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# A prospective study on the link between weight-related self-stigma and binge eating: Role of food addiction and psychological distress

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1  **ABSTRACT**

2  **Objectives:** This prospective study investigated the link between weight-related self-stigma

3  and binge eating by (i) examining the temporal association between weight-related self-

4  stigma and binge eating; (ii) investigating the mediating role of food addiction in the

5  association between weight-related self-stigma and binge eating; and (iii) examining the

6  mediating role of psychological distress in the association between weight-related self-stigma

7  and binge eating.

8  **Method:** Participants comprised 1,497 adolescents (mean=15.1 years; SD=6.0). At baseline,

9  three months, and six months, demographics, body mass index, weight bias, psychological

10  distress (i.e., depression, anxiety, stress), food addiction, and binge eating were assessed. The

11  mediation model was analyzed using Model 4 in the PROCESS macro for SPSS with 10,000

12  bootstrapping resamples.

13  **Results:** There was no significant direct association between weight-related self-stigma and

14  binge eating. However, food addiction and psychological distress significantly mediated the

15  association between weight-related self-stigma and binge eating.

16  **Discussion:** These findings highlight the indirect association between weight-related self-

17  stigma and binge eating via food addiction and psychological distress. Consequently,

18  intervention programs targeting food addiction and psychological distress among adolescents

19  may have significant positive effects on outcomes for weight-related self-stigma and binge

20  eating. The findings will be beneficial to researchers and healthcare professionals working

21  with adolescents during this critical developmental period.

22

23  **Keywords:** adolescents; binge eating; food addiction; psychological distress; weight-related

24  self-stigma

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**1. INTRODUCTION**

Eating disorders among adolescents are of public health concern due to their prevalence (Erskine et al., 2017; Michaud & Fombonne, 2005), early onset (Erskine et al., 2017; Kessler et al., 2007), and impact on educational achievements (Patel, Flisher, Hetrick, & McGorry, 2007), families (Patel et al., 2007), and communities (Patel et al., 2007). Indeed, eating disorders account for 1.2% (0.9%–1.5%) disability-adjusted life years (DALYs), with the highest proportion of total DALYs occurring among individuals aged 10–29 years (Whiteford et al., 2013). Of increasing interest to researchers is binge eating, which has higher lifetime and global prevalence estimates than both anorexia nervosa and bulimia nervosa (Erskine & Whiteford, 2018; Swanson, Crow, Le Grange, Swendsen, & Merikangas, 2011). There is also a high prevalence of binge eating among adolescents. Recent epidemiological research examining binge eating among adolescents reported that approximately 1%–5% of adolescents experience binge eating, and onset peaks at ages 16–17 years (Marzilli, Cerniglia, & Cimino, 2018).

Individuals with binge eating often suffer physical, social, and psychological challenges. With regard to physical challenges, individuals with binge eating often have overweight or obesity, conditions that are associated with serious health problems such as cardiovascular disease and type II diabetes (Kumar & Kelly, 2017; Raj & Kumar, 2010). With regard to social challenges, individuals with binge eating who are overweight may experience isolation, being teased, and/or being bullied (Y-C Lin, Latner, Fung, & Lin, 2018). Concerning psychological challenges, individuals with binge eating may have high risk of low self-esteem, negative body image, and high levels of psychological distress, including depression, anxiety, and stress (American Psychiatric Association, 2013; M. Y. Cheng et al., 2018). These challenges hinder the holistic biopsychosocial development of an adolescent

and highlight the need to understand the factors that contribute to binge eating. The factors

contributing to binge eating remain understudied, especially in comparison to anorexia

nervosa and bulimia nervosa (Erskine & Whiteford, 2018). A better etiological understanding

of the psychopathology underlying and contributing to binge eating may improve prevention

and treatment efforts.

Weight-related self-stigma is the extent to which an individual who has weight concerns

perceives, endorses, accepts, and internalizes discrimination, prejudice, and stereotypes

toward obesity or being overweight (Lin et al., accepted; Wong et al., 2019). After accepting

and endorsing these negative attitudes toward obesity or being overweight, individuals may

feel hopeless and distressed about their weight and use maladaptive coping strategies such as

eating and avoiding social interaction (American Psychiatric Association, 2013; Puhl & Suh,

2015; Wong et al., 2019). It has been reported that weight-related self-stigma may increase

body shame, and subsequently deteriorate psychological wellbeing (Tylka et al., 2014). This

may create a vicious cycle, whereby individuals with high weight-related self-stigma may

become physically inactive and gain weight (O. Y. Cheng et al., 2019). Moreover, with high

levels of weight-related self-stigma, individuals have greater levels of eating disturbances

including binge eating (Carels et al., 2010; Durso et al., 2012; Roberto et al., 2012). Thus,

weight-related self-stigma is likely to be one of the contributors to binge eating (M. Y. Cheng

et al., 2018; O. Y. Cheng et al., 2019; C-Y Lin, Strong et al., 2019).

Fully understanding the factors that affect binge eating and potential mediators in its

relationship with weight-related self-stigma may help clinicians foster healthier eating habits.

Two tentatively modifiable mediators in the relationship between weight-related self-stigma

and binge eating are psychological distress and food addiction (Figure 1).

1

2 Closely related to weight-related self-stigma and binge eating is food addiction, which is

3 reported to be an important factor in both obesity and binge eating (American Psychiatric

4 Association, 2013; Pacanowski et al., 2018). Food addiction is positively associated with

5 weight-related self-stigma (Cassin et al., 2019; Gearhardt et al., 2012; Lee, Hall, Lucke,

6 Forlini, & Carter, 2014) because patients with greater severity of food addiction have greater

7 internalized weight bias and body shame (Burmeister, Hinman, Koball, Hoffmann, & Carels,

8 2013; Cassin et al., 2019). Additionally, food addiction is reported to be positively associated

9 with binge eating (Burrows, Skinner, McKenna, & Rollo, 2017; Gearhardt, Corbin, &

10 Brownell, 2009; Gearhardt et al., 2012; Gearhardt, White, & Potenza, 2011), and was the

11 strongest predictive factor of binge eating (57%) in one study (Gearhardt et al., 2012).

12 Consequently, food addiction may be considered as a potential mediator of the relationship

13 between weight-related self-stigma and binge eating (American Psychiatric Association,

14 2013; Swanson et al., 2011).

15

16 Weight-related self-stigma has been found to increase mood problems, such as depression,

17 anxiety, and psychological distress, symptoms which significantly relate to weight-related

18 self-stigma and binge eating (American Psychiatric Association, 2013; Marzilli et al., 2018;

19 Swanson et al., 2011). That is, although there is no known study of psychological distress

20 mediating the relationship between weight-related self-stigma and binge eating, it can be

21 deduced from previous studies that psychological distress serves as a common factor with

22 respect to the relationship between weight-related self-stigma and binge eating (Marzilli et

23 al., 2018; Swanson et al., 2011). Further supporting this proposition, a similar study reported

24 that psychological distress mediated the relationship between weight stigma and disordered

25 eating behavior (emotional eating, uncontrolled eating, and loss-of-control eating; O'Brien et

1  al., 2016). Therefore, psychological distress may also be a potential mediator of the

2  relationship between weight-related self-stigma and binge eating. An enhanced understanding

3  of the direction of these associations and their mediators could benefit future research and

4  treatment.

5

6  The present study extends previous literature on factors associated with binge eating (e.g.,

7  Gearhardt et al., 2012; Marzilli et al., 2018; Pacanowski et al., 2018; Swanson et al., 2011) by

8  examining two variables hypothesized to mediate the relationship between weight-related

9  self-stigma and binge eating. Specifically, this prospective study examines the link between

10  weight-related self-stigma and binge eating by (i) examining the temporal association

11  between weight-related self-stigma and binge eating; (ii) investigating the mediating role of

12  food addiction in the association between weight-related self-stigma and binge eating; and

13  (iii) examining the mediating role of psychological distress in the association between

14  weight-related self-stigma and binge eating.

15

16  **2. METHODS**

17  **2.1 Participants**

18  A total of 1,810 adolescents were recruited from 16 high schools from 78,850 students from

19  98 high schools in Qazvin (Iran) for this prospective study from September 2018 to May

20  2019. A total of 313 participants were excluded due to unavailability of data. Therefore,

21  1,497 participants comprised the final sample used for this study. Participants were within the

22  age range of 13-18 years and had an overweight or obese body mass index (BMI) greater than

23  the 85th percentile for age and gender. The study design and procedure were approved by the

24  ethics committee of Qazvin University of Medical Sciences (IR.QUMS.REC.1397.325), and

1    informed consent was obtained from all participants and their guardians before completing

2    the survey.

3

4    **2.2 Instruments**

5    **2.2.1 Demographics:** Demographic data (which included age, gender, smoking status of the

6    participants, and the education level of the participants' parents) were gathered using a

7    background information sheet.

8

9    **2.2.2 Weight Bias Internalization Scale (WBIS):** The WBIS was used to assess weight-

10   related self-stigma (i.e., the extent to which individuals endorse and apply weight-based

11   stereotypes to themselves) (Pearl & Puhl, 2014). With 11 items rated on a five-point Likert

12   scale, a higher score on the WBIS indicates higher levels of weight-related self-stigma (Durso

13   & Latner, 2008). The psychometric properties of the WBIS have been found to be excellent

14   ($\alpha$ = .90) (Durso & Latner, 2008; Wong et al., 2019). The Persian version was found to have

15   excellent internal consistency ($\alpha$=0.90), good test-retest reliability over a two-week interval

16   (Pearson's r=0.78), and an empirically supported one-factor structure (as evidenced by the fit

17   indices in the confirmatory factor analysis) on adolescents (C-Y Lin, Imani, Cheung, &

18   Pakpour, 2019).

19

20   **2.2.3 Body mass index (BMI) and z-BMI:** BMI ($kg/m^2$) was used to identify individuals

21   with overweight and obesity. Height (to the nearest cm) and weight (to the nearest 0.1 kg)

22   were measured using a stadiometer (Seca Model 207, Seca, Hamburg, Germany) without

23   wearing shoes and with minimum clothing. The BMI values were transformed into BMI z-

24   scores using the World Health Organization (WHO) BMI-for-age reference values (WHO

1    Multicentre Growth Reference Study Group, 2006). Anthropometric data were collected by

2    two trained assistants in a classroom.

3

4    **2.2.4 Depression, Anxiety, and Stress Scale-21 (DASS-21):** The DASS-21 was used to

5    assess psychological distress. It comprises three subtypes of psychological distress

6    (depression, anxiety, and stress), assessed via its three 7-item subscales. A four-point Likert

7    scale (0=*did not apply to me at all, never*; 3=*applied to me very much, or most of the time,*

8    *almost always*) is applied to all the DASS-21 items, and a total score ranging between 0 and

9    63 is calculated by summing all the responses. A higher level of the psychological distress is

10   indicated by a higher DASS-21 score. The Persian DASS-21 version has been translated and

11   validated with very good to excellent internal consistency ($\alpha$=0.84 to 0.91; Asghari, Saed, &

12   Dibajnia, 2008; C-Y Lin, Broström, Nilsen, Griffiths, & Pakpour, 2017) and promising

13   convergent validity (r=0.4 to 0.7 with the Four Systems Anxiety Questionnaire and Beck

14   Depression Inventory; Asghari et al., 2008). Also, the DASS-21 has been validated among

15   adolescents (Shaw, Campbell, Runions, & Zubrick, 2017; Silva et al., 2016).

16

17   **2.2.5 Yale Food Addiction Scale for Children (YFAS-C):** The YFAS-C was used to assess

18   food addiction. The YFAS-C is modified from the adult version (i.e., Yale Food Addiction

19   Scale; YFAS; Gearhardt et al., 2009), and contains 25 items that assess seven criteria based

20   on substance-used disorders listed in the *Diagnostic and Statistical Manual of Mental*

21   *Disorders 4th edition, Text revision* (DSM-IV-TR; American Psychiatric Association, 2000).

22   A five-point Likert scale (0=*never*; 4=*always*) is applied to the first 18 YFAS-C items, and a

23   dichotomous (*yes/no*) scale is used for the last seven items. Following this, all the items are

24   converted dichotomously (0=*no*; 1=*yes*) according to specific scoring thresholds for each

25   item. Using the converted dichotomous scores, a symptom count scoring version (ranging

between 0 and 7) and a diagnostic scoring version (having three or more criteria met plus

having clinically significant impairment or distress) can be generated. In the present study,

the symptom count scoring version was used for analyses. The YFAS-C has very good

internal consistency (KR-20=0.82), and good construct validity supported by confirmatory

factor analysis (Magyar et al., 2018). The Persian YFAS-C version has good internal

consistency (KR20=0.81), test-retest reliability (intraclass correlation coefficient=0.83),

separation reliability (person separation reliability=0.77; item separation reliability=0.98),

and separation index (person separation index=2.04; item separation index=8.01) (C-Y Lin,

Imani, Griffths, & Pakpour, 2019).

**2.2.6 Binge Eating Scale (BES):** The BES was used to assess binge eating, and is a 16-item

scale that assesses both behavioral manifestations (e.g., eating large amounts of food) and

feeling/cognitions surrounding a binge episode (e.g., guilt, fear of being unable to stop

eating) (Gormally, Black, Daston, & Rardin, 1982). Each of the 16 items has three or four

statements. Participants were asked to select the statement which describes them best. The

total score of BES varies from 0 to 46. According to BES scores, individuals can be classified

into three categories: (i) those who score 17 or less are defined as "non-binge eaters"; (ii)

those who score 18 to 26 are "moderate binge eaters"; and (iii) those who score 27 or more

are considered as "severe binge eaters" (Gormally et al., 1982; Marcus, Wing, & Hopkins,

1988; Mootabi, Moloodi, Dezhkam, & Omidvar, 2009). The Persian version of the BES

showed a sensitivity of 84.6% and specificity of 80.8% in identification of binge-eating

disorder. The test-retest reliability and internal consistency of BES were 0.71 and 0.85,

respectively (Mootabi et al., 2009). Also, the BES has been validated among adolescents

(Cuzzocrea, Costa, Larcan, & Toffle, 2015; Gan, Mohamad, & Law, 2018).

1 **2.3 Procedure**

2 A list of all high schools in the Iranian city of Qazvin (located 150 km northwest of Tehran,

3 population 566,773, based on 2011 census figures) was obtained from the Organization for

4 Education. Sixteen high schools were randomly selected from 98 high schools in Qazvin.

5 Informed consent was obtained from the school authorities before the commencement of this

6 survey. A meeting was held in the schools for participants and their parents to explain the

7 study's aims. The research assistants determined participants' eligibility by assessing the

8 anthropometric parameters among all students and their parents. The adolescents completed

9 the study measures in a classroom at each school at baseline (BMI and WBIS), three months

10 (DASS and YFAS-C), and six months after the baseline assessment (BES).

11

12 **2.4 Data analysis**

13 Pearson correlations were conducted to examine the relationship between the studied

14 variables (psychological distress, binge eating, food addiction, and weight stigma). In terms

15 of the mediation model, binge eating (assessed using BES) was the dependent variable;

16 weight-related self-stigma (assessed using WBIS) was the independent variable; and food

17 addiction (assessed using YFAS), and psychological distress (assessed using DASS-21) were

18 the mediators. Additionally, age, gender, and parents' BMI, and baseline z-BMI were

19 controlled for in the mediation model. The mediation model was assessed using Model 4 in

20 the PROCESS macro for SPSS with 10,000 bootstrapping resamples (Model 4, Process

21 Macro) (Hayes, 2018).

22

23 **3. RESULTS**

24 Among the 1,497 adolescents, less than half were males (n=684; 45.7%). In addition, the

25 mean age of the participants was 15.1 years (SD=6.0) years with 284 participants being

current cigarette smokers (19.0%). Additional demographics and scores for the DASS-21,

WBIS, YFAS, and BES are shown in Table 1.


(Insert Table 1 here)


Table 2 demonstrates the correlations between psychological distress, binge eating, food

addiction, and weight-related self-stigma. All correlations were significant ($p<0.01$, range =

0.10 to 0.27). Mediation analysis was used to examine whether food addiction or

psychological distress were significant mediators in the association between weight-related

self-stigma and binge eating. The 95% CIs of food addiction (unstandardized

coefficient=0.38; LLCI=0.26; ULCI=0.52) and psychological distress (unstandardized

coefficient=0.20; LLCI=0.10; ULCI=0.31) did not include zero. Therefore, both variables

were significant mediators. Additionally, the total indirect effect on the association between

weight-related self-stigma and binge eating was 0.58 (LLCI=0.41; ULCI=0.77). The

mediation model also demonstrated significant direct effects of weight-related self-stigma on

mediators but not the dependent variable, binge eating (unstandardized coefficient of 0.17;

SE=0.22; $p=0.44$). The unstandardized coefficient was 1.58 for psychological distress

(SE=0.31; $p<0.001$) and 0.33 for food addiction (SE=0.04; $p<0.001$). Weight-related self-

stigma had a significant total effect of 0.75 (SE=0.23; $p<0.001$) on binge eating (Table 3).


(Insert Tables 2 and 3 here)


**4. DISCUSSION**

This study used a prospective research design to examine the temporal association between

weight-related self-stigma and binge eating as well as two potential mediators (i.e.,

1    psychological distress and food addiction). The results showed that there was no direct

2    temporal association between weight-related self-stigma and binge eating although they were

3    positively related. This suggests that weight-related self-stigma does not directly influence

4    binge eating, though it may have a direct effect on other mental health problems (M. Y.

5    Cheng et al., 2018; Ratcliffe & Ellison, 2015; Tylka et al., 2014). Therefore, this suggests the

6    existence of mediators in the association between weight-related self-stigma and binge eating.

7    The results of present study demonstrate that food addiction and psychological distress are

8    two of the mediators in such an association.

9

10   The mediation analysis indicated that the strongest mediated effects appeared for food

11   addiction (unstandardized coefficient=0.38) followed by psychological distress

12   (unstandardized coefficient=0.20). This suggests that weight-related self-stigma indirectly

13   predicts binge eating via food addiction. It is not surprising that food addiction was the

14   strongest mediator between weight-related self-stigma and binge eating because individuals

15   with obesity have higher weight-related self-stigma (Chan et al., 2019). It has also been

16   reported that individuals with food addiction are typically overweight or obese (Barry,

17   Brescoll, Brownell, & Schlesinger, 2009; Gearhardt et al., 2009; Gearhardt et al., 2011).

18   Consequently, food addiction seems to be the strongest of the mediators in the relationship

19   between weight-related self-stigma and binge eating. Hence, future research should examine

20   several mediators in the relationship between weight-related self-stigma and binge eating to

21   ascertain the magnitude of the various mediators. This will further inform researchers and

22   clinicians on possible interventional studies.

23

24   Psychological distress also acted as another pathway that mediated the association between

25   weight-related self-stigma and binge eating. The relationship between weight-related self-

1  stigma and psychological distress is consistent with previous research (M. Y. Cheng et al.,

2  2018; C-Y Lin, Strong et al., 2019). Additionally, previous studies have indicated that higher

3  psychological distress is associated with higher risk of eating disturbances (Isomaa, Isomaa,

4  Marttunen, Kaltiala-Heino, & Björkqvist, 2010). The mediating role of psychological distress

5  found in the present study supports previous literature (American Psychiatric Association,

6  2013; Fairburn, Cooper, & Shafran, 2003; Pacanowski et al., 2018). This novel study

7  indicates that factors that mediated the association between weight-related self-stigma and

8  binge eating were food addiction and psychological distress. These results add to the

9  literature on weight-related self-stigma and binge eating.

10

11  **4.1 Limitations and strengths**

12  There are some limitations in the present study. First, the findings of the present study cannot

13  be generalized to other countries because all the participants were Iranian adolescents. That

14  is, differences in Eastern and Western cultures have been reported to influence response

15  styles and attitudes toward overweight and eating habits (Hamamura, Heine, & Paulhaus,

16  2008; Johnson, Shavitt, & Holbrook, 2011; Westenhoefer et al., 2018). Therefore, future

17  replication of this study is warranted to examine whether the proposed mediation model

18  presented here can be extended to other countries and Western culture. Second, most of the

19  data collected in the study were self-report in nature. Therefore, biases such as social

20  desirability and memory recall cannot be excluded. However, the strong and robust

21  psychometric properties established for these measures (Asghari et al., 2008; C-Y Lin et al.,

22  2017; C-Y Lin, Imani, et al., 2019; Magyar et al., 2018; Mootabi et al., 2009) suggest that

23  these instruments are valid and trustworthy. Third, although the prospective design supports a

24  potential causal effect among the factors of weight-related self-stigma, food addiction,

25  psychological distress and binge eating, stronger evidence should be examined using

1   randomized controlled trials. For example, future RCT studies could examine the efficacy of

2   treatment programs for food addiction and psychological challenges and identify whether

3   reductions in food addiction and psychological distress potentially lower the prevalence of

4   binge eating. Fourth, even though a prospective design was used in this study, the intervals

5   between the assessment time points were relatively close. Therefore, whether a *real* change

6   can be observed in such a short period is questionable. Moreover, the temporal association is

7   only one criterion to determine causality. Following this, the present study did not ask the

8   participants to complete all the measures at each assessment point. Hence, the strong

9   evidence of causality cannot be examined using advanced statistical analyses, such as cross-

10   lagged models. Future studies are thus warranted to collect all data at every time point to

11   provide strong causality evidence.

12

13   The strengths of this study include the relatively large sample size (nearly 1,500 adolescents)

14   and the robust statistical testing. The large sample size decreases the chance that the findings

15   are biased by any outliers, and the robust statistical testing suggests high internal validity.

16   Consequently, these strengths improve the generalizability of the results to Iranian

17   adolescents. Additionally, this study is one of the first to adopt a prospective design to better

18   understand whether food addiction and psychological distress are mediators in the association

19   between weight stigma and binge eating. The present study's design allowed us to understand

20   the patterns in these variables over time during a critical developmental period.

21

22   **4.2 Implication for research and practice**

23   The findings of this study demonstrated that weight stigma impacted binge eating indirectly

24   via the mediators of food addiction and psychological distress. The findings indicate that

25   weight-related self-stigma remains an important mental health challenge among adolescents,

1  one that may significantly affect the biopsychosocial state of adolescents. It was not

2  surprising that weight-related self-stigma indirectly affected binge eating via the mediators of

3  food addiction and psychological distress. However, there may be other mental health factors

4  that directly predict binge eating, and future research should continue to explore these.

5  Additionally, these findings are also beneficial to healthcare professionals because they

6  indicate how healthcare professionals may better tackle binge eating among adolescents.

7  From the study's findings, healthcare professionals may explore the management of binge

8  eating among adolescents by designing interventions that help to reduce their weight-related

9  self-stigma, food addiction, and psychological distress. Effective psychoeducational

10  programs can be developed and implemented to help inform adolescents about binge eating

11  and the role of stigma in influencing it. Furthermore, healthcare professionals can establish

12  mental health peer mentorship and training programs to train adolescents in mental health

13  issues as well as help them deal with these psychological challenges if they manifest. Finally,

14  teachers, family members, and friends should be educated on the effects of stigma on the

15  mental health of adolescents as well as how they can intervene during mental health crises.

16

17  **5. CONCLUSION**

18  The present study demonstrated that food addiction and psychological distress are important

19  mediators in the temporal association between weight stigma and binge eating. Healthcare

20  providers may use current findings to develop appropriate and effective intervention

21  programs to prevent binge eating among adolescents. For example, healthcare providers may

22  be able to help adolescents tackle the underlying problems (weight stigma) or the mediators

23  (food addiction and psychological distress) to prevent binge eating by utilizing mental health

24  peer mentorship and training programs. A previous study that trained people in mental health

25  first aid for eating disorders reported significant increases in problem recognition, knowledge

1    of appropriate mental health first aid strategies, and assistance to individuals with a suspected

2    eating disorder (Hart, Jorm, & Paxton, 2012). Such programs would inform adolescents on

3    how to handle mental health issues individually and utilize supportive networks during crises.

4    This would help prevent internalization of weight-related stigma and alleviate related mental

5    health challenges, such as food addiction, distress, and binge eating. Adolescence is a critical

6    developmental period (Tsai, Hsieh, Strong, & Lin, 2015; Tsai, Strong, & Lin, 2015), and

7    given the negative effects of weight self-stigma in adolescence (Roberto et al., 2012), the

8    present findings may benefit researchers and healthcare professionals in reducing weight bias

9    internalization and eating disturbances.

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3 research and to everyone who worked on this project and made it possible.

4

5 **CONFLICT OF INTEREST**

6 The authors declare no potential conflict of interest.

7

8 **Data availability statement**

9 The data that support the findings of this study are available on request from the
10 corresponding author.

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1    Table 1 Characteristics of the study participants (N=1,497)

|  | Mean (±SD) or n (%) |
|---|---|
| Age (Year) | 15.1 (±6.0) |
| Gender (Male) | 684 (45.7) |
| Fathers' educational year | 9.3 (±4.5) |
| Mothers' educational year | 6.9 (±4.1) |
| BMI (kg/m$^2$) at baseline | 31.8 (±5.4) |
| z-BMI at baseline | 2.2 (±0.5) |
| BMI (kg/m$^2$) at six-month follow-up | 33.8 (±5.1) |
| z-BMI at six-month follow-up | 2.4 (±0.7) |
| Mothers' BMI (kg/m$^2$) | 34.3 (±6.7) |
| Fathers' BMI (kg/m$^2$) | 33.6 (±5.3) |
| Current smoker (Yes) | 284 (19.0%) |
| Psychological distress[a] at three-month follow-up | 22.5 (±11.2) |
| Binge eating scale at six-month follow-up | 11.3 (±8.1) |
| Food addiction symptom count[b] at three-month follow-up | 2.7 (±1.6) |
| Weight stigma at baseline | 3.8 (±0.97) |

2    [a] Assessed using Depression, Anxiety, and Stress Scale-21.

3    [b] Assessed using symptom counts on Yale Food Addiction Scale for Children

4

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Table 2. Pearson correlation matrix of the variables of interest

| | Binge eating at six-month follow-up [a] | Psychological distress at three-month follow-up [b] | Food addiction at three-month follow-up [c] | Weight stigma at baseline [d] |
|---|---|---|---|---|
| Binge eating at six-month follow-up | — | 0.22** | 0.27** | 0.10** |
| Psychological distress at three-month follow-up | | — | 0.21** | 0.15** |
| Food addiction at three-month follow-up | | | — | 0.21** |
| Weight stigma at baseline | | | | — |

[a] Assessed using Binge Eating Scale (BES)

[b] Assessed using Depression, Anxiety, and Stress Scale-21

[c] Assessed using symptom counts on Yale Food Addiction Scale for Children

[d] Assessed using Weight Bias Internalization Scale for Children

**p-values < 0.01

1    Table 3. Models of the effect of adolescents' weight stigma on binge-eating disorder with

2    mediators of food addiction and psychological distress

| | Unstand. Coeff. | SE or (Bootstrapping SE) | t-value or (Bootstrapping LLCI) | p-value or (Bootstrapping ULCI) |
|---|---|---|---|---|
| Total effect of WBIS on Binge eating disorder | 0.75 | 0.23 | 3.29 | 0.001 |
| Direct effect of WBIS on Binge eating disorder | 0.17 | 0.22 | 0.76 | 0.44 |
| Direct effect of WBIS on mediators | | | | |
| Psychological distress | 1.58 | 0.31 | 5.07 | <0.001 |
| Food addiction | 0.33 | 0.04 | 7.60 | <0.001 |
| Indirect effect of WBIS on Binge eating disorder | | | | |
| Total indirect effect | 0.58 | 0.09 | (0.41) | (0.77) |
| Through Food addiction | 0.38 | 0.07 | (0.26) | (0.52) |
| Through psychological distress | 0.20 | 0.05 | (0.10) | (0.31) |

3    Note: Age, gender, parents' BMI and baseline z-BMI were adjusted for the model.

4    Psychological distress was assessed using Depression, Anxiety, and Stress Scale-21; weight

5    stigma using Weight Bias Internalization Scale; food addiction using Yale Food Addiction Scale

6    for Children.

7    Unstand. Coeff.=unstandardized coefficient

8    LLCI=lower limit in 95% confidence interval

9    ULCI=upper limit in 95% confidence interval
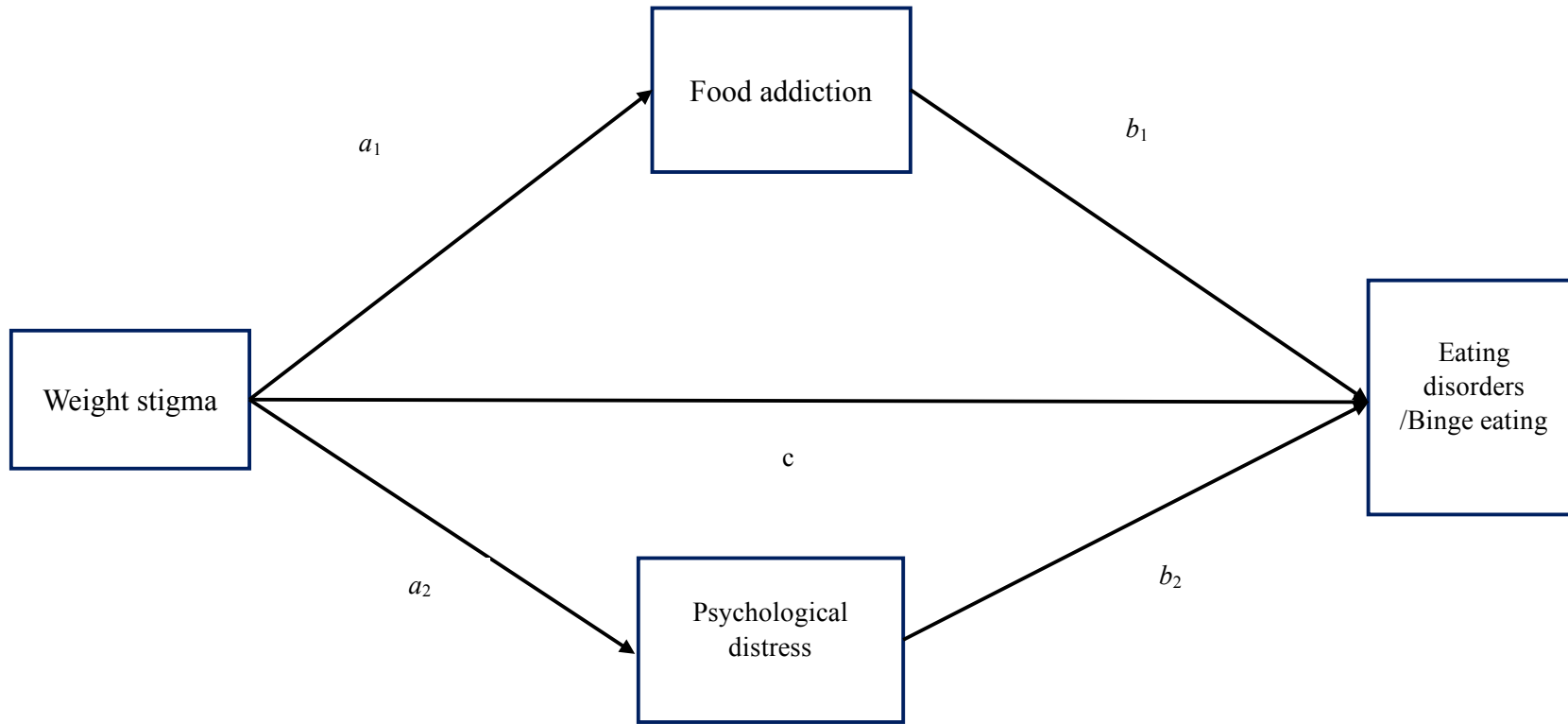
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4    Figure 1: Theoretical Mediation Model (adjusted for zBMI, age, and gender)

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