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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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ABSTRACT

Objectives: This prospective study investigated the link between weight-related self-stigma and binge eating by (i) examining the temporal association between weight-related self-stigma and binge eating; (ii) investigating the mediating role of food addiction in the association between weight-related self-stigma and binge eating; and (iii) examining the mediating role of psychological distress in the association between weight-related self-stigma and binge eating.

Method: Participants comprised 1,497 adolescents (mean=15.1 years; SD=6.0). At baseline, three months, and six months, demographics, body mass index, weight bias, psychological distress (i.e., depression, anxiety, stress), food addiction, and binge eating were assessed. The mediation model was analyzed using Model 4 in the PROCESS macro for SPSS with 10,000 bootstrapping resamples.

Results: There was no significant direct association between weight-related self-stigma and binge eating. However, food addiction and psychological distress significantly mediated the association between weight-related self-stigma and binge eating.

Discussion: These findings highlight the indirect association between weight-related self-stigma and binge eating via food addiction and psychological distress. Consequently, intervention programs targeting food addiction and psychological distress among adolescents may have significant positive effects on outcomes for weight-related self-stigma and binge eating. The findings will be beneficial to researchers and healthcare professionals working with adolescents during this critical developmental period.

Keywords: adolescents; binge eating; food addiction; psychological distress; weight-related self-stigma

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).

Closely related to weight-related self-stigma and binge eating is food addiction, which is reported to be an important factor in both obesity and binge eating (American Psychiatric Association, 2013; Pacanowski et al., 2018). Food addiction is positively associated with weight-related self-stigma (Cassin et al., 2019; Gearhardt et al., 2012; Lee, Hall, Lucke, Forlini, & Carter, 2014) because patients with greater severity of food addiction have greater internalized weight bias and body shame (Burmeister, Hinman, Koball, Hoffmann, & Carels, 2013; Cassin et al., 2019). Additionally, food addiction is reported to be positively associated with binge eating (Burrows, Skinner, McKenna, & Rollo, 2017; Gearhardt, Corbin, & Brownell, 2009; Gearhardt et al., 2012; Gearhardt, White, & Potenza, 2011), and was the strongest predictive factor of binge eating (57%) in one study (Gearhardt et al., 2012). Consequently, food addiction may be considered as a potential mediator of the relationship between weight-related self-stigma and binge eating (American Psychiatric Association, 2013; Swanson et al., 2011).

Weight-related self-stigma has been found to increase mood problems, such as depression, anxiety, and psychological distress, symptoms which significantly relate to weight-related self-stigma and binge eating (American Psychiatric Association, 2013; Marzilli et al., 2018; Swanson et al., 2011). That is, although there is no known study of psychological distress mediating the relationship between weight-related self-stigma and binge eating, it can be deduced from previous studies that psychological distress serves as a common factor with respect to the relationship between weight-related self-stigma and binge eating (Marzilli et al., 2018; Swanson et al., 2011). Further supporting this proposition, a similar study reported that psychological distress mediated the relationship between weight stigma and disordered eating behavior (emotional eating, uncontrolled eating, and loss-of-control eating; O'Brien et

al., 2016). Therefore, psychological distress may also be a potential mediator of the relationship between weight-related self-stigma and binge eating. An enhanced understanding of the direction of these associations and their mediators could benefit future research and treatment.

The present study extends previous literature on factors associated with binge eating (e.g., Gearhardt et al., 2012; Marzilli et al., 2018; Pacanowski et al., 2018; Swanson et al., 2011) by examining two variables hypothesized to mediate the relationship between weight-related self-stigma and binge eating. Specifically, this prospective study examines the link between weight-related self-stigma and binge eating by (i) examining the temporal association between weight-related self-stigma and binge eating; (ii) investigating the mediating role of food addiction in the association between weight-related self-stigma and binge eating; and (iii) examining the mediating role of psychological distress in the association between weight-related self-stigma and binge eating.

2. METHODS

2.1 Participants

A total of 1,810 adolescents were recruited from 16 high schools from 78,850 students from 98 high schools in Qazvin (Iran) for this prospective study from September 2018 to May 2019. A total of 313 participants were excluded due to unavailability of data. Therefore, 1,497 participants comprised the final sample used for this study. Participants were within the age range of 13-18 years and had an overweight or obese body mass index (BMI) greater than the 85th percentile for age and gender. The study design and procedure were approved by the ethics committee of Qazvin University of Medical Sciences (IR.QUMS.REC.1397.325), and

informed consent was obtained from all participants and their guardians before completing the survey.

2.2 Instruments

2.2.1 Demographics: Demographic data (which included age, gender, smoking status of the participants, and the education level of the participants' parents) were gathered using a background information sheet.

2.2.2 Weight Bias Internalization Scale (WBIS): The WBIS was used to assess weight-related self-stigma (i.e., the extent to which individuals endorse and apply weight-based stereotypes to themselves) (Pearl & Puhl, 2014). With 11 items rated on a five-point Likert scale, a higher score on the WBIS indicates higher levels of weight-related self-stigma (Durso & Latner, 2008). The psychometric properties of the WBIS have been found to be excellent ($\alpha = .90$) (Durso & Latner, 2008; Wong et al., 2019). The Persian version was found to have excellent internal consistency ($\alpha=0.90$), good test-retest reliability over a two-week interval (Pearson's $r=0.78$), and an empirically supported one-factor structure (as evidenced by the fit indices in the confirmatory factor analysis) on adolescents (C-Y Lin, Imani, Cheung, & Pakpour, 2019).

2.2.3 Body mass index (BMI) and z-BMI: BMI (kg/m^2) was used to identify individuals with overweight and obesity. Height (to the nearest cm) and weight (to the nearest 0.1 kg) were measured using a stadiometer (Seca Model 207, Seca, Hamburg, Germany) without wearing shoes and with minimum clothing. The BMI values were transformed into BMI z-scores using the World Health Organization (WHO) BMI-for-age reference values (WHO

Multicentre Growth Reference Study Group, 2006). Anthropometric data were collected by two trained assistants in a classroom.

2.2.4 Depression, Anxiety, and Stress Scale-21 (DASS-21): The DASS-21 was used to assess psychological distress. It comprises three subtypes of psychological distress (depression, anxiety, and stress), assessed via its three 7-item subscales. A four-point Likert scale (0=*did not apply to me at all, never*; 3=*applied to me very much, or most of the time, almost always*) is applied to all the DASS-21 items, and a total score ranging between 0 and 63 is calculated by summing all the responses. A higher level of the psychological distress is indicated by a higher DASS-21 score. The Persian DASS-21 version has been translated and validated with very good to excellent internal consistency (α=0.84 to 0.91; Asghari, Saed, & Dibajnia, 2008; C-Y Lin, Broström, Nilsen, Griffiths, & Pakpour, 2017) and promising convergent validity (r=0.4 to 0.7 with the Four Systems Anxiety Questionnaire and Beck Depression Inventory; Asghari et al., 2008). Also, the DASS-21 has been validated among adolescents (Shaw, Campbell, Runions, & Zubrick, 2017; Silva et al., 2016).

2.2.5 Yale Food Addiction Scale for Children (YFAS-C): The YFAS-C was used to assess food addiction. The YFAS-C is modified from the adult version (i.e., Yale Food Addiction Scale; YFAS; Gearhardt et al., 2009), and contains 25 items that assess seven criteria based on substance-used disorders listed in the *Diagnostic and Statistical Manual of Mental Disorders 4th edition, Text revision* (DSM-IV-TR; American Psychiatric Association, 2000). A five-point Likert scale (0=*never*; 4=*always*) is applied to the first 18 YFAS-C items, and a dichotomous (*yes/no*) scale is used for the last seven items. Following this, all the items are converted dichotomously (0=*no*; 1=*yes*) according to specific scoring thresholds for each 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).

2.3 Procedure

A list of all high schools in the Iranian city of Qazvin (located 150 km northwest of Tehran, population 566,773, based on 2011 census figures) was obtained from the Organization for Education. Sixteen high schools were randomly selected from 98 high schools in Qazvin. Informed consent was obtained from the school authorities before the commencement of this survey. A meeting was held in the schools for participants and their parents to explain the study's aims. The research assistants determined participants' eligibility by assessing the anthropometric parameters among all students and their parents. The adolescents completed the study measures in a classroom at each school at baseline (BMI and WBIS), three months (DASS and YFAS-C), and six months after the baseline assessment (BES).

2.4 Data analysis

Pearson correlations were conducted to examine the relationship between the studied variables (psychological distress, binge eating, food addiction, and weight stigma). In terms of the mediation model, binge eating (assessed using BES) was the dependent variable; weight-related self-stigma (assessed using WBIS) was the independent variable; and food addiction (assessed using YFAS), and psychological distress (assessed using DASS-21) were the mediators. Additionally, age, gender, and parents' BMI, and baseline z-BMI were controlled for in the mediation model. The mediation model was assessed using Model 4 in the PROCESS macro for SPSS with 10,000 bootstrapping resamples (Model 4, Process Macro) (Hayes, 2018).

3. RESULTS

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

psychological distress and food addiction). The results showed that there was no direct temporal association between weight-related self-stigma and binge eating although they were positively related. This suggests that weight-related self-stigma does not directly influence binge eating, though it may have a direct effect on other mental health problems (M. Y. Cheng et al., 2018; Ratcliffe & Ellison, 2015; Tylka et al., 2014). Therefore, this suggests the existence of mediators in the association between weight-related self-stigma and binge eating. The results of present study demonstrate that food addiction and psychological distress are two of the mediators in such an association.

The mediation analysis indicated that the strongest mediated effects appeared for food addiction (unstandardized coefficient=0.38) followed by psychological distress (unstandardized coefficient=0.20). This suggests that weight-related self-stigma indirectly predicts binge eating via food addiction. It is not surprising that food addiction was the strongest mediator between weight-related self-stigma and binge eating because individuals with obesity have higher weight-related self-stigma (Chan et al., 2019). It has also been reported that individuals with food addiction are typically overweight or obese (Barry, Brescoll, Brownell, & Schlesinger, 2009; Gearhardt et al., 2009; Gearhardt et al., 2011). Consequently, food addiction seems to be the strongest of the mediators in the relationship between weight-related self-stigma and binge eating. Hence, future research should examine several mediators in the relationship between weight-related self-stigma and binge eating to ascertain the magnitude of the various mediators. This will further inform researchers and clinicians on possible interventional studies.

Psychological distress also acted as another pathway that mediated the association between weight-related self-stigma and binge eating. The relationship between weight-related self-

stigma and psychological distress is consistent with previous research (M. Y. Cheng et al., 2018; C-Y Lin, Strong et al., 2019). Additionally, previous studies have indicated that higher psychological distress is associated with higher risk of eating disturbances (Isomaa, Isomaa, Marttunen, Kaltiala-Heino, & Björkqvist, 2010). The mediating role of psychological distress found in the present study supports previous literature (American Psychiatric Association, 2013; Fairburn, Cooper, & Shafran, 2003; Pacanowski et al., 2018). This novel study indicates that factors that mediated the association between weight-related self-stigma and binge eating were food addiction and psychological distress. These results add to the literature on weight-related self-stigma and binge eating.

4.1 Limitations and strengths

There are some limitations in the present study. First, the findings of the present study cannot be generalized to other countries because all the participants were Iranian adolescents. That is, differences in Eastern and Western cultures have been reported to influence response styles and attitudes toward overweight and eating habits (Hamamura, Heine, & Paulhaus, 2008; Johnson, Shavitt, & Holbrook, 2011; Westenhoefer et al., 2018). Therefore, future replication of this study is warranted to examine whether the proposed mediation model presented here can be extended to other countries and Western culture. Second, most of the data collected in the study were self-report in nature. Therefore, biases such as social desirability and memory recall cannot be excluded. However, the strong and robust psychometric properties established for these measures (Asghari et al., 2008; C-Y Lin et al., 2017; C-Y Lin, Imani, et al., 2019; Magyar et al., 2018; Mootabi et al., 2009) suggest that these instruments are valid and trustworthy. Third, although the prospective design supports a potential causal effect among the factors of weight-related self-stigma, food addiction, psychological distress and binge eating, stronger evidence should be examined using

randomized controlled trials. For example, future RCT studies could examine the efficacy of treatment programs for food addiction and psychological challenges and identify whether reductions in food addiction and psychological distress potentially lower the prevalence of binge eating. Fourth, even though a prospective design was used in this study, the intervals between the assessment time points were relatively close. Therefore, whether a *real* change can be observed in such a short period is questionable. Moreover, the temporal association is only one criterion to determine causality. Following this, the present study did not ask the participants to complete all the measures at each assessment point. Hence, the strong evidence of causality cannot be examined using advanced statistical analyses, such as cross-lagged models. Future studies are thus warranted to collect all data at every time point to provide strong causality evidence.

The strengths of this study include the relatively large sample size (nearly 1,500 adolescents) and the robust statistical testing. The large sample size decreases the chance that the findings are biased by any outliers, and the robust statistical testing suggests high internal validity. Consequently, these strengths improve the generalizability of the results to Iranian adolescents. Additionally, this study is one of the first to adopt a prospective design to better understand whether food addiction and psychological distress are mediators in the association between weight stigma and binge eating. The present study's design allowed us to understand the patterns in these variables over time during a critical developmental period.

4.2 Implication for research and practice

The findings of this study demonstrated that weight stigma impacted binge eating indirectly via the mediators of food addiction and psychological distress. The findings indicate that weight-related self-stigma remains an important mental health challenge among adolescents,

one that may significantly affect the biopsychosocial state of adolescents. It was not surprising that weight-related self-stigma indirectly affected binge eating via the mediators of food addiction and psychological distress. However, there may be other mental health factors that directly predict binge eating, and future research should continue to explore these. Additionally, these findings are also beneficial to healthcare professionals because they indicate how healthcare professionals may better tackle binge eating among adolescents. From the study's findings, healthcare professionals may explore the management of binge eating among adolescents by designing interventions that help to reduce their weight-related self-stigma, food addiction, and psychological distress. Effective psychoeducational programs can be developed and implemented to help inform adolescents about binge eating and the role of stigma in influencing it. Furthermore, healthcare professionals can establish mental health peer mentorship and training programs to train adolescents in mental health issues as well as help them deal with these psychological challenges if they manifest. Finally, teachers, family members, and friends should be educated on the effects of stigma on the mental health of adolescents as well as how they can intervene during mental health crises.

5. CONCLUSION

The present study demonstrated that food addiction and psychological distress are important mediators in the temporal association between weight stigma and binge eating. Healthcare providers may use current findings to develop appropriate and effective intervention programs to prevent binge eating among adolescents. For example, healthcare providers may be able to help adolescents tackle the underlying problems (weight stigma) or the mediators (food addiction and psychological distress) to prevent binge eating by utilizing mental health peer mentorship and training programs. A previous study that trained people in mental health first aid for eating disorders reported significant increases in problem recognition, knowledge

of appropriate mental health first aid strategies, and assistance to individuals with a suspected eating disorder (Hart, Jorm, & Paxton, 2012). Such programs would inform adolescents on how to handle mental health issues individually and utilize supportive networks during crises. This would help prevent internalization of weight-related stigma and alleviate related mental health challenges, such as food addiction, distress, and binge eating. Adolescence is a critical developmental period (Tsai, Hsieh, Strong, & Lin, 2015; Tsai, Strong, & Lin, 2015), and given the negative effects of weight self-stigma in adolescence (Roberto et al., 2012), the present findings may benefit researchers and healthcare professionals in reducing weight bias internalization and eating disturbances.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

Data availability statement

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

References

American Psychiatric Association, D. S. M. T. F. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR* (4th ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association, D. S. M. T. F. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5th ed.). Arlington, VA: American Psychiatric Association.

Asghari, A., Saed, F., & Dibajnia, P. (2008). Psychometric properties of the Depression Anxiety Stress Scales-21 (DASS-21) in a non-clinical Iranian sample. *International Journal of Psychology, 2*(2), 82-102.

Barry, C. L., Brescoll, V. L., Brownell, K. D., & Schlesinger, M. (2009). Obesity metaphors: How beliefs about the causes of obesity affect support for public policy. *The Milbank Quarterly, 87*(1), 7-47. doi: https://doi.org/10.1111/j.1468-0009.2009.00546.x

Burmeister, J. M., Hinman, N., Koball, A., Hoffmann, D. A., & Carels, R. A. (2013). Food addiction in adults seeking weight loss treatment. Implications for psychosocial health and weight loss. *Appetite, 60*, 103-110. doi:https://doi.org/10.1016/j.appet.2012.09.013

Burrows, T., Skinner, J., McKenna, R., & Rollo, M. (2017). Food addiction, binge eating disorder, and obesity: Is there a relationship? *Behavioral Sciences, 7*(3), 54. doi:10.3390/bs7030054

Carels, R. A., Wott, C. B., Young, K. M., Gumble, A., Koball, A., & Oehlhof, M. W. (2010). Implicit, explicit, and internalized weight bias and psychosocial maladjustment among treatment-seeking adults. *Eating Behaviors*, *11*(3), 180–185. doi: 10.1016/j.eatbeh.2010.03.002

Cassin, S. E., Buchman, D. Z., Leung, S. E., Kantarovich, K., Hawa, A., Carter, A., & Sockalingam, S. (2019). Ethical, stigma, and policy implications of food addiction: A scoping review. *Nutrients, 11*(4), 710. doi:10.3390/nu11040710

Chan, K. L., Lee, C. S., Cheng, C. M., Hui, L. Y., So, W. T., Yu, T. S., & Lin, C.-Y. (2019). Investigating the relationship between weight-related self-stigma and mental health for overweight/obese children in Hong Kong. *Journal of Nervous and Mental Disease, 207*(8), 637-641.

Cheng, M. Y., Wang, S.-M., Lam, Y. Y., Luk, H. T., Man, Y. C., & Lin, C.-Y. (2018). The relationships between weight bias, perceived weight stigma, eating behavior, and psychological distress among undergraduate students in Hong Kong. *Journal of Nervous and Mental Disease, 206*(9), 705-710.

Cheng, O. Y., Yam, C. L. Y., Cheung, N. S., Lee, P. L. P., Ngai, M. C., & Lin, C.-Y. (2019). Extended Theory of Planned Behavior on eating and physical activity. *American Journal of Health Behavior, 43*(3), 569-581. doi:https://doi.org/10.5993/AJHB.43.3.11

Cuzzocrea, F., Costa, S., Larcan, R., & Toffle, M. E. (2015). Differences between adolescents exhibiting moderate binging and non-binging eating behaviors. *SpringerPlus, 4*(1), 593. doi:10.1186/s40064-015-1372-1

Durso, L. E., & Latner, J. D. (2008). Understanding self-directed stigma: Development of the weight bias internalization scale. *Obesity, 16*(S2), S80-S86.

Durso, L. E., Latner, J. D., White, M. A., Masheb, R. M., Blomquist, K. K., Morgan, P. T., & Grilo, C. M. (2012). Internalized weight bias in obese patients with binge eating disorder: Associations with eating disturbances and psychological functioning. *International Journal of Eating Disorders*, *45*(3), 423–427. doi: 10.1002/eat.20933

Erskine, H. E., Baxter, A. J., Patton, G., Moffitt, T. E., Patel, V., Whiteford, H. A., & Scott, J. G. (2017). The global coverage of prevalence data for mental disorders in children and adolescents. *Epidemiology and Psychiatric Sciences, 26*(4), 395-402.

Erskine, H. E., & Whiteford, H. A. (2018). Epidemiology of binge eating disorder. *Current Opinion in Psychiatry, 31*(6), 462-470. doi:10.1097/yco.0000000000000449

Fairburn, C. G., Cooper, Z., & Shafran, R. (2003). Cognitive behaviour therapy for eating disorders: a "transdiagnostic" theory and treatment. *Behaviour Research and Therapy, 41*(5), 509-528. doi:https://doi.org/10.1016/S0005-7967(02)00088-8

Gan, W., Mohamad, N., & Law, L. (2018). Factors associated with binge eating behavior among Malaysian adolescents. *Nutrients, 10*(1), 66. doi:10.3390/nu10010066

Gearhardt, A. N., Corbin, W. R., & Brownell, K. D. (2009). Preliminary validation of the Yale food addiction scale. *Appetite, 52*(2), 430-436. doi:https://doi.org/10.1016/j.appet.2008.12.003

Gearhardt, A. N., White, M. A., Masheb, R. M., Morgan, P. T., Crosby, R. D., & Grilo, C. M. (2012). An examination of the food addiction construct in obese patients with binge eating disorder. *The International Journal of Eating Disorders, 45*(5), 657-663. doi:10.1002/eat.20957

Gearhardt, A. N., White, M. A., & Potenza, M. N. (2011). Binge eating disorder and food addiction. *Current Drug Abuse Reviews, 4*(3), 201-207.

Gormally, J., Black, S., Daston, S., & Rardin, D. (1982). The assessment of binge eating severity among obese persons. *Addictive Behaviors, 7*(1), 47-55.

Hamamura, T., Heine, S. J., & Paulhus, D. L. (2008). Cultural differences in response styles: The role of dialectical thinking. *Personality and Individual Differences, 44*(4), 932-942.

Hart, L. M., Jorm, A. F., & Paxton, S. J. (2012). Mental health first aid for eating disorders: pilot evaluation of a training program for the public. *BMC Psychiatry, 12(1)*, 98. doi:10.1186/1471-244X-12-98

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). New York: Guilford Publications.

Isomaa, R., Isomaa, A. L., Marttunen, M., Kaltiala-Heino, R., & Björkqvist, K. (2010). Psychological distress and risk for eating disorders in subgroups of dieters. *European Eating Disorders Review, 18*(4), 296-303. doi: https://doi.org/10.1002/erv.1004

Johnson, T. P., Shavitt, S., & Holbrook, A. L. (2011). Survey response styles across cultures. In D. Matsumoto & F. J. R. van de Vijver (Eds.), *Culture and psychology: Cross-cultural research methods in psychology* (pp. 130-175). New York, NY, US: Cambridge University Press.

Kessler, R. C., Amminger, G. P., Aguilar-Gaxiola, S., Alonso, J., Lee, S., & Ustün, T. B. (2007). Age of onset of mental disorders: A review of recent literature. *Current Opinion in Psychiatry, 20*(4), 359-364. doi:10.1097/YCO.0b013e32816ebc8c

Kumar, S., & Kelly, A. S. (2017). Review of childhood obesity: From epidemiology, etiology, and comorbidities to clinical assessment and treatment. *Mayo Clinic Proceedings, 92*(2), 251-265. doi:10.1016/j.mayocp.2016.09.017

Lee, N. M., Hall, W. D., Lucke, J., Forlini, C., & Carter, A. (2014). Food addiction and its impact on weight-based stigma and the treatment of obese individuals in the U.S. and Australia. *Nutrients, 6*(11), 5312-5326. doi:10.3390/nu6115312

Lin, C-Y., Broström, A., Nilsen, P., Griffiths, M. D., & Pakpour, A. H. (2017). Psychometric validation of the Persian Bergen Social Media Addiction Scale using classic test theory and Rasch models. *Journal of Behavioral Addictions, 6*(4), 620-629.

Lin, C-Y., Imani, V., Cheung, P., & Pakpour, A. H. (2019). Psychometric testing on two weight stigma instruments in Iran: Weight Self-Stigma Questionnaire and Weight Bias Internalized Scale. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 1-13. doi:https://doi.org/10.1007/s40519-019-00699-4

Lin, C-Y., Imani, V., Griffths, M. D., & Pakpour, A. H. (2019). Further psychometric testing of the Yale Food Addiction Scale for Children (YFAS-C): Classical test theory and Rasch analysis of the Persian YFAS-C. *Mansuscript under review*.

Lin, C-Y., Strong, C., Latner, J. D., Lin, Y.-C., Tsai, M.-C., & Cheung, P. (2019). Mediated effects of eating disturbances in the association of perceived weight stigma and emotional distress. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 1-10. doi:https://doi.org/10.1007/s40519-019-00641-8

Lin, C.-Y., Tsai, M.-C., Liu, C.-H., Lin, Y.-C., Hsieh, Y.-P., & Strong, C. (accepted). Psychological pathway from obesity-related stigma to depression via internalized stigma and self-esteem among adolescents in Taiwan. *International Journal of Environmental Research and Publich Health.*

Lin, Y-C., Latner, J. D., Fung, X. C. C., & Lin, C.-Y. (2018). Poor health and experiences of being bullied in adolescents: Self-perceived overweight and frustration with appearance matter. *Obesity, 26*(2), 397-404. doi:10.1002/oby.22041

Magyar, E. E., Tenyi, D., Gearhardt, A., Jeges, S., Abaligeti, G., Toth, A. L., . . . Csábi, G. (2018). Adaptation and validation of the Hungarian version of the Yale Food Addiction Scale for Children. *Journal of Behavioral Addictions, 7*(1), 181-188.

Marcus, M. D., Wing, R. R., & Hopkins, J. (1988). Obese binge eaters: Affect, cognitions, and response to behavioral weight control. *Journal of Consulting and Clinical Psychology, 56*(3), 433-439.

Marzilli, E., Cerniglia, L., & Cimino, S. (2018). A narrative review of binge eating disorder in adolescence: prevalence, impact, and psychological treatment strategies. *Adolescent Health, Medicine and Therapeutics, 9*, 17-30. doi:10.2147/AHMT.S148050

Michaud, P.-A., & Fombonne, E. (2005). Common mental health problems. *BMJ (Clinical research ed.), 330*(7495), 835-838. doi:10.1136/bmj.330.7495.835

Mootabi, F., Moloodi, R., Dezhkam, M., & Omidvar, N. (2009). Standardization of the Binge Eating Scale among Iranian obese population. *Iranian Journal of Psychiatry, 4*(4), 143-146.

O'Brien, K. S., Latner, J. D., Puhl, R. M., Vartanian, L. R., Giles, C., Griva, K., & Carter, A. (2016). The relationship between weight stigma and eating behavior is explained by weight bias internalization and psychological distress. *Appetite, 102*, 70-76. doi: 10.1016/j.appet.2016.02.032

Pacanowski, C. R., Mason, T. B., Crosby, R. D., Mitchell, J. E., Crow, S. J., Wonderlich, S. A., & Peterson, C. B. (2018). Weight change over the course of binge eating disorder treatment: Relationship to binge episodes and psychological factors. *Obesity, 26*(5), 838-844. doi:10.1002/oby.22149

Patel, V., Flisher, A. J., Hetrick, S., & McGorry, P. (2007). Mental health of young people: a global public-health challenge. *The Lancet, 369*(9569), 1302-1313.

Pearl, R. L., & Puhl, R. M. (2014). Measuring internalized weight attitudes across body weight categories: validation of the modified weight bias internalization scale. *Body Image, 11*(1), 89-92.

Puhl, R., & Suh, Y. (2015). Health consequences of weight stigma: implications for obesity prevention and treatment. *Current Obesity Reports, 4*(2), 182-190.

Raj, M., & Kumar, R. K. (2010). Obesity in children and adolescents. *The Indian Journal of Medical Research, 132*(5), 598-607.

Ratcliffe, D., & Ellison, N. (2015). Obesity and internalized weight stigma: A formulation model for an emerging psychological problem. *Behavioural and Cognitive Psychotherapy, 43*(2), 239-252.

Roberto, C. A., Sysko, R. , Bush, J. , Pearl, R. , Puhl, R. M., Schvey, N. A. and Dovidio, J. F. (2012), Clinical correlates of the weight bias internalization scale in a sample of obese adolescents seeking bariatric surgery. Obesity, 20: 533-539. doi:10.1038/oby.2011.123

Shaw, T., Campbell, M. A., Runions, K. C., & Zubrick, S. R. (2017). Properties of the DASS-21 in an Australian Community Adolescent Population. *Journal of Clinical Psychology, 73*(7), 879-892. doi:10.1002/jclp.22376

Silva, H. A., Passos, M. H. P. D., Oliveira, V. M. A., Palmeira, A. C., Pitangui, A. C. R., & Araújo, R. C. (2016). Short version of the Depression Anxiety Stress Scale-21: is it valid for Brazilian adolescents? *Einstein (Sao Paulo, Brazil), 14*(4), 486-493. doi:10.1590/S1679-45082016AO3732

Swanson, S. A., Crow, S. J., Le Grange, D., Swendsen, J., & Merikangas, K. R. (2011). Prevalence and correlates of eating disorders in adolescents. Results from the national comorbidity survey replication adolescent supplement. *Archives of General Psychiatry, 68*(7), 714-723. doi:10.1001/archgenpsychiatry.2011.22

Tsai, M.-C., Hsieh, Y.-P., Strong, C., & Lin, C.-Y. (2015). Effects of pubertal timing on alcohol and tobacco use in the early adulthood: A longitudinal cohort study in Taiwan. *Research in Developmental Disabilities, 36*, 376-383.

Tsai, M.-C., Strong, C., & Lin, C.-Y. (2015). Effects of pubertal timing on deviant behaviors in Taiwan: A longitudinal analysis of 7th-to 12th-grade adolescents. *Journal of Adolescence, 42*, 87-97.

Tylka, T. L., Annunziato, R. A., Burgard, D., Daníelsdóttir, S., Shuman, E., Davis, C., & Calogero, R. M. (2014). The weight-inclusive versus weight-normative approach to health: Evaluating the evidence for prioritizing well-being over weight loss. *Journal of Obesity, 2014*. doi:https://doi.org/10.1155/2014/983495

Westenhoefer, J., von Katzler, R., Jensen, H-J., Zyriax, B-C., Jagemann, B., Harth, V., & Oldenburg, M. (2018). Cultural differences in food and shape related attitudes and eating behavior are associated with differences of Body Mass Index in the same food environment: cross-sectional results from the Seafarer Nutrition Study of Kiribati and European seafarers on merchant ships. *BMC obesity, 5*, 1-1. doi:10.1186/s40608-018-0180-x

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., . . . Johns, N. (2013). Global burden of disease attributable to mental and substance use disorders: Findings from the Global Burden of Disease Study 2010. *The Lancet, 382*(9904), 1575-1586.

WHO Multicentre Growth Reference Study Group. (2006). WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatrica (Oslo, Norway: 1992). Supplement, 450*, 76-85.

Wong, P. C., Hsieh, Y.-P., Ng, H. H., Kong, S. F., Chan, K. L., Au, T. Y. A., . . . Fung, X. C. (2019). Investigating the self-stigma and quality of life for overweight/obese children in Hong Kong: A preliminary study. *Child Indicators Research, 12*(3), 1065-1082. doi:https://doi.org/10.1007/s12187-018-9573-0

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)

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

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

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

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

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

Psychological distress was assessed using Depression, Anxiety, and Stress Scale-21; weight stigma using Weight Bias Internalization Scale; food addiction using Yale Food Addiction Scale for Children.

Unstand. Coeff.=unstandardized coefficient

LLCI=lower limit in 95% confidence interval

ULCI=upper limit in 95% confidence interval

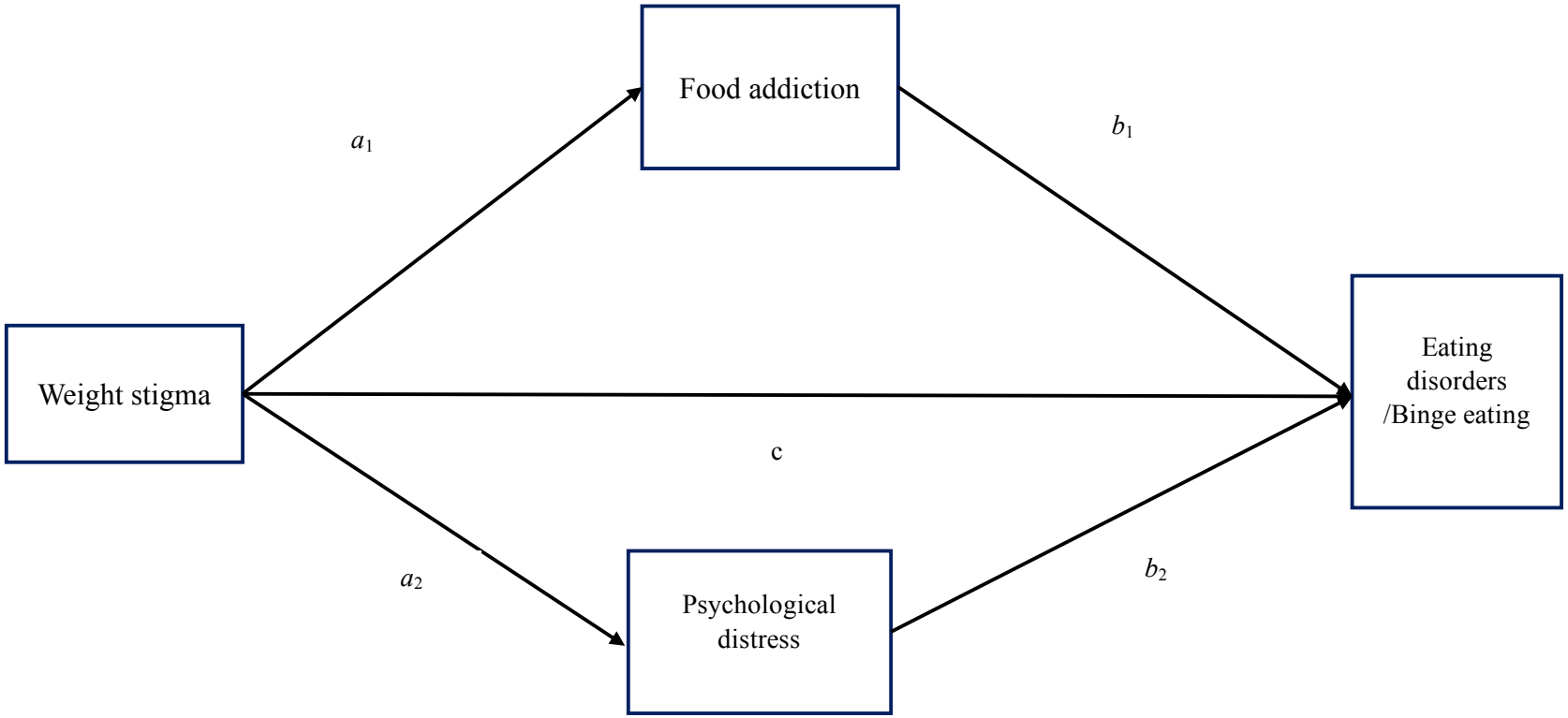

Figure 1: Theoretical Mediation Model (adjusted for zBMI, age, and gender)