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Loss-of-Control Eating and Obesity Among Children and Adolescents

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Abstract

Purpose of Review This review summarizes findings on pediatric loss-of-control (LOC) eating and obesity published since 2013 in relation to physiological, socioenvironmental, and psychological factors.

Recent Findings LOC eating and obesity are highly comorbid in youth. Genetic and physiological risk factors are associated with the development of LOC eating. Adverse physiological outcomes of LOC eating include increased risk for overweight and obesity and greater dysfunction in components of metabolic syndrome. Socioenvironmental, psychological, and behavioral factors, such as weight-based teasing, dieting, negative affect, emotion dysregulation, and aspects of cognitive functioning, are consistently related to LOC eating in youth, independent of weight. Prospectively, LOC eating may predict the onset of anxiety disorders, depression, and more severe eating psychopathology later in life. Updates on interventions and future directions are discussed.

Summary LOC eating may be a key symptom to target adverse physiological and psychological outcomes; however, treatments are limited and require further examination.

Keywords Loss-of-control eating · Obesity · Overweight · Binge eating · Pediatric · Eating disorders

Introduction

This review is guided primarily by empirical research published since 2013 and aims to summarize the emerging findings for pediatric loss-of-control (LOC) eating in relation to genetic/biological factors, socioenvironmental factors, and psychological factors. Given the robust link between LOC eating and pediatric obesity [1••], the overlap will be addressed throughout the review. Finally, recent updates on interventions for LOC eating and obesity, as well as future directions for research, will be discussed.

Prevalence

Binge eating, defined as the consumption of a large amount of food accompanied by a perceived inability to stop eating, is the hallmark feature of binge eating disorder (BED). Full-syndrome BED is characterized by recurrent objectively large binge episodes in the absence of regular compensatory behaviors and significant distress surrounding binge episodes [2]. However, full-syndrome BED is uncommon in childhood [2]. While binge eating involves consuming an objectively large amount of food, it can be difficult to determine what constitutes a large amount among growing boys and girls at different developmental stages [3, 4]. For example, what would be defined as an objectively large amount of food for a 12-year-old girl may be normative for a 17-year-old boy. Further, younger children may have less autonomy over food decisions compared to older adolescents or adults, and consequently may not have access to objectively large amounts of food [5]. Thus, youth may experience subjective lack of control over eating, or inability to control what or how much is being consumed, without necessarily consuming an objectively large amount of food. Thus, LOC eating is a feature of binge eating that is drawn from DSM-5 criteria for bulimia nervosa and binge eating disorder [2]. This has prompted most researchers studying children and adolescents to examine loss-of-control (LOC) eating as opposed to, or in addition to, binge eating episodes.

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Self- or parent-report questionnaires are used to screen for LOC eating; however, child and parent reports are often discordant [6]. Clinical semi-structured interview is often preferred, as the interviewer has the opportunity to clarify and probe difficult to understand constructs. The most commonly used semi-structured for disordered eating attitudes and behaviors is the Eating Disorder Examination [7], which has been adapted specifically for youth who report LOC eating [8, 9]. Additional assessment techniques high in ecological and internal validity include ecological momentary assessment (EMA) [10, 11] and direct observation of energy intake at a laboratory test meal designed to simulate an LOC eating episode [12, 13].

LOC eating is highly prevalent among children and adolescents with overweight and obesity; almost one-third of these youth experience LOC [1••]. Roughly 23% of youth of all weight strata report LOC eating in the past month, with almost 10% reporting recurrent episodes [14]. LOC eating is a known predictor of partial- or full-syndrome BED as well as worsening of eating disorder psychopathology [15, 16]. Consistently, pediatric LOC eating has been associated with adverse physiological [17, 18] and psychosocial [19] correlates and outcomes.

Course

Although BED does not typically manifest until adolescence or adulthood, with a peak age of onset occurring between 18 and 20 years old [20], youth report the subjective experience of feeling out of control during eating as early as middle childhood [8, 21]. The transition from late adolescence/early young adulthood to early/middle young adulthood may be a time of particularly increased risk, given binge eating and BED symptoms tend to persist or worsen during this time [22•]. While some studies have shown that LOC eating persists over time [23], others suggest that the behavior generally tends to remit in about 50% of youth, even in the absence of intervention [15, 22•].

Genetic and Physiological Contributors and Consequences

Genetic Factors

Personal and familial history of obesity is a prominent risk factor for binge-type eating disorders and symptoms of LOC eating [24], and twin studies reveal that additive genetic factors account for approximately 40 to 60% of liability for BED [25]. Prior to 2013, studies have shown various genetic factors, such as the *FTO* high-risk A allele, the homozygous A2 allele of the Taq1A polymorphism, and the T genotype of the C957T marker, appear to play a role in the development of LOC eating behaviors in youth [5] as well as adults [26–28]. Emerging data suggest that genes and environment influence each other bi-directionally in their impact on risk for LOC eating. The diathesis-stress theory posits that severe environmental threat or stress may trigger the expression of latent genetic risk factors for LOC eating, which has been supported in the literature [25]. One twin study found that LOC eating differentially loaded onto a common disordered eating factor compared to other symptoms of eating disorders, suggesting LOC may be uniquely influenced by genetic and environmental factors that are not shared with other symptoms of eating pathology [29].

Physiological Factors

Appetitive and Metabolic Correlates

Given the link between LOC eating and excess body weight [1••], data on the physiological correlates of LOC eating have typically focused on appetitive hormones and metabolic functioning. Some research suggests that pediatric LOC eating is associated with higher fasting serum leptin, an adipose-tissue-derived hormone which promotes hunger, food intake, and body weight regulation, above and beyond the contribution of adiposity [17]. Further, youth reporting LOC eating episodes show greater dysfunction in components of metabolic syndrome (MetS), such as higher systolic blood pressure, higher low-density lipoprotein cholesterol (LDL-C) [18], higher fasting insulin, and insulin resistance [30], even after adjusting for adiposity. Data suggest dietary intake and macronutrient consumption may be partially responsible for the association between LOC eating and metabolic dysfunction. Youth with LOC eating typically consume a greater amount of carbohydrates, including snack and dessert-type foods [12, 31], which could potentially contribute to worsened MetS-related measures [18, 32]. It is possible that higher inflammation may contribute to the relationship between LOC eating and higher blood pressure and LDL-C. As a primary marker of inflammation, high-sensitivity C-reactive protein (hsCRP) has shown an association with LOC eating among youth [33]. Relationships between LOC eating and markers of obesity-related health issues indicate youth with LOC eating may be at particular risk for adverse physiological outcomes.

Neural Correlates

Neural factors, such as altered corticolimbic functioning, neuroendocrine dysregulation, and self-reported negative affect may be possible physiological risk factors for LOC eating among youth [34•]. Compared to those without LOC eating, children with LOC eating exhibit increased neural activation in the cerebellum, which is involved in satiety signaling, in response to highly palatable food cues [35]. A recent pilot

study found group differences in neural activity among youth with overweight and LOC eating compared to controls, showing increased neural activation in areas implicated in attentional processes, inhibitory control, emotion regulation, and response inhibition [36]. These preliminary findings suggest that youth with LOC eating and overweight may need to expend more cognitive effort relative to their peers in order to regulate energy consumption [36]. In another imaging trial involving a simulated social peer rejection task, adolescent girls with overweight and LOC showed a blunting in the ventromedial prefrontal cortex, an area of executive function implicated in interpreting social intentions and affect regulation, relative to their counterparts without LOC, who experienced increased activation [37]. Moreover, only among girls with reported LOC eating, greater activity in the fusiform face area was positively associated with energy intake at a laboratory test meal immediately following the imaging session [37]. These findings suggest that LOC eating may be a disinhibited behavioral response to negative affect, which stems from heightened sensitivity to interpersonal cues or a bias in processing negative feedback from peers. Together, these studies provide a potentially compelling argument that the interaction of executive functioning, stress, and satiety may result in the engagement of LOC eating among certain youth.

Hormonal Correlates

Hormonal factors appear to contribute to the development of LOC eating in children and adolescents prospectively. Estradiol, a hormone involved in the expression of genes linked to negative valence system functioning, has been shown to mediate the relationship between genetic risk and LOC eating behaviors [38]. Additionally, reproductive hormones may be potential risk factors for the development of LOC eating. Females with an opposite-sex twin have decreased risk for disordered eating in late puberty compared to females with a same-sex twin [39], which suggests prenatal exposure to testosterone may decrease sensitivity to ovarian hormones, therefore minimizing risk for the development of LOC eating during puberty. Elevated cortisol, particularly in the presence of palatable foods, can promote non-homeostatic food consumption and thus could be link with LOC eating [40]. However, no difference in cortisol response has been observed in adolescents with and without LOC eating [41].

Physiological Outcomes

LOC eating in childhood is associated with many adverse physiological outcomes in prospective studies. Youth who engage in LOC eating behaviors are uniquely at risk for subsequent overweight and obesity across studies [5, 19]. Further, LOC eating is prospectively associated with greater risk for adiposity and adverse metabolic outcomes [5]. Thus, pediatric LOC eating not only places youth at higher risk for development of obesity but additionally increases risk for comorbid obesity-related health outcomes.

Socioenvironmental Contributors and Consequences

Social and environmental factors, such as dieting, maladaptive family environments, and weight-based teasing, have been shown to be cross-sectionally and prospectively associated with LOC eating. Factors within the family environment, such as insecure attachments style, have been associated with child reports of LOC eating and may impact the development of eating disorder symptoms in youth [42]. Thin-ideal internalization promoted by the media predicts self-objectification, which in turn further predicts negative emotional experiences related to one's body and appearance. Indeed, data support these negative emotional experiences impact subsequent dietary restraint and binge eating, and each of these core features of eating disorders may influence each other [43]. Taken together, unrealistic standards of beauty, unhealthy weight control behaviors, and peer and family pressures likely all impact youth's risk for developing LOC eating and unhealthy relationships with eating.

Psychological and Behavioral Contributors and Consequences

Affective Correlates

A number of psychological and behavioral factors have been associated with the development of LOC eating in youth. Youth with LOC eating tend to have maladaptive emotion regulation strategies compared to their counterparts without LOC eating [44]. Data further support emotion dysregulation as a moderator between LOC eating and weight-related variables [44], such that only among youth who reported LOC eating, fat mass and BMI*z* are positively associated with emotion dysregulation.

Negative affect may also play a critical role in the risk for LOC eating among youth. One laboratory study among youth at high risk for obesity and with reported LOC eating found that pre-meal-state negative affect was related to increased intake of energy-dense foods, including greater consumption of carbohydrates, dessert, and snack-type foods [45]. Further, in a sample of adolescent girls with LOC eating, various negative mood states were examined in relation to eating patterns utilizing a laboratory test meal paradigm; results found that only state anxiety mediated the relationship between recent social stress and energy intake during a laboratory test meal [46]. Additionally, an ecological momentary assessment study

found that interpersonal stressors predicted increases in negative affect as well as momentary LOC episodes [11]. These findings suggest LOC eating may be a response to negative affect, which stems from heightened sensitivity to interpersonal cues. The interpersonal model of LOC eating suggests interpersonal issues lead to negative affect and in turn contribute to LOC eating [47, 48], and may provide an underlying theory to support a mechanism for these findings.

Cognitive Correlates

Cognitive factors may also play a role in the development of LOC eating in youth. One such cognitive factor is attentional bias to food cues, or a biased cognitive processing of food-related stimuli. One study found that, only among youth with LOC eating, attentional bias toward highly palatable foods was positively associated with BMI_z [49]. Among adolescents with symptoms of LOC eating, associations have been observed between detection bias for food targets and greater reward sensitivity [50]. Further, among youth with LOC eating, overt visual avoidance of food was significantly associated with greater BMI, potentially suggesting a dysfunctional attempt to avoid food that interferes with habituation to those cues, and thus may predispose youth to overeating [50]. Preliminary research suggests that the combination of attentional bias to eating disorder-specific cues, such as food and weight or shape cues, and attentional bias toward social threat cues may contribute to LOC eating in youth. These results underscore the importance of the role of negative affect on LOC eating behaviors [51].

Executive function impairments, such as poorer global processing and set shifting [52], may be an additional cognitive factor that contributes to development of LOC eating among youth with overweight and obesity. Poorer executive functioning has been shown to predict weight gain in adolescents, and LOC eating behaviors may mediate this relationship [53]. Children who report LOC eating may be more susceptible to the impact of increased portion sizes on intake, also known as the portion size effect [35], as evidenced in a trial examining children's intake of energy-dense foods across laboratory test meals. This suggests that individuals with LOC eating may have more impulsivity that relates to an impaired ability to regulate their intake of energy-dense foods when presented with larger portions.

Problems with self-regulation, a facet of executive function, are more often reported by adolescents with LOC eating compared to those without LOC eating [54]. A randomized controlled trial examined the effects of a 3-week pilot program designed to enhance self-regulation and, more specifically, inhibitory control, in preschool-aged children, with the aim of reducing intake of energy-dense foods [55]. A group by weight interaction was observed, such that children with overweight or obesity in the treatment group exhibited similar caloric intake to children with healthy weight. Conversely, children who are overweight or obese in the control group consumed more energy than children with healthy weight [55]. Given the relationship between LOC eating and aspects of cognitive regulation, training of emotion- and self-regulation skills from an early age may provide an intervention to limit excessive calorie intake.

Other Psychological Factors and Outcomes

Prospectively, a number of psychological factors may put youth at higher risk of development of binge (objectively large LOC) eating behaviors. Temperament during childhood development, such as impulsivity and reward sensitivity, may increase risk for subsequent LOC eating in youth [56]. Low self-esteem, depressive symptoms, and body dissatisfaction in adolescence appear to increase subsequent risk for binge eating in adulthood [22•, 23]. Shape concern and weight-related teasing predict a greater likelihood of subsequent LOC eating [15], and in turn, youth with LOC eating and overvaluation of weight and shape have higher levels of distress and lower quality of life compared to healthy youth [57]. Finally, girls with excess weight, negative affect, and disordered eating cognitions who eat in the absence of hunger are at elevated risk for LOC eating behaviors in adolescence [58]. Together, these data suggest that there are a number of potentially modifiable psychological risk factors that lead to increased vulnerability for the development of LOC eating.

Taken together, these data suggest that there may be a high clinical burden of LOC eating for children and adolescents. LOC eating in childhood and adolescence is predictive of subsequent onset of anxiety disorders, depression, substance use, and self-harm in adulthood [19, 59]. LOC eating may be a critical risk factor for the persistence of binge eating, given that preadolescent LOC eating predicts partial BED and greater global eating disorder psychopathology over a 2-year period [15]. Furthermore, onset of LOC eating in childhood, as opposed to onset in adulthood, increases risk for more severe eating psychopathology, such as use of multiple purging behaviors and full-threshold bulimia nervosa or BED diagnosis, later in life [15, 60]. A number of studies identify the overlap of various cognitive, behavioral, and psychological constructs with LOC eating [30, 44, 61], potentially highlighting that targeting LOC eating alone may not be sufficient to reduce adverse outcomes.

Treatment

The potential burden and negative outcomes associated with child and adolescent LOC eating have prompted the study of treatments targeting this behavior. However, trials examining interventions to reduce LOC eating in youth are limited, and

among those that have found significant reduction in disordered eating behavior, impact on LOC eating alone is rarely reported as an outcome. Recent intervention trials for pediatric LOC eating are summarized in Table 1.

One pilot study designed to reduce recurrent binge eating showed promising results, using an adolescent adaption of cognitive behavioral therapy that aimed to reduce disordered eating behaviors by addressing and challenging maladaptive eating-related cognitions [62]. Adolescent girls who received cognitive behavioral therapy reported significantly fewer binge eating episodes, characterized by both an objectively large amount of food and LOC eating, at the end of treatment than the treatment as usual/delayed treatment control group. Further, at a 6-month follow-up time point, 100% of the girls in the cognitive behavior therapy group were abstinent from binge eating [62]. Although preliminary results are promising, this study examined only episodes involving both an objectively large amount of food and LOC eating. Further data are needed to elucidate the effect on LOC eating alone as this may be a more salient behavior for adverse outcomes.

A systematic review including both child and adult studies supported the long-term, sustained efficacy of group interpersonal psychotherapy for binge eating [70]. In some cases, interpersonal psychotherapy may lead to slower changes in symptomology in the short term; however, stable or increasing improvements in binge eating over time have been observed when compared to cognitive behavioral therapy [70]. Although a randomized controlled trial suggested that interpersonal psychotherapy is equally as effective as a standard-of-care health education in reducing LOC eating and preventing excess weight gain at treatment completion, the intervention was more effective at reducing LOC eating for girls of ethnic-racial minorities at 1-year [63] and 3-year follow-ups [66]. Additionally, among participants of all ethnic-racial categories, those in the interpersonal psychotherapy group had reduced percentage intake from snack-type foods at 1-year follow-up, while those in the health education control group showed an increased pattern of intake [64]. Interestingly, at 3-year follow-up assessment, compared to health education, interpersonal psychotherapy was associated with greater declines in BMIz and stabilization of adiposity gain for girls who reported high baseline social-adjustment problems or anxiety [65••]. Additional data are needed to determine whether interpersonal psychotherapy may be particularly helpful for girls with overweight who report social problems or anxiety, with or without LOC eating.

Further support for the reduction of psychosocial and disordered eating symptoms among preadolescents is evident in a pilot trial for family-based interpersonal psychotherapy [67]. This randomized controlled pilot trial evaluated youth-parent dyads at the end of a 12-week treatment program and at 6-month- and 1-year-follow-up. At end of treatment, youth assigned to the family-based interpersonal psychotherapy (compared to a healthy eating and exercise program) reported greater decreases in psychosocial symptoms, including depression and anxiety, and fewer episodes of LOC eating. At both follow-up time points, children showed even greater reductions in depressive symptoms and disordered eating attitudes [67], showing promise for treatments targeting the emotional underpinnings of LOC eating.

Dialectical-behavior therapy is an evidence-based treatment that teaches patients skills to manage negative emotions and decrease conflict within their relationships. A trial examining the effects of a dialectical-behavior therapy intervention on adolescent girls with BED or LOC eating showed initial promise in improving LOC eating–related behaviors in youth [68, 69]. In this trial, targeting disordered eating behaviors and eating in response to negative emotions effectively reduced disinhibited eating behaviors among girls. This sample included ethnically diverse adolescent girls who had high satisfaction and feasibility ratings in response to the intervention [68]. However, the intervention was not found to be significantly more effective than a weight management control group at reducing binge eating behaviors. Additional research on the mechanisms by which LOC eating can be improved would help to further inform randomized control trials of effective interventions. Promising treatment strategies in treatment interventions for LOC eating address interpersonal difficulties that contribute to negative affect and maladaptive eating-related cognitions in youth.

Future Directions

There are several additional areas of pediatric LOC eating that require further exploration. Given that not all youth with LOC eating subsequently develop full-syndrome BED [5, 71], more prospective data are needed to determine trajectories of LOC eating progression or cessation from childhood into adulthood. Similarly, given the known associations between LOC eating and worsening metabolic health among youth, longitudinal data exploring how LOC eating impacts adult metabolic health are needed. Further, the interactions among genetic, neural, psychological, and environmental aspects throughout childhood should be examined longitudinally in order to better elucidate the manifestation of LOC eating in youth. A more thorough understanding of the risk factors for the development of LOC eating in childhood through adulthood is crucial to the development of effective prevention and treatment efforts. Research should aim to better understand multifaceted constructs and potential endophenotypes of LOC eating to help determine which youth are at greatest risk [5, 72]. Given its high comorbidity with excess weight gain, it is possible that targeting LOC eating may decrease risk for overweight and obesity in adulthood. It is recommended that clinicians who encounter youth with overweight or obesity

Table 1 Randomized control trials of treatment for pediatric loss-of-control (LOC) eating

Treatment type	Sample	Treatment design	Outcomes	Reference
Adapted cognitive behavioral therapy (CBT)	$N = 26$ girls ages 12–18 with recurrent binge eating	Treatment: 8 core group sessions with optional 4 supplemental sessions	Post-treatment: reduced number of binge eating episodes in CBT group	DeBar et al. (2013) [62]
		Control: 6-month treatment as usual/delayed treatment	6-month follow-up: 100% of participants abstinent from binge eating in CBT group	
Group interpersonal psychotherapy (IPT)	$N = 113$ girls ages 12–17 with LOC eating and overweight/obesity	Treatment: 12 weekly, 90-min group sessions	Post-treatment: both groups experienced decreased BMI gain, body fat, depressive symptoms, anxiety, and LOC frequency	Tanofsky-Kraff et al. (2014, 2016, 2017) [63, 64, 65••]; Burke et al. (2017) [66]
		Control: health education group	1-year follow-up: greater reduction in LOC eating in IPT group; reduced percentage intake from snack-type foods in IPT group	
			3-year follow-up: greater decreases in BMIz among girls with high social-adjustment problems or anxiety in IPT group; greater likelihood of abstinence from LOC eating among girls of ethnic-racial minority in IPT group	
Family-based interpersonal psychotherapy (FB-IPT)	$N = 29$ youth ages 8–13 with LOC eating and overweight/obesity	Treatment: 12 weekly, 45-min parent-youth dyad sessions	Post-treatment: decreased depressive and anxiety symptoms; reduced odds of LOC eating in FB-IPT group	Shomaker et al. (2017) [67]
		Control: family-based health education	6-month follow-up: decreased disordered eating attitudes in FB-IPT group	
			1-year follow-up: decreased depressive symptoms in FB-IPT group	
Dialectic behavior therapy	$N = 45$ girls ages 13–17 with LOC eating or binge eating disorder	Treatment: 12 weekly, 90-min group sessions	Post-treatment: both groups experienced reduction in disordered eating cognitions, restraint, and negative affect	Mazzeo et al. (2013, 2016) [68, 69]
		Control: weight management group		

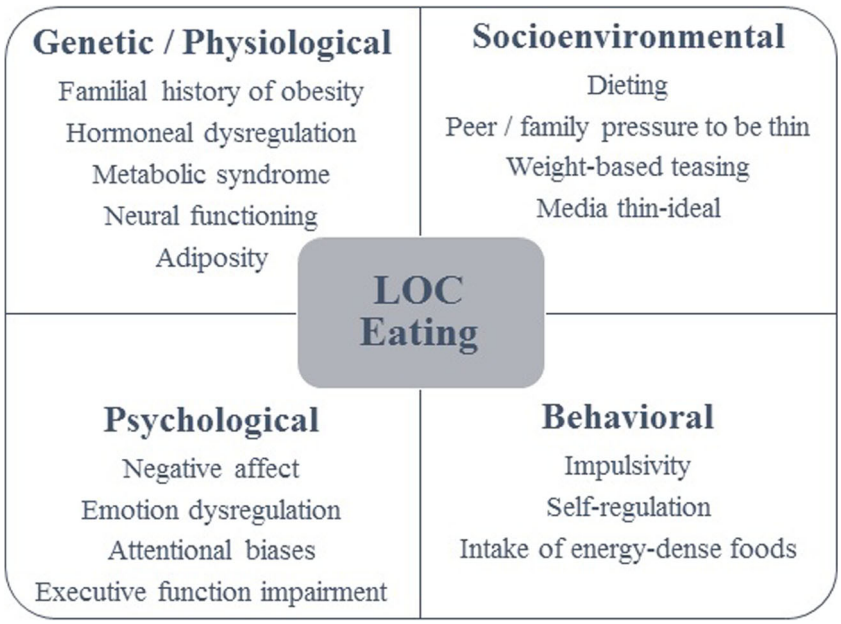

Fig. 1 Domain summary of factors related to pediatric loss-of-control eating

routinely screen for LOC eating (i.e., using brief screening questionnaires) as this could impact long-term adverse health outcomes. Finally, more focused targeting of constructs overlapping with LOC eating is critical for future research. As outlined throughout this review, various studies have indicated the importance of factors such as anxiety [30, 46], emotional eating [61], attentional bias [49, 51], and emotion regulation [44] in relation to LOC eating for adverse correlates or outcomes. As such, it is possible that focusing on LOC eating exclusively, without taking into consideration important exacerbating factors, may result in clinicians missing important treatment targets.

Conclusions

Given the difficulty in assessing what constitutes a large amount of food among youth due to heterogeneity of energy needs, LOC eating may be a key symptom to target binge eating among children and adolescents. Data further support that LOC eating is highly prevalent among youth with overweight and obesity [1••]. Therefore, understanding contributors to the risk and maintenance of LOC eating remains a priority among researchers. Studies continue to demonstrate a number of genetic, physiological, socioenvironmental, psychological, and behavioral links with LOC eating among youth, suggesting a complex etiology and course (see Fig. 1). Additionally, LOC eating has been shown to be predictive of long-term negative psychological and physiological consequences, including anxiety disorders, depression, substance use, self-harm, and obesity [15, 19, 59, 73]. However, results from studies examining various risk and maintenance factors for LOC eating are equivocal, and as a result, more focused targeting is required. It is possible that focusing on LOC eating exclusively, without taking into consideration important exacerbating factors, may result in clinicians missing important treatment targets.

Compliance with Ethical Standards

Conflict of Interest Meghan E. Byrne, Sarah LeMay-Russell, and Marian Tanofsky-Kraff declare they have no conflict of interest.

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

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