($t = -4.485$, $p = 0.001 < 0.01$) toward the BI. Therefore, different BMI groups have significant moderating effects from AT, SN, and BSC to BI.

5 Discussion

This study investigated the relationship between BSCs and BI toward eating disorders among Chinese female university students using the extended TRA model, with a specific focus on the moderating role of BMI. The results reveal several key findings: (1) Impact of BSCs: BSCs positively influence ATs, SNs, and BIs related to eating disorders among

Chinese female university students; (2) Role of ATs and SNs: Both ATs and SNs are positively associated with BIs in this demographic; (3) Moderating Effect of BMI: BMI significantly moderates the relationships between BSCs, ATs, SNs, and BIs. Additionally, the study found significant correlations between age, parents' educational status, family income, and parents' marital status with BSC, AT, SN, and BI.

These findings align with prior research indicating that BMI and BSCs are significant risk factors for eating disorders globally (2, 4, 7, 8, 11, 40). However, our findings also extend previous knowledge by emphasizing the moderating role of BMI in these relationships, highlighting nuanced interactions between BSCs and BIs. In China, the prevalence of eating disorder behaviors is notably high across different BMI categories, with detrimental effects on both physical and mental health (7, 8). These results corroborate earlier studies suggesting that BSCs increase the risk of eating disorders and associated conditions, such as cardiovascular disease (23) and mental health issues (3, 4, 11).

The study also supports the notion that high BSC is associated with various eating disorders, including binge eating disorder, bulimia, and anorexia (47, 21). For instance, individuals with low weight status driven by BSCs may develop anorexia (11, 47, 9, 10), while those in the obesity range may experience heightened appearance anxiety and social anxiety disorders (1, 3, 41, 42). Importantly, our study highlights the differential impacts of BS across BMI levels, reinforcing the need for tailored intervention strategies that consider BMI-specific dynamics in addressing disordered eating intentions.

The study underscores the interconnectedness of BSC, AT, SN, and BI regarding eating disorders. Individual differences were evident across BMI categories, parental educational levels, and family income groups of young female university students in China (7, 8). For instance, students from families with higher educational backgrounds showed different patterns of BSCs compared to those from less educated families (3, 8, 19). Similarly, family income levels appeared to moderate the relationship between BSCs and eating disorder intentions, though these effects varied considerably among individuals (8). However, the strength and nature of these relationships showed considerable individual variation, particularly across different BMI categories (7). Students with higher BMI demonstrated distinct patterns of BSCs and BIs compared to those with lower BMI, suggesting the need for tailored intervention approaches (7, 43).

Notably, this study addresses a gap in the literature, as there is limited research applying the extended TRA model to analyze BSC in predicting eating disorder BIs (17). Previous studies have primarily examined the general applicability of the TRA model, whereas our study provides a more targeted extension by incorporating BSC and BMI-specific moderating effects. Research has demonstrated that personal BIs significantly influence ATs, and that personal BIs and SNs are correlated (3, 19, 20, 44, 45). In China, the growing concern among young females about BSC is well-documented (47), and BMI exacerbates the thin ideal, impacting physical health (47). Conversely, high BMI or obesity is linked to an increased risk of cardiovascular disease (23) and mental health disorders (8, 46).

This study does have limitations. While our sample included students from various backgrounds, the homogeneity of the university setting may not fully capture the range of individual differences present in the broader population. The analysis of individual variations was limited by the focus on BMI as the primary moderating variable, potentially overlooking other important personal characteristics that could influence eating disorder behaviors. The reliance on self-reported data from Chinese female university students introduces potential bias and inaccuracies due to recall and self-reporting issues. Individual differences in self-perception and reporting accuracy could affect the reliability of the measurements. Future research should aim to expand the sample size and include a more diverse population to enhance representativeness and reliability. Moreover, integrating objective measures such as biomarkers or physiological data could provide more robust insights into the mechanisms driving these relationships. Despite these limitations, the study offers valuable insights into the relationship between BSC and eating disorder BIs, highlighting the need for targeted interventions. Future research should not only explore a broader range of individual differences and psychological factors such as media influences, self-esteem, personality traits, cultural background, and stress but also adopt longitudinal designs to uncover causal pathways and temporal dynamics of these associations.

6 Conclusion

The study underscores the interconnectedness of BSC, AT, SN, and BI regarding eating disorders. The findings highlight significant individual variations in these relationships, suggesting that one-size-fits-all approaches to eating disorder prevention may be insufficient. The findings contribute to the existing literature by highlighting the moderating role of BMI in these relationships, offering a more nuanced understanding of the factors influencing eating disorder intentions. The distinct impacts observed across different individual characteristics underscore the importance of personalized intervention strategies. Future research and clinical practice should consider these individual differences when developing prevention and treatment programs. For young female university students in China, BSC significantly influences their AT, SN, and BI. Furthermore, the distinct impacts of BMI underscore the importance of personalized intervention strategies tailored to individuals with varying BMI levels. Future research should explore additional variables and control factors to develop comprehensive prevention and treatment strategies, ultimately contributing to the improved mental and physical health of various demographic groups. By extending the TRA model to include BSC and BMI, this study provides a valuable framework for future investigations into eating disorders and related interventions, while emphasizing the need to account for individual variations in risk factors and treatment responses.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Nanjing Institute of Technology. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JingyZ: Data curation, Formal analysis, Software, Writing – original draft, Writing – review & editing, Conceptualization, Validation, Visualization. JingZ: Writing – review & editing, Investigation. HY: Validation, Visualization, Writing – review & editing, Resources. ZG: Writing – review & editing, Supervision, Formal analysis, Methodology.

Funding

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

Conflict of interest

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

Publisher's note

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

References

1. Aune T, Nordahl HM, Beidel DC. Social anxiety disorder in adolescents: prevalence and subtypes in the young-HUNT3 study. *J Anxiety Disord*. (2022) 87:102546. doi: 10.1016/j.janxdis.2022.102546

2. Hughes EK, Kerr JA, Patton GC, Sawyer SM, Wake M, Le Grange D, et al. Eating disorder symptoms across the weight spectrum in Australian adolescents. *Int J Eat Disord*. (2019) 52:885–94. doi: 10.1002/eat.23118

3. Jang HW, Cho M. The relationship between ugly food value and consumers' behavioral intentions: application of the theory of reasoned action. *J Hosp Tour Manag*. (2022) 50:259–66. doi: 10.1016/j.jhtm.2022.02.009

4. Trompeter N, Austen E, Bussey K, Reilly EE, Cunningham ML, Mond J, et al. Examination of bidirectional relationships between fear of negative evaluation and weight/shape concerns over 3 years: a longitudinal cohort study of Australian adolescents. *Int J Eat Disord*. (2023) 56:646–53. doi: 10.1002/eat.23881

5. Fehm L, Beesdo K, Jacobi F, Fiedler A. Social anxiety disorder above and below the diagnostic threshold: prevalence, comorbidity and impairment in the general population. *Soc Psychiatry Psychiatr Epidemiol*. (2008) 43:257–65. doi: 10.1007/s00127-007-0299-4

6. Griffiths S, Murray SB, Bentley C, Gratwick-Sarll K, Harrison C, Mond JM. Sex differences in quality of life impairment associated with body dissatisfaction in adolescents. *J Adolesc Health*. (2017) 61:77–82. doi: 10.1016/j.jadohealth.2017.01.016

7. Gao Z, Zhao J, Peng S, Yuan H. The relationship and effects of self-esteem and body shape on eating disorder behavior: a cross-sectional survey of Chinese university students. *Healthcare*. (2024) 12:1034. doi: 10.3390/healthcare12101034

8. Zeng G, Tajuddin A, Zamri A, Md K. Eating disorders behaviour and body shape, self-esteem, body mass index level relationship in China. *Int J Acad Res Prog Educ Develop*. (2022) 11:606–14. doi: 10.6007/IJARPED/v11-i1/12123

9. DeBoer L, Medina JL, Davis ML, Presnell KE, Powers MB, Smits JA. Associations between fear of negative evaluation and eating pathology during intervention and 12-month follow-up. *Cogn Ther Res*. (2013) 37:941–52. doi: 10.1007/s10608-013-9547-y

10. Maraldo TM, Zhou W, Dowling J, Vander Wal JS. Replication and extension of the dual pathway model of disordered eating: the role of fear of negative evaluation, suggestibility, rumination, and self-compassion. *Eat Behav*. (2016) 23:187–94. doi: 10.1016/j.eatbeh.2016.10.008

11. Stice E, Van Ryzin MJ. A prospective test of the temporal sequencing of risk factor emergence in the dual pathway model of eating disorders. *J Abnorm Psychol*. (2019) 128:119–28. doi: 10.1037/abn0000400

12. Gupta N, Bhargava R, Chavan B, Sharan P. Eating attitudes and body shape concerns among medical students in Chandigarh. *Indian J Soc. Psych*. (2017) 33:219–24. doi: 10.4103/0971-9962.214605

13. Pétré B, Scheen AJ, Ziegler O, Donneau AF, Dardenne N, Husson E, et al. Body image discrepancy and subjective norm as mediators and moderators of the relationship between body mass index and quality of life. *Patient Prefer Adherence*. (2016) 10:2261–70. doi: 10.2147/PPA.S112639

14. Wang F. (2018). Predicting healthy eating behavior: Examination of attitude, subjective norms, and perceived behavioral control factors. Bowling Green State University. Available at: http://rave.ohiolink.edu/etdc/view?acc_num=bgsu1522766244319902

15. Merino M, Tornero-Aguilera JF, Rubio-Zarapuz A, Villanueva-Tobaldo CV, Martín-Rodríguez A, Clemente-Suárez VJ. Body perceptions and psychological well-being: a review of the impact of social media and physical measurements on self-esteem and mental health with a focus on body image satisfaction and its relationship with cultural and gender factors. *Healthcare*. (2024) 12:1396. doi: 10.3390/healthcare12141396

16. Xu J, Wang Y, Jiang Y. How do social media tourist images influence destination attitudes? Effects of social comparison and envy. *J Travel Tour Mark*. (2023) 40:310–25. doi: 10.1080/10548408.2023.2245410

17. Feishbein M., Arjzen I. (1980). The theory of reasoned action (TRA). Addison-Wesley.

18. Vallerand RJ, Deshaies P, Cuerrier JP, Pelletier LG, Mongeau C. Ajzen and Fishbein's theory of reasoned action as applied to moral behavior: a confirmatory analysis. *J Pers Soc Psychol*. (1992) 62:98–109. doi: 10.1037/0022-3514.62.1.98

19. Chiu TM, Ku BP. Moderating effects of voluntariness on the actual use of electronic health records for allied health professionals. *JMIR Med Inform*. (2015) 3:e7. doi: 10.2196/medinform.2548

20. Ali M, Raza SA, Puah CH. Factors affecting to select Islamic credit cards in Pakistan: the TRA model. *J Islam Market*. (2017) 8:330–44. doi: 10.1108/JIMA-06-2015-0043

21. Vankerckhoven L, Raemen L, Claes L, Eggermont S, Palmeroni N, Luyckx K. Identity formation, body image, and body-related symptoms: developmental trajectories and associations throughout adolescence. *J Youth Adolesc*. (2023) 52:651–69. doi: 10.1007/s10964-022-01717-y

22. Hong Y, Ullah R, Wang JB, Fu JF. Trends of obesity and overweight among children and adolescents in China. *WJP*. (2023) 19:1115–26. doi: 10.1007/s12519-023-00709-7

23. Wu T, Wei B, Song Y, Zhang XH, Yan YZ, Wang XP, et al. Predictive power of a body shape index and traditional anthropometric indicators for cardiovascular disease: a cohort study in rural Xinjiang, China. *Ann Hum Biol*. (2022) 49:27–34. doi: 10.1080/03014460.2022.2049874

24. Hale J. L., Householder B. J., Greene K. L. (2002). The theory of reasoned action. The persuasion handbook: Developments in theory and practice. London, United Kingdom: SAGE Publications. 14, 259–286.

25. Madden TJ, Ellen PS, Ajzen I. A comparison of the theory of planned behavior and the theory of reasoned action. *Personal Soc Psychol Bull*. (1992) 18:3–9. doi: 10.1177/0146167292181001

26. Sung J, Yan RN. Predicting clothing behaviors of generation Y men through self-esteem and body dissatisfaction. *Fash Text*. (2020) 7:1–14. doi: 10.1186/s40691-019-0200-6

27. Lindsey LLM. The influence of persuasive messages on healthy eating habits: a test of the theory of reasoned action when attitudes and subjective norm are targeted for change. *J Appl Biobehav Res*. (2017) 22:e12106. doi: 10.1111/jabr.12106

28. Ruhl H, Holub SC, Dolan EA. The reasoned/reactive model: a new approach to examining eating decisions among female college dieters and nondieters. *Eat Behav*. (2016) 23:33–40. doi: 10.1016/j.eatbeh.2016.07.011

29. Patel GH, Chitte SJ, Bhagat CA, Bhura PA. Correlation between transverse abdominis muscle endurance and body mass index among college students. *J Sci Soc*. (2022) 49:125–7. doi: 10.4103/jss.jss_40_22

30. Shin E. Pandemic fear and weight gain: effects on overweight and obese adults' purchasing exercise apparel online. *Cloth Text Res J*. (2021) 39:232–46. doi: 10.1177/0887302X211004892

31. Yang T, Druică E, Zhang Z, Hu Y, Cirella GT, Xie Y. Predictors of the behavioral intention to participate in Saiga Antelope conservation among Chinese young residents. *Diversity*. (2022) 14:411. doi: 10.3390/d14050411

32. Dubey P, Sahu KK. Students' perceived benefits, adoption intention and satisfaction to technology-enhanced learning: examining the relationships. *J Res Innov Teach Learn*. (2021) 14:310–28. doi: 10.1108/JRIT-01-2021-0008

33. Zeng G, Tajuddin A, Zamri A, Md K. Factor structure and construct validity of the Chinese version of the theory of planned behavior questionnaire (TPB-Q) for eating

disorders among university students. *Int J Acad Res Prog Educ Develop*. (2022) 11:749–62. doi: 10.6007/IJARPED/v11-i2/12319

34. Upadhyaya S. (2018). Detection of eating disorders among young women: Implications for development communication. Bowling Green State University. Available at: http://rave.ohiolink.edu/etdc/view?acc_num=bgsu1521261916063295

35. Liao Y, Knoesen NP, Deng Y, Tang J, Castle DJ, Bookun R, et al. Body dysmorphic disorder, social anxiety and depressive symptoms in Chinese medical students. *Soc Psychiatry Psychiatr Epidemiol*. (2010) 45:963–71. doi: 10.1007/s00127-009-0139-9

36. Evans C, Dolan B. Body shape questionnaire: derivation of shortened "alternate forms". *Int J Eat Disord*. (1993) 13:315–21. doi: 10.1002/1098-108X(199304)13:3<315::AID-EAT2260130310>3.0.CO;2-3

37. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res*. (1981) 18:39–50. doi: 10.1177/002224378101800104

38. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate data analysis: Pearson College division. London, UK: Person (2010).

39. Malhotra NK. Marketing research: an applied prientation. Pearson (2020).

40. Taylor BC. Weight and shape concern and body image as risk factors for eating disorders In: T Wade, editor. Encyclopedia of Feeding and Eating Disorders. Singapore: Springer (2016). 1–5.

41. Barbeau K, Boileau K, Pelletier L. Motivational pathways involved in women's intentions to engage in healthy and disordered eating behavior following a body-related discrepancy. *Motiv Emot*. (2023) 47:928–45. doi: 10.1007/s11031-023-10037-y

42. Crawford R. (2022). A cultural account of "health": control, release, and the social body. In Issues in the political economy of health care. Routledge. (pp. 60–104). Available at: https://www.taylorfrancis.com/chapters/edit/10.4324/9781003284857-3/cultural-account-health-robert-crawford

43. Annesi J. J. (2024). Early effects of body satisfaction on emotional eating: tailored treatment impacts via psychosocial mediators in women with obesity. *Behav Med*. (Washington, D.C.), 50, 91–97. doi: 10.1080/08964289.2023.2174065

44. Almajali DA, Masa'Deh R'E, Dahalin Z. Factors influencing the adoption of cryptocurrency in Jordan: an application of the extended TRA model. *Soc Sci*. (2022) 8:2103901. doi: 10.1080/23311886.2022.2103901

45. Taylor D, Bury M, Campling N, Carter S, Garfied S, Newbould J, et al. (2006). A review of the use of the health belief model (HBM), the theory of reasoned action (TRA), the theory of planned behaviour (TPB) and the trans-theoretical model (TTM) to study and predict health related behaviour change. London, UK: National Institute for Health and Clinical Excellence, 1–215.

46. Simona FP, Elisabeta RL, Cristian RM. Relation between body shape and body mass index. *Procedia Soc Behav Sci*. (2015) 197:1458–63. doi: 10.1016/j.sbspro.2015.07.095

47. Zhang L, Qian H, Fu H. To be thin but not healthy-The body-image dilemma may affect health among female university students in China. *PloS one*. (2018) 13:e0205282. doi: 10.1371/journal.pone.0205282

48. Wang J, Hao QH, Peng W, Tu Y, Zhang L, Zhu TM. Relationship between smartphone addiction and eating disorders and lifestyle among Chinese college students. *Front Public Health*. (2023) 11:1111477. doi: 10.3389/fpubh.2023.1111477

frontiers | Frontiers in Nutrition

TYPE Original Research
PUBLISHED 23 January 2025
DOI 10.3389/fnut.2024.1491544

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
Jose Antonio López-Pina,
University of Murcia, Spain
Wiktoria Staśkiewicz-Bartecka,
Medical University of Silesia, Poland

*CORRESPONDENCE
Hanqing Zhang
✉ 19110420301@163.com

†These authors have contributed equally to this work and share first authorship

RECEIVED 05 September 2024
ACCEPTED 27 December 2024
PUBLISHED 23 January 2025

CITATION
Sun X, Lu Y, Jian C and Zhang H (2025) Cross-cultural adaptation and psychometric properties of the Chinese version of the Orthorexia Nervosa Inventory.
Front. Nutr. 11:1491544.
doi: 10.3389/fnut.2024.1491544

Cross-cultural adaptation and psychometric properties of the Chinese version of the Orthorexia Nervosa Inventory

Xinzhang Sun[1†], Ying Lu[2†], Chengping Jian[3] and Hanqing Zhang[1,4*]

[1]Health Science Center, Yangtze University, Jingzhou, Hubei, China, [2]Department of Nursing, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, China, [3]Department of Nursing, Sixth Affiliated Hospital of Kunming Medical University, Yuxi, Yunnan, China, [4]Faculty of Public Health, Mahidol University, Bangkok, Thailand

Background: Orthorexia nervosa refers to an unhealthy preoccupation with maintaining a perfect diet, which is marked by highly restrictive eating habits, rigid food rituals, and the avoidance of foods perceived as unhealthy or impure. In recent years, the Orthorexia Nervosa Inventory (ONI) has gained recognition as a promising tool for assessing orthorexia tendencies and behaviors, addressing the limitations of existing ON-specific measures. This study aimed to evaluate the psychometric properties of the Chinese version of the ONI.

Methods: A total of 717 participants (Mage = 20.11 years, 78.66% female) completed the Orthorexia Nervosa Inventory (ONI) alongside the Chinese version of the Düsseldorf Orthorexia Scale (C-DOS). The ONI was translated into Chinese using the Brislin traditional translation model, following formal authorization from the original author. This translation process included literal translation, back translation, and cultural adaptation to ensure both linguistic and contextual fidelity. Item analysis was employed to assess item differentiation. Scale reliability was determined by measuring internal consistency. Furthermore, exploratory and confirmatory factor analyses were conducted to investigate and confirm the underlying factor structure and overall validity of the scale.

Results: The Chinese version of the Orthorexia Nervosa Inventory (ONI) consists of 24 items across three dimensions. The overall Cronbach's alpha coefficient for the scale was 0.956, indicating excellent internal consistency. The Cronbach's alpha coefficients for the individual dimensions were 0.894, 0.933, and 0.848, respectively, demonstrating high reliability for each dimension. Additionally, McDonald's ω was 0.957 for the entire scale, reflecting strong stability in internal consistency, with individual dimensions having McDonald's ω coefficients of 0.895, 0.934, and 0.854. The Spearman-Brown split-half reliability coefficient was 0.931, and McDonald's ω for the split-half reliability was also 0.931, indicating excellent consistency across the scale's two halves. The test–retest reliability was 0.987, with a 95% confidence interval ranging from 0.978 to 0.993, suggesting excellent stability over time and strong consistency across different measurement points. All model fit indices fell within acceptable ranges, affirming the structural validity of the Chinese version. The results from both exploratory and confirmatory factor analyses further supported this conclusion.

Conclusion: This study successfully translated and culturally adapted the ONI into Chinese, followed by a comprehensive evaluation of its psychometric properties. The findings demonstrate that the Chinese version of the ONI

possesses strong reliability and validity. In the context of varying cultural backgrounds and dietary habits, this scale serves as a valid tool for assessing and screening the Chinese ON population.

KEYWORDS

orthorexia, psychometric properties, eating disorders, factor analysis, scale

1 Introduction

Orthorexia is originated from Greek *ortho* created by Bratman (1) and means correct appetite (2). Orthorexia Nervosa (ON) is an eating disorder which describes people engaging in extreme diet patterns for health, the main characteristics are the compulsive thinking and obsessive behavior for "healthy food." During a 2022 consensus meeting attended by 47 eating disorders experts from 14 different countries, Orthorexia Nervosa (ON) was classified as a mental health disorder that is closely aligned with the DSM-5 category of 'Feeding and Eating Disorders' (F&ED) (3). The excessive focus on food quality and pursuit of "purity of food" may lead to the development of certain forms of eating disorders with harmful and counter-productive result. Studies find that ON may lead to some adverse outcomes like malnutrition and/or social dysfunction (1). Dieters with ON may experience nutritional deficiency result from ignoring the diversity of food groups, long term dietary restriction develop symptoms similar to severe anorexia such as osteopenia, anemia, hyponatremia, metabolic acidosis, pancytopenia, testosterone deficiency, and bradycardia (4, 5).

At present, ON has no widely accepted official definition and is not listed in official ICD-11 or DSM-V (2). Though, there're amount of diagnostic criteria for ON have been proposed (3), most of them are criticized by researchers or have not been verified. As a result, there's no standardized diagnostic criteria and treatment regime. The diagnostic criteria, classification, and underlying mechanisms of ON are still under discussion. At present, the possible treatment for ON is based on MTD model consisted of pharmacy, cognitive behavioral and nutritional intervention (5–7). In order to find reliable diagnostic criteria, researchers have developed many tools for ON measurement or diagnosis. For example, Orthorexia Self-Test (BOT) developed by Bratman and Knight (8) is widely used to diagnose ON, however, it's criticized for the invalid psychometric characteristics. ORTO-15 was designed by Donini et al. (9) and translated into multiple language version (10–12) as a diagnostic tool for ON, while it was questioned for limitation like no clear validation of the tool, no standardization methods, and an excessive percentage of ON; Eating Habits Questionnaire (EHQ) developed by Gravers (13), though with high integrity, there's controversy for its factor structure. Other scales are not widely applied yet, the quality and the validity need verification. On the other hand, content most of scales focus on knowledge, behaviors or emotions, however, physical impairments caused by ON are ignored, which are very important for clinic.

Orthorexia Nervosa Inventory (ONI) is developed by Oberle et al. (14) in 2020 which is a self-report questionnaire consisted of three dimensions: behaviors and preoccupation with healthy eating; physical and psychosocial impairments; and emotional distress, with a total of 24 items. The initial study reported the strong internal consistency level (total Cronbach $a = 0.94$, subscale Cronbach $a > 0.86$) and retest reliability ($r > 0.86$). What's more, ONI is the first tool to assess physical impairment by ON, which had proved to be key factors of ON (14).

At present, the validity of the English version of ONI has been verified, but it has not been translated into Chinese version and applied to Chinese patients. Therefore, the purpose of this study is to translate the English version of ONI into Chinese and to examine the psychometric properties of the Chinese version of the ONI. By investigating its reliability, factor structure, and validity. Meanwhile In order to evaluate the criterion validity of the ONI, the Chinese version of the 10-item Düsseldorf Orthorexia Scale (C-DOS) was employed.

2 Methods

2.1 Original ONI

The ONI (14) is a self-report instrument comprising 24 items, designed to assess three latent dimensions: behaviors and fixation on healthy eating, physical and psychosocial impairments, and emotional distress. Respondents rate each item on a 4-point scale, where 1 indicates 'not at all' and 4 indicates 'very '. Scale scores are derived by summing the items corresponding to each dimension, and an overall score is calculated by summing all item scores. The total score ranges from 24 to 96, with higher scores reflecting more pronounced orthorexia symptomatology.

2.2 Translation and culture adaption

After obtaining permission from the original authors of the Orthorexia Nervosa Inventory (ONI) to translate and contextually modify the questionnaire, we carefully adhered to prescribed guidelines throughout the process. A comprehensive forward- and back-translation process was employed to ensure accuracy and cultural relevance. The translation and cross-cultural adaptation were rigorously executed in strict accordance with the Brislin translation model, culminating in the creation of a Chinese version of the ONI (15, 16). The specific procedure involved several detailed steps.

2.2.1 Forward translation

The original English version of the scale was independently translated into Chinese by two bilingual researchers on our team, both of whom are native Chinese speakers. These initial translations, labeled T1 and T2, were carefully reviewed and compared by the research team. Through in-depth discussions, any discrepancies were resolved, leading to the integration of these versions into a preliminary draft, designated as T3.

2.2.2 Back translation

To ensure the accuracy of the translation, T3 was independently back-translated into English by two bilingual native English speakers who were unfamiliar with the original scale. These back-translations, referred to as E1 and E2, were synthesized into a single English version, ET3. This version was then sent to the original authors of the scale for feedback.

Based on their input and further deliberations within the research team, the first finalized Chinese version, labeled C1, was produced.

2.2.3 Cross-culture validation

In October 2023, the Chinese version C1 underwent a rigorous cultural adaptation process utilizing the Delphi method. A panel of seven experts in eating disorders—each holding an associate senior professional title, a master's degree or higher, and over 15 years of professional experience—was convened. These experts evaluated the context, cultural relevance, and linguistic expression of the C1 items based on their clinical experience and theoretical knowledge, while also referencing the original scale. Following their review, the research team made the necessary adjustments to the questionnaire based on the experts' feedback, resulting in the development of the revised Chinese version, C2.

2.3 Participants

Data for this study were gathered through an online questionnaire administered between March and May 2024. To guarantee the dependability of the analysis outcomes, the sample size for Exploratory Factor Analysis (EFA) should include a minimum of 120 cases, while Confirmatory Factor Analysis (CFA) requires at least 200 cases. This recommendation follows the guideline that the sample size should be 5–10 times greater than the number of variables (17). And considering a sample loss rate of 20% (18), the total sample size should be at least 384.

After receiving a detailed explanation of the study's objectives and procedures, participants provided informed consent before voluntarily completing the survey. Importantly, no incentives were offered, ensuring genuine participation. The introductory page of the questionnaire provided a thorough overview of the study, explicitly informing respondents of their right to withdraw at any point by choosing not to submit their responses. Each survey session was designed to be brief, lasting approximately 10 min, with strict measures taken to guarantee complete anonymity; no personally identifiable information was collected. The study targeted adults who met specific criteria: participants were required to be of legal age (18 years or older), native speakers of Mandarin Chinese, and willing to provide informed consent. Those with visual or cognitive impairments that hindered their ability to complete the survey were excluded from the study.

2.4 Statistical software

For data entry and analysis, SPSS version 25.0, JAMOVI 2.3.28 and AMOS version 23.0 were utilized. Before the data analysis, we manually deleted the incomplete data.

2.5 Reliability analysis

Reliability serves as a key indicator of the accuracy and consistency of a measurement instrument in capturing the true characteristics of the variables being measured. It reflects the extent to which the measurement tool consistently produces stable and dependable results over repeated trials. In essence, high reliability indicates that the instrument reliably measures the intended variables with minimal error, ensuring that the observed results are a true representation of the measured object or variable. The greater the consistency in test outcomes, the lower the measurement error, and consequently, the higher the reliability of the instrument (19).

2.5.1 Cronbach's alpha

Cronbach's alpha coefficient was computed to evaluate the internal consistency of the scale. A value of $\alpha > 0.70$ was considered acceptable for demonstrating reliability, indicating that the items within each dimension were sufficiently correlated (20).

2.5.2 Omega coefficient

In addition to Cronbach's alpha, the omega coefficient was calculated to provide a more accurate assessment of internal consistency. The omega coefficient is particularly useful when the scale is multidimensional, as it accounts for inter-dimensional variability.

2.5.3 Standard error of measurement (SEM)

The Standard Error of Measurement (SEM) was calculated to estimate the precision of the scale's scores. SEM reflects the amount of error in measurement and was calculated using the formula: $SEM = \sigma 1 - \alpha$, where σ is the standard deviation of scores and α is the Cronbach's alpha coefficient. Lower SEM values indicate greater precision and reliability of the scale.

2.5.4 Split-half reliability

Split-half reliability was used to assess the internal consistency of the scale by dividing the items into two equal halves and comparing the scores from each half. The Spearman-Brown prophecy formula was applied to adjust for the fact that the split version uses only half the items, providing a reliability estimate for the full scale. A split-half reliability coefficient greater than 0.70 indicates good internal consistency.

2.5.5 Test–retest reliability

Test–retest reliability of the scale was calculated using the intraclass correlation coefficient. To examine the stability of the scale over time, a test–retest reliability analysis was conducted. A subset of participants completed the scale twice, with a 2-week interval between administrations. The Pearson correlation coefficient was used to assess the strength of the relationship between the two sets of scores. A correlation greater than 0.70 was considered indicative of good stability.

2.6 Validity analysis

Several methods were employed to assess the validity of the adapted scale, ensuring that it accurately measures the intended construct and can discriminate between relevant groups.

2.6.1 Independent samples t-test

To assess the discriminant validity, an Independent Samples t-Test was performed to compare scores between groups with different levels of the target construct. Significant differences ($p < 0.05$) would provide evidence for the scale's ability to discriminate between relevant groups.

2.6.2 Criterion validity

In order to evaluate the criterion validity of the ONI, the C-DOS was employed (21). The C-DOS demonstrated good internal consistency, with an ordinal alpha of 0.80, and solid test–retest reliability, with a coefficient of 0.77. The scale items are rated on a 4-point scale, ranging from 1 ("this does not apply to me") to 4 ("this

applies to me"), yielding total scores ranging from 10 to 40. Higher scores indicate more severe orthorexia symptoms.

2.6.3 Exploratory factor analysis (EFA)

Exploratory Factor Analysis (EFA) was performed to explore the underlying structure of the scale. This analysis helped identify the number of factors and the items that loaded onto each factor. Principal Axis Factoring (PAF) was used for factor extraction.

2.6.4 Confirmatory factor analysis (CFA)

This study employed Confirmatory Factor Analysis (CFA) to examine the factor structure of the scale and to validate the model proposed by the Exploratory Factor Analysis (EFA). CFA is a structural equation modeling (SEM) technique used to assess the fit between the data and a theoretical model. By using CFA, the construct validity of the scale was tested, the relationships between latent variables and observed variables were clarified, and the overall model fit indices χ^2/df, RMR, CFI, RMSEA, GFI, AGFI were evaluated.

2.7 Item analysis

Item analysis was conducted to evaluate the performance of individual items within the scale and to identify problematic items that may need modification (27).

2.7.1 Item-total correlation

Item-total correlation was calculated to assess the relationship between each item and the total scale score, excluding the item itself. Items with a correlation greater than 0.30 were considered to contribute well to the overall scale, while items with lower correlations were flagged for potential revision.

2.7.2 Item response theory (IRT)

Graded Response Model (GRM) is employed to conduct Item Characteristic Curve (ICC) analyses for each item of the scale, aiming to evaluate the applicability and discrimination of each rating category across varying ability levels.

3 Results

3.1 Demographics

In this study, 720 questionnaires were distributed, and 717 were successfully retrieved, yielding an effective response rate of 99.72%. 153 of them (21.34%) were male and 564 (78.66%) were female. Average scale score is 72.063 ± 14.677. The demographic information collected includes age, sex, marital status, education level, residence and BMI. Additional social demographic details are presented in Table 1.

3.2 Scale translation and cross-cultural adaptation

In accordance with the linguistic and cultural nuances of China, the initial draft of the Chinese version was carefully reviewed and adjusted, considering semantics, idiomatic expressions, and cultural concepts.

TABLE 1 Independent samples t-test results for gender.

		Statistic	df	*p*
Total score	Student's t	2.51[a]	712	0.012
	Welch's t	2.32	217	0.021

$H_a\ \mu_{male} \neq \mu_{female}$.
[a]Levene's test is significant ($p < 0.05$), suggesting a violation of the assumption of equal variances.

First, the original scale was translated from English to Chinese using forward translation. Subsequently, the instruments were translated into English. Finally, the authors scrutinized the phraseology of both the English and Chinese versions and compared them with the original English version, with the objective of identifying uncertainties and correct inconsistencies. Both researchers and linguists approved the Chinese version of the study prior to the research.

3.3 Reliability

3.3.1 Cronbach's alpha and omega coefficient

Cronbach'α coefficients for each dimension and total scale were calculated, all dimensions showed good reliability with Cronbach's $\alpha = 0.894$ and McDonald's $\omega = 0.895$ (Dimension1); Cronbach's $\alpha = 0.933$ and McDonald's $\omega = 0.934$ (Dimension 2); Cronbach's $\alpha = 0.848$ and McDonald's $\omega = 0.854$ (Dimension 3), and the total scale also shows excellent reliability with Cronbach's $\alpha = 0.956$ and McDonald's $\omega = 0.957$.

3.3.2 SEM

According to the formula SEM = SD × $\sqrt{(1-\alpha)}$, we obtain SEM of 3.08. The scale consists of 24 items presented in a 4-point Likert-type format. For a scale with a total score of 96, an SEM of 3.08 represents a measurement error of approximately 3.21%. This is considered a relatively ideal value, indicating that the measurement error is acceptable.

3.3.3 Split-half reliability

Value of Spearman-Brown split-half reliability coefficient is 0.931, which indicates the high consistency across different parts of scale and shows the good reliability.

3.3.4 Test–retest reliability

The test–retest reliability for DOS scores was found to be 0.987. 95% CI from 0.978 to 0.993.

3.4 Validity

3.4.1 Independent samples t-test

In order to learn about the influence of socio-demographic variables, we made the independent samples t-test and found that the gender and medical education background had significant impact on result ($p < 0.05$) while BMI did not (Tables 1–3).

3.4.2 Criterion validity

C-DOS was used to analyze criterion validity of C-ONI and the total score of C-ONI and C-DOS was positively correlated ($r = 0.87$, $p < 0.001$).

3.4.3 EFA

The KMO value is 0.949, >0.6, satisfied with the requirement of factor analysis suggesting that the factor analysis can be used for data. Bartlett's test of sphericity also showed the data is suit for factor analysis ($p < 0.05$). The Principal Axis Factoring method was adopted in combination with Promax rotation. The results indicated that the 24 measurement items were distributed across three latent factors, with significant factor loadings explaining the primary variance structure of each variable. The key findings are summarized as follows: Factor 1 is primarily defined by significant loadings from items Q3, Q4, Q5, Q7, Q10, Q12, Q13, Q14, Q16, Q19, and Q24 (factor loadings ranging from 0.730 to 0.852); Factor 2 is characterized by significant loadings from items Q2, Q6, Q8, Q11, Q15, Q17, Q18, and Q22 (factor loadings ranging from 0.672 to 0.818); Factor 3 is mainly defined by significant loadings from items Q1, Q9, Q20, Q21, and Q23 (factor loadings ranging from 0.677 to 0.831). The factor loading for each item is shown in Figure 1.

TABLE 2 Independent samples t-test results for medical education background.

		Statistic	Df	*p*
Total score	Student's t	3.13[a]	712	0.002
	Welch's t	2.67	87.2	0.009

H_a $\mu_1 \neq \mu_2$.
[a]Levene's test is significant ($p < 0.05$), suggesting a violation of the assumption of equal variances.
*μ_1 represents individuals without a medical background, while μ_2 represents individuals with a medical background.

TABLE 3 Correlation matrix for ONI total scores and BMI.

		Total score	BMI
Total score	Pearson's *r*	—	
	Df	—	
	p-value	—	
BMI	Pearson's *r*	0.028	—
	Df	712	—
	p-value	0.461	—

3.4.4 Confirmatory factor analysis

The model was constructed using Amos 23.0 software, and confirmatory factor analysis (CFA) was conducted on the survey data to derive the structural equation model, as illustrated in Figure 2.

The goodness-of-fit indices for the models are presented in Table 3. In conclusion, the Chinese version of the ONI demonstrates good structural validity.

3.5 Item analysis

The purpose of item analysis is to determine whether the items in the questionnaire or scale are valid and appropriate.

3.5.1 Item-total correlation

All items demonstrating correlations exceeding 0.5 and the majority approaching or surpassing 0.7, which indicates that most items significantly contribute to the overall construct of the scale, underscoring strong construct validity.

Exploratory Factor Analysis

Factor Loadings

	Factor			
	1	2	3	Uniqueness
Q1			0.698	0.553
Q2		0.672		0.569
Q3	0.760			0.403
Q4		0.767		0.381
Q5	0.826			0.384
Q6		0.696		0.501
Q7	0.767			0.428
Q8		0.734		0.416
Q9			0.797	0.343
Q10	0.847			0.287
Q11		0.785		0.440
Q12	0.844			0.291
Q13			0.808	0.308
Q14	0.837			0.321
Q15		0.762		0.441
Q16	0.852			0.265
Q17		0.708		0.396
Q18		0.818		0.375
Q19	0.730			0.399
Q20	0.808			0.316
Q21			0.831	0.309
Q22		0.742		0.392
Q23			0.677	0.513
Q24	0.830			0.291

Note. 'Principal axis factoring' extraction method was used in combination with a 'promax' rotation

FIGURE 1
Factor loadings of each item in the Chinese version ONI.

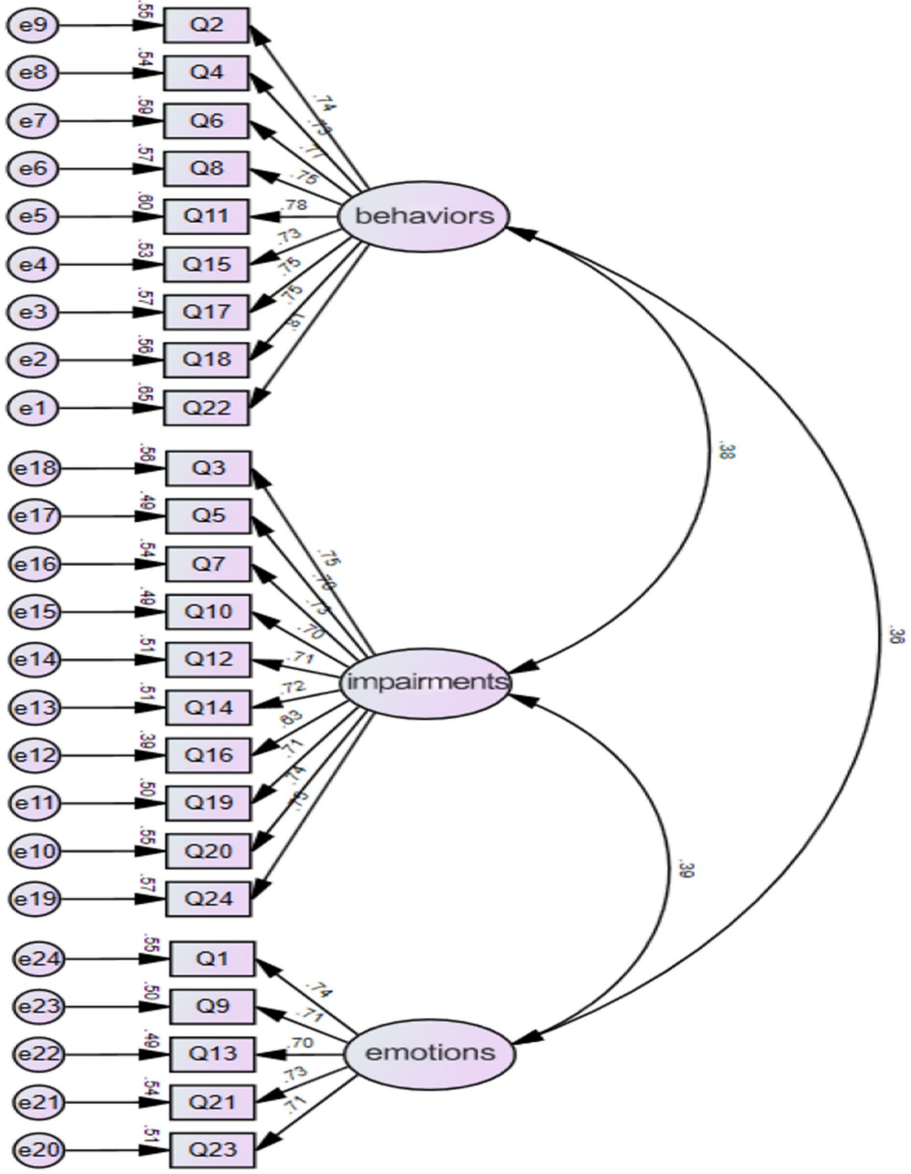


FIGURE 2
Standardized three-factor structural model of the Chinese version of the ONI (*N* = 428).

3.5.2 ICC analyses

All 24 ICC curves illustrate the probability of selecting different rating categories across the spectrum from low to high ability segments. Below is a detailed analysis of these curves.

3.5.2.1 Relationship between ability and selection probability

All 24 curves demonstrated that as participants' abilities increased, the probability of selecting higher rating categories (e.g., Category 3 and Category 4) progressively rose, while the probability of selecting lower rating categories (e.g., Category 1 and Category 2) decreased. This trend indicates that the scale exhibits strong ability discrimination, effectively distinguishing participants across different ability levels.

3.5.2.2 Smoothness and monotonicity of the curves

The majority of the curves displayed smooth and monotonically increasing transitions, aligning with GRM expectations. This indicates that the transitions between rating categories are logical and free from abrupt changes or plateau regions, thereby reinforcing the scale's measurement precision and reliability.

3.5.2.3 Thresholds and category spacing

The intersections of the curves were appropriately distributed, suggesting that the thresholds between rating categories are well-calibrated and can clearly differentiate each category. Notably, in the low and high ability intervals, the differences in the probability of selecting each rating category were substantial, reflecting the scale's excellent discrimination in these extreme ability segments.

3.5.2.4 Discrimination in the moderate ability range

However, within the moderate ability range (approximately around an ability value of 0), some curves exhibited relatively gradual transitions, particularly between Category 2 and Category 3, showing minimal differences in selection probabilities. This may hinder participants in the moderate ability range from distinctly differentiating these rating categories, potentially compromising measurement precision. This observation suggests that, while most curves meet expected standards, the discrimination within the moderate ability range may be insufficient and warrants further optimization.

3.5.2.5 Applicability of rating categories

Overall, the performance of all 24 curves indicates that the spacing between rating categories is appropriate, effectively reflecting varying levels of participants' abilities. Through GRM model fitting, we confirm that the scale's design aligns with expectations and provides high measurement precision across most ability segments.

3.5.2.6 Model fit

Following GRM analyses for all items, the scale demonstrated robust model fit. The transitions between categories were smooth, and there were no significant overlaps or issues in distinguishing rating categories.

In summary, the ICC curves of the scale exhibit optimal discrimination among rating categories, particularly within the extreme ability segments (low and high abilities), where the rating categories effectively differentiate participants with varying ability levels. Nonetheless, in the moderate ability range, some curves display gradual transitions and insufficient discrimination between categories, which may impact measurement precision in this segment.

4 Discussion

The present study aimed to investigate the psychometric properties of the ONI within a sample of Chinese respondents, providing valuable insights into its factorial structure, internal consistency, as well as its convergent and criterion validity.

Eating disorders manifest differently in different cultures and social preferences, and research has been conducted to support the idea that eating disorders manifest differently in Asian countries. More research is needed to investigate the cross-cultural validity of ON and how it manifests differently in different culture background (1, 22, 23). The development of C-ONI can help researchers investigate the different prevalence rates of ON across cultures and enhance the identification and screening of the disease.

4.1 The Chinese version of the scale has suitable reliability

This study assessed the reliability of the Chinese version of the ONI from different aspects, and most of them show the high reliability of the scale. Cronbach's α and Omega Coefficient of all dimensions and the whole scale suggest that the items across all dimensions are well-aligned and contribute effectively to the construction. Split-half reliability also showed the high consistence among different parts of the scale. Test–retest reliability indicates the stability of the scale over time and its consistency with the measured object, suggesting that the measurement results are highly reliable and suitable for long-term or repeated use.

Overall, the scale is highly reliable, with stable internal consistency across all dimensions and minimal impact from item deletions, confirming its suitability for measuring the intended construction.

4.2 The Chinese version of the scale has suitable validity

In this study, the validity of the scale was analyzed and assessed using both content validity and construct validity. Content validity measures how well the scale items align with the intended measurement objectives and requirements, while construct validity assesses the extent to which the scale's theoretical framework is reflected in the observed measurement outcomes (24). The I-CVI of the Chinese version ONI was between 0.857 and 1.000, and the S-CVI was 0.917, which was higher than the reference value of content validity and good content validity (25). Suitable for assessing the Chinese population.

To assess the construct validity of the Chinese scale, both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were employed. It is widely accepted that ideal structural validity should meet the following criteria: The exploratory factor analysis followed the criteria that (1) the extracted factors should collectively explain at least 40.00% of the total variance, and (2) each item should demonstrate a high factor loading (>0.400) on one factor while showing low loadings on other factors. The results indicated that Principal Axis Factoring (PAF) with Promax rotation was applied, and only items with individual factor loadings greater than 0.40 were retained. Ultimately, three common factors were extracted, which collectively accounted for a substantial portion of the variance. The factor loadings across the component matrix were all above 0.5 on their respective dimensions, demonstrating strong associations between items and their corresponding factors. Three common factors were ultimately extracted, collectively accounting for 61.100% of the total variance (26). The results of CFA showed that $\chi^2/df = 1.738$, RMSEA = 0.924, RMR = 0.027, CFI = 0.965, GFI = 0.924, AGFI = 0.908. Convergent validity refers to the size of the factor loading coefficient of the corresponding variable reflected by each item, which is mostly calculated by AVE and CR. The standardization of each variable in this study is greater than 0.7, the AVE value is greater than 0.5, and the CR value is greater than 0.8. Therefore, the convergent validity test of the research data in this article is qualified. On the other hand, Item-Total Correlation shows the existing item structure is well-supported and should be retained. Only items with relatively lower correlations may require minor refinement to enhance their effectiveness. Overall, the scale exhibits excellent construct validity, ensuring that the total score effectively encapsulates the intended measurement objectives.

5 Limitations

This study has several limitations. Firstly, we recruited a non-clinical sample, which may affect the generalizability of the findings. Future surveys will be conducted on a broader group of

people. Secondly the scale used in this study does not have a predefined diagnostic threshold, and therefore, ROC analysis cannot be performed. The scale is designed as a continuous measurement tool and is not intended for binary classification based on a fixed cutoff (i.e., distinguishing between positive and negative cases). Since ROC analysis requires calculating sensitivity and specificity at various thresholds, traditional ROC analysis is not applicable in the absence of a clear diagnostic threshold. The third point is, through calculation, we found that the floor effect of most items exceeded 20%, which is primarily attributed to differences in scale design and participants' ability levels, rather than a lack of item difficulty or discrimination. Therefore, we can confirm that the scale items are effective in terms of design and measurement properties. To reduce the floor effect, further adjustments to the scoring criteria or an increase in the number of items will be necessary in the future. In addition, the primary purpose of this study was the cultural adaptation of the scale. Therefore, during the collection of demographic data, a more diverse range of demographic information was not considered. As a result, only limited hypotheses regarding demographic variables were tested. In future applications of the scale, more in-depth research can be conducted.

6 Conclusion

This study concentrated on translating and culturally adapting the Orthorexia Nervosa Inventory (ONI) into Chinese, followed by a thorough evaluation of its psychometric properties. The findings demonstrate that the Chinese version of the ONI exhibits strong reliability and validity. In the context of diverse cultural backgrounds and dietary habits, this scale provides a reliable tool for assessing and screening the Chinese ON population. Additionally, it lays the groundwork for future intervention studies targeting this group.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon request.

Ethics statement

The studies involving humans were approved by Medical Ethics Committee of the Sixth Affiliated Hospital of Kunming Medical University (2024kmykdx6f024). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

XS: Data curation, Funding acquisition, Writing – original draft. YL: Software, Writing – original draft. CJ: Data curation, Writing – original draft. HZ: Formal analysis, Supervision, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This study was supported by Philosophy and Social Science Research Project of Hubei Provincial Department of Education in 2022 (22Y051).

Conflict of interest

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

Publisher's note

References

1. Dunn TM, Bratman S. On orthorexia nervosa: a review of the literature and proposed diagnostic criteria. *Eat Behav*. (2016) 21:11–7. doi: 10.1016/j.eatbeh.2015.12.006

2. Missbach B, Dunn TM, König JS. We need new tools to assess orthorexia nervosa. A commentary on "prevalence of orthorexia nervosa among college students based on Bratman's test and associated tendencies". *Appetite*. (2017) 108:521–4. doi: 10.1016/j.appet.2016.07.010

3. Donini LM, Barrada JR, Barthels F, Dunn TM, Babeau C, Brytek-Matera A, et al. A consensus document on definition and diagnostic criteria for orthorexia nervosa. *Eat Weight Disord*. (2022) 27:3695–711. doi: 10.1007/s40519-022-01512-5

4. Park SW, Kim JY, Go GJ, Jeon ES, Pyo HJ, Kwon YJ. Orthorexia nervosa with hyponatremia, subcutaneous emphysema, pneumomediastimum, pneumothorax, and pancytopenia. *Electrolyte Blood Press*. (2011) 9:32–7. doi: 10.5049/EBP.2011.9.1.32

5. Moroze RM, Dunn TM, Craig Holland J, Yager J, Weintraub P. Microthinking about micronutrients: a case of transition from obsessions about healthy eating to near-fatal "orthorexia nervosa" and proposed diagnostic criteria. *Psychosomatics*. (2015) 56:397–403. doi: 10.1016/j.psym.2014.03.003

6. Bartrina JA. Orthorexia or when a healthy diet becomes an obsession. *Arch Latinoam Nutr*. (2007) 57:313–5.

7. Barsky AJ, Ahern DK, Bauer MR, Nolido N, Orav EJ. A randomized trial of treatments for high-utilizing somatizing patients. *J Gen Intern Med*. (2013) 28:1396–404. doi: 10.1007/s11606-013-2392-6

8. Bratman S, Knight D. Health food junkies: orthorexia nervosa: overcoming the obsession with healthful eating. New York, USA: Harmony, (2004).

9. Donini LM, Marsili D, Graziani MP, Imbriale M, Cannella C. Orthorexia nervosa: validation of a diagnosis questionnaire. *Eat Weight Disord*. (2005) 10:e28–32. doi: 10.1007/BF03327537

10. Arusoğlu G, Kabakçi E, Köksal G, Merdol TK. Orthorexia nervosa and adaptation of ORTO-11 into Turkish. *Turk Psikiyatri Derg*. (2008) 19:283–91.

11. Brytek-Matera A, Krupa M, Poggiogalle E, Donini LM. Adaptation of the ORTHO-15 test to polish women and men. *Eat Weight Disord*. (2014) 19:69–76. doi: 10.1007/s40519-014-0100-0

12. Missbach B, Hinterbuchinger B, Dreiseitl V, Zellhofer S, Kurz C, König J. When eating right, is measured wrong! A validation and critical examination of the ORTO-15 questionnaire in German. *PLoS One*. (2015) 10:e0135772. doi: 10.1371/journal.pone.0135772

13. Gleaves DH, Graham EC, Ambwani S. Measuring "orthorexia": development of the eating habits questionnaire. *Int J Educ Psychol Assess*. (2013) 12:1–18.

14. Oberle CD, De Nadai AS, Madrid AL. Orthorexia nervosa inventory (ONI): development and validation of a new measure of orthorexic symptomatology. *Eat Weight Disord*. (2021) 26:609–22. doi: 10.1007/s40519-020-00896-6

15. Lopez GI, Figueroa M, Connor SE, Maliski SL. Translation barriers in conducting qualitative research with Spanish speakers. *Qual Health Res*. (2008) 18:1729–37. doi: 10.1177/1049732308325857

16. Li S, Hou S, Deng X, Chen S, Wang H, Tang L, et al. Reliability and validity assessment of the Chinese version of the intrahospital transport safety scale (IHTSS) in intensive care units. *BMC Nurs*. (2024) 23:296. doi: 10.1186/s12912-024-01906-z

17. du Q, Liu H, Yang C, Chen X, Zhang X. The development of a short Chinese version of the state-trait anxiety inventory. *Front Psych*. (2022) 13:854547. doi: 10.3389/fpsyt.2022.854547

18. Zheng C, Yang Z, Kong L, Gao Z, Lu T, Zhang H. Psychometric evaluation of the Chinese version of the elderly-constipation impact scale: a translation and validation study. *BMC Public Health*. (2023) 23:1345. doi: 10.1186/s12889-023-16231-4

19. Ahmed I, Ishtiaq S. Reliability and validity: importance in medical research. *J Pak Med Assoc*. (2021) 71:2401–6.

20. Alkhadim GS. Cronbach's alpha and semantic overlap between items: a proposed correction and tests of significance. *Front Psychol*. (2022) 13:815490. doi: 10.3389/fpsyg.2022.815490

21. He J, Ma H, Barthels F, Fan X. Psychometric properties of the Chinese version of the Düsseldorf orthorexia scale: prevalence and demographic correlates of orthorexia nervosa among Chinese university students. *Eat Weight Disord*. (2019) 24:453–63. doi: 10.1007/s40519-019-00656-1

22. Atchison AE, Zickgraf HF. Orthorexia nervosa and eating disorder behaviors: a systematic review of the literature. *Appetite*. (2022) 177:106134. doi: 10.1016/j.appet.2022.106134

23. Håman L, Barker-Ruchti N, Patriksson G, Lindgren EC. Orthorexia nervosa: an integrative literature review of a lifestyle syndrome. *Int J Qual Stud Health Wellbeing*. (2015) 10:26799. doi: 10.3402/qhw.v10.26799

24. Sim SS, Bourke-Taylor HM, Yu ML, Fossey E, Tirlea L. Cross-cultural validation of the Chinese version of the health promoting activities scale. *Am J Occup Ther*. (2022) 76:7606205080. doi: 10.5014/ajot.2022.049434

25. Sobral-Monteiro-Junior R, Coutinho LA, Rodrigues VD, Machado FSM, Soares WD, Oliva HNP, et al. Validity and reliability of SEIS-3: an instrument for subjective measuring of strength in older adults. *Methods X*. (2024) 12:102512. doi: 10.1016/j.mex.2023.102512

26. Kong L, Lu T, Zheng C, Zhang H. Psychometric evaluation of the Chinese version of the positive health behaviours scale for clinical nurses: a cross-sectional translation. *BMC Nurs*. (2023) 22:296. doi: 10.1186/s12912-023-01453-z

27. Ferketich S. Focus on psychometrics. Aspects of item analysis. *Res Nurs Health*. (1991) 14:165–8. doi: 10.1002/nur.4770140211

frontiers | Frontiers in Psychology

TYPE Case Report
PUBLISHED 14 March 2025
DOI 10.3389/fpsyg.2025.1537844

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
Emilio Gutierrez,
University of Santiago de Compostela, Spain
Octavian Vasiliu,
Dr. Carol Davila University Emergency Military Central Hospital, Romania
Ida Lysdahl Fahrenholtz,
University of Agder, Norway
Eirini Koidou,
Aristotle University of Thessaloniki, Greece

*CORRESPONDENCE
Szilvia Boros
✉ boros.szilvia1@sze.hu

RECEIVED 01 December 2024
ACCEPTED 18 February 2025
PUBLISHED 14 March 2025

CITATION
Kovács RE and Boros S (2025) Case Report: From disordered eating to an eating disorder—a case study of an orienteering athlete with anorexia nervosa and the shortcomings of the multidisciplinary approach.
Front. Psychol. 16:1537844.
doi: 10.3389/fpsyg.2025.1537844

Case Report: From disordered eating to an eating disorder—a case study of an orienteering athlete with anorexia nervosa and the shortcomings of the multidisciplinary approach

Réka Erika Kovács[1,2] and Szilvia Boros[3]*

[1]Doctoral School of Education, Faculty of Pedagogy and Psychology, Eötvös Loránd University, Budapest, Hungary, [2]National Institute for Sports Medicine, Budapest, Hungary, [3]Department of Health and Nursing Sciences, Faculty of Health and Sport Sciences Széchenyi István University, Győr, Hungary

This case study explores the transition from disordered eating (DE) to an eating disorder (ED) in a 23-year-old female orienteer. Despite her talent as an athlete, her eating habits and training practices led to significant health concerns. After following an ovo-lacto vegetarian diet for 3 years, she exhibited symptoms of DE, including low energy intake (1,200 kcal/day), low body weight (50.1 kg, BMI: 16.9), and amenorrhea. Her condition deteriorated over 2 years, resulting in a diagnosis of anorexia nervosa (AN) by February 2023. During the treatment process, the athlete utilized a multidisciplinary approach that included dietitians, psychologists, and physicians. Despite achieving some initial progress, including a slight increase in body weight and the return of menstruation in July 2022, her health declined after psychological consultations were halted, leading to a further decrease in body fat and persistent low serum iron levels. This case highlights the importance of continuous monitoring, timely intervention, and a coordinated multidisciplinary team in addressing DE and ED in athletes. It also highlights the significance of effective communication among healthcare professionals and the need for comprehensive treatment strategies that include psychological, nutritional, and medical support. This study highlights the significance of early detection, suitable intervention, and the prevention of long-term health complications, such as decreased bone density and cardiovascular issues, in athletes with DE and ED.

KEYWORDS

disordered eating, eating disorder, athlete, anorexia nervosa, multidisciplinary approach

Introduction

Adequate nutrient intake is essential for achieving optimal athletic performance (Holtzman and Ackerman, 2021; Jeukendrup, 2017). Individualized nutrition strategies, developed by dietitians and sports nutritionists, play a crucial role in health promotion, body composition optimization, performance enhancement, and postinjury recovery (Chatterton and Petrie, 2013; Martinsen and Sundgot-Borgen, 2013; Sundgot-Borgen and Torstveit, 2004). However, many athletes depend on unqualified sources—such as coaches, parents, or teammates—for nutrition advice. This can lead to unsupervised practices that increase the risk of disordered eating (DE) and eating disorders (ED) (Mancine et al., 2020).

The prevalence of DE and ED among athletes is rising and is notably higher compared to the general population (Ghazzawi et al., 2024; Martinsen and Sundgot-Borgen, 2013; Sundgot-Borgen and Torstveit, 2004). While it was once believed that only female atheletes suffer from DE and ED, it is now recognized that male counterparts can also be affected (Chatterton and Petrie, 2013). However, female athletes still exhibit a higher prevalence of these conditions (Hazzard et al., 2020; Cabre et al., 2022). Every sport discipline is affected, but those involving esthetics (dance, gymnastics, rhythmic gymnastics, etc.), endurance (running, canoeing, diving, etc.), and weight-dependent sports (wrestling, judo, taekwondo, karate, etc.) are particularly at risk (Mancine et al., 2020; Sundgot-Borgen and Garthe, 2011). Additionally, team sports have been recognized as including a group of vulnerable athletes (Kampouri et al., 2019; Gouttebarge et al., 2018).

Among athletes, DE includes all pathological behaviors aimed at periodically reducing body weight, such as meal restriction, the use of weight-loss pills, binge eating, and purging, or enhancing sports performance (Wells et al., 2020). Clinical EDs are characterized by more severe and frequent behaviors, such as fasting, binge eating, and purging several times a week. Unlike DE, which involves a less pervasive preoccupation with food, ED significantly disrupts an individual's daily life (Wells et al., 2020).

DE and ED are multifactorial conditions that exist on a spectrum, as described by the Australian Institute of Sport (AIS) and the National Eating Disorders Collaboration (NEDC) in 2020 (Wells et al., 2020). Optimal nutrition serves as the foundation, supplying the energy necessary for both health maintenance and athletic performance. When this balance is disrupted, symptoms of DE may appear. Without intervention, DE can progress to ED, a clinical condition with serious health implications (Wells et al., 2020).

Both DE and ED can be managed using a multidisciplinary approach, involving physicians, psychiatrists, and dietitians in the medical team (Cena et al., 2022; Temme and Hoch, 2013; Joy et al., 2003). Physicians assess overall health, prescribe medication when necessary, and suggest mental health and nutritional interventions (Mairs and Nichols, 2016; Woodruff et al., 2020; Cena et al., 2022). Dietitians examine eating behaviors, monitor physical symptoms, and develop personalized nutritional plans, while psychologists and psychiatrists provide psychotherapy, track mental health progress, and prescribe medication as needed. The multidisciplinary team may also involve physiotherapists, coaches, family members, teammates, or others essential to the athlete's recovery (Joy et al., 2016). Despite this structured approach, recovery outcomes remain challenging, with only 40–50% of patients achieving full recovery (Joy et al., 2003).

There are several internationally accepted manuals for diagnosing EDs, such as the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) (American Psychiatric Association, 2013), the *International Statistical Classification of Diseases and Related Health Problems* (ICD) (World Health Organization, 2019), the *Chinese Classification of Mental Disorders* (CCDM) (Chen, 2020), *Psychodynamic Diagnostic Manual* (PDM) (Lingiardi and McWilliams, 2015). Currently, *the Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition, Text Revision (DSM-V-TR) with text revisions is the most comprehensive clinical resource available including updated diagnostic criteria and the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes (American Psychiatric Association, 2024).

Insufficient nutrient intake can negatively affect various areas. Among athletes, prolonged low energy availability (LEA), lasting for weeks or months, can lead to a decrease in sports performance as well as health deterioration, as defined by the term Relative Energy Deficiency in Sport (REDs) by the International Olympic Committee's Medical Commission (Mountjoy et al., 2023). This syndrome affects multiple organ systems, including the endocrine system, cardiovascular system, immune system, and gastrointestinal system. It also impacts growth, bone health, and mental state (Cabre et al., 2022; Logue et al., 2020). Furthermore, the increased risk of injury contributes to the number of missed training hours, subsequently resulting in a decline in sports performance (Henninger et al., 2024; Joubert et al., 2020; Rauh et al., 2010).

Petrie and Greenleaf (2007) summarized a theoretical model highlighting several factors that may influence athletes' disordered eating behaviors. This model suggests that social and sport-related pressures can lead to body dissatisfaction, which may result in restrictive eating, followed by binge eating and the onset of other disordered eating behaviors. Different moderators play a role at each stage, with body dissatisfaction influenced by weight and body shape, while restrictive eating is shaped by perfectionism, body perception, neuroticism, and self-esteem. Family and peer behavior models also play a role in the occurrence of the problem (Petrie and Greenleaf, 2007).

Although longitudinal studies on the connection between DE and ED are limited, research indicates that DE rarely resolves without appropriate intervention (Mountjoy et al., 2014; Gouttebarge and Kerkhoffs, 2017). Both DE and ED have negative effects on health in various ways, including adverse changes in body composition (reduced body weight and fat ratio) and abnormal blood test results (serum iron, ferritin, fasting blood sugar, and hormonal imbalances). These complications can result in long-term health issues, such as amenorrhea and iron deficiency, which hinder performance (Attwell et al., 2022; Hulmi et al., 2017; Banfi et al., 2012; Gordon, 2010). The diagnosis of EDs is often delayed because symptoms can remain hidden for extended periods (Tan et al., 2016).

All of these conditions underline the importance of early recognition and prevention, as well as the need for continuous joint action of the multidisciplinary team. In our study, there was a lack of proper cooperation among the members of the medical staff which led to serious health deterioration.

Patient information

We present the 2-year case study of a 23-year-old female orienteer who has been involved in the sport since the age of 13 and has been following an ovo-lacto vegetarian diet for 3 years. She is a talented athlete; in the year prior to the intervention, she competed in 45 events and won medals in 20 of them. We aim to illustrate how her symptoms transitioned from DE to ED. This case study was approved by the Human Ethics Committee of ELTE Eötvös Loránd University, Faculty of Pedagogy and Psychology (license number: 2023/104). The athlete gave written permission to publish the results. Detailed first-year information is available from a previous study (Kovács and Boros, 2024). We sought special permission to disclose the data in the medical documentation from the institution where the treatments were conducted.

The starting point was in February 2022, when she visited the ambulatory dietetic care. She sought support from her coach and was also motivated by her own determination. Her current goal was to focus on achieving her best performance; however, her coach was rather worried about her health. According to her food diary, she consumed an average of 1,200 kcal/day (25.9 kcal/fat-free kgs) and trained 6 days per week. She was 1.73 meters tall, weighed 50.1 kg, had a BMI of 16.9 kg/m^2, and a body fat percentage (PBF) of 7.5%. She had not had her menstrual period and had not undergone a gynecological examination since 2020. The laboratory results confirmed low levels of serum iron. Before she became vegetarian, she weighed 57–58 kgs, and her periods were regular.

Therapeutic intervention and clinical findings

Following the nutritional assessment, she underwent consultations with an internist, psychologist, and psychiatrist, after which a common therapeutic assessment commenced in May 2022. According to the DSM-V, she did not meet the criteria of an ED, but she exhibited several DE symptoms. She counted calories but was not afraid of gaining weight; rather, she worried about not consuming a sufficient amount of energy. Moreover, she declined restaurant invitations because she believed that there would not be suitable dishes for vegetarians. Based on the medical team's decision, it was not necessary to revoke her competition license or reduce her training volume. Psychiatric medicine prescription and hospitalization were also deemed unnecessary. She started working with a sports psychologist, who also worked with the athlete's teammates. To help regulate her serum iron levels, Krauterblut syrup was recommended by the nutritionist (OGYI-NYTSZ-337/92).

Throughout the treatment process, monthly dietary assessments, biweekly psychological evaluations, and semiannual internal medicine examinations, including blood test analysis, were conducted. During the dietary consultations, body composition measurements [performed with an (InBody Co., Ltd., Seoul, Korea) device; Brewer et al., 2021] and food diary analysis (with Nutricomp DietCAD software) were conducted. The athlete did not want to follow a structured diet prepared by the specialist, but she agreed to discuss and review her meals during each meeting. The therapeutic goals were defined as follows: a minimum BMI of 18.5 kg/m^2 (~ 55 kg), a minimum of 12% body fat, and the maintenance of regular menstrual cycles. The medical team never convened a joint meeting to discuss the athlete's condition and further treatment recommendations, so the practitioners were informed by the athlete about the progress she was making in each of the respective fields. The internist and the dietitian were at the same institute, so they accessed each other's documentation regarding the athlete; however, there was no information about the psychological consultations.

In her first year, she achieved initial success. Her body weight slightly reached the therapeutic goal (54.8 kg), so her body fat percentage (11%), and in July 2022, she had her menstrual period. The body composition results started to deteriorate after the suspension of the psychological consultations (August 2022). By the end of the first year (February 2023), the orienteer was diagnosed with an ED [anorexia nervosa (AN)]. The events of the upcoming year are summarized in Figure 1. Psychological consultations were recommended to be restarted urgently, but this time weekly instead of biweekly. Concerning the competition license, she was still not banned from sport. The most important thing for the athlete was to be still able to compete, but she was not aware of her serious health condition. In April 2023, the athlete's body weight dropped below 50 kgs (BMI 16.7 kg/m^2). Her serum iron levels remained low, as did the red blood cell and hemoglobin concentrations. By July, the body fat percentage dropped to 4.5% when a cardiology examination was performed with no abnormalities. The medical team determined that AN clearly presented her medical history and current physical condition, which required the immediate revocation of her competition license. Hospitalization and psychiatric prescriptions were not recommended. At this point, the coach radically reduced the training volume rather than eliminating it entirely (as would have been necessary, but the athlete strongly opposed it). For the next 6 months, contact was made more difficult by an Erasmus scholarship program, which meant that the athlete was abroad. We overcame this by having her body composition checked at a foreign university, which was evaluated online by the dietitian. She also participated in individual online therapies with the sports psychologist. After returning home in February 2024, the athlete reported severe abdominal pain and spasms, especially after meals. An abdominal ultrasound was conducted, which revealed no abnormalities. However, the laboratory results indicated concerning findings for liver function (GOT-glutamate-oxalacetate-transaminase, GPT- glutamate-piruvate-transaminase, gamma GT- gamma-glutamil-transferase, LDH-lactate dehydrogenase), and no further investigation was conducted. It was recommended to start psychotherapy with a clinical psychiatrist specialized in eating disorders instead of a sports psychologist. From then on, therapy included weekly psychiatric consultations (now with the ED specialist), monthly dietary counseling, and quarterly internal medicine check-ups.

Follow-up and outcomes

Since then, the athlete's condition had improved. However, similar to the previous 2 years, there had been minor setbacks in body weight and body composition due to personal life problems. Her current weight was 54 kg, her body fat percentage was 10.8%, and her abdominal pain had disappeared. Although these values did not yet reach the target set at the beginning of the therapy, she had maintained them steadily in recent months. The frequency of psychiatric consultations had been reduced to once every 2 weeks. Psychiatric prescription was still not recommended.

In October 2024, after a joint decision by the medical team, the athlete was issued a 1-month competition license. Her training load had increased, but she had not yet returned to her preintervention level. The competition permit was renewed each month, with the consent of the dietitian and psychiatrist.

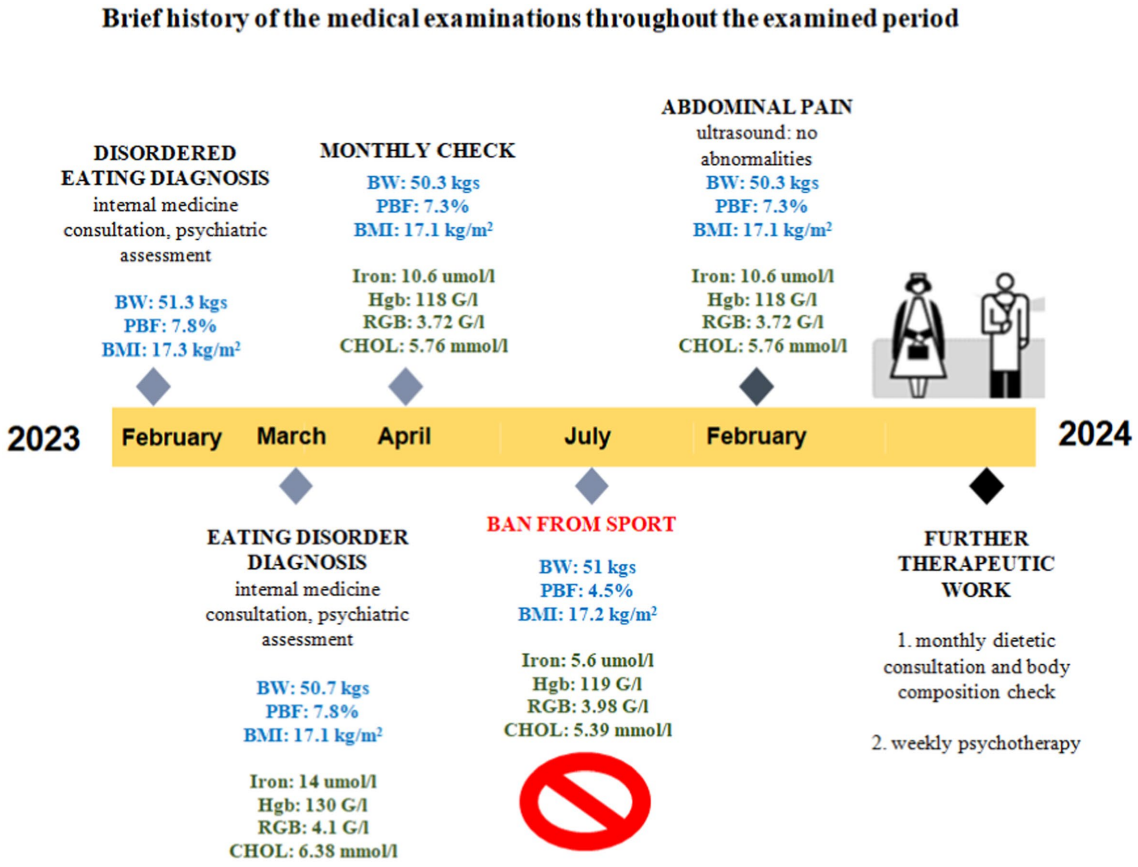


FIGURE 1
Brief history of the medical exaninations provided througout the examined period. Hgb, hemoglobin; RBC, red blood cell; CHOL, cholesterol; BW, body weight; PBF, percent body fat; BMI, body mass index; GOT, glutamate-oxalacetate-transaminase; GPT, glutamate-piruvate-transaminase; Gamma GT, gamma-glutamil-transferase; LDH, lactate-dehydrogenase.

Regarding her eating habits, she continued to follow an ovo-lacto vegetarian diet. The blood test results indicated a slight increase in serum iron levels, hemoglobin, and red blood cells; however, these levels still remained low. Cholesterol and liver function markers had normalized. She has had her menstrual period once since then, marking the second occurrence since 2020. Consequently, the sports physician referred her for a dual-energy X-ray absorptiometry (DXA or DEXA) bone density test that revealed early-stage osteoporosis in the spine. Further endocrinological testing is ongoing.

Discussion

The relationship between low body weight, body fat percentage, and amenorrhea

The most serious issue in this case is the low body weight and body fat percentage, which was accompanied by amenorrhea. Low body weight, inadequate nutrition, and excessive physical activity can collectively disrupt the production of sex hormones (such as estrogen and luteinizing hormone), leading to menstrual irregularities or even the complete cessation of menstruation (Berz and McCambridge, 2016; Klein and Poth, 2013; Winston, 2012). This is particularly critical among female athletes, as amenorrhea not only threatens reproductive health but also raises risks, such as decreased bone density and stress fractures (Costa et al., 2022). Therefore, restoring energy balance and maintaining adequate body fat levels are essential (Melin et al., 2019; De Bruin, 2017; Mountjoy et al., 2014).

The link between high cholesterol levels and anorexia nervosa

Throughout the observed period, the athlete's cholesterol levels remained consistently elevated. Previous studies indicate that in cases of AN, endogenous cholesterol production increases, likely triggered by the body's energy-deficient state (Hussain et al., 2019; Winston, 2012). This may arise from the liver's compensatory mechanism trying to maintain the necessary lipid levels necessary for cellular function. This increase in cholesterol poses long-term cardiovascular risks, especially if other metabolic issues are present. A thorough review of the diet and addressing nutritional deficiencies

are essential for managing the condition (Neglia, 2021; Melin et al., 2015).

Suspected superior mesenteric artery syndrome

Although the abdominal ultrasound report was negative, the symptoms indicated the possibility of superior mesenteric artery syndrome (SMAS). This condition typically occurs in cases of significant weight loss, where the reduction of abdominal fat causes the artery to compress the duodenum, resulting in digestive issues and severe pain (Bloomberg et al., 2023; Singh and Contrucci, 2023). SMAS is often associated with EDs and can serve as a warning sign of AN (Recio-Barbero et al., 2019; Sato and Fukudo, 2015). Nevertheless, SMAS is a relatively rare condition; however, its incidence is higher in patients with EDs, especially AN, than in the general population (Farina et al., 2017; Oliva-Fonte et al., 2017).

Challenges of vegetarianism for athletes

The athlete followed a vegetarian diet, which may be a challenge in restoring energy balance and adequate nutrient intake. However, numerous professional guidelines exist for the nutrition of vegetarian athletes, emphasizing that both health and performance enhancement can be achieved through proper planning (Craddock et al., 2016; Barr and Rideout, 2004). Nevertheless, these diets require careful attention, especially regarding adequate intake of essential proteins, iron, calcium, vitamin D, and vitamin B12 (Nebl et al., 2019; West et al., 2023). Collaborating with a sports dietitian is essential to ensure that the athlete's diet meets the requirements for recovery and hormonal balance restoration (Kussman and Choo, 2024).

Treatment recommendations and multidisciplinary approach

By the end of the first year, the athlete's condition further deteriorated, necessitating the revocation of the competition license. This decision aligns with other case studies that indicate better long-term outcomes when competition is suspended, allowing for a focus on rehabilitation (Quatromoni, 2017).

A multidisciplinary approach is essential for effective treatment as recommended by the IOC (Mountjoy et al., 2023). Collaborating with a psychologist or psychiatrist who specializes in ED is crucial, as psychotherapy assists in uncovering and addressing the underlying psychological causes (Grilo, 2024; Eichstadt et al., 2020; Hay, 2020; Petisco-Rodríguez et al., 2020; Murphy et al., 2010). Furthermore, a controlled and gradually increased nutritional intake, along with a temporary halt to physical activity, is vital for the body's recovery (Neglia, 2021).

This athlete's situation shows that improvement is possible with appropriate treatment. The condition can be reversed when physical, nutritional, and psychological aspects are thoughtfully considered and addressed in an integrated approach.

Limitations

The case study presents a detailed overview of an athlete's journey. However, several limitations must be considered. This is a single case study, which means that the findings are specific to one individual. While it can provide valuable insights into the athlete's experience, these results cannot necessarily be generalized to all athletes, particularly those with varying eating habits, training routines, or backgrounds. Although psychological treatments and interventions were part of the athlete's care, we were unable to provide detailed information on the types of therapies used. Furthermore, an eating disorder specialist was involved only after a year and a half. The specific impact of these therapies on her recovery remains unclear. The athlete's progress was monitored by various specialists (internist, dietitian, psychologist, and psychiatrist) who did not always collaborate directly. This lack of coordinated care may have influenced the outcomes and indicates that a more integrated, multidisciplinary approach might have been more beneficial.

Conclusion

This case study highlights the need for developing effective preventive strategies to reverse the effects of disordered eating (DE) and to prevent the onset of eating disorders (EDs) in athletes. Early intervention is essential, and coaches play a vital role in identifying subtle shifts in an athlete's behavior, eating habits, or physical performance. Their awareness can help prompt early medical evaluations, preventing further progression of DE. However, once DE symptoms are recognized, medical staff must make informed decisions about temporarily suspending training or competitions to prioritize the athlete's physical and mental health.

Although a theoretical framework for multidisciplinary team care exists, practical challenges often hinder its implementation. Limited resources, time constraints, and challenges in coordinating professionals from diverse fields, each with unique priorities, can impede effective collaboration. This case study highlights the need for improvements in two key areas: early identification of at-risk athletes and better collaboration within multidisciplinary teams.

To address these challenges, developing more effective screening methods—such as regular check-ins or questionnaires for athletes and coaching staff— and emphasizing collaboration among medical team members—could provide early indicators of DE or ED.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving humans were approved by Eötvös Loránd University Human Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

RK: Investigation, Software, Writing – original draft. SB: Conceptualization, Visualization, Writing – review & editing.

Funding

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

Conflict of interest

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

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

References

American Psychiatric Association (2013). Diagnostic and statistical manual of mental disorders: DSM-5. *5th* Edn. Washington, DC: American Psychiatric Publishing.

American Psychiatric Association (2024). Unrecognised Eating disorders in boys young men. Available at: https://www.apa.org/monitor/2024/10/eating-disorders-boys-men (Accessed February 28, 2025).

Attwell, C., Dugan, C., McKay, A. K. A., Nicholas, J., Hopper, L., and Peeling, P. (2022). Dietary Iron and the elite dancer. *Nutrients* 14:1936. doi: 10.3390/nu14091936

Banfi, G., Colombini, A., Lombardi, G., and Lubkowska, A. (2012). "Metabolic markers in sports medicine" in Advances in clinical chemistry (Elsevier), 1–54.

Barr, S. I., and Rideout, C. A. (2004). Nutritional considerations for vegetarian athletes. *Nutrition* 20, 696–703. doi: 10.1016/j.nut.2004.04.015

Berz, K., and McCambridge, T. (2016). Amenorrhea in the female athlete: what to do and when to worry. *Pediatr. Ann.* 45. doi: 10.3928/00904481-20160210-03

Bloomberg, L., Hoscheit, M., Hendler, S., and Abegunde, A. T. (2023). Superior mesenteric artery syndrome in an adolescent female with anorexia nervosa. *Clin. Med. Res.* 21, 46–48. doi: 10.3121/cmr.2022.1768

Brewer, G. J., Blue, M. N. M., Hirsch, K. R., Saylor, H. E., Gould, L. M., Nelson, A. G., et al. (2021). Validation of InBody 770 bioelectrical impedance analysis compared to a four-compartment model criterion in young adults. *Clin. Physiol. Funct.* 41, 317–325. doi: 10.1111/cpf.12700

Cabre, H., Moore, S., Smith-Ryan, A., and Hackney, A. (2022). Relative energy deficiency in sport (RED-S): scientific, clinical, andpractical implications for the female athlete. *Dtsch Z Sportmed* 73, 225–234. doi: 10.5960/dzsm.2022.546

Cena, H., Vandoni, M., Magenes, V. C., Di Napoli, I., Marin, L., Baldassarre, P., et al. (2022). Benefits of exercise in multidisciplinary treatment of binge eating disorder in adolescents with obesity. *IJERPH* 19:8300. doi: 10.3390/ijerph19148300

Chatterton, J. M., and Petrie, T. A. (2013). Prevalence of disordered eating and pathogenic weight control behaviors among male collegiate athletes. *Eat. Disord.* 21, 328–341. doi: 10.1080/10640266.2013.797822

Chen, Y. F. (2020). Chinese classification of mental disorders (CCMD-3): towards integration in international classification. *Psychopathology* 35, 171–175. doi: 10.1159/000065140

Costa, T. M. D. R. L., Borba, V. Z. C., Correa, R. G. P., and Moreira, C. A. (2022). Stress fractures. *Arch Endocrinol Metabol* 66, 765–773. doi: 10.20945/2359-3997000000562

Craddock, J. C., Probst, Y. C., and Peoples, G. E. (2016). Vegetarian and omnivorous nutrition—comparing physical performance. *Int. J. Sport Nutr. Exerc. Metab.* 26, 212–220. doi: 10.1123/ijsnem.2015-0231

De Bruin, A. P. (2017). Athletes with eating disorder symptomatology, a specific population with specific needs. *Curr. Opin. Psychol.* 16, 148–153. doi: 10.1016/j.copsyc.2017.05.009

Eichstadt, M., Luzier, J., Cho, D., and Weisenmuller, C. (2020). Eating disorders in male athletes. *Sports Health* 12, 327–333. doi: 10.1177/1941738120928991

Farina, R., Foti, P. V., Cocuzza, G., Costanzo, V., Costanzo, G., Conti, A., et al. (2017). Wilkie's syndrome. *J Ultrasound* 20, 339–342. doi: 10.1007/s40477-017-0257-2

Ghazzawi, H. A., Nimer, L. S., Haddad, A. J., et al. (2024). A systematic review, meta-analysis, and meta-regression of the prevalence of self-reported disordered eating and associated factors among athletes worldwide. *J. Eat. Disord.* 12:24. doi: 10.1186/s40337-024-00982-5

Gordon, C. M. (2010). Clinical practice. Functional hypothalamic amenorrhea. *N. Engl. J. Med.* 363, 365–371. doi: 10.1056/NEJMcp0912024

Grilo, C. M. (2024). Treatment of eating disorders: current status, challenges, and future directions. *Annu. Rev. Clin. Psychol.* 20, 97–123. doi: 10.1146/annurev-clinpsy-080822-043256

Gouttebarge, V., Hopley, P., Kerkhoffs, G., Verhagen, E., Viljoen, W., Wylleman, P., et al. (2018). A 12-month prospective cohort study of symptoms of common mental disorders among professional rugby players. *EJSS*, 18, 1004–1012. doi: 10.1080/17461391.2018.1466914

Gouttebarge, V., and Kerkhoffs, G. M. M. J. (2017). A prospective cohort study on symptoms of common mental disorders among current and retired professional ice hockey players. *PHSPDE* 45, 252–258. doi: 10.1080/00913847.2017.1338497

Hay, P. (2020). Current approach to eating disorders: a clinical update. *Intern. Med. J.* 50, 24–29. doi: 10.1111/imj.14691

Hazzard, V. M., Schaefer, L. M., Mankowski, A., Carson, T. L., Lipson, S. M., Fendrick, C., et al. (2020). Development and validation of the eating disorders screen for athletes (EDSA): A brief screening tool for male and female athletes. *Psychol Sport and Exer*, 50:101745. doi: 10.1016/j.psychsport.2020.101745

Henninger, K., Pritchett, K., Brooke, N. K., and Dambacher, L. (2024). Low energy availability, disordered eating, exercise dependence, and fueling strategies in trail runners. *Int. J. Exerc. Sci.* 16, 1471–1486. doi: 10.70252/FFDK5934

Holtzman, B., and Ackerman, K. E. (2021). Recommendations and nutritional considerations for female athletes: health and performance. *Sports Med.* 51, 43–57. doi: 10.1007/s40279-021-01508-8

Hulmi, J. J., Isola, V., Suonpää, M., Järvinen, N. J., Kokkonen, M., Wennerström, A., et al. (2017). The effects of intensive weight reduction on body composition and serum hormones in female fitness competitors. *Front. Physiol.* 7:689. doi: 10.3389/fphys.2016.00689

Hussain, A. A., Hübel, C., Hindborg, M., Lindkvist, E., Kastrup, A. M., Yilmaz, Z., et al. (2019). Increased lipid and lipoprotein concentrations in anorexia nervosa: a systematic review and meta-analysis. *Int. J. Eat. Disord.* 52, 611–629. doi: 10.1002/eat.23051

Jeukendrup, A. E. (2017). Periodized nutrition for athletes. *Sports Med.* 47, 51–63. doi: 10.1007/s40279-017-0694-2

Joubert, L. M., Gonzalez, G. B., and Larson, A. J. (2020). Prevalence of disordered eating among international sport Lead rock climbers. *Front. Sports Act. Living* 2:86. doi: 10.3389/fspor.2020.00086

Joy, E., Kussman, A., and Nattiv, A. (2016). 2016 update on eating disorders in athletes: A comprehensive narrative review with a focus on clinical assessment and management. *BJSM*, 50, 154–162. doi: 10.1136/bjsports-2015-095735

Joy, E. A., Wilson, C., and Varechok, S. (2003). The multidisciplinary team approach to the outpatient treatment of disordered eating. *Curr Sport Med Rep*, 2, 331–336. doi: 10.1249/00149619-200312000-00009

Kampouri, D., Kotopoulea-Nikolaidi, M., Daskou, S., and Giannopoulou, I. (2019). Prevalence of disordered eating in elite female athletes in team sports in Greece. *EJSS*, 19, 1267–1275. doi: 10.1080/17461391.2019.1587520

Klein, D. A., and Poth, M. A. (2013). Amenorrhea: an approach to diagnosis and management. *Am. Fam. Phys.* 87, 781–788.

Kovács, R. E., and Boros, S. (2024). Case study: an orienteer athlete with disordered eating. *M Sporttud Szle* 110, 34–37.

Kussman, A., and Choo, H. J. (2024). Mental health and disordered eating in athletes. *Clin Sports Med*, 43, 71–91. doi: 10.1016/j.csm.2023.07.001

Lingiardi, V., and McWilliams, N. (2015). The psychodynamic diagnostic manual - 2nd edition (PDM-2). *WPA* 14, 237–239. doi: 10.1002/wps.20233

Logue, D. M., Madigan, S. M., Melin, A., Delahunt, E., Heinen, M., Donnell, S.-J. M., et al. (2020). Low energy availability in athletes 2020: an updated narrative review of prevalence, risk, within-day energy balance, knowledge, and impact on sports performance. *Nutrients* 12:835. doi: 10.3390/nu12030835

Mancine, R. P., Gusfa, D. W., Moshrefi, A., and Kennedy, S. F. (2020). Prevalence of disordered eating in athletes categorized by emphasis on leanness and activity type – a systematic review. *J. Eat. Disord.* 8:47. doi: 10.1186/s40337-020-00323-2

Mairs, R., and Nicholls, D. (2016). Assessment and treatment of eating disorders in children and adolescents. *Arch Dis Child*, 101, 1168–1175. doi: 10.1136/archdischild-2015-309481

Martinsen, M., and Sundgot-Borgen, J. (2013). Higher prevalence of eating disorders among adolescent elite athletes than controls. *Med. Sci. Sports Exerc.* 45, 1188–1197. doi: 10.1249/MSS.0b013e318281a939

Melin, A. K., Heikura, I. A., Tenforde, A., and Mountjoy, M. (2019). Energy availability in athletics: health, performance, and physique. *Int. J. Sport Nutr. Exerc. Metab.* 29, 152–164. doi: 10.1123/ijsnem.2018-0201

Melin, A., Tornberg, Å. B., Skouby, S., Møller, S. S., Sundgot-Borgen, J., Faber, J., et al. (2015). Energy availability and the female athlete triad in elite endurance athletes. *Scand. Med. Sci. Sports* 25, 610–622. doi: 10.1111/sms.12261

Mountjoy, M., Ackerman, K. E., Bailey, D. M., Burke, L. M., Constantini, N., Hackney, A. C., et al. (2023). 2023 International Olympic Committee's (IOC) consensus statement on relative energy deficiency in sport (REDs). *Br. J. Sports Med.* 57, 1073–1097. doi: 10.1136/bjsports-2023-106994

Mountjoy, M., Sundgot-Borgen, J., Burke, L., Carter, S., Constantini, N., Lebrun, C., et al. (2014). The IOC consensus statement: beyond the female athlete triad—relative energy deficiency in sport (RED-S). *BJSM*, 48, 491–497. doi: 10.1136/bjsports-2014-093502

Murphy, R., Straebler, S., Cooper, Z., and Fairburn, C. G. (2010). Cognitive behavioral therapy for eating disorders. *Psychiatr. Clin. N. Am.* 33, 611–627. doi: 10.1016/j.psc.2010.04.004

Nebl, J., Schuchardt, J. P., Ströhle, A., Wasserfurth, P., Haufe, S., Eigendorf, J., et al. (2019). Micronutrient status of recreational runners with vegetarian or non-vegetarian dietary patterns. *Nutrients*, 11:1146. doi: 10.3390/nu11051146

Neglia, A. (2021). Nutrition, eating disorders, and behavior in athletes. *Psychiatr. Clin. North Am.* 44, 431–441. doi: 10.1016/j.psc.2021.04.009

Oliva-Fonte, C., Fernández Rey, C., Pereda Rodríguez, J., and González-Fernández, A. M. (2017). Wilkie´s syndrome. *Rev Espan Enferm Dis*, 109, 62–63.

Petisco-Rodríguez, C., Sánchez-Sánchez, L. C., Fernández-García, R., Sánchez-Sánchez, J., and García-Montes, J. M. (2020). Disordered eating attitudes, anxiety, self-esteem and perfectionism in young athletes and non-athletes. *IJERPH* 17:6754. doi: 10.3390/ijerph17186754

Petrie, T. A., and Greenleaf, C. A. (2007). Eating disorders in sport: from theory to research to intervention. G. In In G. Tenenbaum and R. C. Eklund (Eds.), Handbook of sport psychology (*3rd ed*., pp. 352–378). John Wiley & Sons, Inc.

Quatromoni, P. A. (2017). A tale of two runners: a case report of athletes' experiences with eating disorders in college. *J. Acad. Nutr. Diet.* 117, 21–31. doi: 10.1016/j.jand.2016.09.032

Rauh, M. J., Nichols, J. F., and Barrack, M. T. (2010). Relationships among injury and disordered eating, menstrual dysfunction, and low bone mineral density in high school athletes: a prospective study. *J. Athl. Train.* 45, 243–252. doi: 10.4085/1062-6050-45.3.243

Recio-Barbero, M., Fuertes-Soriano, S., Cabezas-Garduño, J., López-Atanes, M., Peña-Rotella, A., and Sáenz-Herrero, M. (2019). Delayed diagnosis of an eating disorder in a male patient with superior mesenteric artery syndrome: results from a case study. *Front. Psych.* 10:731. doi: 10.3389/fpsyt.2019.00731

Sato, Y., and Fukudo, S. (2015). Gastrointestinal symptoms and disorders in patients with eating disorders. *Clin. J. Gastroenterol.* 8, 255–263. doi: 10.1007/s12328-015-0611-x

Singh, S., and Contrucci, A. L. (2023). Superior mesenteric artery syndrome and anorexia nervosa: a case report. *J. Med. Case Rep.* 17:459. doi: 10.1186/s13256-023-04168-6

Sundgot-Borgen, J., and Garthe, I. (2011). Elite athletes in aesthetic and Olympic weight-class sports and the challenge of body weight and body compositions. *J. Sports Sci.* 29, S101–S114. doi: 10.1080/02640414.2011.565783

Sundgot-Borgen, J., and Torstveit, M. K. (2004). Prevalence of eating disorders in elite athletes is higher than in the general population. *Clin. J. Sport Med.* 14, 25–32. doi: 10.1097/00042752-200401000-00005

Tan, J. O. A., Calitri, R., Bloodworth, A., and McNamee, M. J. (2016). Understanding eating disorders in elite gymnastics. *Clin. Sports Med.* 35, 275–292. doi: 10.1016/j.csm.2015.10.002

Temme, K. E., and Hoch, A. Z. (2013). Recognition and rehabilitation of the female athlete triad/tetrad: A multidisciplinary approach. *Curr Sports Med Rep*, 12, 190–199. doi: 10.1249/JSR.0b013e318296190b

Wells, K. R., Jeacocke, N. A., Appaneal, R., Smith, H. D., Vlahovich, N., Burke, L. M., et al. (2020). The Australian Institute of Sport (AIS) and National Eating Disorders Collaboration (NEDC) position statement on disordered eating in high performance sport. *Br. J. Sports Med.* 54, 1247–1258. doi: 10.1136/bjsports-2019-101813

West, S., Monteyne, A. J., van der Heijden, I., Stephens, F. B., and Wall, B. T. (2023). Nutritional considerations for the vegan athlete. *Adv Nutr (Bethesda*, Md.), 14, 774–795. doi: 10.1016/j.advnut.2023.04.012

Winston, A. P. (2012). The clinical biochemistry of anorexia nervosa. *Ann. Clin. Biochem.* 49, 132–143. doi: 10.1258/acb.2011.011185

Woodruff, K., Clark, L., Joy, E., Summers, S. A., Metos, J. M., Clark, N., et al. (2020). An interpretive description of women's experience in coordinated, multidisciplinary treatment for an eating disorder. *GQNR*, 7:2333393620913271. doi: 10.1177/2333393620913271

World Health Organization. (2019) International statistical classification of diseases and related health problems 10th revision. Available online at: https://icd.who.int/browse10/2019/en#/F50.0 (Accessed February 5, 2025).

frontiers | Frontiers in Nutrition

TYPE Original Research
PUBLISHED 13 June 2025
DOI 10.3389/fnut.2025.1537433

OPEN ACCESS

EDITED BY
Carmen Adina Pastiu,
1 Decembrie 1918 University, Romania

REVIEWED BY
Patrycja Klimek,
University of California, San Francisco, United States
Iuliana Petronela Gardan,
Spiru Haret University, Romania

*CORRESPONDENCE
Mona Vintilă
✉ mona.vintila@e-uvt.ro

RECEIVED 30 November 2024
ACCEPTED 27 May 2025
PUBLISHED 13 June 2025

CITATION
Lăzărescu G and Vintilă M (2025) The relationship between objectification and the desire to undergo cosmetic surgery: the mediating role of intuitive eating and body image flexibility.
Front. Nutr. 12:1537433.
doi: 10.3389/fnut.2025.1537433

The relationship between objectification and the desire to undergo cosmetic surgery: the mediating role of intuitive eating and body image flexibility

Gianina Lăzărescu and Mona Vintilă*

Faculty of Sociology and Psychology, West University of Timișoara, Timișoara, Romania

Objectives: Sociocultural standards that emphasize idealized appearance and promote the objectification of women's bodies have been consistently associated with negative body image outcomes and increased interest in cosmetic surgery (Fredrickson & Roberts; Calogero et al.). Constructs such as body image flexibility and intuitive eating have been discussed in the literature as psychological resources that promote well-being in body image–related contexts (Sandoz et al.; Tylka & Kroon Van Diest). However, their specific role in the relationship between objectification and cosmetic surgery interest remains underexplored. Recent evidence suggests that body image flexibility may function as a protective factor in this relationship (Huang et al.), while intuitive eating has been associated with greater psychological well-being and reduced body-related distress (Tylka and Wilcox), suggesting its potential relevance. Building on this background, the present study investigates the mediating roles of body image flexibility and intuitive eating in the relationship between body objectification and the desire to undergo cosmetic surgery for intrapersonal and social reasons, as well as the likelihood of pursuing such procedures in the future.

Methods: The sample consisted of 555 Romanian women (M = 29.61 years, SD = 13.396), who completed validated scales measuring body objectification, body image flexibility, intuitive eating, and attitudes toward cosmetic surgery. Data were analyzed using parallel mediation models, controlling for age, educational status, ethnicity, relationship status, and body mass index.

Findings: The findings indicated that body objectification was negatively associated with body image flexibility and intuitive eating. While intuitive eating did not mediate the relationship between body objectification and the desire for cosmetic surgery in any of the tested models, body image flexibility emerged as a partial mediator in the model related to social motivations and a full mediator in the model predicting future consideration of cosmetic procedures. These results are consistent with theoretical frameworks emphasizing self-perception and sociocultural context—such as self-verification and self-affirmation theories—that help explain how women's behaviors are shaped by societal expectations and patriarchal cultural norms.

Conclusion and recommendations: The study highlights the relevance of cultural context in understanding adaptive factors that may buffer the psychological impact of objectification. The results suggest that body image flexibility may function as a protective factor in reducing the desire for cosmetic surgery. While these findings may suggest potential directions for intervention, such as

promoting positive body image and intuitive eating, we emphasize that further longitudinal research is needed before such psychoeducational programs can be designed or implemented. This study contributes to the growing body of literature by shedding light on culturally specific dynamics influencing cosmetic surgery motivations.

KEYWORDS

cosmetic surgery, body objectification, intuitive eating, body flexibility, cosmetic surgery motivations

Introduction

From time immemorial, society has played a significant role in transmitting culturally accepted ideals of beauty. The sociocultural perspective emphasizes the importance of physical appearance in Western cultures, with the predominant beauty ideal for women being thinness (1–3). The societal pressure to conform to culturally imposed body ideals has been consistently linked to various negative outcomes, including body dissatisfaction (4, 5), eating disorders (6, 7), low self-esteem (8, 9), the desire to undergo cosmetic surgery (10, 11), and self-objectification (12, 13). Objectification Theory (14) describes how social norms and representations can lead women to internalize an observer's perspective of their own bodies, resulting in self-objectification. This process is associated with increased body surveillance, feelings of shame and guilt, and negative perceptions of body image (15–18, 112). According to this framework, women are often perceived more as objects than as individuals, and their bodies become instruments for the pleasure and evaluation of others (19, 20). Experiences of sexual objectification have been associated with body surveillance and body shame, which, in turn, are linked to positive attitudes toward cosmetic surgery (15, 21).

Although objectification is a widespread phenomenon, cultural context plays an important role in how body-related pressures are expressed and internalized. In Romania, the post-socialist legacy has contributed to the persistence of traditional gender norms, especially after 1989, when women were redefined primarily as caregivers and esthetic figures, and the pursuit of gender equality was deprioritized (22–24). The liberalization of the market economy after communism reinforced consumerist ideals, positioning physical appearance—particularly for women—as a key indicator of value and success (25, 26). These historical and cultural processes have shaped a context in which women are often evaluated based on their physical appearance. At the same time, Romanian public discourse continues to reflect patriarchal expectations and sexualized portrayals of women. Scholars have highlighted how patriarchal ideologies are sustained through norms and imagery that reinforce traditional roles and the objectification of women (27, 28). For example, Kaser (29) notes the frequent use of overtly sexualized representations of women in Romanian media, while Frunza et al. (30) document the use of hypersexualized imagery in advertising. These dynamics contribute to a socio-cultural environment in which women's appearance is emphasized and objectifying messages are normalized.

One psychological variable that has received attention in relation to body image is body image flexibility, a construct grounded in Acceptance and Commitment Therapy (31). It refers to an individual's capacity to experience negative body-related thoughts and emotions without attempting to suppress or change them (32). Individuals with high body image flexibility can respond to these experiences with openness and self-compassion rather than avoidance or criticism (33, 34). This construct has been studied in connection with body image difficulties (35) and disordered eating (36). A systematic review by Rogers et al. (37) identified associations between body image flexibility and lower levels of eating disorder symptoms, appearance concerns, and psychological distress, as well as higher levels of intuitive eating and self-compassion. It has also been examined as a mediator between negative emotional experiences and behavioral outcomes such as binge eating and BMI (38), and in relation to body appreciation among women with low BMI (39). Webb (40) found that body image flexibility partially explained the relationship between body dissatisfaction and body appreciation. In the context of objectification, Huang et al. (41) showed that body image inflexibility mediated the relationship between self-objectification and the intention to undergo cosmetic surgery. Individuals with lower body image flexibility may respond to body-related distress through maladaptive coping strategies, including cosmetic surgery, as a way to reduce unfavorable comparisons and internal discomfort (42).

A second construct of interest in this study is intuitive eating, which refers to eating based on internal physiological cues rather than external or emotional ones (43). The model includes four components: unconditional permission to eat, eating for physical rather than emotional reasons, reliance on internal hunger and fullness cues, and making food choices in line with the body's needs (44, 45). Intuitive eating has been associated with lower engagement in unhealthy dietary behaviors and eating disorder symptoms (46–48), reduced pressure to maintain a thin ideal (49, 50), and more positive body image (51–54). Other findings point to associations with higher well-being and lower BMI (55, 56). Although intuitive eating has been associated with constructs relevant to objectification theory, including lower body surveillance, reduced internalization of appearance ideals, and greater body appreciation (57, 58), its mediating role in the link between objectification and cosmetic surgery interest remains unexplored. Additionally, intuitive eating has been found to be negatively associated with objectification experiences (59, 60), suggesting its potential relevance in understanding appearance-related investment behaviors.

Considering the broader cultural context characterized by persistent patriarchal influences and the hypersexualization of women documented in Romania (29, 30), alongside the potential protective roles of body image flexibility and intuitive eating, the present study examines whether these constructs mediate the relationship between objectification and the desire to undergo cosmetic surgery. Building on the findings of Huang et al. (41), this study includes both body image flexibility and intuitive eating as

parallel mediators. In addition, we examine three specific outcomes: intrapersonal reasons for cosmetic surgery, social reasons, and future consideration. To our knowledge, no prior study has investigated these mediators simultaneously within a Romanian sample. The proposed mediation models and hypotheses are presented in Figure 1.

H1a. Higher levels of body objectification are expected to be associated with lower levels of body image flexibility, which in turn may be related to a stronger intrapersonal desire to undergo cosmetic surgery.

H2a. Higher levels of body objectification are expected to be associated with lower levels of body image flexibility, which in turn may be related to a stronger social desire to undergo cosmetic surgery.

H3a. Higher levels of body objectification are expected to be associated with lower levels of body image flexibility, which in turn may be related to a greater likelihood of considering cosmetic surgery in the future.

H1b. Higher levels of body objectification are expected to be associated with lower levels of intuitive eating, which in turn may be related to a stronger intrapersonal desire to undergo cosmetic surgery.

H2b. Higher levels of body objectification are expected to be associated with lower levels of intuitive eating, which in turn may be related to a stronger social desire to undergo cosmetic surgery.

H3b. Higher levels of body objectification are expected to be associated with lower levels of intuitive eating, which in turn may be related to a greater likelihood of considering cosmetic surgery in the future.

Materials and methods

Participants

The sample consisted of 555 female participants aged between 18 and 79 years (M = 29.61; SD = 13.396). Of these, 69.91% identified as belonging to the ethnic majority, which in the Romanian context refers to ethnic Romanians. A total of 15.32% identified as belonging to an ethnic minority, and 14.77% did not give an answer to the ethnicity item. Participants were asked to indicate whether they belonged to an ethnic majority or an ethnic minority based on predefined response options. These options did not include specific categories for ethnic minority groups. This design choice aimed to maintain participant anonymity and reduce potential discomfort associated with disclosing sensitive

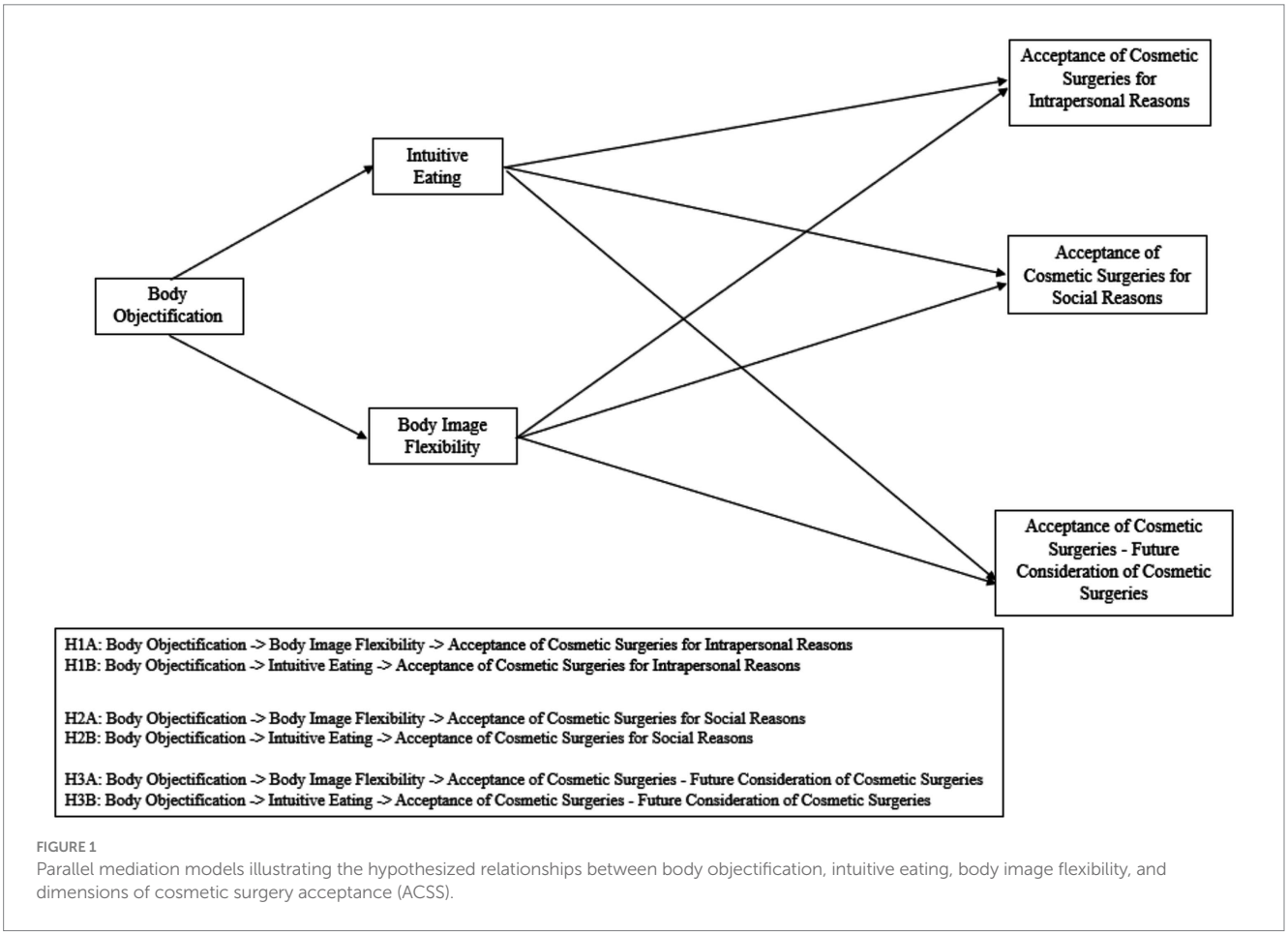


FIGURE 1
Parallel mediation models illustrating the hypothesized relationships between body objectification, intuitive eating, body image flexibility, and dimensions of cosmetic surgery acceptance (ACSS).

identity-related information (61). Regarding education, 42.34% identified as students, 29.01% had completed undergraduate studies, 14.05% had completed secondary education, 13.33% had completed postgraduate studies, and 0.90% had completed primary education. In terms of marital status, 37.66% reported being in a non-marital relationship, 36.94% reported being single, 22.88% reported being married, and 0.72% reported being divorced or widowed.

Measures

Intuitive Eating was measured using the Intuitive Eating Scale-2 (IES-2; (62)), in its version validated for the Romanian population (63). The scale consists of 23 items assessing the presence of this behavior in participants' daily lives on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The internal consistency of the scale in the current study was 0.91, 95% [CI = 0.90, 0.92].

Body Image Flexibility. The Body Image-Acceptance and Action Questionnaire (BI-AAQ; (32)) was used to measure this variable. The questionnaire consists of 12 items that assess various indicators related to body image, such as body image flexibility and the ability to experience and accept thoughts, beliefs, and feelings about one's body. Items are rated on a Likert scale from 1 (never true) to 7 (always true), with the total score calculated by summing responses to all items. Items reflecting inflexibility were reverse-coded, so higher scores indicate greater body image flexibility. The scale demonstrated an internal consistency of 0.94, 95% [CI = 0.93, 0.95].

Interest in Cosmetic Surgery was assessed using the Acceptance of Cosmetic Surgery Scale (64), in its version validated for the Romanian population (65). The scale comprises 15 items measured on a Likert scale from 1 (strongly disagree) to 7 (strongly agree), investigating respondents' attitudes toward cosmetic surgery as well as their self-reported likelihood of undergoing such procedures in the future. The three subscales corresponding to the factors identified in the psychometric validation on the Romanian population demonstrated the following internal consistencies in the current study: ACSS – Intrapersonal: 0.90, 95% [CI = 0.88, 0.91]; ACSS – Social: 0.86, 95% [CI = 0.83, 0.88]; ACSS – Consider: 0.93, 95% [CI = 0.91, 0.94].

Body Objectification was measured using the Objectified Body Consciousness Scale (OBCS; (66)), which consists of 24 items assessing women's attitudes toward their bodies in relation to cultural beauty standards. The scale includes three subscales (Body Surveillance, Body Shame, and Control), with items rated on a Likert scale from 1 (strongly disagree) to 7 (strongly agree). Scores are calculated by summing the responses within each subscale and across the entire scale, with higher scores indicating higher levels of the measured constructs. The scale demonstrated an internal consistency of 0.79, 95% CI [0.76, 0.82].

Since no validated Romanian versions were available, the Objectified Body Consciousness Scale (OBCS) and the Body Image-Acceptance and Action Questionnaire (BI-AAQ) were translated using the 5-step adaptation procedure recommended by Beaton et al. (67). This included forward translation, synthesis, back-translation, expert committee review, and informal testing on a small group of Romanian women to ensure clarity and semantic accuracy. The final versions demonstrated good internal consistency (Cronbach's $\alpha = 0.79$ for the OBCS and $\alpha = 0.94$ for the BI-AAQ).

Procedure

Prior to conducting this research, ethical approval was obtained from the Ethics Committee of West University of Timișoara (approval code: 88120/23.11.2023). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Participants were recruited using a non-probability snowball sampling method, which was appropriate given the exploratory nature of the study and the lack of access to a centralized sampling frame for Romanian adult women. The initial pool of participants was identified through the academic and professional networks of the authors, including university students, colleagues, and collaborators in the fields of psychology, health, and education. The survey was hosted on Google Forms and disseminated exclusively online.

No paid advertisements were used in the recruitment process. The survey link was shared organically via social media platforms, including public and private Facebook groups, discussion forums, and mailing lists. These included communities focused on topics such as body image, self-acceptance, and psychological well-being, as well as general-interest groups for women. Most participants were reached through networks centered in the Timișoara region, which likely resulted in a sample composed predominantly of individuals from urban areas. No data were collected regarding participants' specific place of residence (urban vs. rural), as the recruitment process did not target or reach a geographically or residentially diverse population. This strategy nevertheless allowed for broad thematic dissemination of the study.

Potential participants were provided with detailed information about the study requirements and were assured of data confidentiality, anonymity, and the exclusive use of their responses for scientific research purposes. They were also informed of the estimated time needed to complete the survey (20–25 min) and reminded of their right to withdraw at any time if they experienced discomfort or distress.

Informed consent was obtained through a digital form prior to participation. Participants then completed the anonymous questionnaire, which included the validated scales described above. No financial compensation was offered. Before completing the scales, participants were asked to optionally provide their email addresses if they were willing to be contacted for future studies. Data collection took place between November and December 2023. Internet Protocol (IP) addresses were verified to ensure that no participant completed the survey multiple times.

Results

Preliminary analyses

Table 1 presents the central tendency indicators (mean and standard deviation) for the variables included in the study. Prior to conducting the mediation analyses, all assumptions were tested. Linearity was assessed through scatterplots with fitted regression lines between predictor, mediator, and outcome variables, confirming the presence of linear relationships.

Normality of distributions was evaluated by examining skewness and kurtosis values. As shown in Table 1, all variables exhibited values within commonly accepted thresholds—skewness within ±2 and

TABLE 1 Cronbach's alpha coefficient values and descriptive statistics for the analyzed variables.

Variable	Cronbach's alpha	M	Minim and maximum possible variable values	SD	Skewness	Kurtosis
Body Objectification (OBCS)	0.79	97.33	24–168	17.61	0.108	0.351
Body Image Flexibility (BI-AAQ)	0.94	58.02	12–84	18.70	−0.513	−0.687
Intuitive Eating (IES-2)	0.91	83.44	23–115	15.99	−0.203	−0.516
Acceptance of Cosmetic Surgeries for Intrapersonal Reasons (ACSS – I)	0.90	21.33	5–35	7.97	−0.211	−0.666
Acceptance of Cosmetic Surgeries for Social Reasons (ACSS – S)	0.86	17.74	5–35	9.01	0.151	−1.184
Acceptance of Cosmetic Surgeries, future consideration of cosmetic surgeries (ACSS – C)	0.93	14.72	5–35	7.10	0.660	−0.198

M, Mean; SD, Standard Deviation; ACSS – I, Acceptance of Cosmetic Surgeries for Intrapersonal reasons; ACSS – S, Acceptance of Cosmetic Surgeries for Social reasons; ACSS – C, Acceptance of Cosmetic Surgeries, future consideration of cosmetic surgery.

TABLE 2 Intercorrelations among study variables.

Variable	OBCS	BI-AAQ	IES-2	ACSS – I	ACSS – S	ACSS – C
OBCS		−0.62**	−0.50**	0.22**	0.35**	0.28**
BI-AAQ			0.60**	−0.16**	−0.33**	−0.32**
IES-2				−0.09*	−0.25**	−0.21**
ACSS – I					0.75**	0.67**
ACSS – S						0.73**
ACSS – C						

**$p < 0.01$, *$p < 0.05$; OBCS, Body Objectification; BI-AAQ, Body Image Flexibility; IES-2, Intuitive Eating; ACSS – I, Acceptance of Cosmetic Surgeries for Intrapersonal reasons; ACSS – S, Acceptance of Cosmetic Surgeries for Social reasons; ACSS – C, Acceptance of Cosmetic Surgeries, future consideration of cosmetic surgery.

kurtosis within ±7—based on guidelines drawn from applied psychometric literature (68, 69). Regardless of the guideline applied, our variables met the criteria for acceptable normality. Homoscedasticity was tested through the visual inspection of residual scatterplots, which showed no pattern indicating heteroscedasticity. These results support the robustness of the regression-based mediation approach used in this study. Additionally, we examined the potential for multicollinearity between the two mediators—intuitive eating and body image flexibility. The Pearson correlation coefficient between them was $r = 0.60$, $p < 0.001$, indicating a moderate relationship that does not exceed conventional thresholds for multicollinearity concerns ($r > 0.70$; (70, 71)). To further ensure the robustness of the model, Variance Inflation Factor (VIF = 1.587) and Tolerance (0.630) values were calculated in SPSS, both falling within acceptable limits (VIF < 5, Tolerance > 0.10; (72)). These results confirm that multicollinearity was not present and that the two mediators contributed distinct information to the analysis. Significant correlations were observed among all study variables (See Table 2).

A parallel mediation model was constructed, in which each of the three factors of the ACSS scale (Intrapersonal, Social, and Consider) was treated as the dependent variable in turn. Scores on the body image flexibility and intuitive eating scales were considered mediators, while body objectification was treated as the independent variable. Model 4 of the PROCESS extension, version 4.2 for SPSS (73), was used for the analysis.

To account for the influence of extraneous variables, age, educational status, ethnicity, relationship status, and body mass index were controlled as covariates in each analyzed model. Following Hayes's (113) recommendation, the bootstrap sample size was set at 10,000, with a 95% confidence interval in PROCESS to ensure the stability of each proposed mediation model. A statistically significant effect was noted when 0 was not included within the confidence intervals (74). In this study, effect sizes were evaluated through standardized regression coefficients (β) and indirect effects with 95% bias-corrected bootstrap confidence intervals, consistent with the recommendations for mediation analysis.

Testing parallel mediation models

The first parallel mediation model was constructed with body objectification as the independent variable, intuitive eating and body image flexibility as mediators, and the desire to undergo cosmetic surgery for intrapersonal reasons as the dependent variable. Age, educational status, ethnicity, relationship status, and body mass index were included as covariates and controlled for in the analysis. Body objectification was negatively associated with body image flexibility ($\beta = -0.55$, $p < 0.01$). However, no significant association was found between body image flexibility and the desire to undergo cosmetic surgery for intrapersonal reasons ($\beta = -0.08$, $p = 0.169$). Mediation

analysis indicated that body image flexibility did not mediate the relationship between body objectification and the desire to undergo cosmetic surgery for intrapersonal reasons [indirect effect 1 = 0.04, CIs = (−0.02, 0.01)]. Similarly, body objectification was negatively associated with intuitive eating ($\beta = -0.44$, $p < 0.001$), but no significant association was found between intuitive eating and the desire to undergo cosmetic surgery for intrapersonal reasons ($\beta = 0.03$, $p = 0.578$). Thus, intuitive eating also did not mediate the relationship between body objectification and the desire to undergo cosmetic surgery for intrapersonal reasons [indirect effect 2 = −0.01, CIs = (−0.06, 0.03)]. A positive direct relationship was observed between body objectification and the desire to undergo cosmetic surgery for intrapersonal reasons ($\beta = 0.06$, $p < 0.05$), with a total effect of $\beta = 0.08$, $p < 0.01$.

The second parallel mediation model was constructed with body objectification as the independent variable, intuitive eating and body image flexibility as mediators, and the desire to undergo cosmetic surgery for social reasons as the dependent variable. Age, educational status, ethnicity, relationship status, and body mass index were again included as covariates. Body objectification was negatively associated with body image flexibility ($\beta = -0.55$, $p < 0.001$), and body image flexibility was negatively associated with the desire to undergo cosmetic surgery for social reasons ($\beta = -0.16$, $p < 0.01$). Mediation analysis revealed that body image flexibility mediated the relationship between body objectification and the desire to undergo cosmetic surgery for social reasons [indirect effect 1 = 0.09, CIs = (0.02, 0.16)]. Meanwhile, body objectification was negatively associated with intuitive eating ($\beta = -0.44$, $p < 0.001$), but no significant association was found between intuitive eating and the desire to undergo cosmetic surgery for social reasons ($\beta = -0.04$, $p = 0.390$). Thus, intuitive eating did not mediate the relationship between body objectification and the desire to undergo cosmetic surgery for social reasons [indirect effect 2 = 0.02, CIs = (−0.03, 0.07)]. Given the positive association between body objectification and the desire to undergo cosmetic surgery for social reasons ($\beta = 0.09$, $p < 0.01$), it can be concluded that body image flexibility partially mediates this relationship. The total effect was $\beta = 0.15$, $p < 0.001$, and the total indirect effect was also significant [indirect total = 0.11, CIs = (0.05, 0.18)].

The third parallel mediation model was constructed with body objectification as the independent variable, intuitive eating and body image flexibility as mediators, and the likelihood of undergoing cosmetic surgery in the future as the dependent variable. Age, educational status, ethnicity, relationship status, and body mass index were included as covariates and controlled for in the analysis.

Body objectification was negatively associated with body image flexibility ($\beta = -0.55$, $p < 0.001$), and body image flexibility was negatively associated with the likelihood of undergoing cosmetic surgery in the future ($\beta = -0.28$, $p < 0.001$). Mediation analysis indicated that body image flexibility mediated the relationship between body objectification and the likelihood of undergoing cosmetic surgery in the future [indirect effect 1 = 0.15, CIs = (0.09, 0.22)].

Simultaneously, body objectification was negatively associated with intuitive eating ($\beta = -0.44$, $p < 0.001$), but no significant association was found between intuitive eating and the likelihood of undergoing cosmetic surgery in the future ($\beta = -0.01$, $p = 0.728$). Thus, intuitive eating did not mediate the relationship between body objectification and the likelihood of undergoing cosmetic surgery in the future [indirect effect 2 = 0.001, CIs = (−0.03, 0.05)].

Since no direct associations were found between body objectification and the likelihood of undergoing cosmetic surgery in the future ($\beta = 0.04$, $p > 0.05$), it can be concluded that body image flexibility fully mediates the relationship between the two variables. The total effect was $\beta = 0.10$, $p < 0.001$, and the total indirect effect was also significant [indirect total = 0.16, CIs = (0.09, 0.23)].

Discussion

The objective of this study was to examine whether body image flexibility and intuitive eating mediate the association between body objectification and the desire to undergo cosmetic surgery for intrapersonal and social reasons, as well as the likelihood of pursuing such interventions in the future, within an exclusively female population in Romania.

Across all tested models, body objectification was negatively associated with intuitive eating. Intuitive eating showed negative, yet non-significant, associations with the desire to undergo cosmetic surgery for social reasons and future intentions, and a positive, non-significant association with the intrapersonal motive. Consequently, intuitive eating did not emerge as a significant mediator in any of the proposed models.

This outcome may be understood in light of previous findings, which primarily link intuitive eating to eating behaviors and disorders (46–48). Individuals who engage in intuitive eating rely on physiological hunger and satiety cues to guide their food-related decisions (75). Moreover, intuitive eating is a relatively new concept, positioned as a psychologically adaptive strategy when compared to emotional or restrictive eating patterns (76), which are reportedly more prevalent among the Romanian population (77, 78).

Given the inconsistent levels of nutritional education in Romania (63, 79), it is plausible that participants were unfamiliar with this approach or less inclined to associate it with body-related investment strategies such as cosmetic surgery. It is also possible that intuitive eating, when employed, is more often linked to non-invasive appearance regulation behaviors such as healthy eating (80), gym participation (81), or maintaining a toned physique (82). Although intuitive eating was not found to be a significant mediator in the current study, this finding does not necessarily imply that the construct is irrelevant to appearance-related investment behaviors. While the mean score on the intuitive eating scale was above the minimum, suggesting some familiarity or openness to the construct, this does not guarantee consistent behavioral application or deep internalization of intuitive eating principles. As Avalos and Tylka (57) noted, intuitive eating is a multifaceted construct that requires both body trust and attitudinal alignment—not merely occasional reliance on hunger cues. In the Romanian cultural context, where appearance-focused norms and diet culture remain prevalent (63, 79), it is plausible that intuitive eating is not as deeply rooted or practiced as in populations where it has been more widely promoted or studied. Consequently, even moderate levels of intuitive eating may not be sufficient to act as a protective factor against objectification-related cosmetic surgery motivations in this sample (57). Future research using qualitative methods or

subscale-level analysis could help clarify how intuitive eating is expressed and internalized in such cultural contexts.

Regarding body image flexibility, this construct was consistently and negatively associated with body objectification in all three models. Significant negative associations were also found between body image flexibility and the desire to undergo cosmetic surgery for social reasons and future intentions. The association with intrapersonal desire was negative but not statistically significant. As such, body image flexibility significantly mediated two of the three relationships tested.

These findings are consistent with prior research highlighting body image flexibility as a protective psychological resource. One possible explanation for these results lies in the social interaction model of objectification, which posits that individuals weigh the costs and benefits of objectifying interactions within patriarchal structures that grant men greater power and reduce women to bodily attributes (83). While men are known to objectify women through suggestive comments and gazes (84), women also engage in self-objectification through strategies such as provocative dress (85) or curated online appearances (86).

In this context, Romania remains shaped by persistent patriarchal norms and post-communist gender expectations (87). Following Romania's accession to the European Union and neoliberal transitions, women have increasingly been positioned as hyper-feminine, sexualized subjects, especially in the media (28, 88, 89). The present findings align with these cultural patterns, suggesting that cosmetic surgery motivations may be rooted in sociocultural dynamics that reinforce appearance-based worth.

Theoretical frameworks such as self-verification (90), symbolic self-completion (91), and self-affirmation theory (92) further explain how individuals pursue identity-consistent behaviors. When objectification is normalized and perceived as socially rewarding, women may engage in body-altering practices as a means of reinforcing their self-image and gaining social validation (93).

These dynamics may help explain why lower levels of body image flexibility were associated with cosmetic surgery motivations, particularly for social reasons and future intentions. Recent studies have emphasized how social media environments amplify these pressures by promoting narrow beauty ideals and appearance-based comparison. Zaharia and Gonța (94) demonstrate that exposure to idealized body representations on social platforms contributes to internalization of unrealistic esthetic standards, body dissatisfaction, and compensatory behaviors aimed at reducing the gap between actual and ideal appearance. Similarly, Arab et al. (95) found that viewing cosmetic surgery-related content online and comparing oneself to influencers significantly increases the likelihood of considering cosmetic procedures, often driven by perceived social expectations rather than intrinsic desire. Franchina and Lo Coco (96) further argue that even positive social media feedback may reinforce body monitoring and concern, as individuals internalize the idea that their appearance is continuously evaluated. Taken together, these findings suggest that the pursuit of cosmetic enhancement is not merely esthetic, but reflects a deeper social logic of validation, symbolic affirmation, and identity maintenance. In contrast, the intrapersonal pathway was not statistically significant, potentially because such motivations relate more to self-worth and internal validation, which may not be fully captured by body image flexibility alone (97).

The desire to enhance physical appearance may also be fueled by broader interpersonal concerns, such as partner retention strategies (98–100) or intrasexual competition (101, 102). Previous research indicates that women may be more likely to invest in appearance-enhancing behaviors when competing for male attention (103).

Finally, our results complement those of Huang et al. (41), who found that body image inflexibility mediates the relationship between self-objectification and cosmetic surgery interest. Individuals with low flexibility may rely on maladaptive coping strategies to manage body-related distress and unfavorable comparisons (42), including cosmetic procedures aimed at restoring perceived body control and social value.

Limitations and future research

The primary limitation of this study lies in its cross-sectional design, which does not allow for causal inferences. Longitudinal or experimental intervention studies are needed to examine how these variables change over time and to explore the potential of intuitive eating and body image flexibility as protective and adaptive factors in the relationship between objectification and the desire to undergo cosmetic surgery.

Another limitation concerns the composition of the sample. Most participants were recruited from the Timișoara region, which may reduce the geographical and cultural variability within the sample. Additionally, information regarding the participants' residential environment (urban vs. rural) was not collected, although the recruitment methods likely reached predominantly urban individuals. These factors limit the generalizability of the findings to women from other regions of Romania or from rural settings, where sociocultural attitudes toward body image and cosmetic surgery may differ.

An additional limitation concerns the recruitment strategy. Participants were recruited online, primarily through Facebook groups oriented toward themes such as body image, self-acceptance, psychological wellbeing, or general women's interests. Although the study invitation was framed broadly and did not explicitly mention cosmetic surgery or related constructs, it is possible that individuals already invested in appearance-related issues were more likely to participate. This self-selection may limit the generalizability of the findings to the broader female population, particularly to women who are less engaged with appearance or body image topics. Future research should consider broader and more diverse recruitment strategies to minimize potential sampling biases.

Furthermore, although the study included a wide age range of participants (18–79 years), the majority were younger women, with a mean age of 29.61 years. Age was statistically controlled for in all analyses to minimize potential confounding; however, objectification experiences and attitudes toward cosmetic surgery may vary across developmental stages. Therefore, future research could benefit from stratified analyses or targeted recruitment to explore age-specific patterns. Such investigations may help clarify whether the psychological mechanisms identified in this study operate differently across early, middle, and later adulthood.

Additionally, a limitation of the current study is the lack of detailed information regarding the specific composition of the ethnic minority group(s). Although ethnicity was controlled for in the analyses, the use of general ethnic categories ("majority" vs. "minority") limits the possibility of exploring within-group differences

among minority participants. Future research may benefit from including more granular ethnic identification, provided confidentiality can be ensured.

Moreover, the present study did not examine the specific motivations underlying participants' interest in cosmetic surgery beyond the three general dimensions assessed (intrapersonal, social, and future intention). It is possible that intuitive eating may be more or less relevant depending on the reason for pursuing surgery—for example, motivations driven by body dissatisfaction may relate differently to eating behaviors than those rooted in social approval or appearance enhancement. Additionally, the study did not assess which specific body areas participants were interested in modifying through cosmetic surgery (e.g., face, breasts, and body fat). This distinction may be important, as dissatisfaction with weight-related areas could be more closely linked to eating behaviors and intuitive eating than dissatisfaction with features less influenced by weight. Future research should incorporate assessments of the targeted body areas to better understand how different types of appearance concerns may interact with psychological factors such as intuitive eating.

Another methodological consideration concerns the inclusion of body mass index (BMI) as a covariate in all mediation models. Although BMI was not a primary variable of interest, it has been associated in prior research with both objectification experiences and body image-related outcomes, including appearance investment and cosmetic surgery intentions. Therefore, we included it to statistically adjust for its potential confounding influence on the relationships under investigation. Similar analytic choices have been reported in previous studies examining body image and esthetic attitudes (104–106). However, we acknowledge the ongoing debate in the literature regarding the role of BMI as a potential mediator or collider variable in appearance-related research. Future studies might consider modeling BMI differently or comparing models with and without BMI as a covariate to better understand its function within these psychological processes. Sensitivity analyses were also conducted excluding BMI as a covariate. These analyses indicated that the exclusion of BMI did not substantively alter the direction, significance, or interpretation of the direct and indirect effects observed in the study.

Finally, all research instruments were self-report scales, which may introduce response bias due to the inability to control factors specific to the respondents (e.g., their level of motivation to respond, providing answers inconsistent with reality to appear socially desirable).

In future research, it would also be valuable to explore other psychological factors that may mediate or moderate the relationship between self-objectification and the desire to undergo cosmetic surgery. Variables such as self-esteem (107), body dysmorphic disorder symptoms (108), and perfectionism (109) have been associated with body image disturbances and esthetic investment. For instance, Mancin et al. (108) found that individuals with higher levels of body dysmorphic disorder symptoms were more likely to engage in photo-related behaviors, such as frequent photo editing or sharing, which reflect heightened appearance concerns and may be linked to motivations for cosmetic procedures. Incorporating such constructs into future models could provide a more comprehensive understanding of the psychological mechanisms underlying body-related distress and the interest in cosmetic surgery.

Moreover, although this study tested three separate mediation models using different dependent variables, we did not apply formal correction procedures for Type I error (e.g., Bonferroni). Each model was theory-driven and addressed a distinct dimension of cosmetic surgery motivations. As Hayes (73) notes, applying overly strict correction methods in theoretically grounded models can unnecessarily inflate the risk of Type II errors. Additionally, the use of 10,000 bootstrap resamples offers a robust method for estimating indirect effects, reducing the likelihood of spurious findings. Future research may benefit from replication using preregistered designs or confirmatory models in independent samples.

Theoretical and practical implications

This study underscores the importance of integrating cultural context when examining the psychological mechanisms linking body objectification to cosmetic surgery motivations. Rather than attempting to validate an existing theoretical model, our aim was to explore the applicability of concepts such as body image flexibility and intuitive eating within a Romanian sample—a population underrepresented in this area of research. Given Romania's distinct sociocultural backdrop, shaped by both patriarchal values and post-communist gender dynamics, we argue that theoretical frameworks developed in Western contexts may not generalize seamlessly across cultures. As such, testing whether these mechanisms operate similarly in non-Western or transitional societies is a necessary step toward building culturally sensitive models of appearance-related investment. Given Romania's specific sociocultural context, including its evolving post-communist identity and the influence of traditional gender expectations, the use of culturally adapted and semantically coherent measures is essential (110). This ensures that psychological constructs retain their theoretical integrity across languages and contexts. Our findings offer preliminary insights into how these psychological constructs manifest in a Romanian context and highlight the need for further cross-cultural investigations.

At the same time, psychotherapists, counselors, and school psychologists can develop prevention, psychoeducation, and intervention programs to emphasize the negative aspects of objectification in societies where such behavior is normalized. In this context, effective communication strategies are essential to ensure that messages related to body functionality, self-acceptance, and intuitive eating are accessible and impactful (111). Children and adolescents can thus learn from an early age to appreciate their bodies for their functionality rather than what they can offer to others. Educating individuals about intuitive eating can serve as a valuable starting point for fostering a positive relationship with their bodies. However, it is important to note that, in the present study, intuitive eating did not emerge as a significant mediator, and thus these recommendations should be considered preliminary and subject to further empirical validation in future research.

Conclusion

In a society that normalizes objectification and places significant emphasis on physical appearance, it is crucial to investigate factors

that can counteract the harmful effects of these behaviors. Promoting a positive relationship with one's body by appreciating it for its functionality and fostering trust in the signals it provides regarding its needs can serve as precursors to enhanced psychological and physical well-being.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Ethics Committee of West University of Timişoara. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

GL: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. MV: Conceptualization, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

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

Conflict of interest

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

Generative AI statement

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2025.1537433/full#supplementary-material

References

1. Klaczynski PA, Goold KW, Mudry JJ. Culture, obesity stereotypes, self-esteem, and the "thin ideal": a social identity perspective. *J Youth Adolesc*. (2004) 33:307–17. doi: 10.1023/B:JOYO.0000032639.71472.19

2. Swami V. Cultural influences on body size ideals. *Eur Psychol*. (2015) 20:44–51. doi: 10.1027/1016-9040/a000150

3. Tylka TL, Wilcox JA. Are intuitive eating and eating disorder symptomatology opposite poles of the same construct? *J Couns Psychol*. (2006) 53:474–85. doi: 10.1037/0022-0167.53.4.474

4. Fitzsimmons-Craft EE, Harney MB, Koehler LG, Danzi LE, Riddell MK, Bardone-Cone AM. Explaining the relation between thin ideal internalization and body dissatisfaction among college women: the roles of social comparison and body surveillance. *Body Image*. (2012) 9:43–9. doi: 10.1016/j.bodyim.2011.09.002

5. Rukavina T, Pokrajac-Bulian A. Thin-ideal internalization, body dissatisfaction and symptoms of eating disorders in Croatian adolescent girls. *Eating Weight Disorders-Stud Anorexia, Bulimia Obesity*. (2006) 11:31–7. doi: 10.1007/BF03327741

6. Keel PK, Forney KJ. Psychosocial risk factors for eating disorders. *Int J Eat Disord*. (2013) 46:433–9. doi: 10.1002/eat.22094

7. Yamamiya Y, Stice E. Risk factors that predict future onset of anorexia nervosa, bulimia nervosa, binge eating disorder, and purging disorder in adolescent girls. *Behav Ther*. (2024) 55:712–23. doi: 10.1016/j.beth.2023.10.002

8. Fernandez S, Pritchard M. Relationships between self-esteem, media influence and drive for thinness. *Eat Behav*. (2012) 13:321–5. doi: 10.1016/j.eatbeh.2012.05.004

9. Hawkins N, Richards PS, Granley HM, Stein DM. The impact of exposure to the thin-ideal media image on women. *Eat Disord*. (2004) 12:35–50. doi: 10.1080/10640260490267751

10. Lunde C. Acceptance of cosmetic surgery, body appreciation, body ideal internalization, and fashion blog reading among late adolescents in Sweden. *Body Image*. (2013) 10:632–5. doi: 10.1016/j.bodyim.2013.06.007

11. Wu Y, Alleva JM, Broers NJ, Mulkens S. Attitudes towards cosmetic surgery among women in China and the Netherlands. *PLoS One*. (2022) 17:e0267451. doi: 10.1371/journal.pone.0267451

12. Dakanalis A, Carrà G, Calogero R, Fida R, Clerici M, Zanetti MA, et al. The developmental effects of media-ideal internalization and self-objectification processes on adolescents' negative body-feelings, dietary restraint, and binge eating. *Eur Child Adolesc Psychiatry*. (2015) 24:997–1010. doi: 10.1007/s00787-014-0649-1

13. Harper B, Tiggemann M. The effect of thin ideal media images on women's self-objectification, mood, and body image. *Sex Roles*. (2008) 58:649–57. doi: 10.1007/s11199-007-9379-x

14. Fredrickson BL, Roberts TA. Objectification theory: toward understanding women's lived experiences and mental health risks. *Psychol Women Q*. (1997) 21:173–206.

15. Calogero RM, Pina A, Park LE, Rahemtulla Z. Objectification theory predicts college women's attitudes toward cosmetic surgery. *Sex Roles*. (2010) 63:32–41. doi: 10.1007/s11199-010-9759-5

16. Dryden C, Anderson J. The dark triad, trait-based self-objectification, and body image concerns in young women. *Pers Individ Differ*. (2019) 145:1–8. doi: 10.1016/j.paid.2019.03.015

17. Mercurio AE, Landry LJ. Self-objectification and well-being: the impact of self-objectification on women's overall sense of self-worth and life satisfaction. *Sex Roles*. (2008) 58:458–66. doi: 10.1007/s11199-007-9357-3

18. Schaefer LM, Burke NL, Calogero RM, Menzel JE, Krawczyk R, Thompson JK. Self-objectification, body shame, and disordered eating: testing a core mediational model of objectification theory among white, black, and Hispanic women. *Body Image*. (2018) 24:5–12. doi: 10.1016/j.bodyim.2017.10.005

19. Morris KL, Goldenberg J, Boyd P. Women as animals, women as objects: evidence for two forms of objectification. *Personal Soc Psychol Bull*. (2018) 44:1302–14. doi: 10.1177/0146167218765739

20. Roberts T-A, Calogero RM, Gervais SJ. (2018). Objectification theory: Continuing contributions to feminist psychology. In CB Travis, JW White, A Rutherford, WS Williams, SL Williams and SLCKF Wyche, editors. *APA handbook of the psychology of women: History, theory, and battlegrounds*. American Psychological Association. 249–271. doi: 10.1037/0000059-013

21. Vaughan-Turnbull C, Lewis V. Body image, objectification, and attitudes toward cosmetic surgery. *J Appl Biobehav Res*. (2015) 20:179–96. doi: 10.1111/jabr.12035

22. Bucur M. Gender analysis and gender ideology: gender studies in Romania. *Stud Polit*. (2021) 21:385–407.

23. Massino J. Something old, something new: marital roles and relations in state socialist Romania. *J Womens Hist*. (2010) 22:34–60. doi: 10.1353/jowh.0.0132

24. Massino J. Gender and the ambiguities of economic transition in Romania In: K Fábián, JE Johnson and M Lazda, editors. The Routledge handbook of gender in Central-Eastern Europe and Eurasia. (London: Routledge) (2021). 357–65.

25. Bucur-Deckard M, Miroiu M. Birth of democratic citizenship: Women and power in modern Romania. Bloomington, Indiana, USA: Indiana University Press (2018).

26. Popa D, Gavriliu D. Gender representations and digital media. *Procedia Soc Behav Sci*. (2015) 180:1199–206. doi: 10.1016/j.sbspro.2015.02.244

27. Cuşmir AA. Gender equality in Romania. Statistical data and cultural norms. *Rom J Sociol Stud*. (2015) 2:137–48.

28. Oprica V. Gender equality and conflicting attitudes toward women in post-communist Romania. *Hum Rights Rev*. (2008) 9:29–40. doi: 10.1007/s12142-007-0027-1

29. Kaser K. (ed). Porno-chic cultures In: Femininities and masculinities in the digital age: Realia and utopia in the Balkans and South Caucasus. Cham: Springer International Publishing (2021). 171–221.

30. Frunza M, Grad I, Sandu F. Ethical aspects of gender stereotypes in Romanian advertising (aspects Éthiques des Stéréotypes De genre Dans les Publicités Roumaines). *ESSACHESS-J Commun Stud*. (2016) 9:17.

31. Hayes SC, Strosahl KD, Wilson KG. Acceptance and commitment therapy: The process and practice of mindful change. New York, USA: Guilford press (2011).

32. Sandoz EK, Wilson KG, Merwin RM, Kellum KK. Assessment of body image flexibility: the body image-acceptance and action questionnaire. *J Contextual Behav Sci*. (2013) 2:39–48. doi: 10.1016/j.jcbs.2013.03.002

33. Brichacek AL, Neill JT, Murray K, Rieger E, Watsford C. Ways of responding to body image threats: development of the body image flexibility and inflexibility scale for youth. *J Contextual Behav Sci*. (2023) 30:31–40. doi: 10.1016/j.jcbs.2023.08.007

34. Lee EB, Ong CW, Twohig MP, Lensegrav-Benson T, Quakenbush-Roberts B. Increasing body image flexibility in a residential eating disorder facility: correlates with symptom improvement. *Eat Disord*. (2018) 26:185–99. doi: 10.1080/10640266.2017.1366229

35. Tan W, Holt N, Krug I, Ling M, Klettke B, Linardon J, et al. Trait body image flexibility as a predictor of body image states in everyday life of young Australian women. *Body Image*. (2019) 30:212–20. doi: 10.1016/j.bodyim.2019.07.006

36. Pellizzer ML, Waller G, Wade TD. Body image flexibility: a predictor and moderator of outcome in transdiagnostic outpatient eating disorder treatment. *Int J Eat Disord*. (2018) 51:368–72. doi: 10.1002/eat.22842

37. Rogers CB, Webb JB, Jafari N. A systematic review of the roles of body image flexibility as correlate, moderator, mediator, and in intervention science (2011–2018). *Body Image*. (2018) 27:43–60. doi: 10.1016/j.bodyim.2018.08.003

38. Duarte C, Pinto-Gouveia J. Body image flexibility mediates the effect of body image-related victimization experiences and shame on binge eating and weight. *Eat Behav*. (2016) 23:13–8. doi: 10.1016/j.eatbeh.2016.07.005

39. Hill ML, Masuda A, Latzman RD. Body image flexibility as a protective factor against disordered eating behavior for women with lower body mass index. *Eat Behav*. (2013) 14:336–41. doi: 10.1016/j.eatbeh.2013.06.003

40. Webb JB. Body image flexibility contributes to explaining the link between body dissatisfaction and body appreciation in white college-bound females. *J Contextual Behav Sci*. (2015) 4:176–83. doi: 10.1016/j.jcbs.2015.06.001

41. Huang X, Lin R, Yan Y. Self-objectification and cosmetic surgery consideration among Chinese young women: the mediating roles of alienation and body image inflexibility. *J Health Psychol*. (2024) 29:1006–17. doi: 10.1177/13591053231222854

42. Mancuso SG. Body image inflexibility mediates the relationship between body image evaluation and maladaptive body image coping strategies. *Body Image*. (2016) 16:28–31. doi: 10.1016/j.bodyim.2015.10.003

43. Tribole E, Resch E. Intuitive eating. New York, USA: Macmillan (2012).

44. Barrada JR, Cativiela B, Van Strien T, Cebolla A. Intuitive eating. *Eur J Psychol Assess*. (2018) 36:19–31. doi: 10.1027/1015-5759/a000482

45. Tylka TL. Development and psychometric evaluation of a measure of intuitive eating. *J Couns Psychol*. (2006) 53:226. doi: 10.1037/0022-0167.53.2.226

46. Duran S, Bozkurt G, Doğan D, Aygen S, Yıldırım E. The effects of intuitive eating on mental well-being and eating behaviors of health workers. *Ankara Med J*. (2022) 22:172–181. doi: 10.5505/amj.2022.99897

47. Giacone L, Sob C, Siegrist M, Hartmann C. Intuitive eating and its influence on self-reported weight and eating behaviors. *Eat Behav*. (2024) 52:101844. doi: 10.1016/j.eatbeh.2024.101844

48. Hazzard VM, Telke SE, Simone M, Anderson LM, Larson NI, Neumark-Sztainer D. Intuitive eating longitudinally predicts better psychological health and lower use of disordered eating behaviors: findings from EAT 2010–2018. *Eating Weight Disorders-Stud Anorexia, Bulimia Obesity*. (2021) 26:287–94. doi: 10.1007/s40519-020-00852-4

49. Dockendorff SA, Petrie TA, Greenleaf CA, Martin S. Intuitive eating scale: an examination among early adolescents. *J Couns Psychol*. (2012) 59:604–11. doi: 10.1037/a0029962

50. Gödde JU, Yuan TY, Kakinami L, Cohen TR. Intuitive eating and its association with psychosocial health in adults: a cross-sectional study in a representative Canadian sample. *Appetite*. (2022) 168:105782. doi: 10.1016/j.appet.2021.105782

51. Babbott KM, Cavadino A, Brenton-Peters J, Consedine NS, Roberts M. Outcomes of intuitive eating interventions: a systematic review and meta-analysis. *Eat Disord*. (2023) 31:33–63. doi: 10.1080/10640266.2022.2030124

52. Keirns NG, Hawkins MA. The relationship between intuitive eating and body image is moderated by measured body mass index. *Eat Behav*. (2019) 33:91–6. doi: 10.1016/j.eatbeh.2019.04.004

53. Linardon J. Reciprocal associations between intuitive eating and positive body image components: a multi-wave, cross-lagged study. *Appetite*. (2022) 178:106184. doi: 10.1016/j.appet.2022.106184

54. Messer M, McClure Z, Lee S, Linardon J. Bidirectional relationships between intuitive eating and shape and weight overvaluation, dissatisfaction, preoccupation, and fear of weight gain: a prospective study. *Body Image*. (2021) 39:227–31. doi: 10.1016/j.bodyim.2021.09.001

55. Atalay S, Baş M, Eren B, Karaca E. Intuitive eating, diet quality, body mass index and abnormal eating: a cross-sectional study in young Turkish women. *Prog Nutr*. (2020) 22:1–11. doi: 10.23751/pn.v22i4.9773

56. Camilleri GM, Méjean C, Bellisle F, Andreeva VA, Kesse-Guyot E, Hercberg S, et al. Intuitive eating is inversely associated with body weight status in the general population-based NutriNet-santé study. *Obesity*. (2016) 24:1154–61. doi: 10.1002/oby.21440

57. Avalos LC, Tylka TL. Exploring a model of intuitive eating with college women. *J Couns Psychol*. (2006) 53:486–97. doi: 10.1037/0022-0167.53.4.486

58. Messer M, Tylka TL, Fuller-Tyszkiewicz M, Linardon J. Does body appreciation predict decreases in eating pathology via intuitive eating? A longitudinal mediation analysis. *Body Image*. (2022) 43:107–11. doi: 10.1016/j.bodyim.2022.08.014

59. Luo YJ, Niu GF, Kong FC, Chen H. Online interpersonal sexual objectification experiences and Chinese adolescent girls' intuitive eating: the role of broad conceptualization of beauty and body appreciation. *Eat Behav*. (2019) 33:55–60. doi: 10.1016/j.eatbeh.2019.03.004

60. Murray K, Rieger E, Brown PM, Brichacek A, Walker I. Body image explains differences in intuitive eating between men and women: examining indirect effects across negative and positive body image. *Body Image*. (2023) 45:369–81. doi: 10.1016/j.bodyim.2023.03.018

61. Burton J, Nandi A, Platt L. Measuring ethnicity: challenges and opportunities for survey research. *Ethn Racial Stud*. (2010) 33:1332–49. doi: 10.1080/01419870903527801

62. Tylka TL, Kroon Van Diest AM. The intuitive eating scale–2: item refinement and psychometric evaluation with college women and men. *J Couns Psychol*. (2013) 60:137–53. doi: 10.1037/a0030893

63. Vintilă M, Todd J, Goian C, Tudorel O, Barbat CA, Swami V. The Romanian version of the intuitive eating Scale-2: assessment of its psychometric properties and gender invariance in Romanian adults. *Body Image*. (2020) 35:225–36. doi: 10.1016/j.bodyim.2020.09.009

64. Henderson-King D, Henderson-King E. Acceptance of cosmetic surgery: scale development and validation. *Body Image*. (2005) 2:137–49. doi: 10.1016/j.bodyim.2005.03.003

65. Lazarescu G, Maïano C, Vintilă M, Goian C, Swami V. Psychometric properties of a Romanian translation of the acceptance of cosmetic surgery scale (ACSS): an examination using bifactor exploratory structural equation modelling. *Body Image*. (2023) 45:273–83. doi: 10.1016/j.bodyim.2023.03.011

66. McKinley NM, Hyde JS. The objectified body consciousness scale: development and validation. *Psychol Women Q*. (1996) 20:181–215.

67. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*. (2000) 25:3186–91. doi: 10.1097/00007632-200012150-00014

68. Curran PJ, West SG, Finch JF. The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychol Methods*. (1996) 1:1–16.

69. Mallery P., George D. SPSS for windows: Step by step (17.0 update). Boston, MA: Allyn & Bacon (2010).

70. Cohen J, Cohen P, West SG, Aiken LS. Applied multiple regression/correlation analysis for the behavioral sciences. New York, USA: Routledge (2013).

71. Tabachnick BG, Fidell LS. Using multivariate statistics. *6th* ed. Boston: Pearson (2013).

72. O'brien RM. A caution regarding rules of thumb for variance inflation factors. *Qual Quant*. (2007) 41:673–90. doi: 10.1007/s11135-006-9018-6

73. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. *3rd* ed. New York: The Guilford Press (2022).

74. Hayes AF, Scharkow M. The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: does method really matter? *Psychol Sci*. (2013) 24:1918–27. doi: 10.1177/0956797613480187

75. Faw MH, Davidson K, Hogan L, Thomas K. Corumination, diet culture, intuitive eating, and body dissatisfaction among young adult women. *Pers Relat*. (2021) 28:406–26. doi: 10.1111/pere.12364

76. Markey CH, Strodl E, Aimé A, McCabe M, Rodgers R, Sicilia A, et al. A survey of eating styles in eight countries: examining restrained, emotional, intuitive eating and their correlates. *Br J Health Psychol*. (2023) 28:136–55. doi: 10.1111/bjhp.12616

77. Astani AI. Dysfunctional eating behavior in Romanian samples. *STUDII ŞI CERCETĂRI*. (2015) 61:257–67.

78. Iorga M, Manole I, Pop L, Muraru ID, Petrariu FD. Eating disorders in relationship with dietary habits among pharmacy students in Romania. *Pharmacy*. (2018) 6:97. doi: 10.3390/pharmacy6030097

79. Voinea L, Popescu DV, Negrea TM, Dina R, Filip A. The prevalence of emotional criteria in food choice-the main source of imbalance in the eating behaviour of the young consumers from Romania. *New Trends Sustain Business Consumption*. (2019) 336–43.

80. Hensley-Hackett K, Bosker J, Keefe A, Reidlinger D, Warner M, D'Arcy A, et al. Intuitive eating intervention and diet quality in adults: a systematic literature review. *J Nutr Educ Behav*. (2022) 54:1099–115. doi: 10.1016/j.jneb.2022.08.008

81. Gast J, Madanat H, Nielson AC. Are men more intuitive when it comes to eating and physical activity? *Am J Mens Health*. (2012) 6:164–71. doi: 10.1177/1557988311428090

82. Hockin-Boyers H, Jamie K, Pope S. Intuitive tracking: blending competing approaches to exercise and eating. *Sociol Health Illn*. (2024) 46:1828–48. doi: 10.1111/1467-9566.13821

83. Gervais SJ, Sáez G, Riemer AR, Klein O. The social interaction model of objectification: a process model of goal-based objectifying exchanges between men and women. *Br J Soc Psychol*. (2020) 59:248–83. doi: 10.1111/bjso.12339

84. Bareket O, Shnabel N, Abeles D, Gervais S, Yuval-Greenberg S. Evidence for an association between men's spontaneous objectifying gazing behavior and their endorsement of objectifying attitudes toward women. *Sex Roles*. (2019) 81:245–56. doi: 10.1007/s11199-018-0983-8

85. Keys E, Bhogal MS. Mean girls: provocative clothing leads to intra-sexual competition between females. *Curr Psychol*. (2018) 37:543–51. doi: 10.1007/s12144-016-9536-x

86. Yan K, Salmon J, Aubrey JS. A sexy post a day brings the "likes" your way: a content analytic investigation of sexualization in fraternity Instagram posts. *Sex Cult*. (2022) 26:685–706. doi: 10.1007/s12119-021-09915-9

87. Roman D. Gendering Eastern Europe: pre-feminism, prejudice, and east-west dialogues in post-communist Romania. *Womens Stud Int Forum*. (2001) 24:53–66. doi: 10.1016/S0277-5395(00)00161-8

88. Hurubean A. Gender equality policies during the post-communist Romanian society-transformation or conservation of gender patriarchal regime? *Chall Knowl Soc*. (2013) 3:1377–91.

89. Ibroscheva E. Advertising, sex, and post-socialism: Women, media, and femininity in the Balkans. Lanham, MD, USA & Plymouth, United Kingdom: Lexington books (2013).

90. Swann WB. Self-verification theory In: P Lang, A Kruglanski and ET Higgins, editors. Handbook of theories of social psychology. New York: Sage (2012)

91. Wicklund RA, Gollwitzer PM. Symbolic self completion. New York: Routledge (2013).

92. Aronson J, Cohen G, Nail PR. (1999). Self-affirmation theory: An update and appraisal. In: E Harmon-Jones and J Mills, editors. Cognitive dissonance: Progress on a pivotal theory in social psychology. American Psychological Association. 127–147. doi: 10.1037/10318-006

93. Goldenberg JL, Cooper DP, Heflick NA, Routledge C, Arndt J. Is objectification always harmful? Reactions to objectifying images and feedback as a function of self-objectification and mortality salience. *J Exp Soc Psychol*. (2011) 47:443–8. doi: 10.1016/j.jesp.2010.11.013

94. Zaharia A, Gonța I. The healthy eating movement on social media and its psychological effects on body image. *Front Nutr*. (2024) 11:1474729. doi: 10.3389/fnut.2024.1474729

95. Arab K, Barasain O, Altaweel A, Alkhayyal J, Alshiha L, Barasain R, et al. Influence of social media on the decision to undergo a cosmetic procedure. *Plast Reconstr Surg*. (2019) 7:e2333. doi: 10.1097/GOX.0000000000002333

96. Franchina V, Lo Coco G. The influence of social media use on body image concerns. *Int J Psychoanal Educ*. (2018) 10:1–7.

97. Ashikali EM, Dittmar H, Ayers S. The effect of cosmetic surgery reality tv shows on adolescent girls' body image. *Psychol Pop Media Cult*. (2014) 3:141. doi: 10.1037/ppm0000022

98. Atari M, Barbaro N, Sela Y, Shackelford TK, Chegeni R. Consideration of cosmetic surgery as part of women's benefit-provisioning mate retention strategy. *Front Psychol*. (2017) 8:1389. doi: 10.3389/fpsyg.2017.01389

99. Bradshaw HK, Leyva RP, Nicolas SC, Hill SE. Costly female appearance-enhancement provides cues of short-term mating effort: the case of cosmetic surgery. *Pers Individ Differ*. (2019) 138:48–55. doi: 10.1016/j.paid.2018.09.019

100. Locatelli K, Boccara D, De Runz A, Fournier M, Chaouat M, Villa F, et al. A qualitative study of life events and psychological needs underlying the decision to have cosmetic surgery. *Int J Psychiatry Med*. (2017) 52:88–105. doi: 10.1177/0091217417703287

101. Arnocky S, Piché T. Cosmetic surgery as intrasexual competition: the mediating role of social comparison. *Psychology*. (2014) 5:1197–205. doi: 10.4236/psych.2014.510132

102. Wang X, Chen H, Chen Z, Yang Y. Women's intrasexual competition results in beautification. *Soc Psychol Personal Sci*. (2021) 12:648–57. doi: 10.1177/1948550620933403

103. Hill SE, Durante KM. Courtship, competition, and the pursuit of attractiveness: mating goals facilitate health-related risk taking and strategic risk suppression in women. *Personal Soc Psychol Bull*. (2011) 37:383–94. doi: 10.1177/0146167210395603

104. Claesson IM, Myrgård M, Wallberg M, Blomberg M. The association between covariates, with emphasis on maternal body mass index, and duration of exclusive and total breastfeeding. *Breastfeed Med*. (2020) 15:622–9. doi: 10.1089/bfm.2019.0138

105. Holsen I, Jones DC, Birkeland MS. Body image satisfaction among Norwegian adolescents and young adults: a longitudinal study of the influence of interpersonal relationships and BMI. *Body Image*. (2012) 9:201–8. doi: 10.1016/j.bodyim.2012.01.006

106. Ko YS, You SE. Comparisons of physical fitness and body composition among Sasang types with and without body mass index as a covariate. *Integrative Med Res*. (2015) 4:41–7. doi: 10.1016/j.imr.2015.01.002

107. Bagherinia H, Saghebi SA. Study on the mediator role of self-esteem in the relationship between female self-objectification and social physique anxiety. *J Educ Health Promot*. (2023) 12:385. doi: 10.4103/jehp.jehp_597_22

108. Mancin P, Ghisi M, Spoto A, Cerea S. The relation between body dysmorphic disorder symptoms and photo-based behaviors: is body appreciation a protective factor? *Body Image*. (2024) 51:101764. doi: 10.1016/j.bodyim.2024.101764

109. Gajić M, Gajić LD. Personality traits as determinants of body image and the mediation role of perfectionism in cosmetic surgery. *Hrvat Čas Zdr Znan*. (2022) 2:16–23. doi: 10.48188/hczz.2.1.10

110. Goian C. Zece categorii de inconsecvenţe semantice prezente în limbajul asistenţei sociale din spaţiul românesc. *Rev Asist Soc*. (2010) 1:79–90.

111. Goian C. Tehnici de comunicare în asistenţă socială. Timisoara, Romania: Editura e Vest (2009).

112. Calogero RM, Pina A. Body guilt: Preliminary evidence for a further subjective experience of self-objectification. *Psychol. Women Q*. (2011) 35:428–40. doi: 10.1177/0361684311408564

113. Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. (2017) Guilford publications.

frontiers | Frontiers in Nutrition

TYPE Original Research
PUBLISHED 27 November 2025
DOI 10.3389/fnut.2025.1535911

OPEN ACCESS

EDITED BY
Mona Vintilă,
West University of Timișoara, Romania

REVIEWED BY
Marcela Gomes Reis,
Faculty of Medical Sciences of Minas Gerais, Brazil
Anwar Abouelnasr,
Alexandria University, Egypt

*CORRESPONDENCE
Xiao-Dong Han
✉ 18930172941@163.com
Hui Zheng
✉ zh.dmtr@gmail.com
Jian-Zhong Di
✉ dijianzhong@sjtu.edu.cn

†These authors have contributed equally to this work

RECEIVED 28 November 2024
ACCEPTED 03 November 2025
PUBLISHED 27 November 2025

CITATION
Ban X-Y, Wang C, Xu T, Liu L, Yin C-Y, Zhang H-L, Zhang H-W, Han X-D, Zheng H and Di J-Z (2025) When bariatric surgery reduces food addiction: a prospective study. *Front. Nutr.* 12:1535911. doi: 10.3389/fnut.2025.1535911

When bariatric surgery reduces food addiction: a prospective study

Xu-Yan Ban[1,2†], Chen Wang[1†], Ting Xu[1†], Lin Liu[1], Chuan-Yu Yin[1,3], Hui-Lin Zhang[1,3], Hong-Wei Zhang[1], Xiao-Dong Han[1*], Hui Zheng[4*] and Jian-Zhong Di[1*]

[1]Department of Metabolic & Bariatric Surgery, Shanghai Sixth People's Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Shanghai, China, [2]Department of Gastrointestinal Surgery, Shanghai Fourth People's Hospital, School of Medicine, Tongji University, Shanghai, China, [3]College of Fisheries and Life Science, Shanghai Ocean University, Shanghai, China, [4]Neuroimaging Research Branch, National Institute on Drug Abuse, National Institutes of Health, Baltimore, MD, United States

Background: Studies have shown that patients with obesity appear to be more susceptible to food addiction than the general population. Bariatric surgery stands as the most potent remedy for combating obesity, and it is believed to alleviate the manifestations of food addiction. However, the timing of bariatric surgery to improve food addiction has seldom been the focus of attention.
Methods: In this research, 78 individuals who underwent bariatric surgery were tracked over a period of 2 years. The Yale Food Addiction Scale 2.0 (YFAS 2.0) was employed to assess changes in food addiction tendencies post-surgery. Mixed linear modeling and cluster analysis were applied to investigate the timing of influence of bariatric surgery on the evolution of sub domains of food addiction.
Results: We found that: (1) Bariatric surgery significantly reduces food addiction scores; (2) Bariatric surgery rapidly reduces food addiction scores within first month of surgery and extends to 2 years after surgery; (3) Symptoms in the YFAS 2.0 could be divided into two domains (rapid decline / slow decline) based on their progression following surgery. Rapid decline domain experience rapid improvement shortly (usually 1st month) after the bariatric surgery and maintains a consistently low symptom level, while the slow decline domain improves slowly (usually 4th month) in the post-operative phase.
Discussion: Bariatric surgery induced rapid and sustained remission of food addiction, significantly reducing total food addiction scores within 1 month postoperatively. The effects maintained through 24 months, potentially through neurophysiological and gut microbiota alterations. Despite rapid remission of most food addiction symptoms, social/interpersonal problems, hazardous use, and large amount/longer showed delayed improvement, suggesting distinct behavioral persistence mechanisms.
Conclusion: Food addiction scores can rapidly decline postoperatively and remain consistently lower. However, bariatric surgery does not fully improve all addiction symptoms at the 1st month. This suggests the importance of establishing multidisciplinary clinics in bariatric metabolic surgery.

KEYWORDS

food addiction, bariatric surgery, YFAS 2.0, mixed linear model, cluster analysis

Introduction

Obesity is a pervasive and costly public health crisis (1), with higher prevalence of complications such as psychological disorders, such as anxiety (2), depression (3) and eating behavior disorders (4, 5). Bariatric surgery is the most effective form of treatment for patients with severe obesity and associated complications (6). However, not all those who have bariatric surgery can solve these complications, especially complex eating behavior disorders. Such as food addition, anorexia, bulimia, before and after surgery, can lead to weight regain and associated mental health challenge (7).

Food addiction as a complex multifactorial eating behaviors disorder has high prevalence in obesity and may be improved by bariatric surgery (8, 9). According to a recent meta-analysis, the prevalence of food addiction in individuals with obesity could be as high as 32%, while between 2 and 12% of healthy individuals are affected by food addiction (10). Even adjusting for health factors (such as smoking, substance use and physical activity), food addiction still showed a significant association with obesity (11–13). A prospective study has shown that food addiction can be reduced by bariatric surgery, with prevalence rates decreasing from 57.8% preoperatively to 7.2 and 13.7% at the 6 and 12-month postoperative time points, respectively (14). It has also been observed clinically that in the early post-operative period after bariatric surgery (within 6 months), there is acute improvements in eating behaviors (15, 16). However, the situation of how food addiction continues to change after surgery has not been explicitly explored due to the lack of high temporal frequency and long cohort studies.

Food addiction can be characterized by a lack of control over food intake, strong appetite, excessive food consumption despite negative health or social consequences, and repeated unsuccessful attempts to control intake (17) and divided into eleven different symptoms, each of which describes an addictive behavior with different positivity rate by the Yale Food Addiction Scale 2.0 (YFAS 2.0) (18). Symptoms of food addiction are different, some are better recognized, such as behavioral signs, and some are not so well recognized, such as social relationships, which are often difficult to intervene in. A recent study has shown that the most endorsed symptom is the symptom 'large amount / longer' (19) as a common phenomenon among people with obesity (20), which was defined as substance taken in larger amount and for longer period than intended by YFAS 2.0. Its discrimination parameter remains high, indicating its relatively good ability to delineate individuals who are higher on the latent trait (19). In contrast, Mohsen Saffari considered 'social/interpersonal problems' as the most adopted symptom (21), which represented continued consumption despite social or interpersonal problems. While there was another result that the symptom 'hazardous use', which represented food use in physically hazardous situation, had a scarcity of endorsement and the lowest discrimination parameter indicating a poor ability to delineate individuals who are higher vs. lower on the latent trait (19). Consequently, the symptom 'hazardous use' may not be improved or improved slowly after people with obesity lose weight through bariatric surgery. There are also previous researches which mentioned that the 'persistent desire or repeated unsuccessful attempts to quit' symptom is the most commonly recognized criterion (22, 23). These studies have collectively concluded that self-reported food addiction has different rates of positivity for different symptoms. Although the identification of symptoms of food addiction varies among subjects, there is a lack of nooses regarding whether different symptoms of food addiction are equally improved by bariatric surgery. Even when the total food addiction score decreases after bariatric surgery but these symptoms with more recognized and represented do not improve well, people with obesity may still be suffering from food addiction.

Because the available evidence suggests that bariatric surgery reduces the incidence of postoperative food addiction, the symptoms associated with eating behaviors are more readily identifiable and ameliorated. Therefore, we hypothesized that: (1) bariatric surgery could rapidly alleviate postoperative food addiction symptoms in obese patients; (2) bariatric surgery is ineffective in alleviating some of the symptoms of interpersonal problems symptoms of food addiction.

Methods

Subjects

This study was part of a larger prospective cohort study at Shanghai Sixth People's Hospital. We obtained the following baseline information before patients underwent bariatric surgery: age, years of education, sex, body mass index (BMI), the YFAS 2.0 (food addiction score). Based on the Chinese criteria for overweight and obesity, the overweight or obesity (OW/OB) group comprised patients with overweight or obesity (BMI > 26 kg/m2) who were undergoing bariatric surgery at the Weight Loss Metabolism Clinic in Shanghai Sixth People's Hospital. The healthy control (HC) group comprised individuals with healthy BMIs (18 kg/m2 < BMI < 24 kg/m2) who were randomly recruited. Postoperative follow-up examinations were performed at 1-month intervals until 18 months postoperatively and then at 6-month intervals until 24 months postoperatively. All participants had to meet the following inclusion criteria: (i) age between 18 and 65 years, (ii) the capacity to give informed consent, (iii) no untreated mental illness or unstable mental state, (iv) all participants with a history of bariatric surgery, and pregnant or breast-feeding females were excluded. The study and the survey obtained ethics approval by the independent IRB of the authors' institution (Ethics Committee of Shanghai Sixth People's Hospital, NO 2020–219-(1)).

Measurements

YFAS 2.0

The YFAS 2.0, which contained a total of 11 judgment criteria and one clinical diagnostic criterion, was revised and published in 2016 by Gearhardt et al. on this basis (18). The method of analysis was a questionnaire containing personal information and the YFAS 2.0 carried out in an online platform (www.wjx.cn). The YFAS 2.0 consists of 35 questions scored on an 8-level Likert scale ranging from 0 to 7. It provides two scoring methods: symptom count or diagnostic threshold. The presence of no more than one symptom or the absence of a symptom 12 was classified as non-addiction, the presence of 2–3 symptoms and the occurrence of a symptom 12 was classified as mild addiction, the presence of 4–5 symptoms together with the symptom 12 addiction was classified as moderate and the occurrence of more

symptoms with 12 was classified as severe addiction. The Chinese version of the YFAS 2.0 had good internal consistency in our study. Cronbach's α for the YFAS 2.0 was 0.93. For convenience, we abbreviated each symptom using one or few words. Detailed description of the symptoms can be found in Table 1.

Statistical methods

All the statistical analyses were performed using Jamovi v2.3.16, GraphPad v 9.4.1 and R 4.2.3. The normally distributed data were analyzed by Student's t-test and expressed as mean ± standard deviation. The non-normally distributed data were analyzed by the Mann–Whitney U test and expressed as median (quartiles [P25, P75]; the sex-related characteristics of the two groups were tested by the chi-square test).

For our primary endpoint, we conducted a mixed linear model (MLM) using food addiction score as the dependent variable. In this model, individual patients were included as a random effect, and the data timepoint for YFAS 2.0 collection as fixed effects. The MLM model was as follows:

$$Food\ addiction\ score \sim 1 + time + \left(1 \mid Participants\right)$$

Hierarchical clustering was performed using the Ward clustering algorithm and separated by Euclidean distance with factors arranged visually by time point and by groups. To assess the statistical significance of the clustering solution, we conducted an analysis of variance (ANOVA) to compare the means of variables across clusters. Our results indicated significant differences ($p < 0.05$) in the means of variables between clusters, supporting the validity of the clustering solution.

The model effectively controls for baseline heterogeneity between individuals by incorporating random intercept terms. It is suitable for longitudinal data analysis with repeated measurements. Model parameter estimation uses restricted maximum likelihood estimation (REML), and statistical significance is set at $\alpha = 0.05$. Model fit was evaluated using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). All statistical modeling procedures, including model fitting and validation, were implemented using dedicated open-source packages in R 4.4.3.

Results

Characteristics of the participants

Group comparisons of the sociodemographic characteristics; the BMI; and the food addiction score are shown in Table 2. The OW/OB group consisted of 78 subjects (61 females and 17 males) with a median age of 29.12 years. The HC group consisted of 65 subjects (51 females and 14 males) with a median age of 27.79 years. There were no significant differences in gender ($p = 0.0970$) or age (27.79 [25.27, 32.90] vs. 29.12 [24.53, 33.39], respectively; U = 2499.50, $p = 0.886$) between the two groups. The BMI and food addiction score in the HC group significantly differed from those in the OW/OB group before surgery; specifically, the OW/OB group had higher food addiction score. The bar chart showed that before surgery, the median food addiction score was significantly higher in the HC than OW/OB group (1 [0, 4] vs. 9 [4.25,

TABLE 1 Cronbach's α for each symptom the YFAS2.0.

Abbreviations	Subdimension (symptom)	Item-rest correlation	If item dropped Cronbach's α
Large amount/longer	Substance taken in larger amount and for longer period than intended	0.656	0.925
Quit/control	Persistent desire or repeated unsuccessful attempts to quite	0.742	0.922
Time spent	Much time/activity to obtain, use, recover	0.733	0.922
Activities given up	Important social, occupational, or recreational activities given up or reduced	0.675	0.924
Psychological/physical problem	Use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems)	0.775	0.921
Tolerance	Tolerance (marked increase in amount; marked decrease in effect)	0.704	0.923
Withdrawal	Characteristic withdrawal symptoms; substance taken to relieve withdrawal	0.662	0.925
Social/interpersonal problems	Continued use despite social or interpersonal problems	0.579	0.929
Neglect role	Failure to fulfill major role obligation (e.g., work, school, home)	0.677	0.924
Hazardous use	Use in physically hazardous situations	0.671	0.925
Craving	Craving, or a strong desire or urge to use	0.762	0.922

TABLE 2 Demographics of all participants.

Characteristic	HC M (P25, P75)	OW/OB M (P25, P75)	Statistic	*p*	Effect size
Gender (M/F)	14/51	17/61	0 [d]	0.970	/
Age (years)	27.79 (25.27, 32.90)	29.12 (24.53, 33.39)	2499.50	0.886	0.04
BMI (kg/m2)	20.97 ± 1.38 [a]	38.25 ± 5.97 [a]	−22.8 [b]	< 0.001	−3.83[c]
Education years	16 (15, 18)	15 (12, 16)	33.02	0.007	0.32
FA score	1 (0, 4)	9 (4.25, 11)	288.00	< 0.001	0.734
Mild FA	1	1			
Moderate FA	2	1			
Severe FA	2	25			

HC, healthy control; OW/OB, overweight or obesity; M, Median; P25, 25th percentile; P75, 75th percentile; *p*, *p* value; Statistic is Mann–Whitney U test; Effect Size for Mann–Whitney U test is Rank biserial correlation. BMI conforms to the normality test, [a] mean ± Standard deviation, [b] Statistic is Student's t, [c] Effect size for t test is Cohen's d; Gender used chi-squared test, [d] statistic is χ^2.

11], respectively; U = 288.00, $p < 0.001$). 34.6% of individuals in the OW/OB group received a diagnosis of food addiction, while 7.7% of individuals in the HC group received a diagnosis of food addiction.

Prevalence of food addiction categorization after SG

To evaluate the assessment that SG could improve the situation of the food addiction, the MLM was used to describe the trend of the food addiction score, which took postoperative time as predictive variable, the food addiction score as predicted variable, subject as cluster. Compared with preoperative, the food addiction score of participants significantly decreased at 1 month postoperative ($t = -4.64$, $p < 0.001$), and it sustained until 24 months after bariatric surgery ($t = -6.31$, $p < 0.001$) (Figure 1; Supplementary Table S1). Finally, 25% of individuals in the OW/OB group received a diagnosis of food addiction at 24 months postoperative. In addition to the preoperative comparisons, repeated comparisons were made, i.e., changes were compared between two adjacent time points to determine at which postoperative time point the participants' food addiction improvement occurred primarily. It was found that food addiction scores only decreased significantly in the first month postoperatively compared to the preoperative period, and otherwise did not change significantly compared to the previous month (Supplementary Table S2).

Analysis of standardized residuals from the model indicated approximate normality in the overall error distribution. The residual median was −0.0729, demonstrating near-symmetry about zero. Interquartile ranges spanned from −0.454 (lower quartile) to 0.409 (upper quartile), satisfying the normality assumption for linear model errors. Extreme values ranged from −3.379 to 3.891, suggesting potential outliers. The model was estimated using restricted maximum likelihood (REML), with convergence achieved at an objective function value of 2,207. Model fit indices yielded an AIC of 2250.97 and a BIC of 2343.02.

Response of each symptom in YFAS 2.0 after SG

In order to observe how the proportion of positive individuals for each symptom in the YFAS 2.0 description varied, a cluster heat map was created based on each participant's response to the questionnaire. In the heat map, each row corresponds to a symptom in the YFAS 2.0 description, whereas the columns represent the various pre- and post-operative time points. The values represented by each square are calculated according to a generalized MLM. Increasing brightness toward blue indicates a higher mean of possible rate, and white indicates a lower mean of possible rate. We found that out of a total of 11 symptoms, 'psychological/ physical problem', 'craving', 'quit/control', 'time spent', 'activities given up', 'withdrawal', 'tolerance', and 'neglect role' showed more similar trends, 'social/interpersonal problems', 'large amount/longer', and 'hazardous use' showed more similar trends (Figure 2).

In addition, the post-operative trends for each symptom were represented by equations calculated from a generalized MLM and presented as line graphs. For specific trends in each symptom, see Fig. S1 - Fig S11 in the Supporting Materials. We found that not all symptoms began to improve in the early postoperative period immediately. Among the symptoms 'large amount/longer' ($z = -0.243$, $p > 0.05$), 'tolerance' ($z = -1.10$, $p > 0.05$), 'social/interpersonal problems' ($z = -1.27$, $p > 0.05$), 'hazardous use' ($z = -1.116$, $p > 0.05$), there was no significant difference in the first month postoperatively compared to preoperatively. The symptom 'large amount/longer' began to improve significantly at the second month postoperatively ($z = -2.571$, $p < 0.05$). The symptom 'hazardous use' was improved significantly at the second month postoperatively ($z = -2.039$, $p < 0.05$) compared to the preoperative, while did not differ at the third month postoperatively ($z = -0.719$, $p > 0.05$) compared to the preoperative. The symptom 'social/interpersonal problems' was improved significantly at the second month postoperatively ($z = -2.50$, $p < 0.05$) compared to the preoperative, while did not differ at the third month postoperatively ($z = -1.21$, $p > 0.05$) compared to the preoperative. The symptom 'hazardous use' and 'social/interpersonal problems' were both improved from 4th month postoperatively until 24 months after bariatric surgery.

Discussion

This study sought to explore the interventional effects of bariatric surgery on food addiction by continuous measurements at intensive postoperative time points. Two main new findings were found: 1. Total

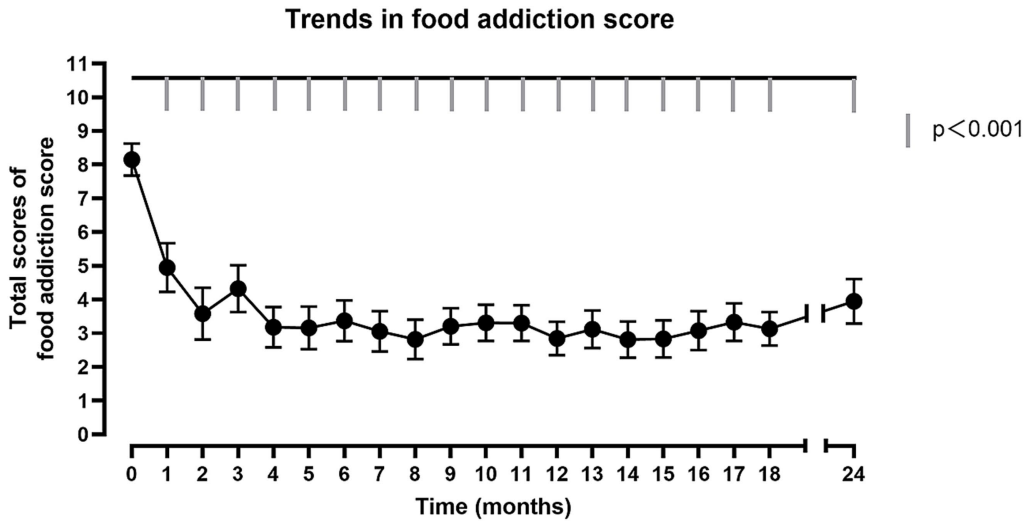


FIGURE 1
The trend of total food addiction score. The horizontal axis represents the post-operative follow-up time. The vertical axis represents the total score of food addiction score. The fold line reflects the trend in food addiction scores after surgery. Significant differences ($p < 0.001$) for each post-operative month compared to pre-operative.

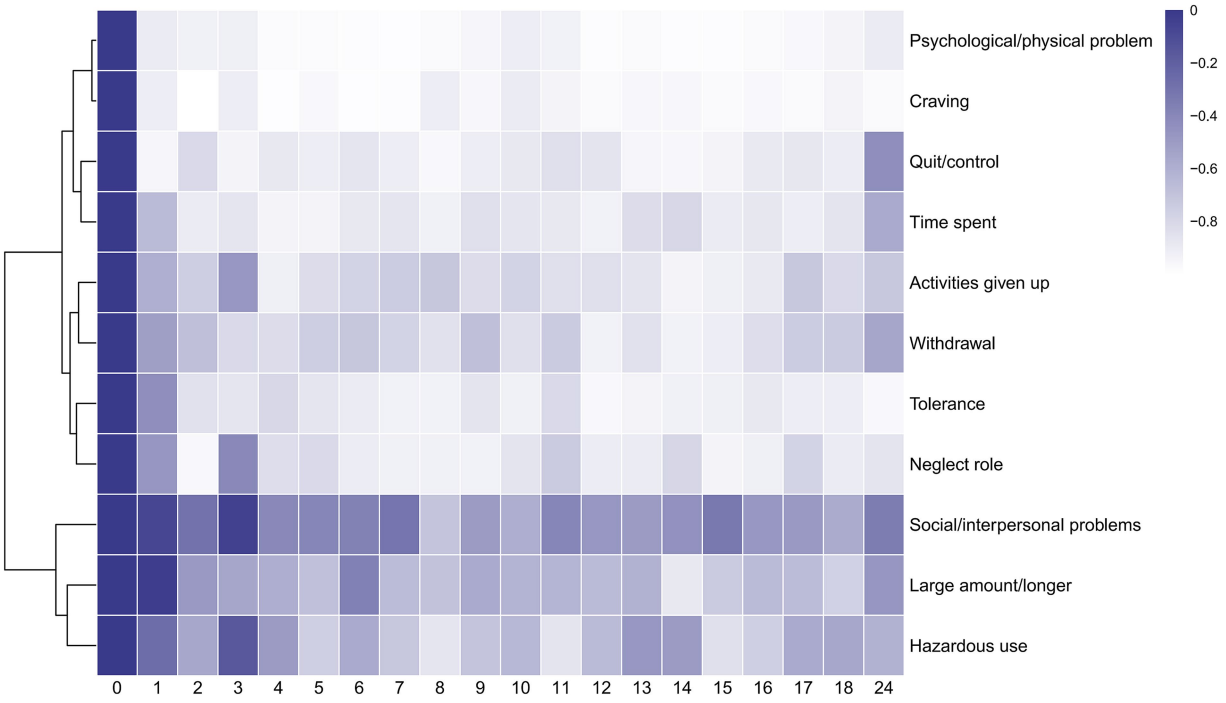


FIGURE 2
Heatmap of 11 symptoms of YFAS 2.0. The horizontal axis represents the post-operative follow-up time. The vertical axis represents 11 symptoms of YFAS 2.0('Large amount/longer' for substance taken in larger amount and for longer period than intended. 'Quit/control' for persistent desire or repeated unsuccessful attempts to quit. 'Time spent' for much time/activity to obtain, use, recover. 'Activities given up' for important social, occupational, or recreational activities given up or reduced. 'Psychological/physical problem' for use continues despite knowledge of adverse consequences. 'Tolerance' for tolerance. 'Withdrawal' for characteristic withdrawal symptoms; substance taken to relieve withdrawal. 'Social/interpersonal problems' for continued use despite social or interpersonal problems. 'Neglect role' for failure to fulfill major role obligation. 'Hazardous use' for use in physically hazardous situations. 'Craving' for craving, or a strong desire or urge to use.) The algorithm for heatmap clustering was based on the Euclidean distance measure for similarity and Ward clustering algorithm.

food addiction scores were substantially reduced by bariatric surgery within 1 month postoperatively, and it could be maintained for at least 24 months postoperatively; 2. Bariatric surgery improved most of the symptoms of food addiction in the early postoperative period, however, it was slower to improve slow decline domain.

Bariatric surgery improves food addiction scores

Food addiction scores started to decline already early after bariatric surgery and leveled off afterwards. This study found that 34.6% of candidates for bariatric surgery have suffered from food addiction and exhibited elevated addiction scores, aligning with another observation reported by our research team (24). And it declined to 25% 2 years postoperatively. This is in line with the results of a recent meta-analysis shown that the absolute prevalence reduction of food addiction was decreased after bariatric surgery. Further, the effect was observed within 6 months of postoperative follow-up (10). We speculate that this may be due to neurophysiology, gut microbiota changes and eating behavior factors in the patients as a result of the bariatric surgery.

Food addiction is largely reduced due to a restriction of the gastric volume after bariatric surgical intervention, during which neuromodulation and hormone regulation are stimulated. The addiction is mediated by brain regions and neurotransmitters (25). Bariatric surgery reduces appetite and induces psychophysiological effects by influencing the expression of numerous brain neurotransmitters, including dopamine, serotonin and various neuropeptides such as neuropeptide Y, leptin, orexin, growth hormone-releasing peptide, growth hormone-releasing factor, leptin and glucagon-like peptide-1 levels (26). Bariatric surgery alters these neuropeptides' secretion, which in turn reduces the patients' food craving and lack of control over food intake (27, 28), important addiction symptoms in food addiction.

Bariatric surgery affects food addiction by altering a patient's gut microbiota, which may in turn affect food addiction. Environmental factors and dietary patterns have a major influence on gut microbiota composition, and the overconsumption of highly palatable food may promote a gut microbiota dysbiosis that has been recently proposed to participate in the loss of eating control (29). Individuals with obesity, which may be promoted by food addiction, showed altered gut microbiota with a reduced diversity that facilitated energy absorption capacity and may affect host brain function (30). In the recent study, researchers demonstrated a translational link between mice and humans in gut microbiome composition associated with food addiction, supporting a link between gut microbiota and vulnerability to this behavioral disorder (31). While bariatric surgery affects the hosts' metabolism by altering the gut microbiota (32) and modulates the inflammatory response through a variety of mechanisms that alter the patient's physiology (33), which is a potential way to improve food addiction.

Food addiction is clinically associated with dysregulated eating patterns including grazing (34), emotional eating, and loss-of-control (LOC) eating (35). Grazing, operationally defined as the persistent, compulsive consumption of small-to-moderate food volumes without discrete meals or temporal structure (36), constitutes a distinct yet potentially mutually reinforcing behavioral phenotype relative to food addiction. Symptomatic overlap exists between grazing and food addiction (34), postoperative grazing may attenuate weight loss efficacy following bariatric surgery (37). Surgical gastric restriction necessitates structured nutritional protocols; consequently, postoperative guidance advocates planned, repetitive meal patterns with prescribed dietary composition. Some authorities contend that intention-regulated eating should be nosologically distinguished from maladaptive grazing (36). Some evidences suggests grazing incidence may increase postoperatively despite these interventions (37, 38). This investigation observed sustained reductions in food addiction scores across a 24-month postoperative follow-up. Crucially, this amelioration persisted even when accounting for putative risk factors associated with elevated postoperative grazing prevalence. A recent study proposed a cyclical reinforcement model wherein emotional eating drives dysregulated consumption, precipitating loss-of-control eating (35). Subsequent maladaptive attempts to regulate this behavior paradoxically perpetuate and intensify food addiction. This model emphasizes the mediating role of food-related cognitions (e.g., food craving) in facilitating LOC episodes, establishing cognitive processes as critical mechanisms in food addiction. Studies indicate bariatric surgery significantly attenuates emotional and LOC eating behaviors while enhancing cognitive restraint in candidates (39, 40). This suggests surgical intervention may ameliorate food addiction symptomatology through modulation of these core behavioral pathways. Notably, a meta-analysis revealed cognitive behavioral therapy (CBT) produces significant short-term reductions in emotional eating post-intervention (41). However, these gains demonstrate poor sustainability at long-term follow-up. Critically, CBT showed no significant effects on sustained LOC improvement at long-term follow-up. These findings remain constrained by limited sample sizes and methodological heterogeneity, precluding definitive conclusions regarding CBT's long-term efficacy. This study documented postoperative food addiction score reduction absent concurrent CBT implementation.

Thus, the data from this study suggest that symptoms of food addiction in patients with obesity can be ameliorated by bariatric surgery. However, previous research on of postoperative outcomes in early food addiction has predominantly focused on follow-up assessments conducted beyond 3 months (42, 43). Although some studies have employed short-term follow-up at 1 month, sequential monthly assessments are notably lacking (44). More and longer longitudinal studies, preferably with experimental designs with control groups, are needed to assess the impact of bariatric surgery on the negative effects of food addiction. In addition, we should further investigate the mechanisms to provide a theoretical basis for finding new treatment pathways for food addiction in the future. As for the patients, we can better manage obesity in this population and reduce the symptoms of food addiction in patients.

Slow improvement in symptom 'social/interpersonal problems', 'hazardous use' and 'large amount/longer'

All eleven symptoms can be classified into two domains based on postoperative trends, with the first domain improving rapidly postoperatively and the second domain improving slowly postoperatively. The rapid decline domain includes 'psychological/

physical problem', 'craving', 'quit/control', 'time spent', 'activities given up', 'withdrawal', 'tolerance', and 'neglect role'; the slow decline domain includes 'social/interpersonal problems', 'large amount/longer', and 'hazardous use'. The slowest improvement after surgery is seen in 'social/interpersonal problems'.

Subjects are sensitive to the social and psychological problems caused by food addiction. The highest number of subjects (40/46) suffered from this problem before surgery, and the tendency to decline after surgery was moderate compared to other symptoms. It was obvious that the symptom for persistent desire or repeated unsuccessful attempts to quit was reduced by bariatric surgery rapidly in the early post-operative period. No previous study has followed up so intensively after surgery and analyzed serial changes in different symptoms. Patients involved in bariatric surgery are obese, a group of patients who face physical impairment, mobility difficulties, low self-esteem or self-control, and illnesses associated with negative body imagery (45, 46). Women may also be more concerned about aesthetic issues and may refuse and not want to disclose their weight. Whereas patients with obesity are often unable to perceive their weight correctly, even after bariatric surgery, patients seem unable to recognize changes in body image following significant weight loss (45). This can lead to patients refusing to participate in social activities for fear of overeating in front of their loved ones or friends, even though they have lost weight after bariatric surgery. This also explains why 'social/interpersonal problems' in the YFAS 2.0 is relatively slow to improve after surgery. A better understanding of this unique postoperative symptom may help to elucidate the underlying biological and psychological bases associated with these more severe symptoms, especially after bariatric surgery.

'Hazardous use' symptom is slow to improve and tend to rebound after bariatric surgery. 'Hazardous use' is the behavior of eating certain foods even when individuals know it was physically dangerous (such as eating sweets even with diabetes), which is one of the main symptoms of food addiction. Some studies have found that over time, cravings for sweets no longer differ from pre-operative (47). We advise patients to eat more foods rich in high protein postoperatively, and sweets such as sugar and beverages are strongly discouraged foods because eating sweets can cause patients to regain weight, as well as being detrimental to diabetes and insulin resistance controlling. This may lead patients to feel that they are hurting themselves by eating sweets, but when they still insist on eating sweets, they self-report as hazardous use. In addition, a recent finding suggests that some patients may substitute the concept of one reinforcer 'food' for another, such as 'alcohol', which is commonly referred to as 'addiction transfer' (48). And these patients with addiction shifts can have alcohol abuse, which may be contributing to the slow decline in symptom of 'hazardous use' after patients undergo bariatric surgery, despite a rapid decline in food addiction scores.

'Large amount/longer' begins to decline in the second month and remains at a lower level from the second month to the 24th month postoperatively. 'Large amount/longer' describes eating behaviors in which individuals eat more than planned or for more time than planned, persist in eating in the absence of hunger and eat to the point where they fell physically ill. Previous studies have shown that patients' hunger, disinhibition and emotional eating decrease postoperatively, whereas restraint and postprandial fullness increase (49, 50). This may lead to an improvement in 'large amount/longer' postoperatively, which is in line with the trend we observed for postoperative changes. Besides, the new finding is that the improvement of 'large amount/longer' starts in the second postoperative month. We hypothesize that the unimprovement of the first month may be caused by the following reasons. Firstly, overall maladaptive eating behaviors (binge eating, night eating and uncontrolled eating) which are associated with 'large amount/longer' improve postoperatively and require an adaptation process (51). Secondly, the recovery of the postoperative diet starts with a liquid diet and gradually transitions to a semi-liquid, soft food and then to a normal diet. We commonly instruct the patients to eat slowly during the postoperative mission and to have an intermediate cut between ingesting solids and liquids at each meal, all of which may lead to an increase in the patient's eating time. Thirdly, bariatric surgery alters the volume of the stomach, causing patients to feel fuller after surgery. In the early postoperative period, eating too quickly or eating too much at once may cause the patients to feel physically uncomfortable. These may explain why 'large amount/longer' did not improve significantly in the first month after surgery compared to the preoperative.

The following are a few limitations of this study. Prior research lacks studies utilizing MLM to characterize the continuous postoperative trajectory of food addiction scores. Consequently, no established reference exists to inform power calculations or sample size estimation for this specific analytical approach. Our sample size was therefore informed provisionally by effect sizes reported in studies examining short- and long-term food addiction improvement following bariatric surgery, with an anticipated attrition rate of 20% incorporated. During longitudinal assessment, attrition rates exceeded the projected 20% threshold at several follow-up intervals. The implementation of MLM for trajectory analysis— rather than reliance on mean food addiction score reporting— partially mitigates the impact of this missing data by accommodating subject-wise inclusion of all available observations. Consequently, despite acknowledged limitations in cohort retention, the reported model outputs remain methodologically robust and clinically interpretable. Future investigations should incorporate longitudinal assessments of dysregulated eating behaviors, trait-level food cravings, and dynamic psychological states. Integrating these multidimensional covariates would refine model specification accuracy and elucidate mechanistic pathways through which bariatric surgery ameliorates food addiction. This study was more of a questionnaire and a behavioral experiment to collect information about the patients, and more biochemical and neuroimaging indicators are needed to help us explain the mechanisms behind this phenomenon. Some patients may have had inadequate energy or time to complete the questionnaire on schedule, instead completing it a few days later than planned. All of the surgeries were performed using sleeve gastrectomy, and we can use the type of surgery as a controlled variable in the future study.

Conclusion

Bariatric surgery induced rapid and clinically meaningful improvement in food addiction symptomatology, with significant reductions observed as early as 1 month postoperatively. This therapeutic effect persisted throughout the 24-month follow-up period. However, the rates of improvement manifested significant

heterogeneity across symptom domains. Notably, amelioration progressed more gradually for items assessing 'Social/interpersonal problems', 'Hazardous use', and 'Large amount/longer' compared to other symptoms.

Data availability statement

The data supporting the conclusions of this article will be made available by the authors upon request.

Ethics statement

The studies involving humans were approved by Ethics Committee of Shanghai Sixth People's Hospital, NO 2020–219-(1). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

X-YB: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. CW: Data curation, Methodology, Visualization, Writing – review & editing. TX: Writing – review & editing. LL: Data curation, Writing – review & editing. C-YY: Data curation, Writing – review & editing. H-LZ: Writing – review & editing. H-WZ: Writing – review & editing. X-DH: Writing – review & editing. HZ: Data curation, Methodology, Writing – review & editing. J-ZD: Funding acquisition, Methodology, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported by the National Key R&D Program of China (Grant No. 2023YFC3043508), the National Natural Science Foundation of China (Grant No. 82370901), and the Shanghai Municipal Science and Technology Commission (Grant No. 24DZ2304800).

Acknowledgments

The authors would like to acknowledge Huiting Cai, Ziqi Liu for their help with data collection, data analysis and advice on writing the article.

Conflict of interest

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

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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

Publisher's note

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

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fnut.2025.1535911/full#supplementary-material

SUPPLEMENTARY FIGURES S1-S11
Trends in each symptom of the YFAS 2.0.

References

1. World Health Organization. (2021). Obesity and overweight. Available online at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

2. Gariepy G, Nitka D, Schmitz N. The association between obesity and anxiety disorders in the population: a systematic review and meta-analysis. *Int J Obes*. (2010) 34:407–19. doi: 10.1038/ijo.2009.252

3. Alshehri T, Mook-Kanamori DO, de Mutsert R, Penninx BW, Rosendaal FR, le Cessie S, et al. The association between adiposity and atypical energy-related symptoms of depression: a role for metabolic dysregulations. *Brain Behav Immun*. (2023) 108:197–203. doi: 10.1016/j.bbi.2022.12.005

4. Heriseanu AI, Hay P, Corbit L, Touyz S. Grazing in adults with obesity and eating disorders: a systematic review of associated clinical features and meta-analysis of prevalence. *Clin Psychol Rev*. (2017) 58:16–32. doi: 10.1016/j.cpr.2017.09.004

5. Macpherson-Sánchez AE. Integrating fundamental concepts of obesity and eating disorders: implications for the obesity epidemic. *Am J Public Health*. (2015) 105:e71–85. doi: 10.2105/AJPH.2014.302507

6. Arterburn DE, Telem DA, Kushner RF, Courcoulas AP. Benefits and risks of bariatric surgery in adults: a review. *JAMA*. (2020) 324:879–87. doi: 10.1001/jama.2020.12567

7. Allison KC, Wu J, Spitzer JC, McCuen-Wurst C, Ashare RL, Tewksbury C, et al. Changes in eating Behaviors and their relation to weight change 6 and 12 months after bariatric surgery. *Obes Surg*. (2023) 33:733–42. doi: 10.1007/s11695-022-06442-w

8. Cassin SE, Sijercic I, Montemarano V. Psychosocial interventions for food addiction: a systematic review. *Curr Addict Rep*. (2020) 7:9–19. doi: 10.1007/s40429-020-00295-y

9. Leary M, Pursey KM, Verdejo-Garcia A, Burrows TL, Cassin SE, Sijercic I, et al. Current intervention treatments for food addiction: a systematic review. *Behav Sci*. (2021) 11:6. doi: 10.3390/bs11060080

10. Praxedes DRS, Silva-Júnior AE, Macena ML, Oliveira AD, Cardoso KS, Nunes LO, et al. Prevalence of food addiction determined by the Yale food addiction scale and associated factors: a systematic review with meta-analysis. *Eur Eat Disord Rev*. (2022) 30:85–95. doi: 10.1002/erv.2878

11. Camacho-Barcia L, Munguía L, Lucas I, De La Torre R, Salas-Salvadó J, Pintó X, et al. Metabolic, affective and neurocognitive characterization of metabolic syndrome patients with and without food addiction. Implications for weight progression. *Nutrients*. (2021) 13:2779. doi: 10.3390/nu13082779

12. Fernandez-Aranda F, Karwautz A, Treasure J. Food addiction: a transdiagnostic construct of increasing interest. *Eur Eat Disord Rev*. (2018) 26:536–40. doi: 10.1002/erv.2645

13. Jiménez-Murcia S, Agüera Z, Paslakis G, Munguia L, Granero R, Sánchez-González J, et al. Food addiction in eating disorders and obesity: analysis of clusters and implications for treatment. *Nutrients*. (2019) 11:2633. doi: 10.3390/nu11112633

14. Sevinçer GM, Konuk N, Bozkurt S, Coşkun H. Food addiction and the outcome of bariatric surgery at 1-year: prospective observational study. *Psychiatry Res*. (2016) 244:159–64. doi: 10.1016/j.psychres.2016.07.022

15. Nance K, Eagon JC, Klein S, Pepino MY. Effects of sleeve gastrectomy vs. Roux-en-Y gastric bypass on eating behavior and sweet taste perception in subjects with obesity. *Nutrients*. (2017) 10:18. doi: 10.3390/nu10010018

16. Pepino MY, Bradley D, Eagon JC, Sullivan S, Abumrad NA, Klein S. Changes in taste perception and eating behavior after bariatric surgery-induced weight loss in women. *Obesity*. (2014) 22:E13–20. doi: 10.1002/oby.20649

17. Gearhardt AN, Hebebrand J. The concept of "food addiction" helps inform the understanding of overeating and obesity: debate consensus. *Am J Clin Nutr*. (2021) 113:274–6. doi: 10.1093/ajcn/nqaa345

18. Gearhardt AN, Corbin WR, Brownell KD. Development of the Yale food addiction scale version 2.0. *Psychol Addict Behav*. (2016) 30:113–21. doi: 10.1037/adb0000136

19. Chapron S-A, Kervran C, Da Rosa M, Fournet L, Shmulewitz D, Hasin D, et al. Does food use disorder exist? Item response theory analyses of a food use disorder adapted from the DSM-5 substance use disorder criteria in a treatment seeking clinical sample. *Drug Alcohol Depend*. (2023) 251:110937. doi: 10.1016/j.drugalcdep.2023.110937

20. Curtis C, Davis C. A qualitative study of binge eating and obesity from an addiction perspective. *Eat Disord*. (2014) 22:19–32. doi: 10.1080/10640266.2014.857515

21. Saffari M, Fan C-W, Chang Y-L, Huang P-C, Tung SEH, Poon WC, et al. Yale food addiction scale 2.0 (YFAS 2.0) and modified YFAS 2.0 (mYFAS 2.0): Rasch analysis and differential item functioning. *J Eat Disord*. (2022) 10:185. doi: 10.1186/s40337-022-00708-5

22. Penzenstadler L, Soares C, Karila L, Khazaal Y. Systematic review of food addiction as measured with the Yale food addiction scale: implications for the food addiction construct. *Curr Neuropharmacol*. (2019) 17:526–38. doi: 10.2174/1570159X16666181108093520

23. Pursey KM, Stanwell P, Gearhardt AN, Collins CE, Burrows TL. The prevalence of food addiction as assessed by the Yale food addiction scale: a systematic review. *Nutrients*. (2014) 6:4552–90. doi: 10.3390/nu6104552

24. Xu T, Liu JJ, Liu ZQ, Qi XG, Zhang HW, Liu L, et al. Altered asymmetry of amygdala volume mediates food addiction and weight gain. *J Behav Addict*. (2025) 14:522–33. doi: 10.1556/2006.2024.00073

25. Lüscher C, Malenka R. Drug-evoked synaptic plasticity in addiction: from molecular changes to circuit remodeling. *Neuron*. (2011) 69:650–63. doi: 10.1016/j.neuron.2011.01.017

26. Huang R, Ding X, Fu H, Cai Q. Potential mechanisms of sleeve gastrectomy for reducing weight and improving metabolism in patients with obesity. *Surg Obes Relat Dis*. (2019) 15:1861–71. doi: 10.1016/j.soard.2019.06.022

27. Wang Q, Tang W, Rao W-S, Song X, Shan C-X, Zhang W. Changes of ghrelin/GOAT axis and mTOR pathway in the hypothalamus after sleeve gastrectomy in obese type-2 diabetes rats. *World J Gastroenterol*. (2017) 23:6231–41. doi: 10.3748/wjg.v23.i34.6231

28. Xu T-R, Yang Y, Ward R, Gao L, Liu Y. Orexin receptors: multi-functional therapeutic targets for sleeping disorders, eating disorders, drug addiction, cancers and other physiological disorders. *Proc Natl Acad Sci*. (2013) 25:2413–23. doi: 10.1016/j.cellsig.2013.07.025

29. Gupta A, Osadchiy V, Mayer EA. Brain–gut–microbiome interactions in obesity and food addiction. *Nat Rev Gastroenterol Hepatol*. (2020) 17:655–72. doi: 10.1038/s41575-020-0341-5

30. Barone M, Garelli S, Rampelli S, Agostini A, Matysik S, D'Amico F, et al. Multi-omics gut microbiome signatures in obese women: role of diet and uncontrolled eating behavior. *BMC Med*. (2022) 20:500. doi: 10.1186/s12916-022-02689-3

31. Samulėnaitė S, García-Blanco A, Mayneris-Perxachs J, Domingo-Rodríguez L, Cabana-Domínguez J, Fernàndez-Castillo N, et al. Gut microbiota signatures of vulnerability to food addiction in mice and humans. *Gut*. (2024) 73:1799–815. doi: 10.1136/gutjnl-2023-331445

32. Basso N, Soricelli E, Castagneto-Gissey L, Casella G, Albanese D, Fava F, et al. Insulin resistance, microbiota, and fat distribution changes by a new model of vertical sleeve gastrectomy in obese rats. *Diabetes*. (2016) 65:2990–3001. doi: 10.2337/db16-0039

33. Galanakis CG, Daskalakis M, Manios A, Xyda A, Karantanas AH, Melissas J. Computed tomography-based assessment of abdominal adiposity changes and their impact on metabolic alterations following bariatric surgery. *World J Surg*. (2015) 39:417–23. doi: 10.1007/s00268-014-2826-2

34. Rossi AA, Mannarini S, Semonella M, Castelnuovo G, Pietrabissa G. The association between grazing and food addiction: the Italian version of the repetitive eating questionnaire (rep(eat)-Q) and its relationships with food addiction criteria. *Nutrients*. (2024) 16:949. doi: 10.3390/nu16070949

35. Rossi AA. Tying food addiction to uncontrolled eating: the roles of eating-related thoughts and emotional eating. *Nutrients*. (2025) 17:369. doi: 10.3390/nu17030369

36. Conceição EM, Mitchell JE, Engel SG, Machado PP, Lancaster K, Wonderlich SA. What is "grazing"? Reviewing its definition, frequency, clinical characteristics, and impact on bariatric surgery outcomes, and proposing a standardized definition. *Surg Obes Relat Dis*. (2014) 10:973–82. doi: 10.1016/j.soard.2014.05.002

37. Colles SL, Dixon JB, O'Brien PE. Grazing and loss of control related to eating: two high-risk factors following bariatric surgery. *Obesity (Silver Spring)*. (2008) 16:615–22. doi: 10.1038/oby.2007.101 Erratum in: Obesity (Silver Spring). 2011 Nov;19(11):2287

38. Kofman MD, Lent MR, Swencionis C. Maladaptive eating patterns, quality of life, and weight outcomes following gastric bypass: results of an internet survey. *Obesity (Silver Spring)*. (2010) 18:1938–43. doi: 10.1038/oby.2010.27

39. Barstad LH, Johnson LK, Borgeraas H, Hofsø D, Svanevik M, Småstuen MC, et al. Changes in dietary intake, food tolerance, hedonic hunger, binge eating problems, and gastrointestinal symptoms after sleeve gastrectomy compared with after gastric bypass; 1-year results from the Oseberg study-a randomized controlled trial. *Am J Clin Nutr*. (2023) 117:586–98. doi: 10.1016/j.ajcnut.2022.11.016

40. Nergård BJ, Leifson BG, Gislason H, Hedenbro JL. Effect of different limb lengths on quality of life, eating patterns and gastrointestinal symptoms after Roux-en-Y gastric bypass in superobese patients: randomized study. *BJS Open*. (2020) 4:1109–16. doi: 10.1002/bjs5.50334

41. Gao H, Wang G, Zhang X, Guo H, Pang L, Gu J. Meta-analysis of the effects of cognitive behavioral therapy on dietary habits and emotional outcomes in patients with obesity undergoing metabolic and bariatric surgery. *J Nutr Educ Behav*. (2025) 57:S1499-4046(25)00309-4. doi: 10.1016/j.jneb.2025.05.193

42. Halbeisen G, Pahlenkemper M, Sabel L, Richardson C, Agüera Z, Fernandez-Aranda F, et al. The prognostic role of food addiction for weight loss treatment outcomes in individuals with overweight and obesity: a systematic review and meta-analysis. *Obes Rev*. (2025) 26:e13851. doi: 10.1111/obr.13851

43. Reche-García C, Piernas C, García-Vizcaíno EM, Lorente-Gallego AM, Piuvezam G, Frutos MD, et al. Bariatric-metabolic surgery is the most effective intervention in reducing food addiction symptoms: a systematic review and meta-analysis. *Obes Surg*. (2024) 34:3475–92. doi: 10.1007/s11695-024-07107-6

44. Bach P, Grosshans M, Koopmann A, Pfeifer AM, Vollstädt-Klein S, Otto M, et al. Predictors of weight loss in participants with obesity following bariatric surgery - a prospective longitudinal fMRI study. *Appetite*. (2021) 163:105237. doi: 10.1016/j.appet.2021.105237

45. Meneguzzo P, Behrens SC, Favaro A, Tenconi E, Vindigni V, Teufel M, et al. Body image disturbances and weight Bias after obesity surgery: semantic and visual evaluation in a controlled study, findings from the BodyTalk project. *Obes Surg*. (2021) 31:1625–34. doi: 10.1007/s11695-020-05166-z

46. Westermann S, Rief W, Euteneuer F, Kohlmann S. Social exclusion and shame in obesity. *Eat Behav*. (2015) 17:74–6. doi: 10.1016/j.eatbeh.2015.01.001

47. Tsouristakis AI, Febres G, McMahon DJ, Tchang B, Conwell IM, Tsang AJ, et al. Long-term modulation of appetitive hormones and sweet cravings after adjustable gastric banding and Roux-en-Y gastric bypass. *Obes Surg*. (2019) 29:3698. doi: 10.1007/s11695-019-04111-z

48. Wong E, Fleishman A, Brem A, Jones DB, Wee CC. High-risk alcohol use and disordered eating behavior before and 1 year after sleeve gastrectomy. *BMC Med*. (2022) 32:593–8. doi: 10.1007/s11695-021-05847-3

49. Al-Najim W, Docherty NG, le Roux CW. Food intake and eating behavior after bariatric surgery. *Physiol Rev*. (2018) 98:1113–41. doi: 10.1152/physrev.00021.2017

50. Wong LY, Zafari N, Churilov L, Stammers L, Price S, Ekinci EI, et al. Change in emotional eating after bariatric surgery: systematic review and meta-analysis. *BMC Med*. (2020) 4:995–1014. doi: 10.1002/bjs5.50318

51. Brode CS, Mitchell JE. Problematic eating behaviors and eating disorders associated with bariatric surgery. *Psychiatr Clin North Am*. (2019) 42:287–97. doi: 10.1016/j.psc.2019.01.014

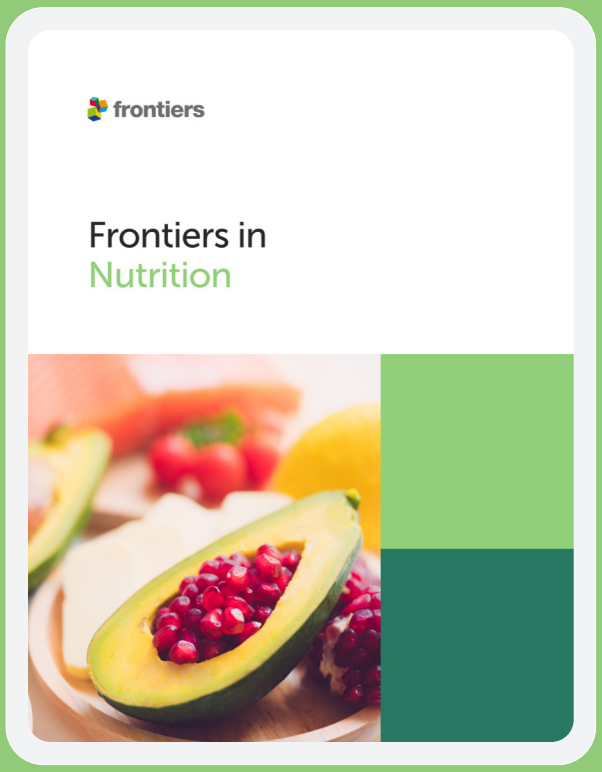
Frontiers in Nutrition

Explores what and how we eat in the context of health, sustainability and 21st century food science

A multidisciplinary journal that integrates research on dietary behavior, agronomy and 21st century food science with a focus on human health.

Discover the latest Research Topics

See more →



Frontiers

Avenue du Tribunal-Fédéral 34
1005 Lausanne, Switzerland
frontiersin.org

Contact us

+41 (0)21 510 17 00
frontiersin.org/about/contact