



OPEN Mindful eating may help explain the association between psychological difficulties and food addiction in adolescents with obesity

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Food addiction (FA) has been proposed as a behavioral factor contributing to obesity in adolescents, particularly among those experiencing psychological difficulties. Mindful eating may represent a protective characteristic, but its statistical relationship with psychological difficulties and FA in adolescents with obesity remains unclear. Forty-eight adolescents with obesity (ages 11–18; 54.2% female) were recruited from a pediatric outpatient clinic in Türkiye. FA symptoms were assessed using the Yale Food Addiction Scale for Children (YFAS-C), mindful eating with the Mindful Eating Questionnaire (MEQ), and psychological difficulties via parent reports on the Strengths and Difficulties Questionnaire (SDQ). SDQ total difficulties score was positively correlated with YFAS-C symptom scores ($r = .45$, $p = .001$) and negatively correlated with MEQ scores ($r = -.38$, $p = .01$). MEQ scores were negatively correlated with YFAS-C scores ($r = -.64$, $p < .001$). A statistical mediation analysis indicated that mindful eating functioned as a hypothesized mediator, with the data showing an associational pattern consistent with a mediation model. Psychological difficulties were associated with FA both directly ($B = 0.068$, $p = .047$) and indirectly through mindful eating ($B = 0.058$, 95% CI [0.014, 0.109]). The observed pattern suggests that mindful eating may be involved in the statistical relationship between psychological difficulties and FA symptoms, but causal mediation cannot be inferred from cross-sectional data. Mindful eating may represent a potential target for future intervention research. Longitudinal and experimental studies are required to determine temporal ordering and clarify causal pathways.

Keywords Adolescents, Food addiction, Mindful eating, Obesity, Psychological difficulties

Abbreviations

BMI	Body-mass index
FA	Food addiction
YFAS	Yale food addiction scale
YFAS-C	Yale food addiction scale for children
MEQ	Mindful eating questionnaire
SDQ	Strengths and difficulties questionnaire

Food addiction (FA) refers to a pattern of compulsive, dysregulated consumption of highly palatable foods (typically those rich in sugar, fat, and salt) that mirrors key features of substance use disorders, including impaired control, craving, tolerance, and withdrawal-like symptoms¹. FA has gained increasing attention as a behavioral factor contributing to obesity in adolescents across both community and clinical settings^{2,3}. Prevalence estimates suggest that 15% to 40% of adolescents with obesity may meet criteria for FA, underscoring its clinical relevance⁴.

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Adolescents presenting with severe FA symptoms in outpatient weight management programs often require tailored interventions⁵.

FA symptoms have been linked to psychological difficulties such as distress, alexithymia, and psychiatric symptoms⁶. Clinical and community studies indicate that children and adolescents with FA exhibit greater emotional and behavioral difficulties, as well as cognitive problems, than their peers^{7–10}. Notably, behavioral weight-loss interventions targeting adolescents have been shown to reduce FA symptoms along with depression and stress¹¹. These findings underscore the importance of investigating potential factors that may clarify how psychological difficulties contribute to FA.

One such mechanism may involve mindful eating, which refers to non-judgmental, present-focused awareness of internal and external cues during eating, including hunger and satiety signals, sensory experiences, and emotional triggers¹². Unlike general mindfulness-based interventions aimed at stress reduction, mindful eating specifically targets eating behaviors. It has been shown to reduce food cravings, support portion control, and contribute to weight management¹³. Individuals with obesity typically report lower mindful eating scores compared to normal-weight individuals, and negative affective states such as depression, anxiety, and stress are inversely related to mindful eating behaviors^{14,15}, suggesting that adolescents with higher psychological difficulties may be less able to engage in mindful eating.

Although limited, emerging evidence suggests an association between mindful eating and FA. A recent study among young adults reported that those with FA had significantly lower mindful eating¹⁶. Despite this, research examining mindful eating in adolescents with obesity is scarce, and its potential role in the statistical relationship between psychological difficulties and FA has not been explored. Therefore, this study aimed to examine the associations among psychological difficulties, mindful eating, and FA symptoms in adolescents with obesity, and to evaluate whether the observed data were consistent with a statistical mediation model. We hypothesized that psychological difficulties would be positively associated with FA symptoms, negatively associated with mindful eating, and that mindful eating would show an indirect statistical association consistent with a mediation pattern. To our knowledge, this is among the first studies to investigate mindful eating as a hypothesized statistical mediator in this context, addressing a gap in the adolescent FA literature.

Methods

Study design, participants, and procedure

This cross-sectional observational study was conducted between April and July 2022 in the Pediatric Health and Diseases outpatient clinics of Gülhane Research and Training Hospital. These clinics serve a high-volume patient population, particularly adolescents with obesity, which enabled efficient recruitment within the four-month period. Adolescents who met the inclusion criteria and had no exclusion criteria were invited to participate.

Inclusion criteria

1. Age between 11 and 18 years.
2. Age-appropriate cognitive functioning as assessed in clinical interview, ensuring the ability to complete questionnaires reliably.
3. BMI-for-age > 95th percentile according to national growth charts¹⁷.

Exclusion criteria

1. Current diagnosis of a psychiatric disorder (e.g., neurodevelopmental, mood, or psychotic disorder), based on parent report and clinical records, to reduce potential confounding effects of active psychiatric disorders and medications on eating behavior.
2. Genetic, chromosomal, or metabolic disorder associated with obesity.
3. Use of medications affecting appetite, metabolism, or cognitive functioning.
4. Chronic physical illness (e.g., diabetes, hypothyroidism, epilepsy) influencing eating behavior or psychological well-being.
5. Inability to complete questionnaires due to language barriers or cognitive limitations.

Self-report and parent-report questionnaires were administered in the outpatient setting (~30 min). Written informed consent was obtained from both adolescents and their parents/legal guardians, with the option to withdraw at any time without affecting care. The study was approved by the Local Ethical Committee (Approval no. 2022/52) and conducted in accordance with the Declaration of Helsinki.

Measurement tools

Yale Food Addiction Scale for Children (YFAS-C): YFAS was initially developed for adults and later validated for children as YFAS-C^{18,19}. The YFAS-C is a self-report scale developed to assess addictive-like eating behaviors in children over the past 12 months, particularly in response to highly palatable foods rich in fat and sugar¹⁹. Prior to completing the scale, participants were instructed to consider food items from five categories: sweets (e.g., chocolate, candy), refined carbohydrates (e.g., pasta, rice), salty snacks (e.g., chips), fatty fast foods (e.g., burgers, fries), and sugary beverages (e.g., soda, juice), when interpreting the questions. The scale includes 25 items, with the first 18 rated on a five-point Likert scale (0–4), and the remaining seven items answered in a dichotomous yes/no format (0–1). Two scoring approaches are available: a symptom count as the YFAS-C total score (range: 0–7) and a diagnostic classification that requires the endorsement of at least 3 symptoms and clinically significant impairment. The Turkish adaptation of the YFAS-C was conducted by Demir²⁰, who

reported a Cronbach's alpha of 0.78 and factor loadings ranging from 0.40 to 0.77, accounting for 49.4% of the total variance²⁰. These findings indicate that the Turkish version is a valid and reliable instrument for assessing FA symptoms in children and adolescents^{20,21}. In the present study, only the YFAS-C symptom count (0–7) was used in all analyses; the diagnostic classification was not employed.

Mindful Eating Questionnaire (MEQ): The MEQ is a self-report instrument developed initially by Framson et al.¹² to assess mindful eating behavior across five domains: disinhibition, awareness, emotional response, external cues, and distraction¹². The Turkish adaptation and psychometric validation of the MEQ were conducted by Köse et al.²², who reported acceptable internal consistency (Cronbach's alpha = 0.733) and confirmed a multidimensional structure with six subscales, including disinhibition, emotional eating, eating discipline, mindfulness, conscious nutrition, and interference²². The adapted 30-item Turkish version was found to be a valid and reliable measure for assessing mindful eating in Turkish populations. In the present study, the MEQ total score was used in all analyses rather than individual subscale scores. This decision was based on (a) conceptual interest in mindful eating as a global behavioral construct, (b) the adequate internal consistency of the total score in the Turkish validation study, and (c) the modest sample size, which precluded reliable modeling of multiple subscales in a mediation analysis.

Strengths and Difficulties Questionnaire (SDQ): The SDQ (copyrighted by Youth in Mind) is a 25-item behavioral screening tool designed to assess emotional and behavioral difficulties in children and adolescents²³. The parent-report version was used in this study. The SDQ has been validated for Turkish populations, and the parent-report form demonstrates good psychometric properties, including satisfactory internal consistency for the total score (Cronbach's alpha = 0.84)²⁴. These findings support its reliability and validity for assessing psychological difficulties in Turkish youth. The SDQ was administered in pen-and-paper format without modification, and total scores were calculated manually by the corresponding author. No SDQ items or forms are reproduced in this article; only the SDQ-derived total difficulties score is reported throughout the manuscript.

Data analysis

Data analyses were performed using IBM SPSS Statistics (Version 22.0) with the PROCESS macro (Version 4.3 for SPSS)²⁵, for mediation analysis. Preliminary descriptive statistics (means, standard deviations, ranges) were computed for all variables, and Pearson correlation coefficients were calculated to examine bivariate associations among psychological difficulties (SDQ total difficulties score), mindful eating (MEQ total score), and food addiction symptoms (YFAS-C total score). Before conducting the mediation analysis, assumptions for linear regression were evaluated. Multicollinearity was assessed using the variance inflation factor (VIF) and tolerance values, and no violations were detected (VIF < 2.0). Normality of residuals was inspected visually and through skewness and kurtosis values, which were within acceptable ranges. We applied the PROCESS Model 4 to test the mediation hypothesis. The mediation model tested whether mindful eating mediated the relationship between psychological difficulties and food addiction symptoms. Indirect effects were estimated using bias-corrected bootstrapping with 5000 resamples, and 95% confidence intervals were computed. An indirect effect was considered significant if the confidence interval did not include zero. Both unstandardized coefficients and completely standardized indirect effects were reported.

Results

A total of 48 adolescents with obesity were included in the analysis. The mean age was 14.69 years (SD=1.86), and 54.2% of the participants were female. All participants were recruited from a Research and Training Hospital located in the capital city of Türkiye, representing an urban adolescent population. Table 1 presents the descriptive statistics for the main study variables, including SDQ total difficulties score, MEQ total score, and YFAS-C total symptom count. Because neither the SDQ nor the MEQ provides a universally established clinical cutoff for total scores, these values are presented for descriptive characterization rather than diagnostic interpretation. For the YFAS-C, a symptom count of three or more may indicate clinically meaningful elevations when accompanied by impairment; thus, the sample's mean symptom level (M = 3.33, range 0–7) reflects elevated symptoms, although the dichotomous diagnostic classification was not applied in this study.

Pearson correlation analyses were conducted to examine the associations among psychological difficulties, mindful eating, and food addiction symptoms. As expected, SDQ total difficulties score was positively correlated with food addiction symptoms ($r=.45, p=.001$) and negatively correlated with MEQ total scores ($r=-.38,$

	Mean	SD	Min	Max
Age	14.69	1.86	11.04	17.99
Body mass index	31.25	3.25	25.95	39.89
BMI percentile	98.83	1.26	95.35	99.99
SDQ total difficulties score	13.65	6.13	1.00	28.00
MEQ total score	3.16	0.59	2.04	4.29
YFAS-C total score	3.33	1.73	0.00	7.00

Table 1. Descriptive statistics. BMI = Body mass index; SDQ = Strengths and Difficulties Questionnaire (psychological difficulties); MEQ = Mindful Eating Questionnaire (mindful eating); YFAS-C = Yale Food Addiction Scale for Children (food addiction symptoms, not a dichotomous diagnostic classification).

	SDQ total difficulties score	MEQ total score	YFAS-C total score
SDQ total difficulties score	–	–.38 ^a	.45 ^a
MEQ total score	–.38 ^a	–	–.64 ^a
YFAS-C total score	.45 ^a	–.64 ^a	–

Table 2. Correlations among scale scores. SDQ = Strengths and Difficulties Questionnaire (psychological difficulties); MEQ = Mindful Eating Questionnaire (mindful eating); YFAS-C = Yale Food Addiction Scale for Children (food addiction symptoms, not a dichotomous diagnostic classification). ^aPearson correlation analysis was used to test the bidirectional relationships. Correlation coefficients were significant at $p < .01$.

Path	B	SE	t	p	95% CI
Total effect (X → Y)	0.126	0.037	3.386 ^a	0.001	[0.051, 0.201]
Direct effect (X → Y)	0.068	0.034	2.038 ^a	0.047	[0.001, 0.136]
Indirect effect (X → M → Y)	0.058	0.024	–	–	[0.014, 0.109]
X → M	–0.036	0.013	–2.747 ^a	0.009	[–0.063, –0.010]
M → Y	–1.593	0.347	–4.587 ^a	< 0.001	[–2.293, –0.894]

Table 3. Mediation Analysis. X = SDQ total difficulties score (psychological difficulties); M = MEQ total score (mindful eating); Y = YFAS-C total score (food addiction symptoms, not a dichotomous diagnostic classification). Bootstrap estimates based on 5000 resamples. Confidence intervals are bias-corrected and accelerated (BCa). ^a t scores are significant at $p < .05$ level.

$p = .01$). Mindful eating was negatively correlated with food addiction symptoms ($r = -.64, p < .001$). No evidence of multicollinearity was observed ($VIF < 2.0$). The correlation matrix is presented in Table 2.

To explore whether mindful eating showed a statistical pattern consistent with a mediation model, we conducted a simple mediation analysis using PROCESS Model 4²⁵. Psychological difficulties (SDQ total difficulties score) were entered as the predictor (X), mindful eating (MEQ total score) as the proposed mediator (M), and food addiction symptom count (YFAS-C total score) as the outcome (Y) (Table 3).

As presented in Table 3, the total association between SDQ total difficulties score and YFAS-C total score was statistically significant ($B = 0.126, SE = 0.037, t(46) = 3.386, p = .001, 95\% \text{ CI } [0.051, 0.201]$). When the MEQ total score was included in the model, the direct association between SDQ total difficulties score and YFAS-C total score remained significant but reduced in magnitude ($B = 0.068, SE = 0.034, t(45) = 2.038, p = .047, 95\% \text{ CI } [0.001, 0.136]$). SDQ total difficulties score was negatively associated with MEQ total score ($B = -0.036, SE = 0.013, t(46) = -2.747, p = .009, 95\% \text{ CI } [-0.063, -0.010]$), and MEQ total score was negatively associated with YFAS-C total score ($B = -1.593, SE = 0.347, t(45) = -4.587, p < .001, 95\% \text{ CI } [-2.293, -0.894]$).

The indirect effect was statistically significant ($B = 0.058, \text{BootSE} = 0.024, 95\% \text{ CI } [0.014, 0.109]$), based on 5,000 bootstrap samples, indicating that the observed data were consistent with a statistical mediation pattern. The completely standardized indirect effect was 0.205 ($95\% \text{ CI } [0.050, 0.367]$). Overall, these findings indicate that lower mindful eating statistically accounted for part of the association between psychological difficulties and food addiction symptoms, within the limits of a cross-sectional, correlational design (Fig. 1).

Discussion

This study explored the relationships among mindful eating, psychological difficulties, and food addiction (FA) in adolescents with obesity and evaluated whether the observed data were consistent with a statistical mediation model. Consistent with our hypotheses, psychological difficulties were positively associated with FA symptoms and negatively associated with mindful eating. Moreover, mindful eating was inversely associated with FA symptom severity. The mediation findings reflected a statistical pattern consistent with partial mediation, suggesting that mindful eating may be one factor associated with—though not temporally mediating—the relationship between psychological difficulties and FA symptoms. Because this was a cross-sectional and modestly powered study, all findings should be interpreted as exploratory and hypothesis-generating rather than confirmatory. Moreover, additional factors such as emotion regulation, impulsivity, and reward sensitivity may contribute to the observed associations.

Evidence in adult and university populations has consistently linked FA to stress-driven or emotion-driven eating²⁶. Our results align with previous reports, which show that FA is associated with higher emotional and behavioral difficulties in children and adolescents^{7,9,10}. Similar to findings in adults, where FA has been linked with elevated depression, anxiety, and stress⁶, our results emphasize the relevance of psychological difficulties in understanding addictive-like eating in younger populations. By extending these associations to an adolescent obesity sample, this study contributes to the growing evidence that FA reflects both psychological vulnerability and self-regulation deficits.

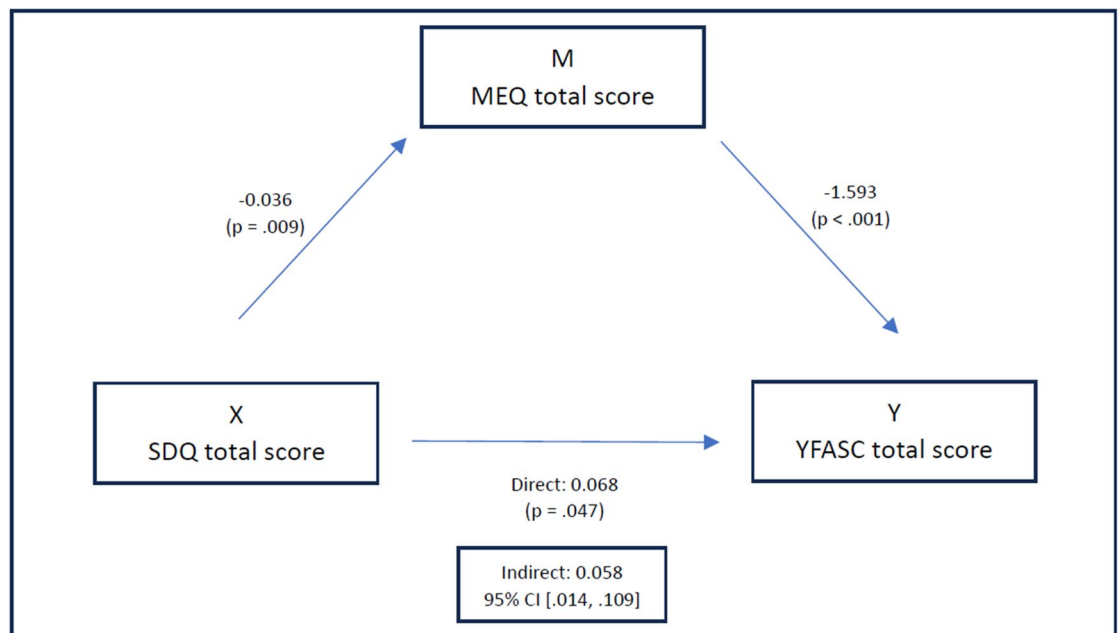


Fig. 1. Mediation model showing the indirect effect of psychological difficulties on food addiction symptoms through mindful eating. X = SDQ total score (psychological difficulties), M = MEQ total scores (mindful eating), Y = YFAS-C total score (food addiction symptoms). Coefficients are unstandardized. Bootstrap confidence intervals are based on 5000 samples. $p < .05$ for all.

Regarding mindful eating, prior studies have demonstrated inverse associations with FA in young adults¹⁶ and with problematic eating patterns more broadly. For example, Keyte et al.²⁷ reported an inverse relationship between mindful eating and motivation for consuming palatable foods, while Mantzios et al.²⁸ found mindful eating inversely related to fat and sugar intake. Together, these studies highlight the role of regulatory deficits, such as distractibility, disinhibition, and unstructured eating. The present results add to this literature by showing that mindful eating is statistically related to both psychological difficulties and FA symptoms in adolescents. Importantly, and cautiously stated, our results indicate that mindful eating may function as a hypothesized statistical mediator in this relationship, although longitudinal studies are necessary to evaluate temporal sequence.

From a theoretical perspective, our results support models positing that psychological difficulties disrupt self-regulatory processes, thereby increasing vulnerability to maladaptive eating. Mindful eating could represent one self-regulatory process relevant to adolescent eating behavior. Neurobehavioral research provides complementary evidence. Constant et al.¹ described altered reward circuitry and impaired inhibitory control in individuals with FA, implicating dysfunction in the orbitofrontal and anterior cingulate regions. Such deficits may hinder adolescents' ability to regulate their eating in response to internal cues, thereby diminishing their ability to engage in mindful eating. Hendrickson and Rasmussen²⁹ demonstrated that mindful eating training improved delay tolerance in food-related decision-making, suggesting that mindfulness may enhance inhibitory control specific to eating. Similarly, Mason et al.^{30,31} reported that mindful eating interventions reduced food cravings, emotional eating motives, and compulsive eating, with downstream benefits for metabolic outcomes. These mechanistic findings offer conceptual support for why mindful eating may be linked with FA symptoms, but causality cannot be inferred from the current data.

The potential clinical implications, while preliminary, are noteworthy. Mindful eating may help adolescents become more attuned to internal hunger and satiety cues, reduce reliance on emotional or external triggers for eating, and support healthier dietary regulation. Experimental studies lend support to these applications: Fisher et al.³² showed that brief mindful attention inductions reduced food intake after exposure to palatable cues, while Forman et al.³³ found mindful decision-making training to be more effective than inhibitory control training in reducing snack consumption. Adolescent-focused interventions have yielded modest but positive outcomes, including reduced binge eating, improved body image, and healthier dietary behaviors^{34,35}. Systematic reviews and meta-analyses provide additional support, with Shao et al.³⁶ and Shan et al.³⁷ reporting improvements in eating behavior, emotional well-being, and even physiological markers (e.g., cortisol, ghrelin). Keck-Kester et al.³⁸ further emphasized that multi-component programs combining mindful eating with emotion regulation strategies and family engagement achieved the most robust outcomes.

Although our findings are correlational, they support the possibility that mindful eating could be explored as a behavioral target in adolescents with obesity who experience psychological difficulties. At the same time, the partial nature of the observed statistical mediation suggests that mindful eating may represent only one component of a more complex network of factors. Interventions may therefore benefit from incorporating mindful eating alongside broader approaches to address underlying psychological difficulties, such as cognitive-

behavioral therapy, emotion regulation training, or family-based interventions. Such integrative approaches may be particularly important for adolescents with high levels of emotional or behavioral difficulties, for whom mindful eating practices may be more challenging to adopt without concurrent support for psychological difficulties.

The findings of the current study should be considered in light of several important limitations. First, the cross-sectional design precludes any conclusions regarding temporal precedence or causal direction. Although we used Hayes' PROCESS macro to test a statistical mediation model, the analysis identifies only an associational pattern consistent with mediation. Therefore, the present mediation findings should be considered exploratory and hypothesis-generating rather than confirmatory. Longitudinal and experimental designs are needed to verify whether mindful eating truly mediates the relationship between psychological difficulties and food addiction symptoms. Second, the modest sample size ($N = 48$) reduces statistical power, may affect the stability of the estimated coefficients, and increases the risk of both Type I and Type II errors. Although bias-corrected bootstrapping improves precision, it does not substitute for a larger, well-powered sample. At the same time, mediation analysis with bootstrapping is well-suited for smaller samples, as it does not rely on normality assumptions and produces accurate confidence intervals²⁵. Moreover, the observed effect sizes were moderate, and the confidence intervals did not include zero, supporting the reliability of the findings.

Third, as participants were recruited from a single outpatient clinic, the findings may not generalize to broader adolescent populations; however, they are clinically relevant. Also limiting the generalizability of the findings is that our sample consists only of urban Turkish adolescents, which may not reflect adolescents from rural areas or from different countries. Because race/ethnicity data were not collected and the sample reflects adolescents receiving care in an urban Turkish outpatient setting, the demographic and cultural diversity of the sample cannot be fully characterized. This limits the interpretability and generalizability of the findings to more diverse or multicultural youth populations. Lack of parent-level sociodemographic variables further limits the ability to contextualize family-level influences. In addition, because we excluded adolescents with current psychiatric diagnoses, the sample reflects youths with obesity who experience subclinical psychological difficulties, as captured by the SDQ, rather than those with clinically diagnosed disorders. While this approach reduced potential confounders related to psychiatric symptoms, medication use, or illness effects on appetite and regulation, it also limits the clinical generalizability of the findings. Given that FA, obesity, and psychiatric disorders frequently co-occur, the associations observed in this study may represent a conservative estimate, and stronger relationships may emerge in samples that include adolescents with formal psychiatric conditions. Additionally, because the study did not include a community comparison group, it remains unclear whether the observed associations differ between adolescents with obesity seeking clinical care and those in the broader community. Future studies should incorporate community-based or multi-group designs to assess the generalizability of these findings. Moreover, the reliance on self-report measures and parent ratings may introduce recall or social desirability bias; future work should incorporate multi-informant reports and behavioral or ecological measures to mitigate these biases. Finally, additional variables, such as impulsivity, executive functioning, or emotion regulation, were not assessed and may further clarify the observed associations.

Our exploratory results are best viewed as a foundation for generating hypotheses and guiding more robust future investigations. Future research should replicate these findings in larger, multi-site, and more diverse samples using longitudinal and experimental designs to establish temporal and causative patterns. Randomized controlled trials should evaluate whether mindful eating interventions reduce FA symptoms, particularly among adolescents with elevated psychological difficulties, and should integrate neurocognitive and affect regulation measures to clarify underlying mechanisms. Finally, although the MEQ total score was used to model mindful eating as a global construct, future studies with larger samples may benefit from examining specific subscales (e.g., emotional eating, disinhibition) to better understand which facets of mindful eating are most relevant to psychological difficulties and food addiction.

Conclusion

In conclusion, this study provides preliminary evidence that mindful eating is statistically associated with the relationship between psychological difficulties and food addiction symptoms in adolescents with obesity, in a pattern consistent with partial mediation. While these findings highlight mindful eating as a potentially relevant behavioral factor, they should be interpreted with caution, given the cross-sectional design and modest sample size. As an initial investigation of a clinical sample, the present study contributes to the identification of behavioral constructs that warrant further examination in larger, longitudinal designs.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Author contributions

Sİ, ŞNKC and MC conceptualized and designed the work; MC acquired the data; Sİ analyzed the data; Sİ and ŞNKC interpreted the findings; Sİ drafted the work; ŞNKC and MC revised the draft. All authors have approved the submitted version and agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

Declarations

Competing interests

The authors declare no competing interests.

Ethical approval

The study protocol was approved by the Ethics Committee of Gülhane Research and Training Hospital, with the approval number 2022/52.

Consent for participation

Prior to participation, written informed consent for participation and publication was obtained from both adolescents and their accompanying parents or legal guardians.

Additional information

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